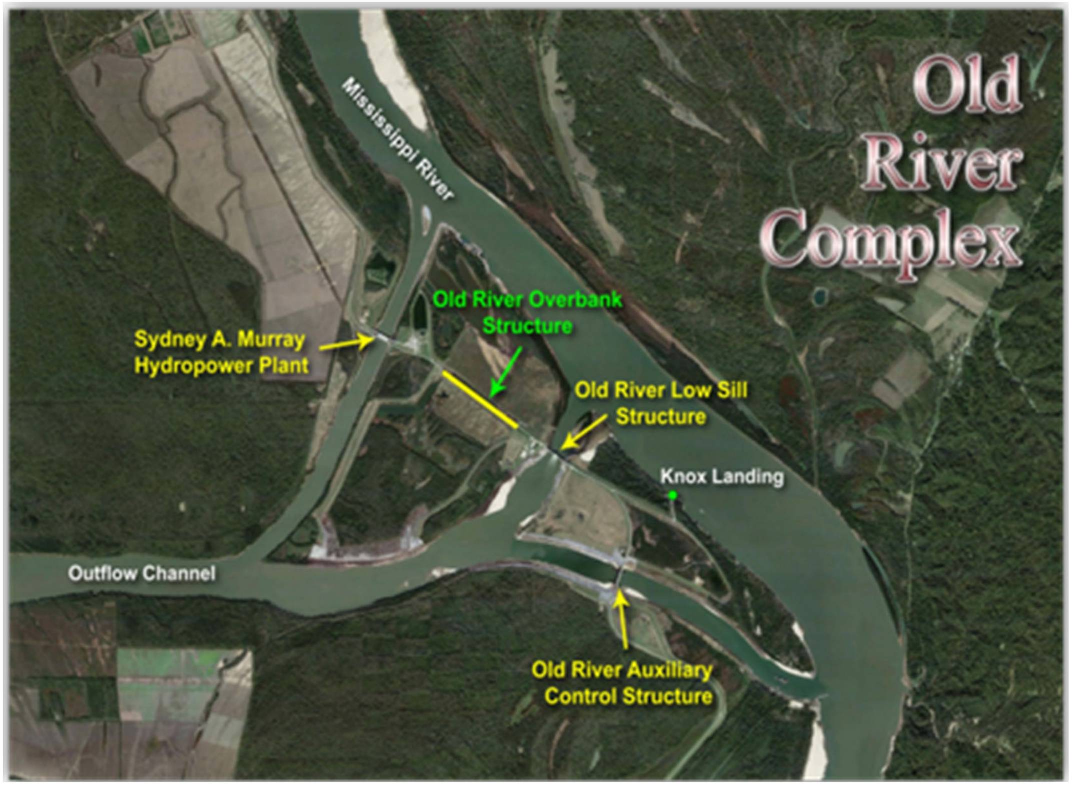
Atchafalaya River Basin – Old River Control Complex Environmental Flows Recommendations Workshop Summary



Old River Control Complex (ORCC) regulating flows between the Mississippi River and the Atchafalaya River, Louisiana.

Sustainable Rivers Program 2025

Abstract

This report describes recommendations for e-flows to benefit fish and crawfish, water quality, and forest health within the Atchafalaya Basin based on a workshop conducted on 8-9 April 2025 in Lafayette, LA.

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1 Sustainable Rivers Program

The Sustainable Rivers Program (SRP) is a national partnership between the U.S. Army Corps of Engineers (USACE) and The Nature Conservancy (TNC) to improve the health and life of rivers by changing operations of existing water management structures to restore and protect ecosystems, while maintaining or enhancing authorized uses and other project benefits (SRP 2021).

The Atchafalaya River (AR) was added to the SRP portfolio in 2020, followed by development of a list of stakeholders, evaluating process for stakeholder engagement, and identifying hydrologic, hydrodynamic, and habitat models and other tools to help identify ecological opportunities within the Atchafalaya River Basin (ARB).

Examples of accomplishments made by the AR team in Louisiana (LA) include identifying the Bayou Courtableau water control structure as having opportunities for reoperation to improve the downstream areas in the Henderson Water Management Unit (WMU) and in Lake Henderson and moving forward with SRP supported efforts to investigate potential operational changes at Old River Control Complex (ORCC) in FY 2023 (SRP 2023). It should be noted that the Old River Control Complex includes not only the Old River Control Structures (operated by the USACE), but also the Sydney A. Murray Hydropower Plant which is not owned or operated by the USACE. However, the hydro plant is obligated to operate in a manner that does not impact operation of the Old River Control Structures and operations between the Sydney A. Murray Hydropower Plant and USACE operators are coordinated. Although the intent of this effort was to make recommendations that fall within congressional authorization, if recommendations fall outside of congressional authorizations, they may require new authorizations prior to implementation. Also, it is acknowledged that any changed in operations at USACE-operated structures may impact operations at the hydropower plant and will need to be coordinated appropriately.

2 Summary of workshop flow-ecology recommendations

Recommendations for three ecological target groups were made during the ARB – ORCC Environmental Flows Recommendation Workshop conducted in April 2025. These target groups included fish and crawfish, water quality, and forest health. The workshop culminated with a collaboration to combine recommendations from each target group into a single unified set of environmental recommendations. All stage recommendations in this report refer to the AR stage as reported at the Atchafalaya River at Butte La Rose (BLR), LA, gage (U.S. Geological Survey - USGS 07381515) , and all gage readings are reported in feet (ft) in the vertical datum of NAVD88. Much research in the ARB has related inundation across the ARB to the stage at BLR, and so the BLR gage was used in the workshop as a consistent point of reference, as all stakeholders are familiar with the BLR gage (Alford and Walker, 2013). Although stage at the BLR gage is a common reference point within the ARB, throughout the workshop it became apparent that different stakeholders had different perspectives on how stage at BLR relates to other areas within the basin. Therefore, although particular stages at BLR were referenced as key to water exchange into and out of floodplain areas throughout the basin, these relationships will need to be confirmed and documented and could be the focus of future funding proposals.

The general recommendations of the fish and crawfish group include keeping AR stage at Butte La Rose between 12-17 ft during fish spawning season in the spring, pulsing water during low flow to improve habitat quality by increasing oxygen and pushing out stagnant water. Further, keeping the floodplain inundated until the end of June creates habitat connectivity, allows for fish to migrate slowly off the floodplain and gives crawfish ample time to burrow.

The general recommendation of the water quality group is implementation of “higher highs and lower lows.” This regime calls for more water to move through the system during wet years and less water to move through the system during dry years, as well as peak stages to be higher and minimum stages to be lower within a given water year. Implementation of this regime and the flow components outlined would provide flushing to remove stagnant waters, deliver nutrients, create conditions for proper drainage, and increase connectivity between the channel and the floodplain.

General recommendations for the forest health group include maintenance flows and recruitment flows. Maintenance years were designed to move water through the floodplain during seed germination for dispersal. The maintenance year is modeled as a wet year and includes a stage peak at 22 ft at BLR to increase channel and floodplain connectivity, capture fine sediment and provide sufficient flooding to eliminate species competing with baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*; Cypress/Tupelo; C/T). It also includes a decline below 12 ft between May 31 and November 30 to allow for head differential and promote drainage. Recruitment years were designed as a nuanced dry year to allow an opportunity for seedlings to grow. This is accomplished by keeping stage at or below 12 ft to keep inundation off the floodplain.

Due to time constraints in the workshop schedule and lack of consistency in flow recommendations across habitat groups, only one overall combined hydrograph for a wet year recommendation was created during the workshop (Figure 1). The flow components outlined in Table 1 provide benefits across all ecological target groups. The Early Spring Pulse creates a flushing pulse, benefiting water quality and fish and crawfish habitats as well as providing inundation for C/T seed dispersal. The High Short Flood provides inundation to the floodplain that allows for fish and crawfish nesting and spawning. It also provides sufficient inundation to aid in the reduction of hypoxic conditions. Further, the level of flooding benefits C/T, as flooding can be withstood by C/T but not by competing species. The Low Water Season Flush provides a pulse of fresh water to improve water quality in stagnant areas, which is beneficial to all ecological target groups.

Table 1. Recommendations for stage at USGS gage Butte La Rose (BLR; 07381515) from the combination of ecological target group wet year recommendations.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Early Spring Pulse	13-17	Dec 15 - Mar 1	7
High Short Flood	18-23	Mar 1 - May 31	10
Low Water Season flush	5-7	Sep 1 - Oct 15	5

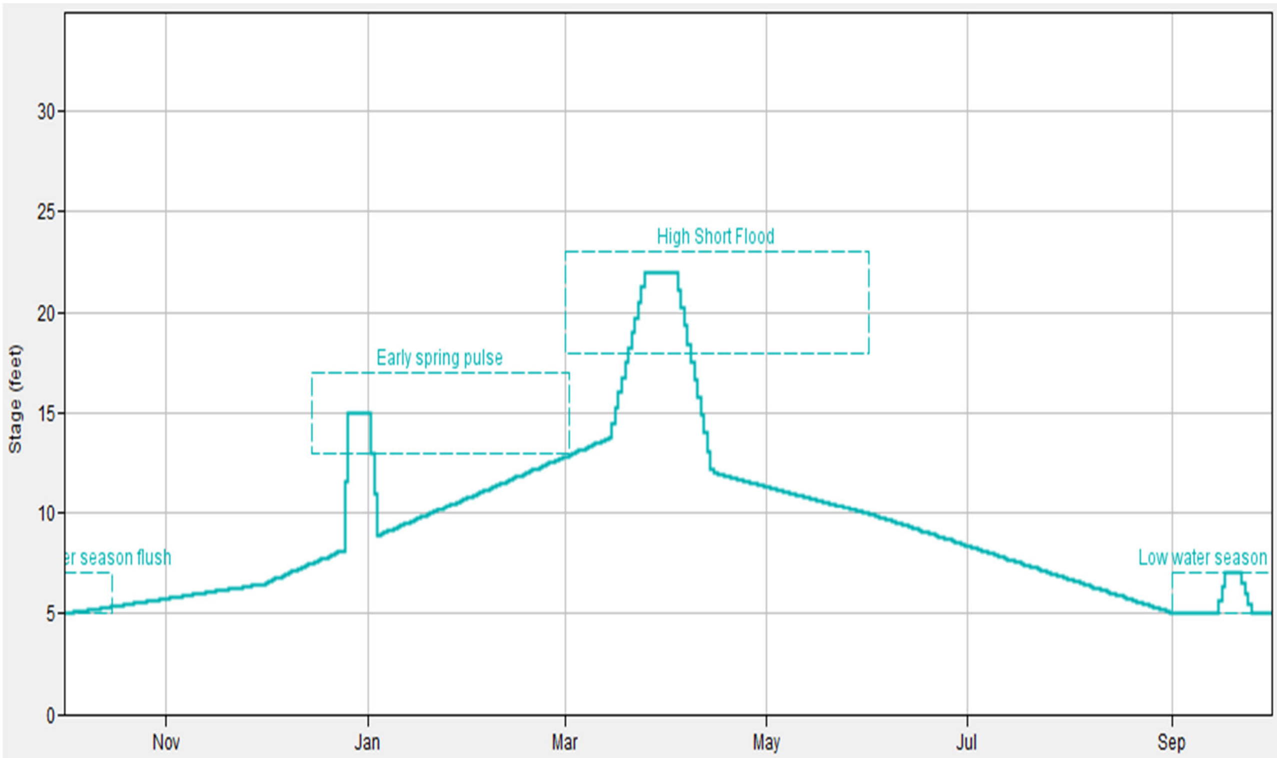

Figure 1. Unified hydrograph that considers recommendations from the fish and crawfish, forest health and water quality ecological target groups. Note that this is a wet year hydrograph using stage (feet) at USGS gage Butte La Rose (07381515).

3 Workshop goals and agenda

The goal of the workshop was to develop e-flow recommendations for the ORCC that could result in benefits to forest health, water quality (flow/exchange) and fish & crawfish habitats within the ARB. The team initiated conversations with ARB stakeholders during a virtual public information meeting conducted on 12 March 2025. The goal of this public information meeting was to introduce stakeholders to the Sustainable Rivers Program and the Atchafalaya ORCC project and to share ways that stakeholders could contribute to the environmental flows process.

The Virtual Public Information briefing was followed by an invitation-only technical workshop on 8-9 April 2025 held within the Atchafalaya Basin at the Louisiana Department of Wildlife and Fisheries (LDFW) building at 200 Dulles Drive, Lafayette, Louisiana 70506. The workshop was attended by 30 participants representing 20 different organizations and resulted in the development of environmental flow (e-flow) recommendations for the ORCC that could result in benefits to forest health, water quality, and fish & crawfish habitats within the ARB. The workshop successfully promoted collaboration and enhanced stakeholder relationships between USACE, TNC and ARB stakeholders. Workshop participants were extremely pleased and thankful to the USACE MVN/TNC Team for hosting the workshop and providing a forum to share ideas.

The workshop agenda was developed collaboratively by USACE, The Nature Conservancy, and Moffatt & Nichol and included the following introductory/orientation presentations:

a. Overview of the Sustainable Rivers Program (Jim Howe, TNC)
b. MR&T and Old River Control Complex operations (Dave Ramirez, USACE)
c. Atchafalaya Basin flow and ecology (Bryan Piazza, TNC)
d. Atchafalaya River Basin Model overview (Kevin Hanegan, Moffatt & Nichol)
e. Overview of Regime Prescription Tool (Heidi Mehl, TNC)
f. Flow data prepped for workshop (Colin Anderson, Moffatt & Nichol/Joe Baustian, TNC)

These plenary presentations oriented and prepared workshop participants for the breakout sessions that followed. The participants elected into one of three break-out groups, Forest Health, Water Quality, and Fish & Crawfish Habitat, based on their technical expertise, to determine what e-flows would improve conditions within the ARB. After a 75-minute break out session, the groups came together to report out their status to the larger group before breaking for the day. The following morning, the break-out groups reconvened for another 60 minutes to wrap up any remaining discussions before a final report out to the entire group of participants. The workshop concluded with a 90-minute plenary discussion of how these break-out group flow recommendations could be combined into an integrated e-flow recommendation. The attendance list, agenda, and plenary presentations are included in Appendix A, B, and C, respectively.

4 Basin characteristics and USACE operations

4.1 Basin characteristics and history of the Old River

The ARB is a critical wetland landscape supporting habitat for over 300 resident and migratory wildlife species and over 100 fish species. It is the only prograding riparian swamp deltaic system in the United States, encompassing roughly one-million acres of unique and valuable habitat. Further, it holds important cultural significance and supports the livelihood of Louisianans. As the basin has been anthropogenically altered through time, much of its valuable habitat has been lost. Of most significance to this workshop is the construction and operation of the ORCC.

The construction of multiple water control structures which are collectively referenced as the Old River Control Structure (ORCS) began in the mid-20th century. In the 1500s, the development of a meander in the Mississippi River (MR) allowed the Red River to flow into the MR channel and the AR to capture part of the flow of the MR as a higher-gradient path to the Gulf of Mexico (USACE 2009). By the 1950's, the flow into the AR had increased to approximately 30% of total flow and the avulsion of the MR into the AR became likely. As a result, the US Congress mandated construction of the first structure at ORCS to maintain the MR flow down the AR pathway at levels present in the 1950s. Flow to the AR is adjusted daily using the ORCS structures to equal 30% of the combined latitudinal flow of the MR + Red River. Construction at ORCS was initiated in 1958 to create the Low Sill Control Structure (completed in 1964) and Overbank Control Structure (completed in 1962), later supplemented by the Auxiliary Control Structure (completed in 1986) in response to near failure of the Low Sill structure in the 1973 flood. A navigation lock was also installed at Old River (completed in 1963) to aid vessel transfer between the MR and the Atchafalaya and Red Rivers. Additionally, the Sidney A. Murray Hydroelectric Plant was constructed by private interests (completed in 1990) upriver of the ORCS access channels and has been operated by private interests to generate hydropower (USACE 2009). Since initial construction of ORCS and subsequent ORCC management of the flow (and associated sediment) split between MR and AR has altered (reduced) flow volume and suspended sediment delivered to the MR channel further downstream and in adjacent floodplain areas (Allison et al. 2012).

4.1.1 Floodplain and channel modifications - Geomorphology

Over time, the AR has become a highly engineered system with a semi-natural hydrograph. The natural flow is disrupted by flood control management and system wide water management hydro-impediments from canal construction, roads, spoil banks and other developments such as the ORCC. Natural and anthropogenic deepening of the channel and other channel modifications have disrupted flow exchange and isolated floodplains from the river. Reduction in flow exchange has led to stagnation and backswamp hypoxia, negatively impacting water quality, forest health, and crawfish and fish populations.

The current flow split of the ORCC is managed daily for an annual total of 70/30 latitudinal flow and was mandated with little consideration for the ARB, the MR and Gulf Coast systems. Since the engineering of the flow split, higher flows below ORCC have been observed in part due to daily flow prescription. As a result of increased flows, more of the floodplain is inundated at an increased scale with respects to geography, duration, frequency and water level. These changes have decreased water quality, C/T habitat, and fish and crawfish production.

4.2 Operations and authorized purposes

The ORCS, authorized by the Flood Control Act of 1954, Public Law (PL) 780 under the 83rd Congress, is located approximately 35 miles south of Natchez, Mississippi, and 48 miles northwest of Baton Rouge, Louisiana, along the west bank of the MR between river miles 317 and 311 in Concordia Parish, Louisiana. The U.S. Army Corps of Engineers operates the ORCS in accordance with the authorizing law to maintain a stable relationship between the Mississippi and Atchafalaya Rivers. The ORCS is:

- Designed and operated to prevent capture of the MR by the AR
- Operated to maintain the distribution of flow and sediments between the Mississippi and Atchafalaya Rivers in approximately the same proportion as occurred naturally in 1950
- In 1950, the annual flow distribution below the latitude of Old River was approximately 70% in the MR and 30% in the AR (70/30 distribution)

5 Background literature

5.1 Kozak et al. (2016) e-flows recommendation summary

Kozak et al. (2016) uses the ARB as an example to develop a prescriptive approach for ecological flows in flow-augmented systems. The study found that there is much overlap between environmental flow recommendations and the current water management model. Flow-ecology relationships backed by literature were used to create flow recommendations for the basin that complement current restoration efforts and occur within the current mandated flow regime.

Flood season minimum flow values were set for all years to account for intra-annual flow variation and optimize hydrology to prevent bottomland hardwood establishment and favor C/T. This also benefits crawfish and fish species. Flood season for minimum flows occurred from January 5 to April 15 for dry years, was prolonged to May 15 for average years and June 1 for wet years.

Dry season maximum flow values were set for all years to allow for necessary drainage of C/T habitats, oxidation of accumulated organic debris, mitigation of invasive aquatic species, and support of C/T growth and regeneration. Maximum flows for the dry season were defined as June 15 to October 31 for dry years, shortening to October 15 for average and wet years.

A spring pulse, designed to generate sufficient overbank to flush hypoxic water and deliver sediment and nutrients to C/T swamps, was modeled during wet and average years between March 15 and May 31. Dry years were intended to coincide with natural drought occurrences and designed to benefit C/T regeneration.

5.2 Moffatt-Nichol modeling report - Key findings and summary

The Moffatt & Nichol ARB model was originally developed for the National Audubon Society in 2012 as a planning tool for evaluating restoration and management initiatives (Moffatt & Nichol 2012) and was made available as a planning tool for restorative efforts in the basin. The model was developed as an unstructured flexible mesh that encompassed the entire Atchafalaya system from Simmesport, Louisiana to offshore, was calibrated to the 2011 AR flood and was validated using the subsequent low flow period in fall 2011. Subsequently, Moffatt & Nichol was contracted by The Nature Conservancy to update the existing ARB model specifically with regards to overbanking, backwater inundation dynamics, and simulation of establishment, regeneration, and survival of C/T swamp habitat (Moffatt & Nichol 2024). The environmental flow model runs based on the Kozak et al. (2016) e-flow recommendations for C/T establishment showed a reduced area of potential establishment (>0%), and increased areas of probable establishment (>50%) and high probable establishment (>80%). The runs show an overall decrease across the basin in extent of potential C/T establishment, but an increase in the probability of establishment in areas where establishment is initially high. Total maximum potential establishment area remains relatively unchanged, but likelihood of establishment increases. Impacts from e-flows on germination showed benefit from dry years. However, dry years negatively impacted recently germinated seedlings and were only recommended to be used following years where germination was not favorable. Wet years are beneficial to germination and flooding competition, and have negligible impacts to recently germinated seedlings, regardless of conditions in preceding years. The ideal e-flow recommendation is comprised of an average flow year with an extended dry period followed by years with brief but extreme spring flood events.

6 Ecological target group issues

Each ecological target group has a unique set of issues that are summarized in the following sections. These issues are summarized by meeting notes taken during breakout group sessions. Many of these group members are representatives of NGOs, agencies, and scientific institutions. Information in the meeting notes is not necessarily backed by USACE principles.

6.1 Fish and crawfish

It is important to identify which water levels and durations of a given water level are critical to spawning and survival. Sheet flow occurs when AR stage at BLR reaches 16-17 ft. This level of stage is necessary as water begins to over top spoil banks and fish are able to migrate onto the floodplain. It is recommended that longer periods of sheet flow are needed.

The rate at which water drains out of the floodplain impacts fish and crawfish. Rapid decrease in water levels results in fish and crawfish deaths. Fish do not have time to migrate out of the wetlands and crawfish do not have sufficient time to harden and burrow into the ground. Conversely, the rate at which water enters the floodplain is recognized as a potential issue by some members of the ecological target group but not agreed upon by all.

Stagnant anoxic water throughout the basin, particularly in the northern area, is not suitable for fish and crawfish. Many of these areas are permanently inundated and do not receive sediment-laden water from overbanking even as water levels increase due to spoil bank height. Further, the potential settlement of sediment onto these spoil banks, rather than distribution into the floodplain, is also of concern. The need to identify an agreed upon water level that is sufficient enough to overtop spoil banks and dissipate anoxic waters, commonly thought to be 16-17 ft at Butte La Rose, is emphasized by the fish and crawfish ecological target group.

Variation of water levels, both intra-annually and interannually, and timing of inundation are other factors to be considered. Sufficient water level in the floodplain for fish and crawfish is dependent upon the timing of inundation occurring in the winter and spring. Annual variability, measured by the occurrence of wet, dry, and average years, is necessary to increase fish productivity, as variability was present before the engineering of the basin. Further, duration of inundation needs to be long enough for nest building in preparation of spawning. The fish and crawfish group recommended that water needs to enter the floodplain early in the water year and remain on the floodplain for a prolonged period of time to avoid fish and crawfish kills. Of emphasis, AR stage needs to rise to or above 16 ft at Butte La Rose for roughly 2 weeks to overtop the spoil banks, and water should not be held at 14 ft for longer than one week, as this level is detrimental to water quality.

6.2 Water quality

The water quality ecological target group has identified the need for “higher highs and lower lows.” This issue pertains to the need for increases in maximum stages and decreases in minimum stages within a water year. The implementation of higher highs and lower lows would help address many of the issues in the basin identified by the water quality group. These include lack of main and secondary channel floodplain connectivity, drainage, and oxygen and nutrients in the floodplain waters.

The water quality group also identified a need for specific variations, durations and timing of flooding. Fluctuations in stage that mimic the natural flow regime and generally benefit water quality are not occurring. The lowering of stages sooner in the water year than what is already occurring is identified as necessary to improve drainage.

Other issues identified by the water quality group included contaminated runoff, the need for sediment in the northern part of the basin, and the increase of sediment in the southern part of the basin. Landowner practices, water rights, and cultural issues were also stated as problems, however, these are not within the scope of this workshop.

6.3 Forest health

Much of the C/T in the ARB is declining rapidly, with only small areas of healthy forest remaining compared to what once was present. The forest health group identified that habitat south of Interstate-10 to Bayou Sorrel consists of fading Bottomland Hardwood Forest (BLH) and struggling C/T that is converting to open water. This is largely due to permanent inundation creating hypoxic conditions. Additionally, the competition between BLH and C/T and the need to flood BLH to favor C/T is controversial.

Similar to the concern of the water quality group, the forest health group notes the lack of sediment in the lower third of the basin as an issue. The lack of sediment has led to decreases in elevation and the reduction of elevation variance that is needed to support healthy C/T and promote drainage. Connectivity between the channel and backwater areas is also needed to deliver necessary sediment, particularly fines, and nutrient rich water.

Overarchingly, the forest health group identifies the basin as too wet. Sufficient drainage is needed through Wax Lake Outlet and the AR for the C/T system to survive. Historically, the flow split was significantly lower to the AR and the changes to flow in the channel have led to negative impacts on Atchafalaya Basin.

The main issue for forest health, prevalent among all target groups, is the lack of hydrologic connection. Sheet flow is not occurring due to roads and spoil banks. Tidal flow, which also occurred historically, is prevented by lack of drainage. The natural water regimes that provided benefits to the C/T are disrupted.

7 Summary of the Hydrologic Engineering Center Regime Prescription Tool (HEC-RPT) and breakout group recommendations

HEC-RPT is a software program created to draft and depict e-flow recommendations (Hickey et al. 2015). It is used to help document river management discussions among scientists, engineers, water managers, local authorities, and other experts. HEC-RPT helps organize, synthesize, and visualize ideas and communicate specific hydrograph recommendations in real-time. It is not intended to perform quantitative analyses, but recommendations may be exported to other software for analysis.

The basic structure of HEC-RPT consists of three inputs— systems, states and flow components. Systems are subjects of focus within the scope of the recommendations that are made such as ecological focus, river management objective, river location, or river reach. States are hydrologic conditions such as wet, dry, or average. Flow components are individual recommendations that contribute to the overall e-flow recommendation such as low flow, pulse flow, and flood pulse.

For this workshop, RPT systems were made for fish, water quality, and forest health (in alignment with the ecological target groups). States were defined for wet, average and dry conditions and past water years were assigned to a particular state. Flow components formulated by the ecological target groups were entered into HEC-RPT per system and state during the workshop such that participants could visualize the flow recommendations, compare recommended and historical conditions, and work together to refine recommendations. Flow components are outlined in section 7.1-7.3.

Initial recommendations were made considering AR stage (ft NAVD 88) at BLR for the purposes of this workshop and ease of communication among ARB experts. As stated earlier, ft at BLR is a common metric among ARB stakeholders and experts, with a stage of 12 ft at BLR being an agreed upon metric for overbanking in the basin (Alford and Walker 2013). Once breakout session recommendations for each ecological target were completed, recommendations were converted to discharge (cubic ft per second, cfs) at Simmesport (Atchafalaya River at Simmesport, LA – 07381490), using the rating curve shown in Figure 2. Recommendations of the three ecological target groups for wet, average, and dry conditions are shown in figures 3-11. The basis for each hydrograph was created based on flows in Kozak et al. (2016) and flow components were added as described in tables 2-9.

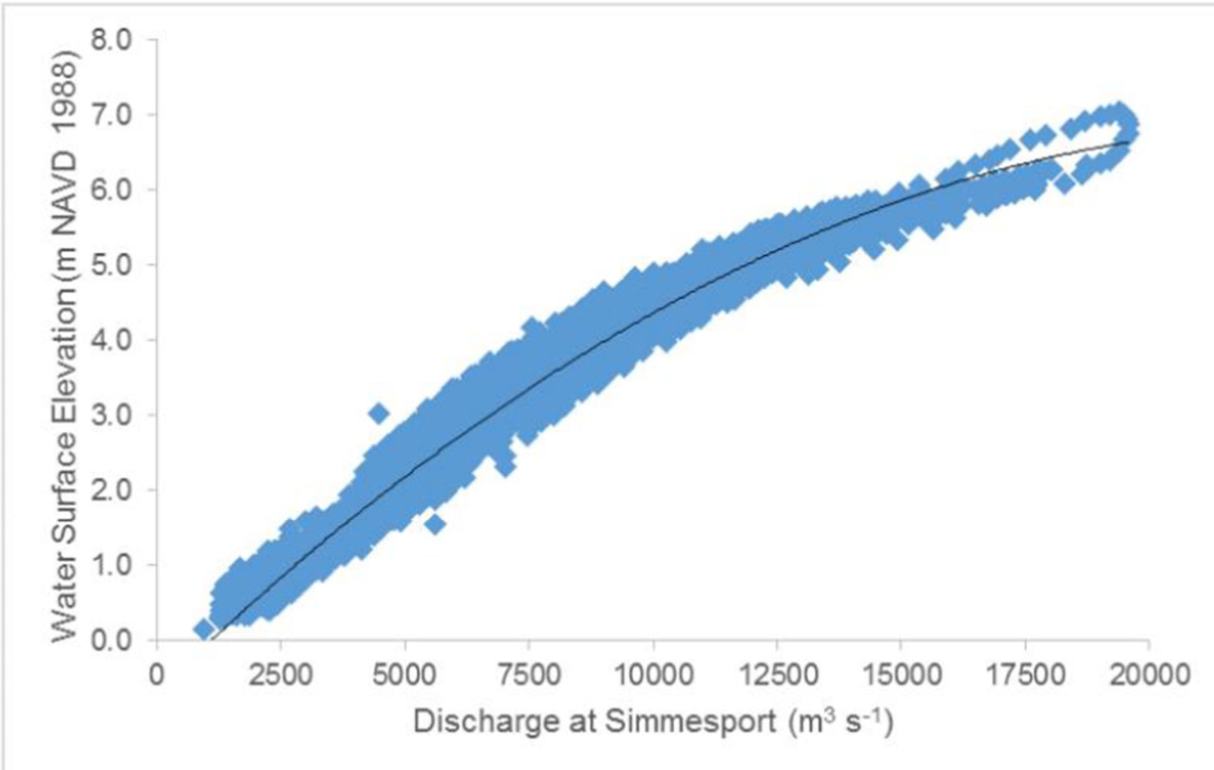

Figure 2. Relationship used to convert AR stage at Butte La Rose to discharge at Simmesport (Kozak et al. 2016).

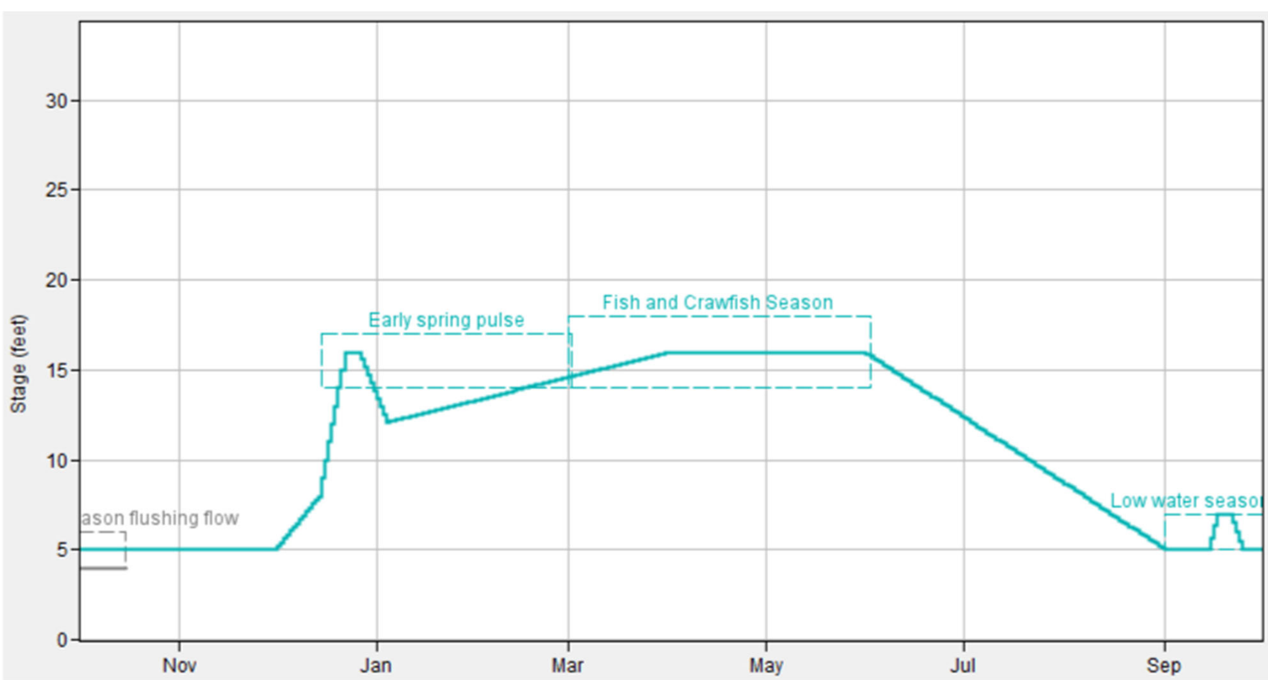

Figure 3. Wet year recommendation made by the fish and crawfish ecological target group.

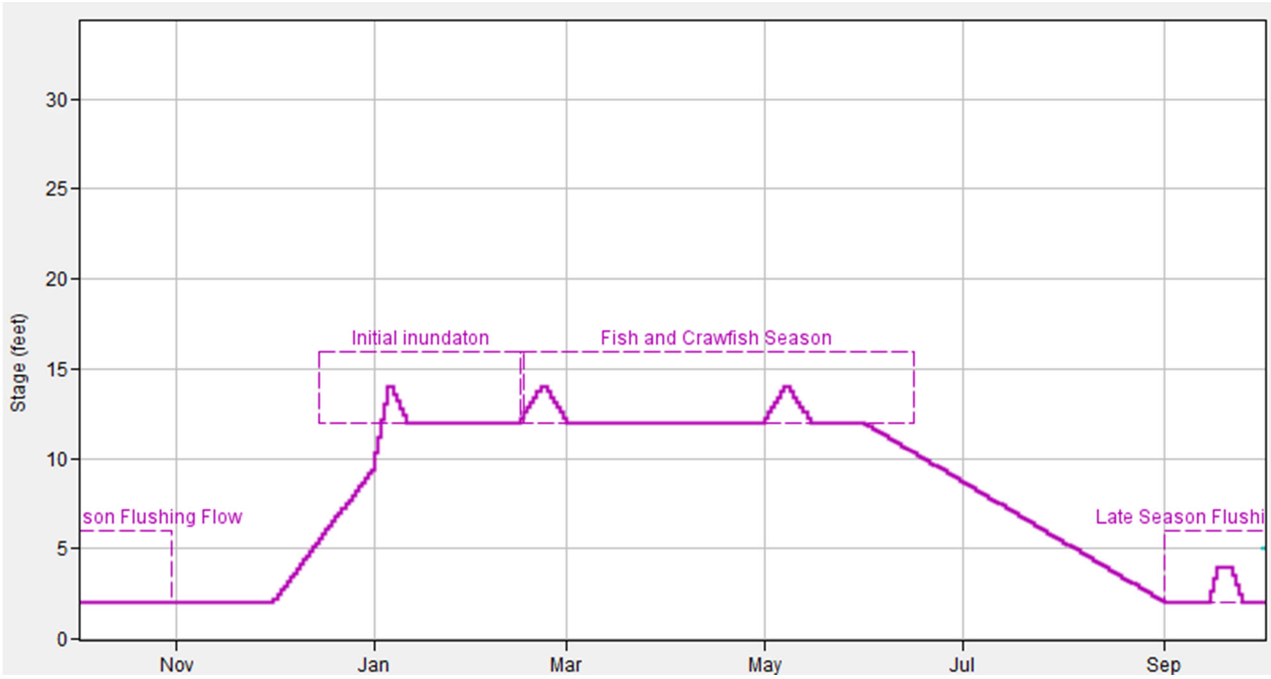

Figure 4. Dry year recommendation made by the fish and crawfish ecological target group.

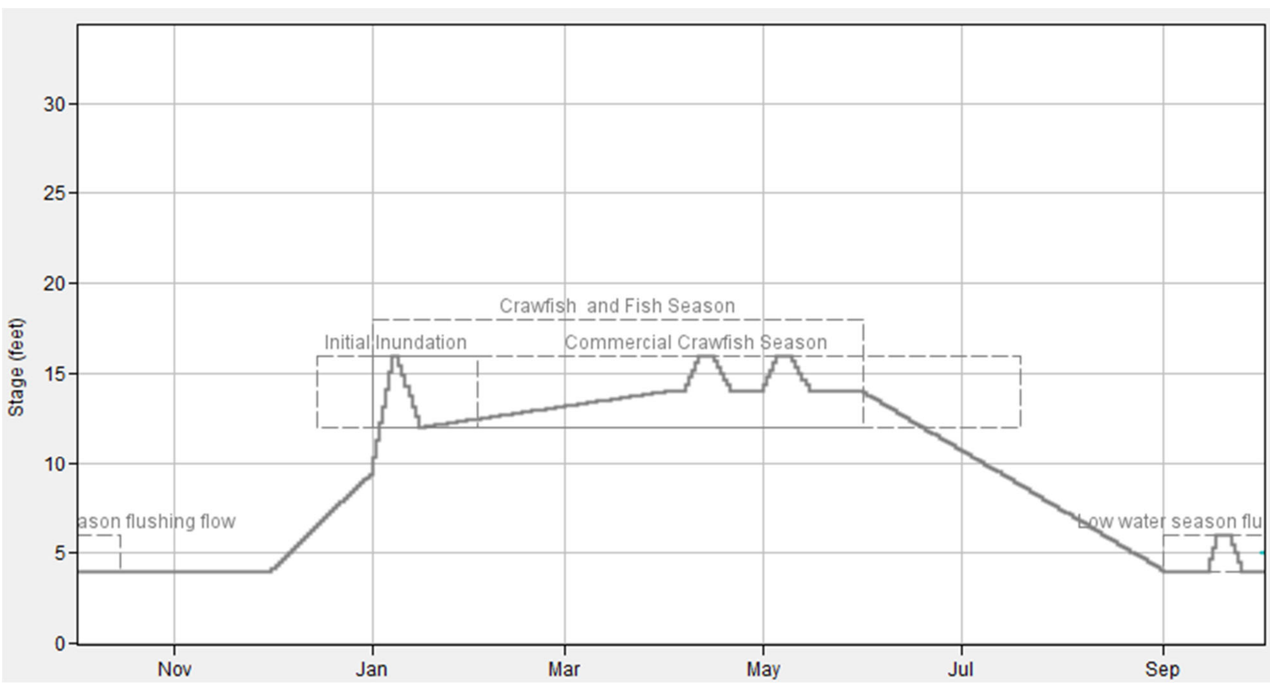

Figure 5. Average year recommendation made by the fish and crawfish ecological target group.

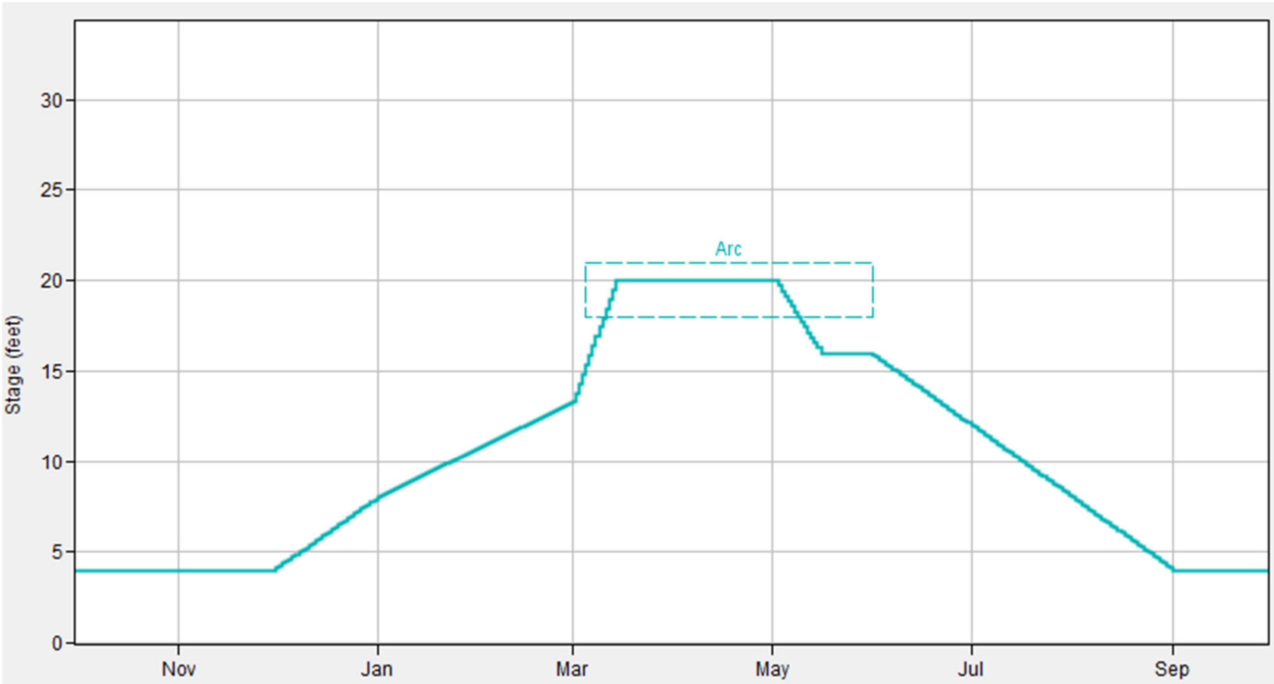

Figure 6. Wet year recommendation made by the water quality ecological target group.

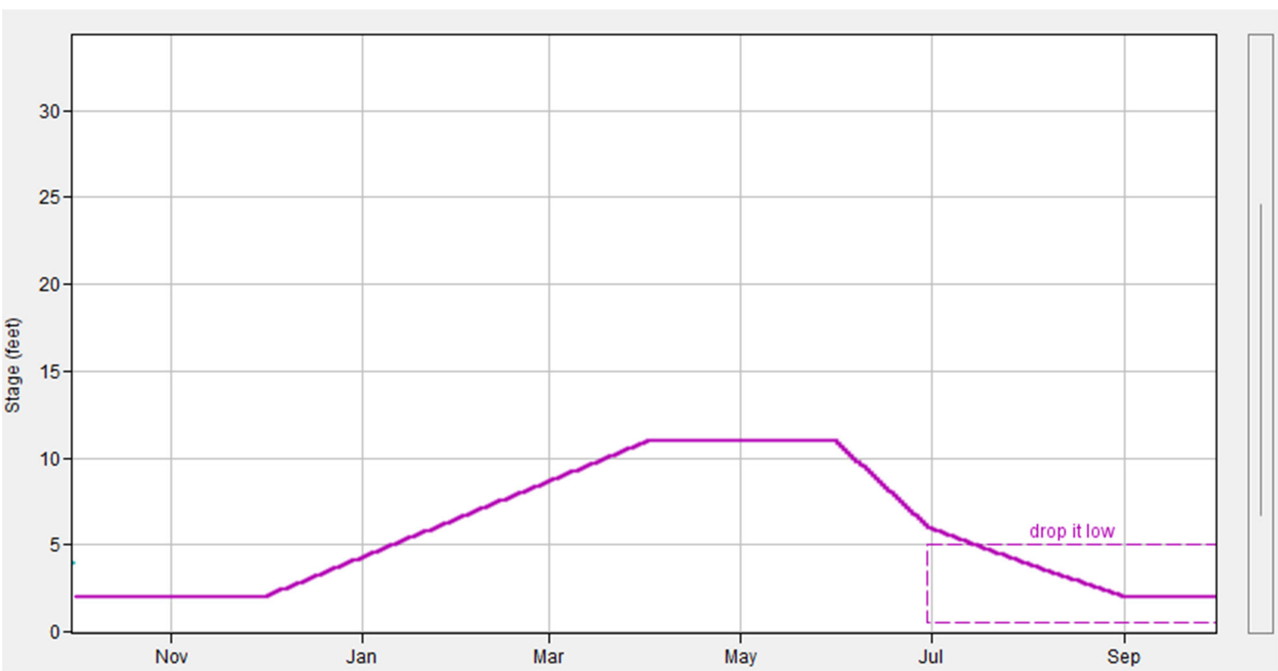

Figure 7. Dry year recommendation made by the water quality ecological target group.

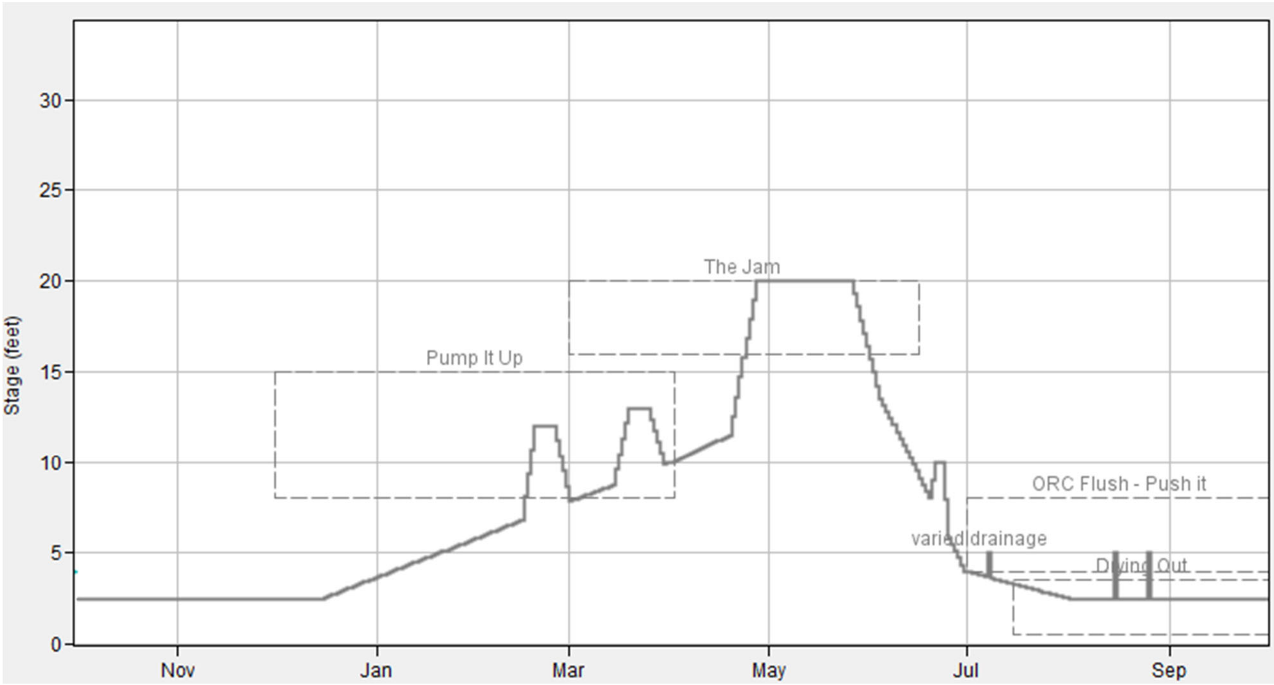

Figure 8. Average year recommendation made by the water quality ecological target group.

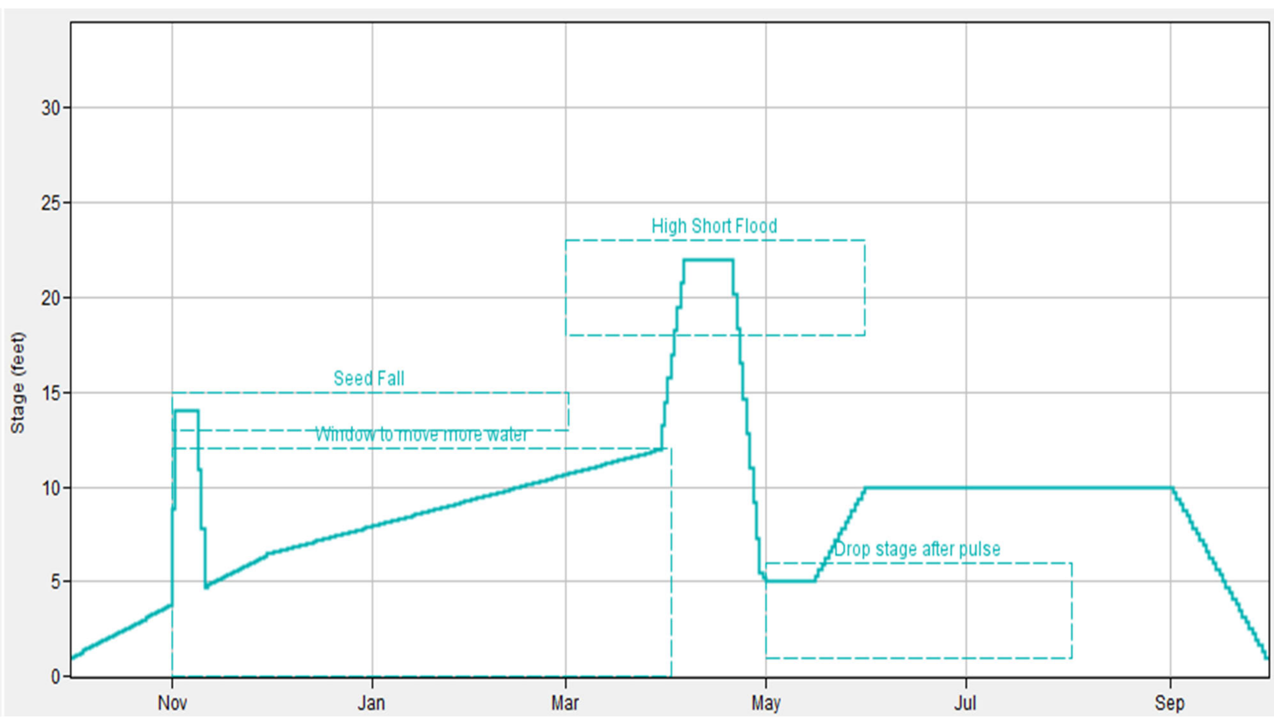

Figure 9. Wet year recommendation made by the forest health ecological target group.

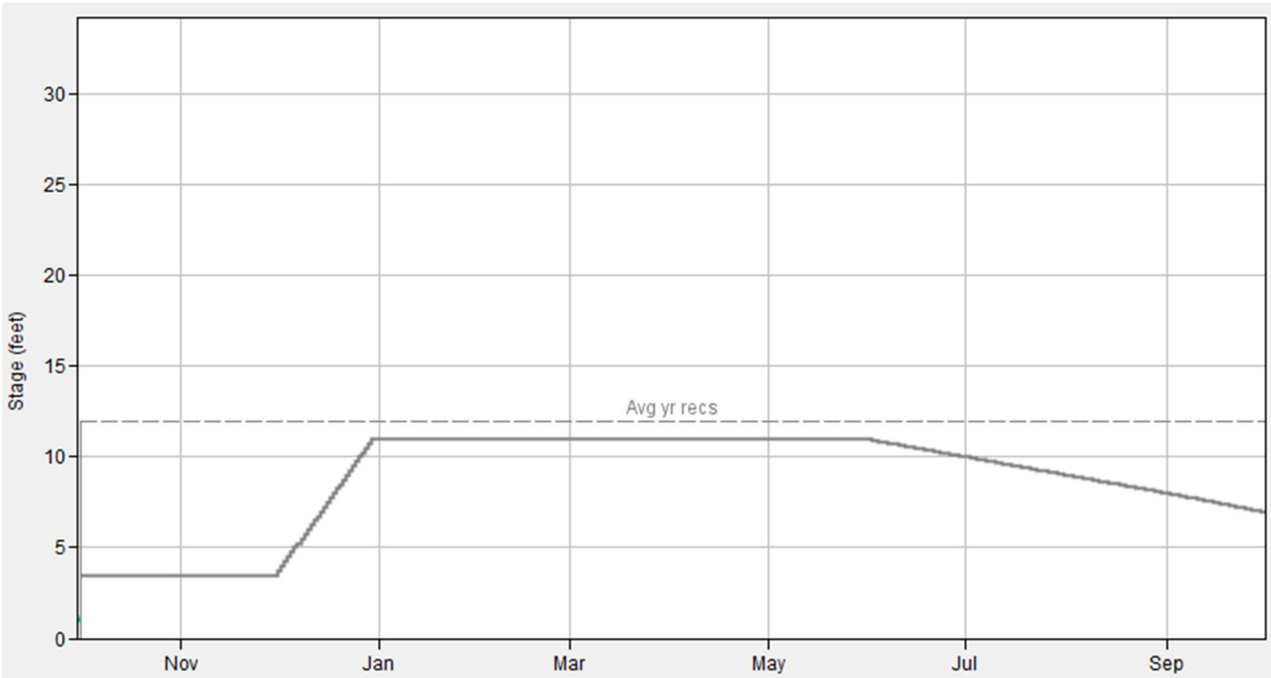

Figure 10. Average year recommendation made by the forest health ecological target group.

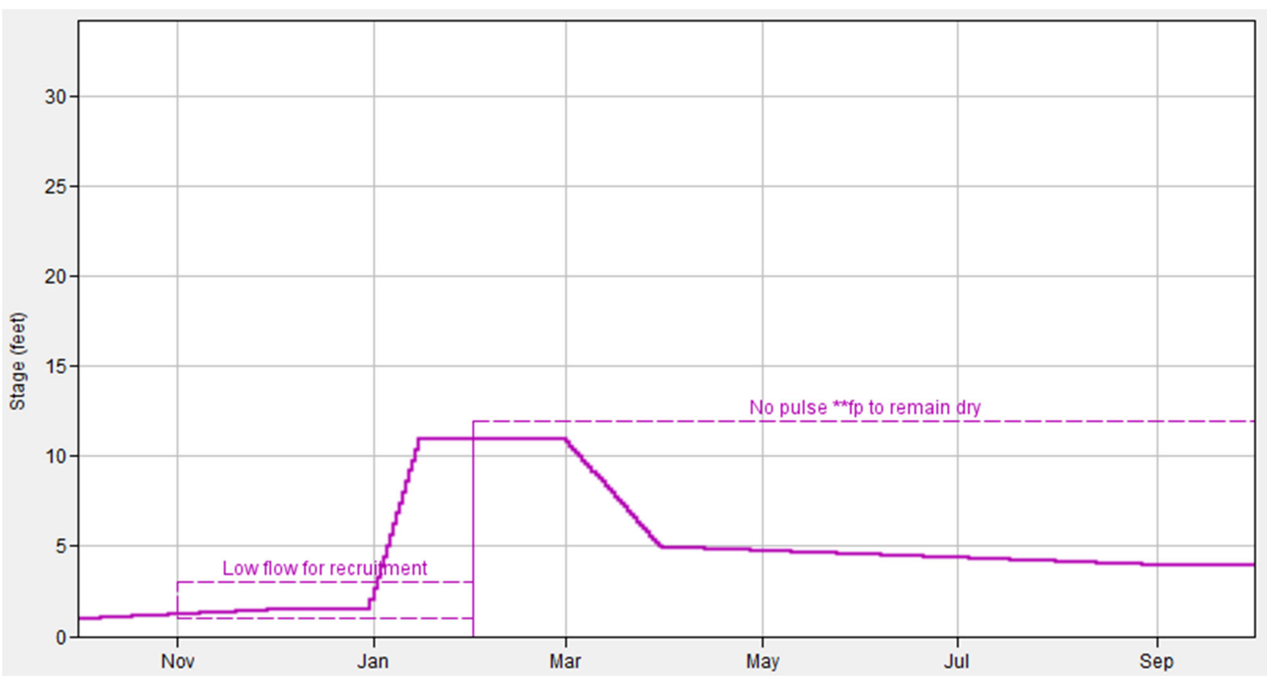

Figure 11. Dry year recommendation made by the forest health ecological target group.

The intent of this workshop was to stay within the congressionally mandated 70/30 flow split, but recommendations that deviated from that split may have also been captured. The USACE's Lower Mississippi River Comprehensive Management Study (LMRCMS) may be evaluating changes outside of the authorized flow split, and recommendations from this workshop could benefit those efforts. It is acknowledged that operational changes to ORCS may require Congressional authorization and any operational changes will require coordination with the privately owned and operated hydropower plant.

Outcomes of the workshop recommendations were tracked using the volume tracking feature of HEC-RPT. This is a feature that allows users to compare the annual or water year volume of water in their e-flow recommendation with the annual or water year volume of water in the imported series. This is presented as a percentage in the HEC-RPT interface, showing the percentage of actual historical flow that the e-flow recommendation would require to implement. For the purposes of this workshop, the volume of the e-flow series was compared to volume at Simmesport, Louisiana. This comparison allowed for real-time assessment of the percentage of river flow necessary to implement the flow recommendations.

To use volume tracking, the e-flow recommendation series must be converted from stage to flow. The initial recommendations created in stage (ft at BLR) were converted to flow (cfs) at the Simmesport gage using the rating curve in Figure 2. Conversions were done during the workshop in part to check feasibility of the recommendations created.

For the water quality target group, volume tracking projected that e-flow recommendations required 83% of historical volumes for wet years, 83% for dry years, and 69% for average years. For the forest health target group flow recommendations required 73% for wet years, 68% for dry years, and 88% for average years. For the fish and crawfish target group flow recommendations required 95% for wet years, 93% for dry years, and 95% for average years.

7.1 Fish and crawfish group (Quenton Fontenot, Justin Kozak, Josh Carson)

The general recommendations of the fish and crawfish group include keeping stage between 12-17 ft at BLR during spring spawning season, pulse water during low flow to increase oxygen and push out stagnant water, and keep the floodplain inundated until the end of June to allow for fish to migrate and for crawfish to burrow. Specific date and stage ranges for wet, average, and dry years are outlined in tables 2, 3, and 4.

There was a suggestion to raise water at 0.3-0.4 ft/day and decrease water more slowly at 0.1 ft/day. More work is needed to develop this into a recommendation because of inherent complexities with geography.

Wet Year

Table 2. Wet year recommendations for the fish and crawfish ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Early Spring Pulse	14-17	Dec 15 - Mar 1	5
Fish/crawfish season	*16+	Mar 1 - Jun 1	14 minimum
Low water season flush	5-7	Sep 1 - Oct 15	5

*Not to hold at 14 ft for more than 1 week.

Average Year

Table 3. Average year recommendations for the fish and crawfish ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Initial inundation	12-16	Dec 15 - Feb 1	2
Initial inundation continued	*12+	Dec 15 - Mar 1	
Fish/crawfish season	**16+	Mar 1 - Jun 1	14 minimum
Low water season flush	4-6	Sep 1 - Oct 15	5

*To be implemented after the initial inundation until fish/crawfish season

** Not to hold at 14 ft for more than 1 week.

Dry Year

Table 4. Dry year recommendations for the fish and crawfish ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Initial inundation	12-16	Dec 15 - Feb 15	2
Fish/crawfish season (1)	*12-16	Mar 1 - Jun 1	2
Fish/crawfish season (2)	*12-16	Mar 1 - Jun 1	2
Low water season flush	4-6	Sep 15 - Oct 15	5

*Total of two pulses; Not to hold at 14 ft for more than 1 week.

7.2 Water quality (Colin Anderson, Joe Baustian, Jill Andrew)

The general recommendation for the water quality group is the implementation of "higher highs and lower lows." This regime calls for more water to move through the system during wet years and less water to move through the system during dry years, as well as peak stages to be higher and minimum stages to be lower within a given water year. The implementation of this regime and the flow components outlined in tables 5-7 would provide flushing of stagnant waters, deliver nutrients, create conditions for proper drainage, and increase connectivity between the channel and the floodplain. Specific date and stage ranges for each wet, average, and dry years are outlined in tables 5, 6, and 7.

<u>Wet Year</u>

Table 5. Wet year recommendations for the water quality ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Higher highs	18-21	Mar 5 - May 31	50

<u>Average</u>

Table 6. Average year recommendations for the water quality ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Early season pulses (1)	8-15	Dec 1 - Apr 1	7
Early season pulses (2)	8-15	Dec 1 - Apr 1	7
Flushing flood pulse	16-20*	Mar 1 - Jun 15	30
Varied drainage	5-15	Jun 7 - Aug 1	3
Flush input channels	4-8	Jul 1 - Jan 1	1**
Drying out	0.5-3.5	Jul 15 - Jan 1	
Drying out pulse	6	Jul 15 - Jan 1	3

* Not to hold at 14 ft for more than 1 week.

**To occur three times across the date range

<u>Dry Year</u>

Table 7. Dry year recommendations for the water quality ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Lower lows	0.5-5	Jun 30 - Oct 31	
Low flow increase	11	Apr 1 - May 30	60

7.3 Forest health (Patrick Smith, Kristina Leggas, Laura Carnes)

General recommendations for the forest health group include maintenance flows and recruitment flows. Maintenance years were designed to move water through the floodplain during seed germination for dispersal. The maintenance year is modeled as a wet year and includes a stage peak at 22 ft at BLR to increase channel and floodplain connectivity, capture fine sediment, and provide sufficient flooding to discourage species competing with C/T. It also includes a decline below 12 ft at BLR between May 31 and November 30 to allow for head differential and promote drainage. The rate of decline is not of concern. The maintenance flow is recommended to occur once every five years. Recruitment years were designed as a nuanced dry year to allow an opportunity for seedlings to grow. This is accomplished by keeping stage at or below 12 ft at BLR to keep inundation off the floodplain and would ideally occur following the recruitment flow for 3 consecutive years once every 5 years. Specific date and stage ranges for wet, average, and dry years are outlined in tables 8 and 9.

Wet Year*

Table 8. Wet year recommendations for the forest health ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Seed fall pulse	13-15	Nov 30- Mar 1	~7
High short flood	18-22	Mar 1- May 30	~10
Drop stage	<12	by Apr 30	Remainder of WY

*Recommended to occur every 5 years.

Average Year

The average year recommendation for forest health is ideally similar to a dry year (see Figure 11 and Table 9) with the opportunity to move more water through the ARB than during a dry year.

Dry Year**

Table 9. Dry year recommendations for the forest health ecological target group.

Flow Component	Stage Range (ft, NAVD 88 at BLR)	Date Range	Duration of Peak (days)
Recruitment low flow	1-3	Nov 1- Jan 31	
No pulse	<12	Mar 1- May 30	
Low flow increase	11	Jan 15- Mar 1	55

**Recommended to occur for 3 consecutive years on a 5-year cycle following wet year.

8 Unification process

The flow recommendations unification process consisted of the three ecological target groups overlaying the wet, average, and dry recommendations and determining areas of overlap (Figure 1). This included identifying conflicting recommendations and attempting to compromise.

Commonalities that were immediately agreed upon among target groups included a small flushing pulse in the late summer/early fall to prevent stagnation of low-oxygen water, followed by a slow decline of stage to drain water off the floodplain. The forest health group had initially modeled a more rapid decline in stage, however, rapid declines in stage lead to fish and crawfish kills. This component of the hydrograph was updated as it was determined that the rate at which water levels decreased was not critical to forest health.

The drawdown period was an area of conflict between the forest health and fish and crawfish target group. The forest health ecological target group recommended that drawdown below overbanking stage (12 ft BLR) occur by the beginning of June to allow for C/T productivity. July was an agreeable month to begin drawdown as it allows time for fish to migrate off the floodplain and for crawfish to burrow. Further, the forest health group initially recommended that drawdown to below 6 ft at BLR to create a head differential and allow drainage of the floodplain. During the unification process, members of the forest health group agreed to a higher stage during the drawdown period, as long as stages were below 12 ft at BLR to allow for drainage.

All ecological target groups agreed it is beneficial to embrace natural variability. While not completely coinciding with the forest health recommendations and the need for dry conditions to promote regeneration, it was agreed that flood pulses may still occur in dry years. Further, the ecological target groups agree that many of the pulses, including the larger winter flood pulse, could occur flexibly within the date range outlined in tables 2-9 and that it is possible for a double pulse to occur beneficially. Varied timing of flood pulses has multiple benefits such as supporting varied spawning time between fish species and reducing stagnation. Overarchingly, the main objective captured with this flexibility is intra- and interannual variation.

9 Next steps in the SRP process

The ARB environmental flows workshop concluded with a discussion of next steps and recommendations for a follow-up workshop. E-flow recommendations reported here will be used to update the ARB model and determine the feasibility and potential outcomes of proposed flow regimes. USACE MVN has submitted a new proposal requesting FY 26 SRP funding to continue coordination with ARB stakeholders, host another workshop, and test recommendations from the initial e-flows workshop. Further, the 2026 proposal includes plans for additional data collection to verify water elevation triggers for flow into and out of backwater areas, and to fill in spatial gaps in data within the basin.

Topics for the next workshop, if funding is provided, will include determining zones and varying management of these zones based on different ecological targets, sediment split, and basin improvements made with management projects.

10 Literature cited

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Allison, M.A., Demas, C.R., Ebersole, B.A., Kleiss, B.A., Little, C.D., Meselhe, E.A., Powell, N.J., Pratt, T.C., and Vosburg, B.M., 2012. A water and sediment budget for the lower Mississippi-Atchafalaya River in flood years 2008-2010: Implications for sediment discharge to the oceans and coastal restoration in Louisiana. J. Hydrol., 432, 84-97. DOI: 10.1016/j.jhydrol.2012.02.020.

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Moffatt & Nichol. 2012. A hydrodynamic model of the Atchafalaya Basin: Evaluating restoration alternatives phase 2. Baton Rouge, LA: prepared for the National Audubon Society.

Moffatt & Nichol. 2024. Modeling Report: Sustainable Rivers Program: Atchafalaya Basin model update. Baton Rouge, LA: prepared for The Nature Conservancy.

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Sustainable Rivers Program. 2023. In Progress Review: FY2022. Prepared for U.S. Army Corp of Engineers, The Nature Conservancy, and other organizations involved with Sustainable Rivers.

U.S. Army Corps of Engineers, 2009. Old River Control brochure. New Orleans District Public Affairs Office.

Appendix A: Attendance list

F = Breakout facilitator

R = Ran RPT software in breakout group

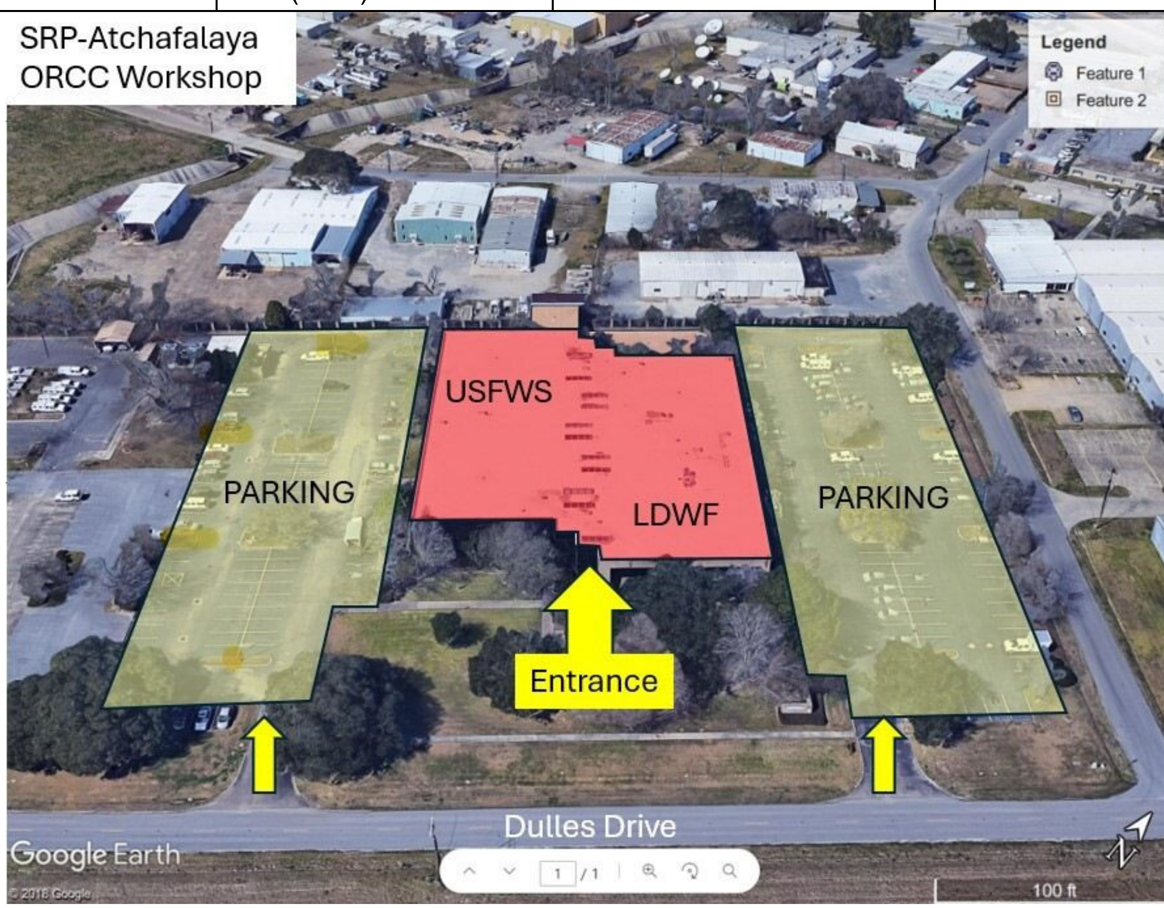
		Alphabetized by first name		Forest Health	Water Quality	Fish & Crawfish
8-Apr	9-Apr	Name	Affiliation			
Y	N	Andy Nyman	Louisiana State University (LSU)	A	B	
Y	Y	Ann Hijuelos	USACE	A	B	C
Y	Y	Arthur Hebert	LDWF	A		
Y	Y	Beth Middleton	USGS	A		
Y	Y	Brac Salyers	LDWF			C
Y	Y	Bryan Piazza	TNC	A	B	C
Y	Y	Cathy Breaux	U.S. Fish and Wildlife Service (USFWS)	A		
Y	Y	Chi Lu	Moffatt & Nichol		B	
Y	Y	Chris Kees	LSU	A		
Y	Y	Chris Macaluso	Theodore Roosevelt Conservation P'ship			C
Y	Y	Cindy Cutrera	Port of Morgan City		B	
Y	Y	Colin Anderson [F]	Moffatt & Nichol		B	
Y	Y	Dan Kroes	USGS		B	
Y	N	Dave Ramirez	USACE		B	
Y	Y	David Castellanos	USFWS			C
Y	Y	Dean Wilson	Atchafalaya Basinkeeper	A	B	C
Y	N	Denise Reed	Royal Engineering	A	B	
Y	Y	Don Haydel	Atchafalaya Basin Program		B	
Y	Y	Ehab Mesehle	Tulane University		B	
N	N	Gavin Stevens	USACE			
Y	Y	Heidi Mehl	TNC	A	B	C
Y	Y	Jill Andrew	TNC		B	
Y	Y	Jim Bergan	Delta Land Services	A		
Y	Y	Jim Howe	TNC	A	B	C
Y	Y	Joe Baustian [R]	TNC		B	
Y	Y	John Remo	Southern Illinois University		B	
Y	Y	Jonathan Hird	Moffatt & Nichol	A	B	
Y	Y	Josh Carson	USACE			C
Y	Y	Justin Kozak [R]	TNC			C
Y	Y	Justin Lemoine	Atchafalaya Natural Heritage Area	A		
Y	Y	Kevin Hanegan	Moffatt & Nichol	A		
Y	Y	Kory Konsoer	LSU		B	
Y	Y	Kristin Chatelain	Coastal Protection and Restoration Auth.			C
Y	Y	Kristina Leggas [R]	USACE	A		
Y	Y	Laura Carnes	USACE	A		
Y	Y	Matt Hiatt	LSU		B	
Y	Y	Paige Green	Coastal Protection and Restoration Auth.		B	
Y	Y	Patrick Smith [F]	USACE	A		
Y	Y	Paul Kemp	G. Paul Kemp and Associates		B	
Y	Y	Quenton Fontenot [F]	Nicholls State University			C
Y	Y	Raynie Harlan	LDWF		B	
Y	Y	Rick Raynie	USACE	A	B	C
Y	Y	Rudy Sparks	Louisiana Landowners Association	A		C
Y	Y	Russell Beauvais	USACE		B	
Y	Y	Sadie Morgan	Coastal Protection and Restoration Auth.	A		
Y	Y	Tanya Richardson	Brookfield Renewable (Manager) Sydney A. Murray Jr. Hydroelectric Station		B	
Y	Y	Tim Nelson	Moffatt & Nichol	A		
Y	Y	Vic Blanchard	A. Wilberts and Sons	A		

Appendix B: Agenda

SRP – Old River Control Complex
Environmental Flows Workshop
FINAL Agenda April 8-9, 2025

Location: 200 Dulles Dr, Lafayette, LA
Lunches: Group order to Jason's Deli. Link will be provided for self-ordering/paying.
Goal: The goal of this workshop is to develop environmental-flow (e-flow) recommendations for the Old River Control Complex that could result in benefits to forest health, water quality (flow/exchange) and fish & crawfish habitats within the Atchafalaya Basin.

Breakout Group	Workgroup facilitators:	RPT-ers:	Note-takers:
A. Forest	Patrick Smith (USACE)	Kristina Leggas (USACE)	Laura Carnes (USACE)
B. WQ	Colin Anderson (M&N)	Joe Baustian (TNC)	Jill Andrew (TNC)
C. Aquatic: Fish & Crawfish	Quenton Fontenot (NSU)	Justin Kozak (TNC)	Josh Carson (USACE)
Workshop	Rick Raynie (USACE) Bryan Piazza & Heidi Mehl (TNC)		



SRP – Old River Control Complex
Environmental Flows Workshop
FINAL Agenda April 8-9, 2025

AGENDA

Day 1: Tuesday April 8, 2025

08:30am	Registration & order lunch (link to be provided)
09:00am	(15 min) Welcome and Introductions (**Rick Raynie**, USACE MVN)
09:15am	(15 min) Review of SRP process, discussion of meeting outcomes (USACE SRP) (**Jim Howe**, TNC)
09:30am	(15 min) Overview, Q&A and Discussion of MRT& ORCC operations (**Dave Ramirez**, USACE MVN)
09:45am	(15 min) Overview of Atchafalaya Basin and flow ecology and targets for flow-ecology (**Bryan Piazza**, TNC)
10:00am	(20 min) Update on the ARB model (**Kevin Hannegan**, Moffatt & Nichol)
10:20am	25 minute break
10:45am	(15 min) Overview of Regime Prescription Tool (RPT) software that will be used in Working Groups (**Heidi Mehl,** TNC)
11:00am	(15 min) Flow data that we will be using (**Colin Anderson, M&N/Joe Baustian, TNC**)
11:15am	(15 min) Instructions for break-out groups & Q&A (**Rick**/**Bryan/Heidi**)
11:30am	Lunch (on-site, pre-ordered)
12:15pm	Group Photo
12:30pm	(90 min) Working Groups (Eco Targets): Low, average, high flows What is important for the basin within this habitat that we need to capture. Focus on what is needed, not limitations. Identify water flow/stage/timing needs. A. Forest Health B. Water Quality C. Fish & Crawfish
2:00pm	15 minute break
2:15pm	(75 min) Continue break-out sessions
3:30pm	(30 min) Report out of working group status and time remaining (**Rick**/**Bryan/Heidi & group facilitator report-outs**)
4:00pm	Adjourn

Continued

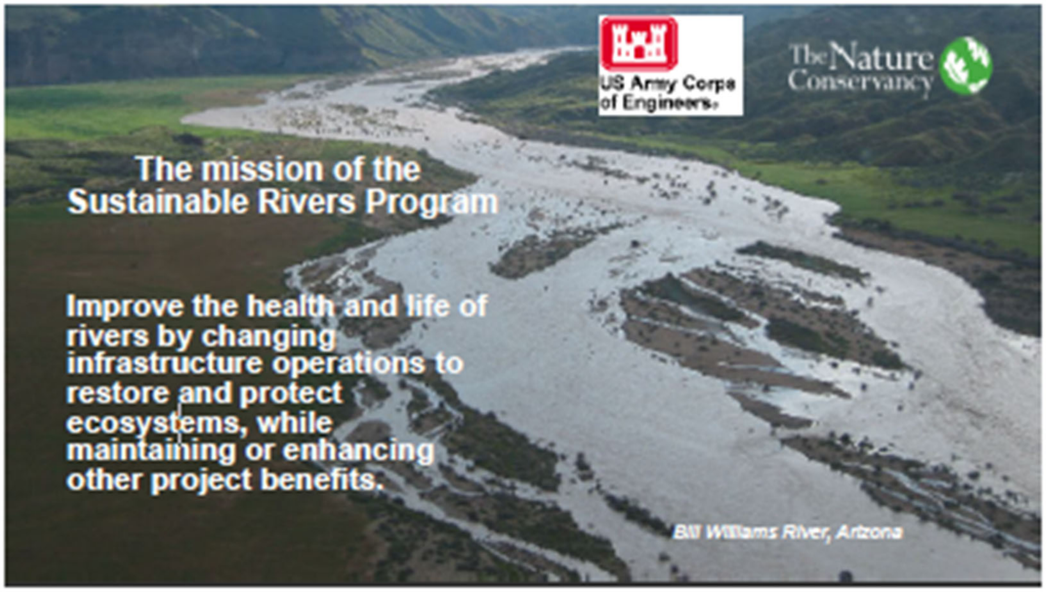
SRP – Old River Control Complex
Environmental Flows Workshop
FINAL Agenda April 8-9, 2025

AGENDA
Day 2: Wednesday April 9, 2025

08:30am	Registration & order lunch (link to be provided)
9:00am	(60 min) Working Groups complete work
10:00am	15 minute break
10:15am	(60 min) Presentations by Working Groups and discussion of flow recommendations for each resource area (20 minutes per group) (**Rick**/**Bryan/Heidi & group facilitator report-outs**)
11:30am	Lunch (on-site, pre-ordered)
12:30pm	(90 min) Continuation of presentations by Working Groups and discussion of flow recommendations for each resource area. Integration of flow recommendations from working groups into a single unified set of flow recommendations for each flow regime. (**Rick**/**Bryan/Heidi & All)**
2:00pm	(30 min) Summary of Results and discussion of next steps
2:30pm	Adjourn
POST-workshop	PDT stay and synthesize notes and debrief (team members only)

Appendix C: Presentations

Review of SRP Process:
Jim Howe, TNC

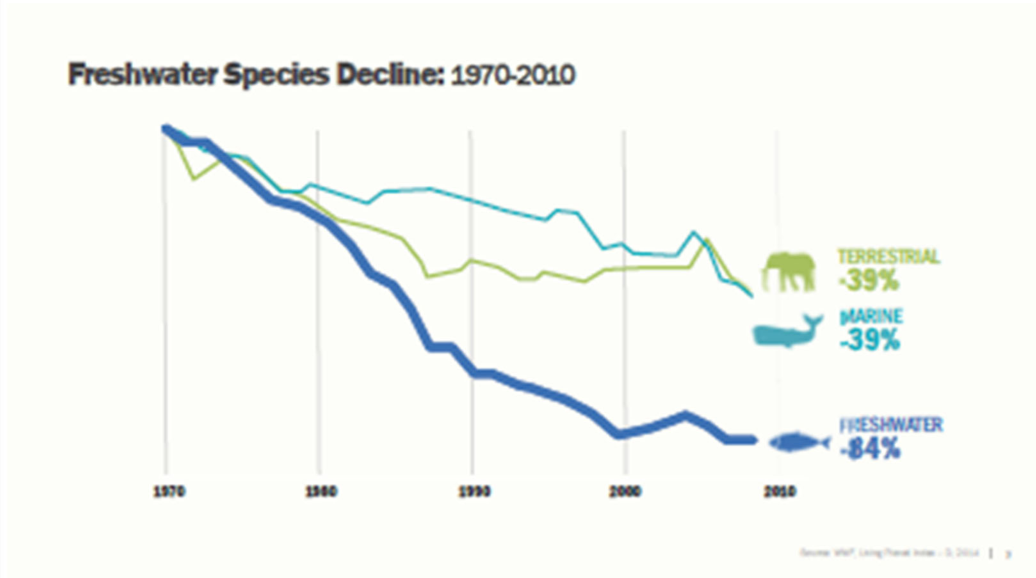



The Nature Conservancy
protects land and water…


And seeks to transform the
way the world meets its needs
for food, energy, and water.

Why is SRP important?

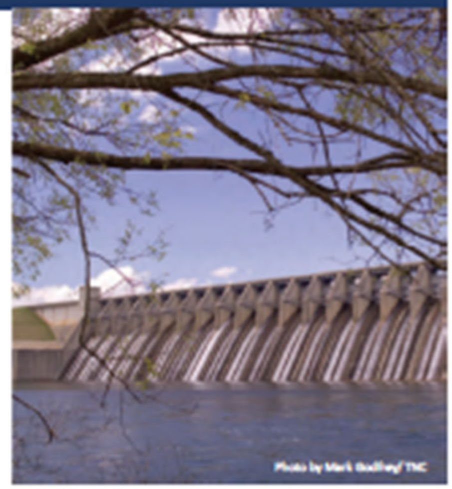
1. Modernizes dams and infrastructure to achieve environmental benefits
2. Creates win-win solutions for nature and people
3. Engages local USACE districts and stakeholders to inclusively develop new science-based water management plans for infrastructure


Freshwater Species Decline: 1970-2010
TERRESTRIAL
-39%
MARINE
-39%
FRESHWATER
-84%
1970
1980
1990
2000
2010


The Good News
Management of existing dams, locks, and reservoirs can be used as a tool to restore ecosystems.

History of the Sustainable Rivers Program (SRP)

- In the 1990s, The Nature Conservancy approached the U.S. Army Corps of Engineers about modifying flows on the Green River in Kentucky.
- Together, they determined that a new flow regime could enhance fish and mussel populations, maintain flood risk management, and extend the recreation season.

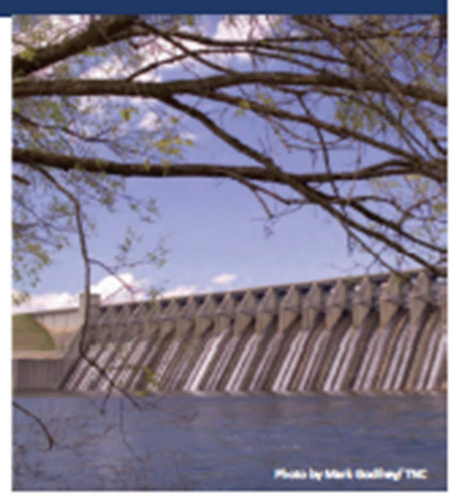


Local Success at the Green River Led to National Partnership

- In 2002, TNC & USACE entered into a Memorandum of Understanding to launch a nationwide "Sustainable Rivers Program."

US Army Corps of Engineers

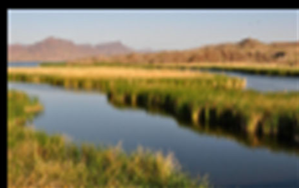
The Nature Conservancy
nature.org



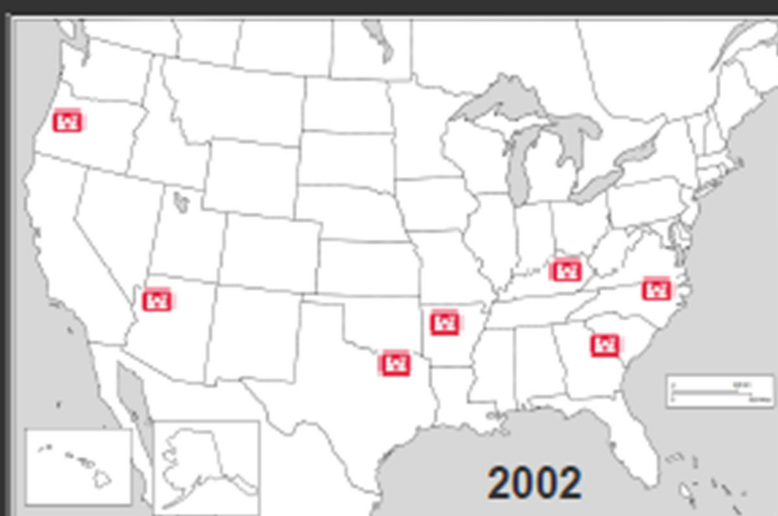
The Nature Conservancy

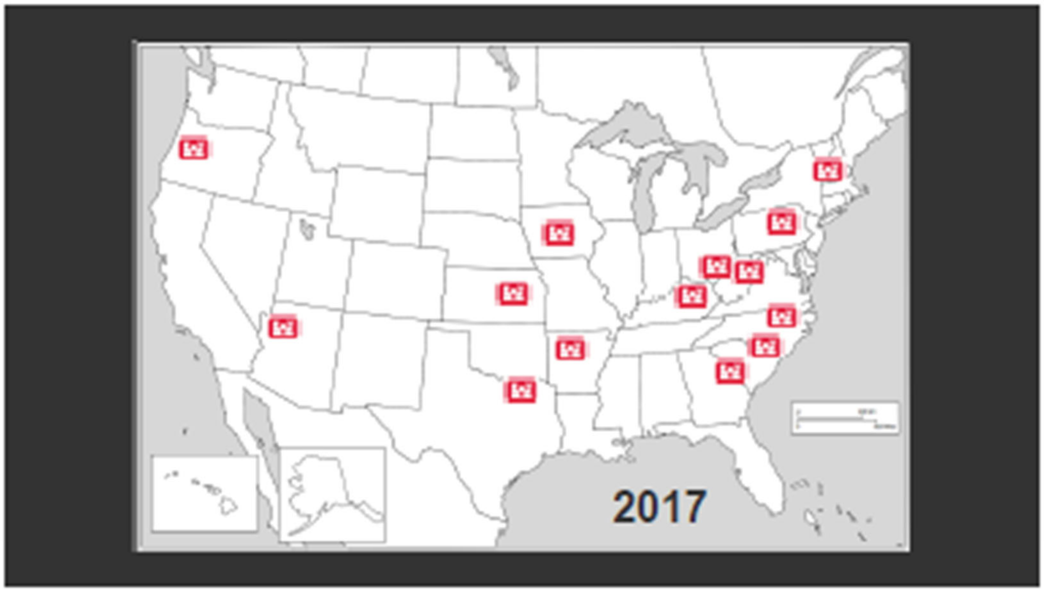
Roles & Responsibilities in the MOU

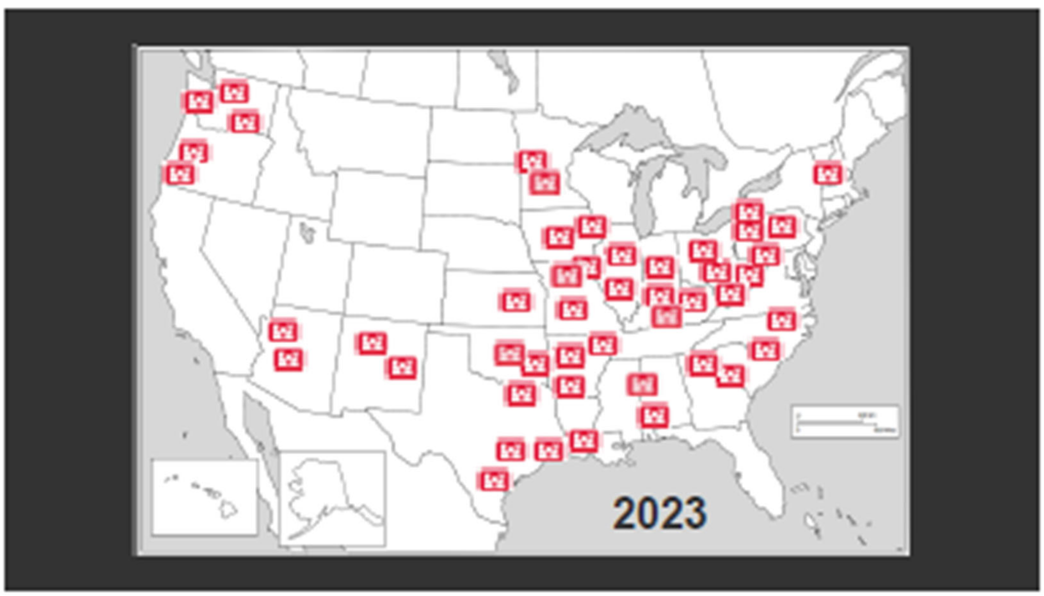
US Army Corps of Engineers

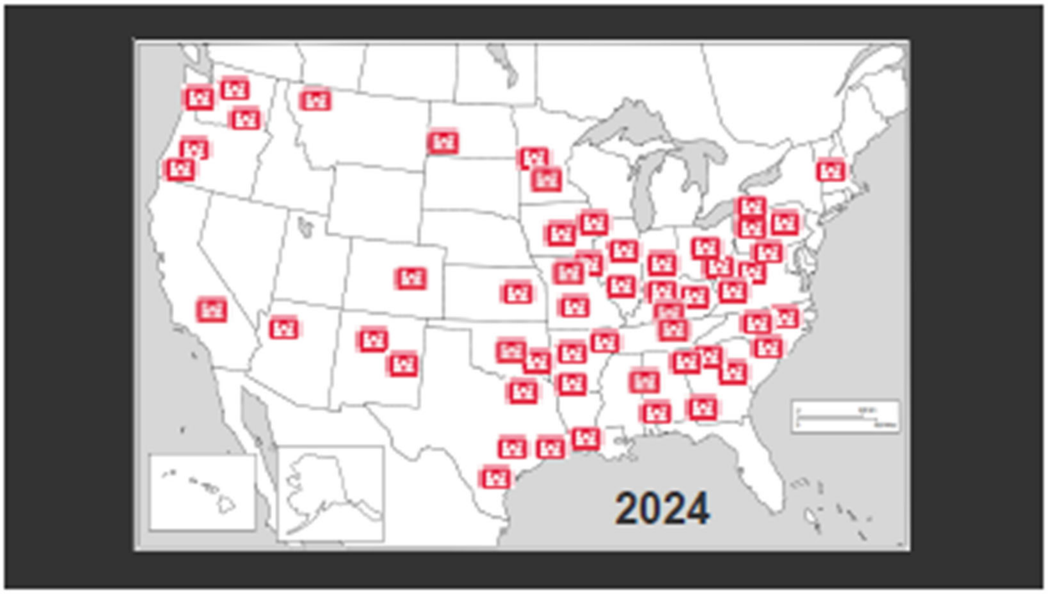


- Advance and share scientific understanding of freshwater systems
- Promote water management projects that enhance biodiversity while meeting human needs
- Convene stakeholders around shared science and shared visions
- Support and implement monitoring and adaptive management



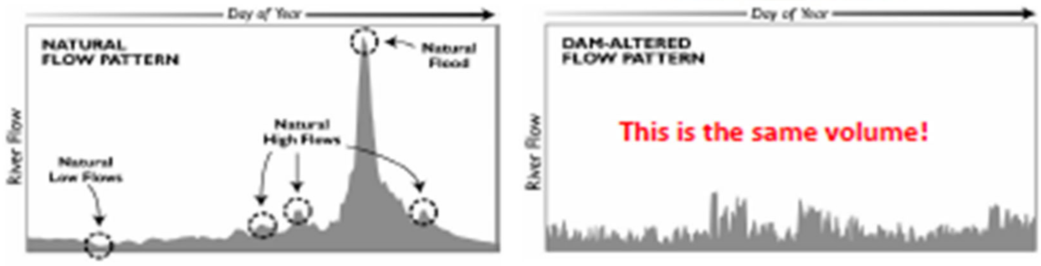

2017


2023


2024

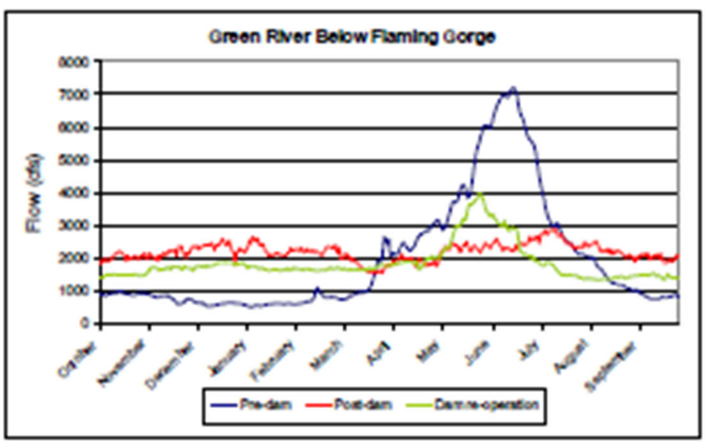

SRP at 22 Years Old
➤ 13,600 miles – 25% of USACE's portfolio
➤ 50 rivers
➤ 90+ reservoirs, 7 lock & dam systems, 5 dry dams

Impacts of altered hydrology



Alterations to flows can affect the timing, magnitude, duration, frequency, and rate of change

Small changes in Dam Operations can yield big results for ecosystems

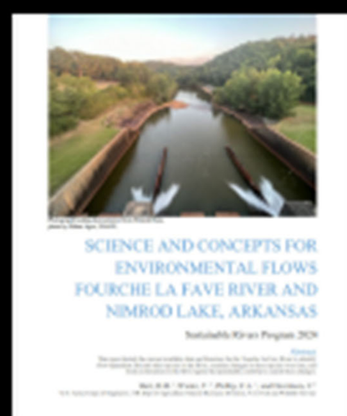


SRP's Multi-Step Process

Step 1 – Advance

Convene scientific experts & stakeholders to develop flow recommendations

Stakeholder report on environmental opportunities and state of the science



Environmental Flow recommendations report

SRP's Multi-Step Process

Step 2 – Implement

Test different flow regimes to evaluate environmental benefits and assess tradeoffs.

SRP's Multi-Step Process

US Army Corps of Engineers

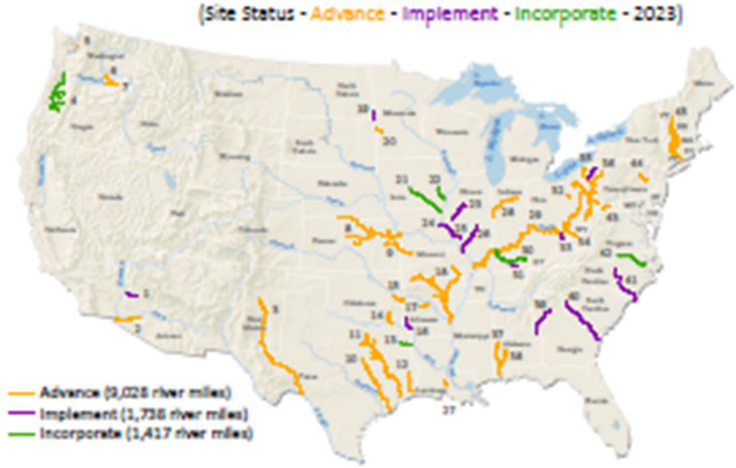
The Nature Conservancy
Protecting nature. Preserving life.

Step 3 – Incorporate

Include reviewed strategies in policies that guide infrastructure operations.

Sustainable Rivers Program

(Site Status - Advance - Implement - Incorporate - 2023)



Mississippi River – Missouri

- Dam managers adjusted outflows from Mel Price Dam gates to mimic velocities from lake sturgeon spawning event in 2015
- Lake sturgeon have spawned every year since the new flow regime was implemented.

Roanoke River, North Carolina

- New prescribed flows better mimic natural pulses, rather than creating prolonged floods downstream of the dam.
- Restores the health of floodplain by reducing stress on 95,000-acre bottomland hardwood forest downstream from dam.
- The new flows also reduce the potential for dissolved oxygen crashes that led to fish kills.

Bill Williams River, Arizona

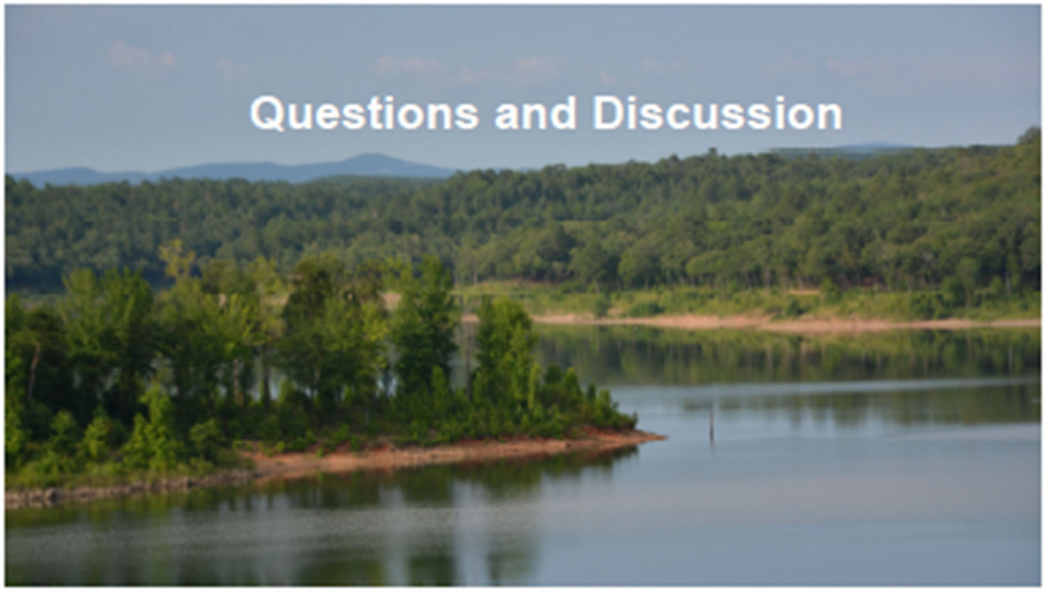
- Water management at Alamo Dam was impacting one of the largest intact riparian forests in the Lower Colorado Basin.
- SRP convened stakeholders from state and federal agencies and the Nature Conservancy, who helped define a new flow regime that restored occasional high water events to the system.
- Periodic high flow events are vital for renewing riparian forest and maintaining channel habitat.

The Nature Conservancy

Best practices for SRP workshops

US Army Corps of Engineers

- Work from a foundation of shared science
- Ensure participation of cross-section of USACE teams – Ops, Water Mgmt, Planning, etc.
- Recruit diverse partners and subject matter experts to attend
- Leave constraints to future phases
- Maintain momentum by completing workshop reports within 30-60 days of workshop



Kaskaskia River -- Illinois

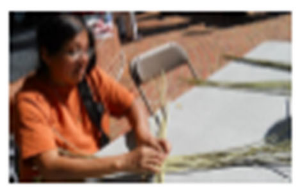
- Stakeholders brainstormed water level management in three reservoirs.
- Reducing the pool level by 6 inches during the growing season:
  - created 2,300 acres of wetland habitat along reservoir banks
  - led to 20 times the amount of waterfowl forage
  - helped improve water quality
  - Increased aquatic habitat
- How Environmental Pool Management Works - Time Lapse Video

Allegheny River, Pennsylvania

- "Conservation locking" efforts from 2010-2013 timed the opening of lock gates to allow fish passage.
- That enabled walleye and sauger to access spawning habitat upstream, increasing populations to the point that the PA Fish & Boat Commission no longer needed to stock these fish.
- Operations funding challenges in USACE Pittsburgh District have discontinued conservation locking at Allegheny.

Rivercane restoration – partnerships with Tribes

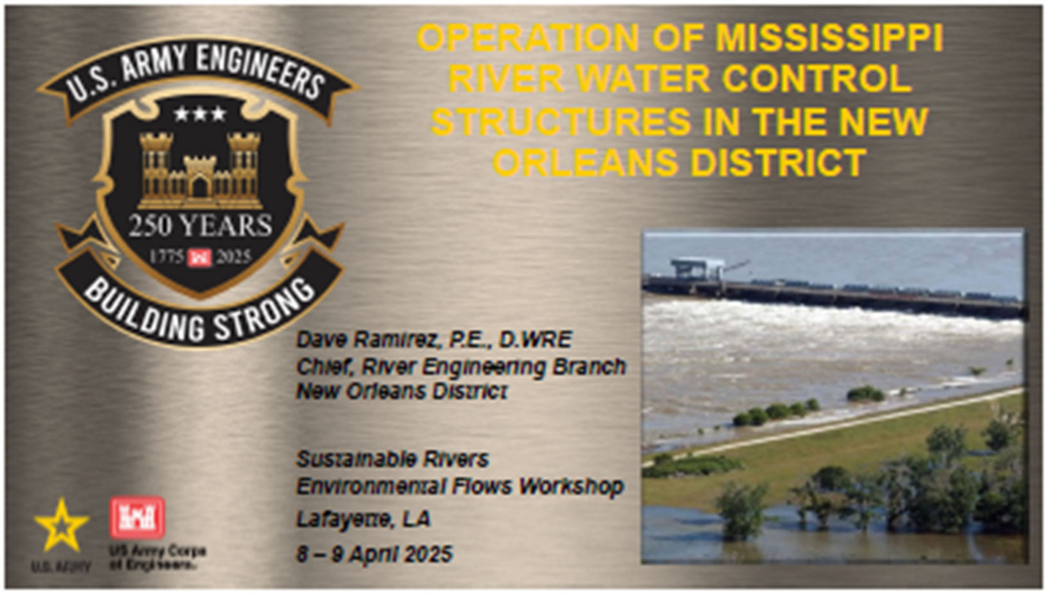
- SRP convened 17 tribes in the Southeast U.S. to develop best practices for restoring rivercane, a culturally significant riparian plant that has disappeared from much of its historic range.
- In 2023, a new Rivercane Restoration Alliance will be teaming up with tribes and the U.S. Fish & Wildlife Service to restore rivercane by adjusting flows at a USACE dam on the Arkansas River in Oklahoma.

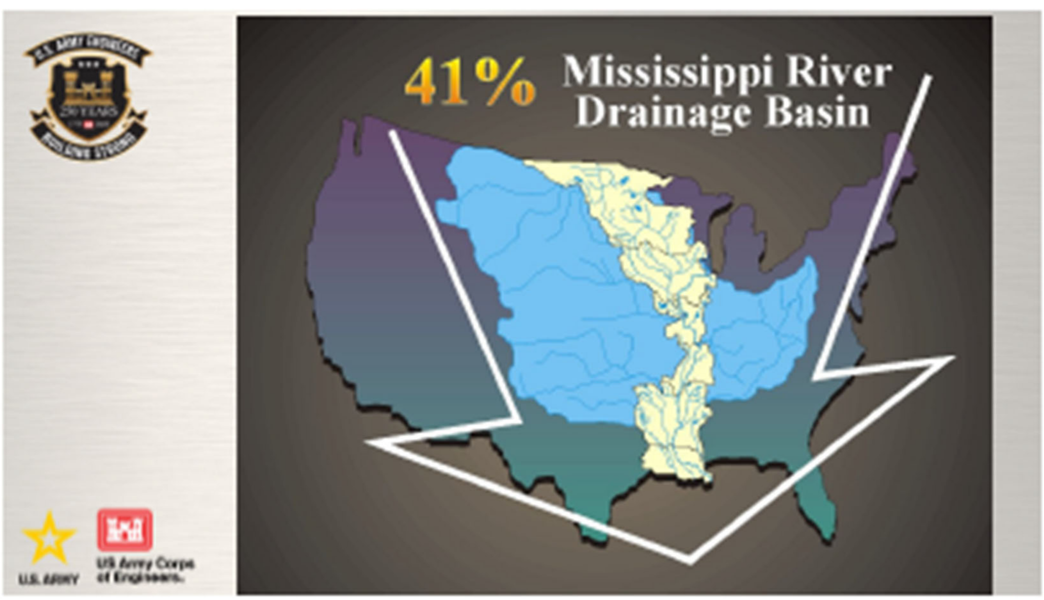


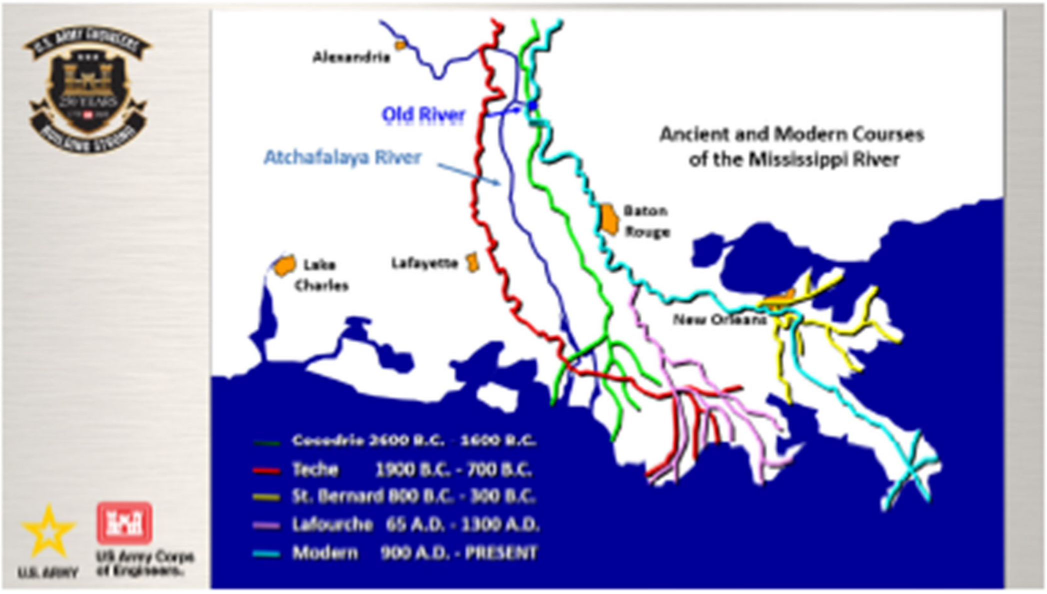
Green River, Kentucky

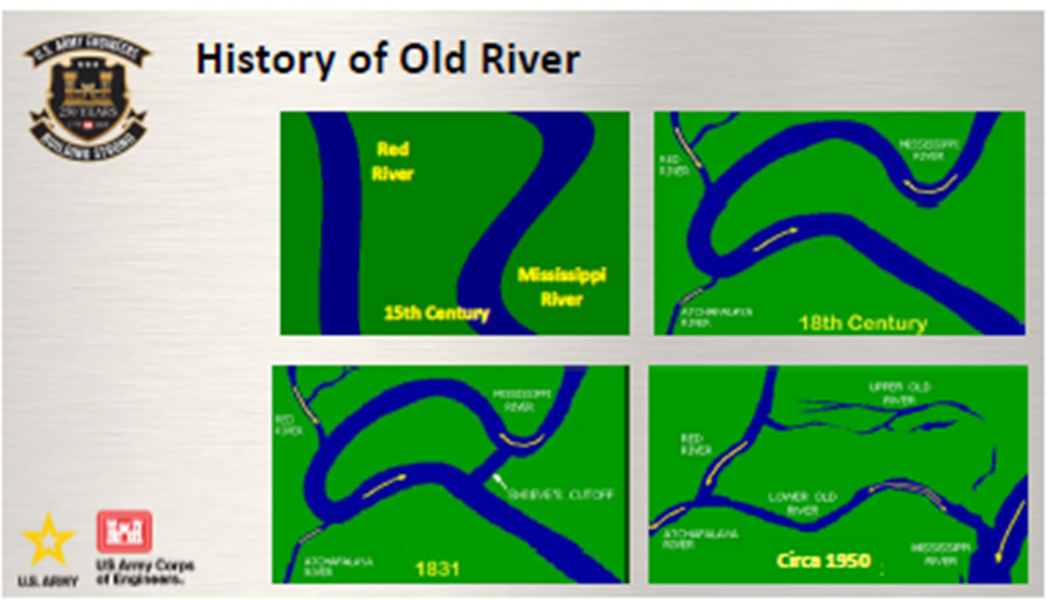
- Water releases from Green River Dam were impacting mussel communities in one of the most biologically diverse rivers in the U.S.
- SRP convened stakeholders to develop a different release schedule that improved water temperatures using "selective withdrawal" from the dam.
- Now officially part of the Water Control Manual, the new flow regime also delays summer drawdown from the reservoir, which extends the recreational fishing and boating season.

Operation of Mississippi River Water Control Structures in the New Orleans District: Dave Ramirez, USACE

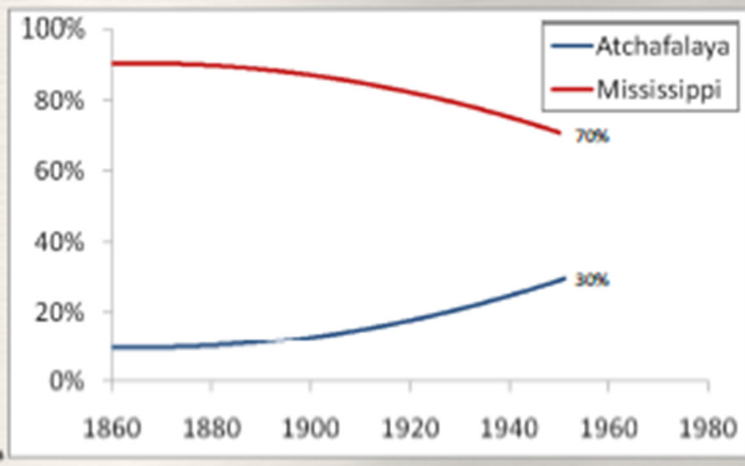





Alexandria
Old River
Atchafalaya River
Ancient and Modern Courses
of the Mississippi River
Baton Rouge
Lake Charles
Lafayette
New Orleans
Cocodrie 2600 B.C. 1600 B.C.
Teche 1900 B.C. - 700 B.C.
St. Bernard 800 B.C. - 300 B.C.
Lafourche 65 A.D. - 1300 A.D.
Modern 900 A.D. - PRESENT
US Army Corps of Engineers.
U.S. ARMY


History of Old River
Red River
Mississippi River
15th Century
18th Century
1831
Circa 1950
US Army Corps of Engineers.
U.S. ARMY

Flow Distribution After Shreve's Cutoff



US Army Corps of Engineers

Flood Control Act of 1954 (HD 478)

"...the distribution of flow and sediments in the Mississippi and Atchafalaya Rivers is now in desirable proportions and should be so maintained. Control measures which will assure the maintenance of the present water-sediment relationship are needed..."

US Army Corps of Engineers

Purpose of the Old River Control Complex

The U.S. Army Corps of Engineers operates the Old River Control Complex (ORCC) in accordance with the authorizing law, the Flood Control Act of 1954, to maintain a stable relationship between the Mississippi and Atchafalaya Rivers

- Designed and is operated to prevent capture of the Mississippi River by the Atchafalaya River
- Operated to maintain the distribution of flow and sediments between the Mississippi and Atchafalaya Rivers in approximately the same proportion as occurred naturally in 1950
- In 1950, the annual flow distribution below the latitude of Old River was approximately 70 percent in the Mississippi River and 30 percent in the Atchafalaya River (70/30 distribution)

Original Old River Control Complex

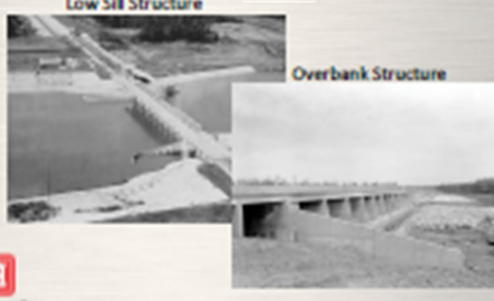
Flood Control Act of 1954 Authorizes two Control Structures and a Navigation Lock connecting Mississippi and Red Rivers

Purpose is to prevent capture of the Mississippi River by the Atchafalaya River

1959

Low Sill Structure

Overbank Structure



1962

Old River Lock

Low Sill Structure

- 11 Vertical Lift Gates
- 3 Deep Bays at -5 ft
- 8 High Bays at +10 ft
- Initial operation gate either open or closed – no orifice flow
- Design Flow – 300,000cfs
- Maximum Head – 35ft

Overbank Structure

- Goes into operation once Knox Landing stages exceed 52 ft.
- 73 Bays – Top Hinged Wooden Panels
- 15 Panels in each bay
- Each Panel – 3 Bounded timber needles
- Design flow 320,000 cfs.

Sample Calculation of 70% / 30% Daily Distribution Procedure

Location	Stage	Flow from Rating Curve @ Stage
Miss River (Qrrl)	50.0 ft	890,000 cfs
Atch River (Qa)	29.7 ft	379,000 cfs

Total Latitude Flow = 1,269,000 cfs

30% of Latitude Flow = 0.30(1,269,000) = 380,700 cfs

Gate Change = 380,700 cfs – Red River flow of 164,000 cfs = 216,700 cfs

216,700 cfs is needed to be passed through the Old River Control Complex (ORCC)

a) Hydropower is offered 100% of the 216,700 cfs
b) Hydropower agrees to pass 93,000 cfs
c) ORCC passes remaining flow
   216,7000 – 93,000 = 123,070 cfs passed through ORCC

US Army Corps of Engineers

1973 Flood - Low Sill Structure

- Low Sill damage in 1973 flood
- Partial repairs made after 1973 flood
- 22 ft head restriction for orifice flow
- 16 ft head restriction for completely open or closed

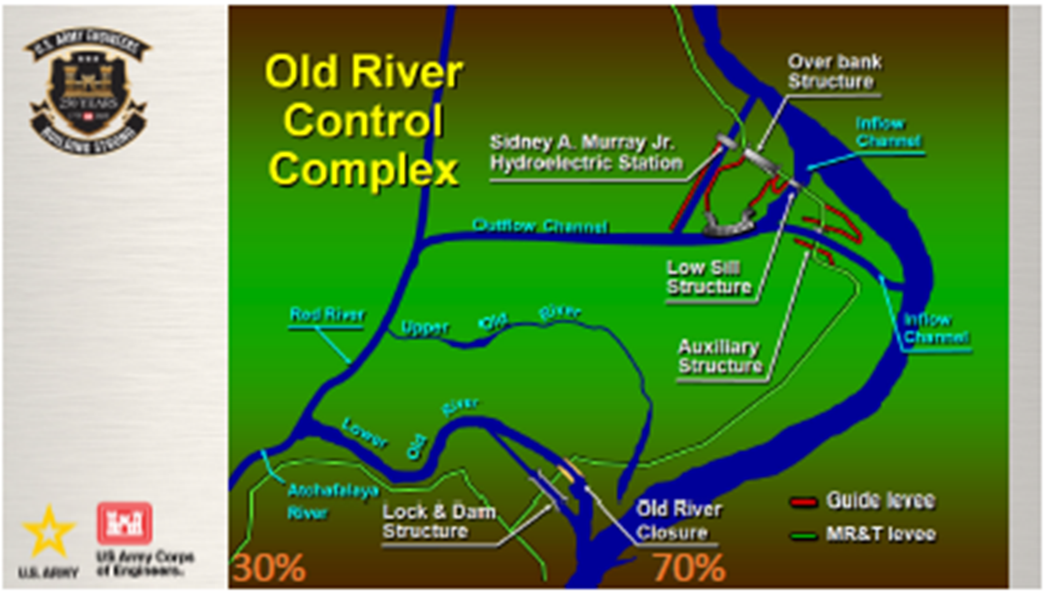
US Army Corps of Engineers

Auxiliary Structure 1986

- 6 – 75' Tainter Gates
- Gate sill elevation -5 ft
- Design Flow 350, 000 cfs
- Design head – 35 ft
- Facilitates the complete closure of Low Sill Structure for inspection, maintenance, or repairs.
- Capacity through structure must be held in reserve to accommodate hydropower flow allocation in event of load rejection

Hydroelectric Plant 1990

- Memorandum of agreement signed in 1989.
- Provided that the authorized purposes of USACE ORCC project are satisfied, the hydro-plant will receive all the diverted flow up to turbine generator saturation.
- Designed not to pass sediment.
- Max flow 160,000cfs – 170,000cfs


Old River Control Complex
Over bank Structure
Inflow Channel
Sidney A. Murray Jr. Hydroelectric Station
Outflow Channel
Low Sill Structure
Red River
Upper Old River
Auxiliary Structure
Inflow Channel
Lower Old River
Atchafalaya River
Lock & Dam Structure
Old River Closure
Guide levee
MR&T levee
30%
70%
US Army Corps of Engineers
U.S. ARMY


Old River Control Complex Operations
Complex Project Flood Flow = 620,000 cfs
▪ Low Sill = 300,000 cfs
▪ Overbank = 320,000cfs
▪ Auxiliary = 350,000 cfs
Operated on a daily basis
US Army Corps of Engineers
U.S. ARMY

Low Sill Operational Limitations

- Differential Head Restrictions across the Structure.
  - Most critical during rising stages in the MS River
- Crane Capacity
  - Limitations on Gate Bays 5, 6, & 7
  - No Operation on Gate Bays 4 & 8
- Symmetry of Operations
  - Scour concerns downstream of the structure
  - Unbalanced forces on the structure monoliths
- Load rejection at S.A. Murray Hydropower
  - Keep reserved capacity available at Auxilary

U.S. ARMY

US Army Corps of Engineers

Old River Sediment Flushing

- Design of the Auxiliary Structure – need for sediment flushing.
  - Maintain inflow/outflow channels
- Flushing limitations
  - ➢Pallid Sturgeon
  - ➢Atchafalaya Stage increases at Simmesport
  - ➢Issues with bank stability of auxiliary inflow channel

U.S. ARMY

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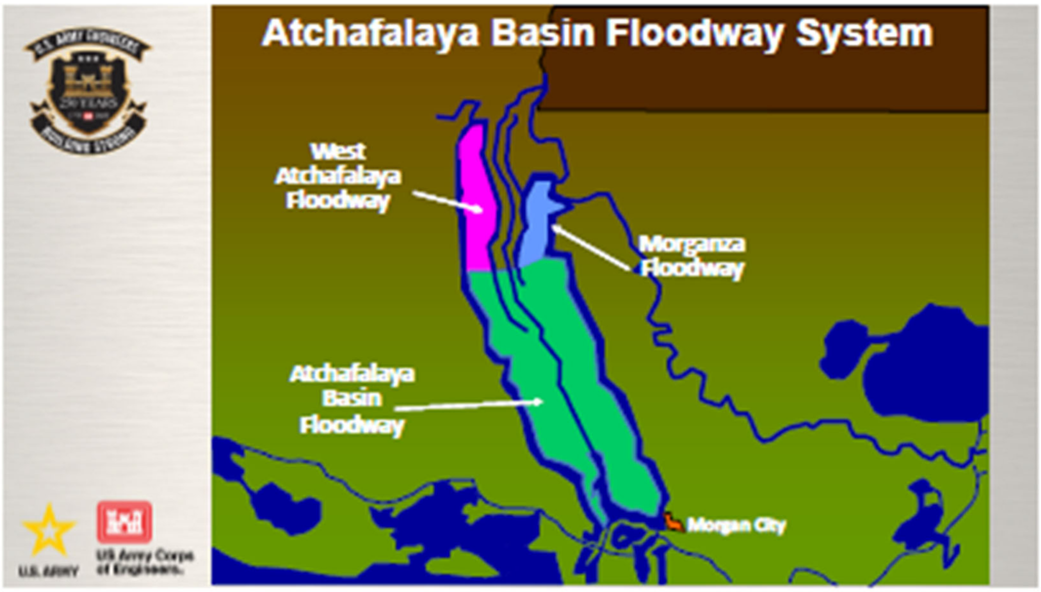
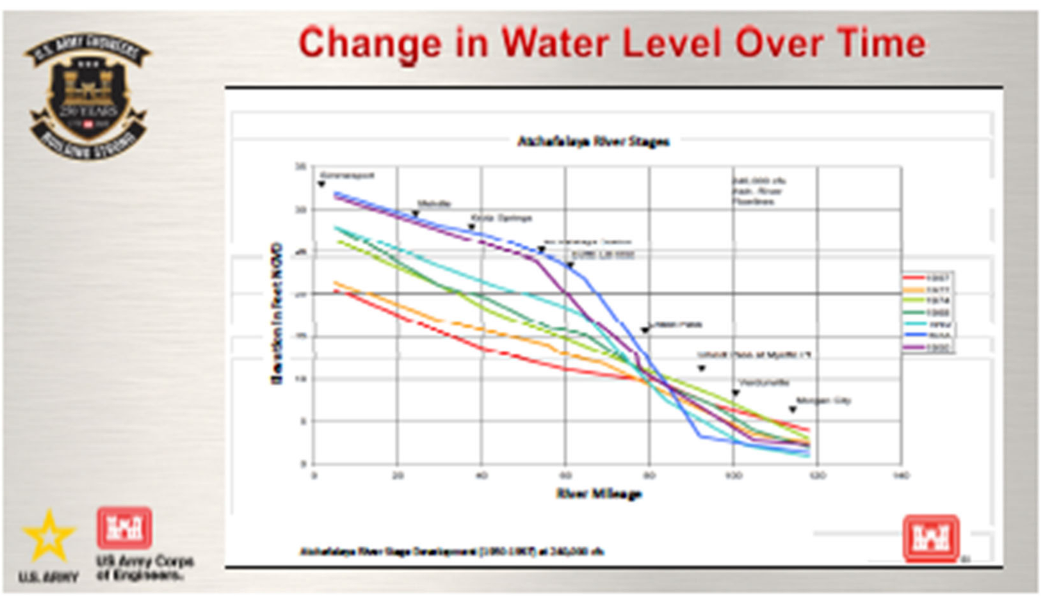
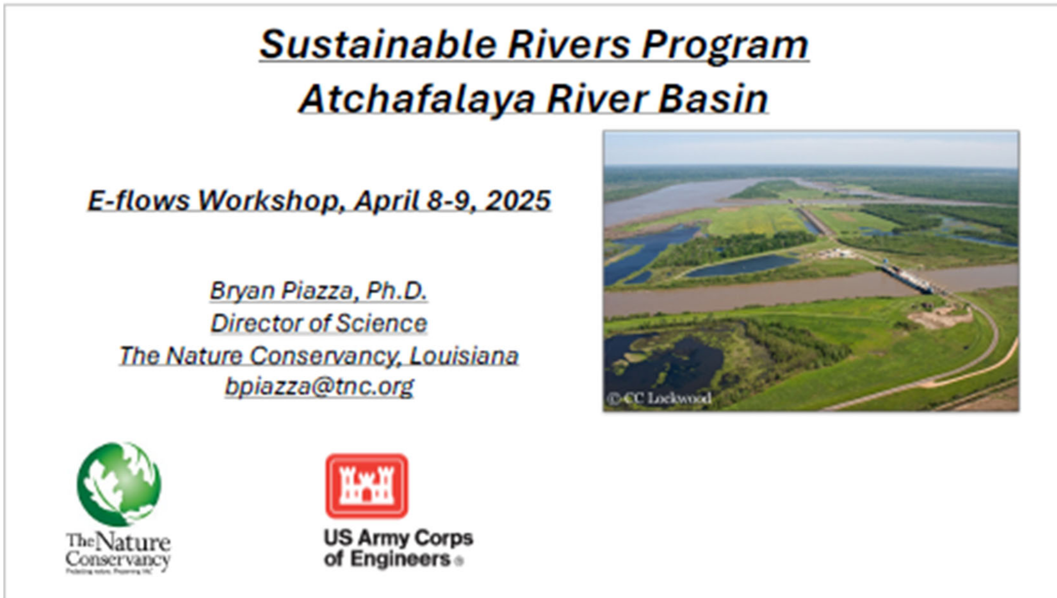

Atchafalaya Basin Floodway System
West Atchafalaya Floodway
Morganza Floodway
Atchafalaya Basin Floodway
Morgan City
U.S. ARMY
US Army Corps of Engineers

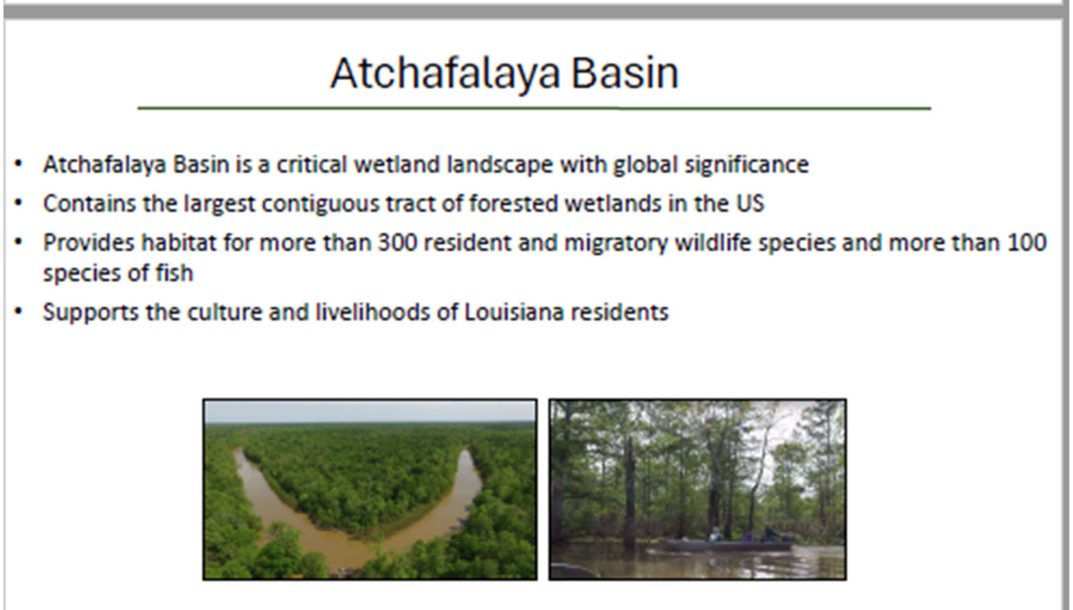

Change in Water Level Over Time
Atchafalaya River Stages
River Mileage
Melville
Morgan City
U.S. ARMY
US Army Corps of Engineers


Morganza Floodway
Operated to prevent Mississippi River flow below Floodway from exceeding 1.5M cfs (55,556 m³/s)
Diverts water from Mississippi River to Atchafalaya Basin
Operated in 1973 and 2011
U.S. ARMY
US Army Corps of Engineers


Bonnet Carré Spillway
Operated to prevent flow below Spillway from exceeding 1.25M cfs (46,296 m³/s)
Diverts water from Mississippi River to Lake Pontchartrain
U.S. ARMY
US Army Corps of Engineers

Sustainable Rivers Program Atchafalaya River Basin:
Bryan Piazza, The Nature Conservancy

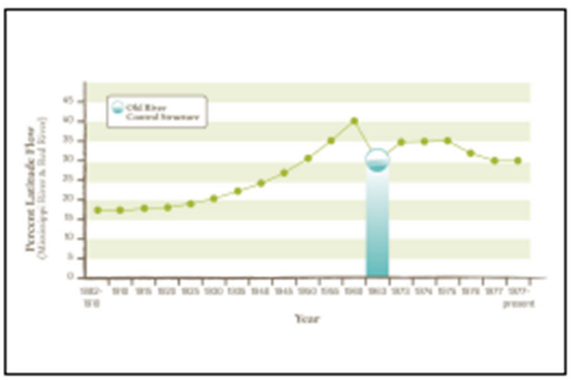




Atchafalaya Basin

- Highly engineered system
  - Still maintains a semi-natural hydrograph
  - Channel modifications have reduced river/floodplain interaction
  - Water stays in channels and flows around floodplain
- Stagnation → backswamp hypoxia
  - Fish kills
  - Reduced crawfish populations
  - Forest impacts

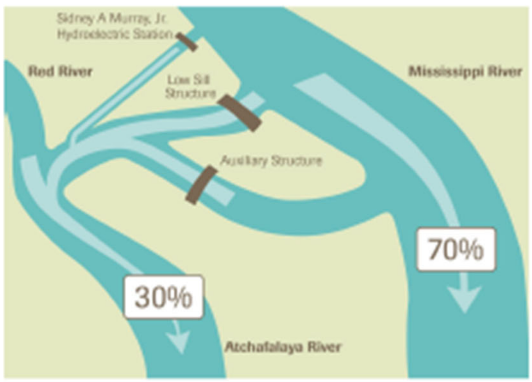
Old River Control Structure

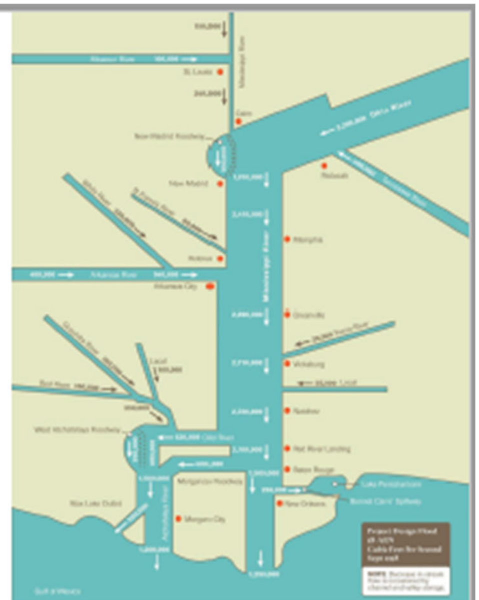


- ***Flows were not set based on science***
- ***Flow changes have not been considered, yet the Basin, the Mississippi River, and the coast have changed.***

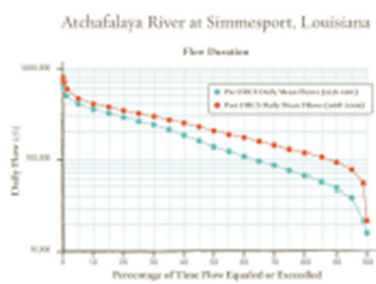
Current River Management

Latitude Flows

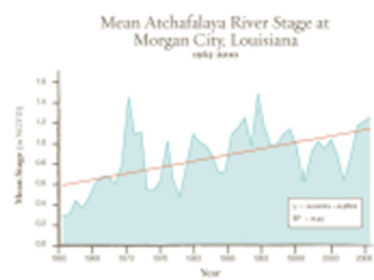




System-wide Flow Regulation



- Natural and anthropogenic deepening of the Atchafalaya River channel and remaining distributaries have isolated the river from the floodplain.
- Higher flows (and stages) across hydrograph.
- Daily flow allocation can exacerbate this problem.

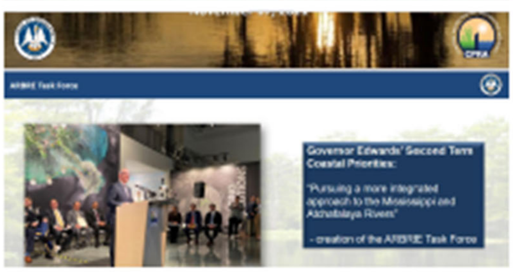


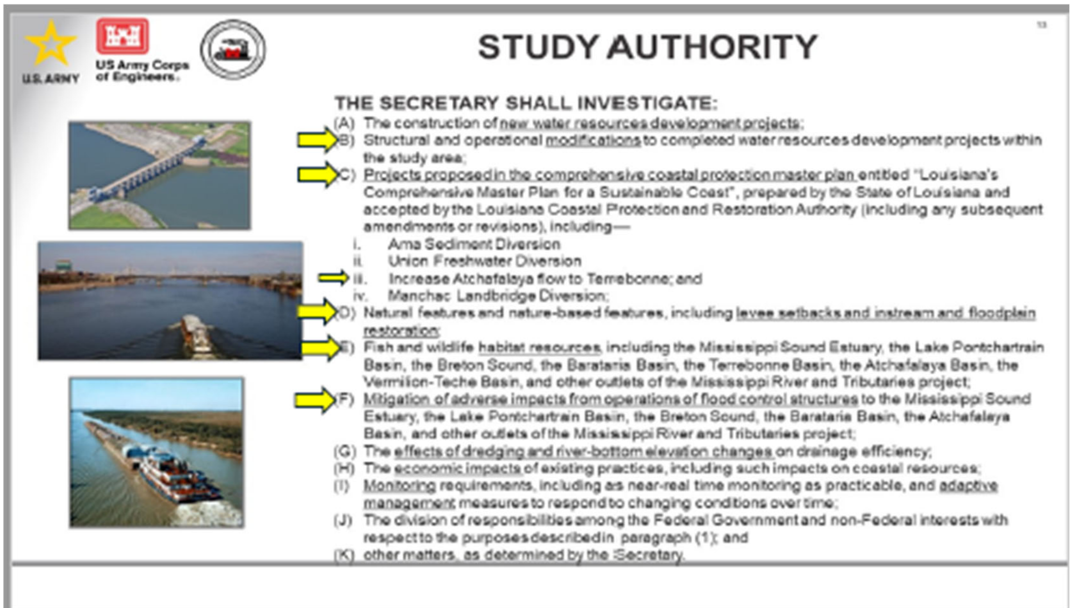
Can Atchafalaya River flows be used to benefit the Atchafalaya Basin?

- The Basin's plumbing system is broken.
  - Flood control projects, systemwide water mgt.
  - Local hydro-impediments from canal construction

- Effects
  - Poor water quality
  - Areas of excessive sedimentation and areas where land subsidence is dominating.
  - Reduced forest health
  - Fish kills
  - Reduced crawfish populations and size

- Climate change may be changing river flow patterns and sea level rise affects drainage.
  - Seeing extremes – repeated, long-duration flooding and deep drought across the MRB.

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US Army Corps of Engineers
STUDY AUTHORITY
13
THE SECRETARY SHALL INVESTIGATE:
(A) The construction of new water resources development projects;
(B) Structural and operational modifications to completed water resources development projects within the study area;
(C) Projects proposed in the comprehensive coastal protection master plan entitled "Louisiana's Comprehensive Master Plan for a Sustainable Coast", prepared by the State of Louisiana and accepted by the Louisiana Coastal Protection and Restoration Authority (including any subsequent amendments or revisions), including—
i. Ama Sediment Diversion
ii. Union Freshwater Diversion
iii. Increase Atchafalaya flow to Terrebonne; and
iv. Manchac Landbridge Diversion;
(D) Natural features and nature-based features, including levee setbacks and instream and floodplain restoration;
(E) Fish and wildlife habitat resources, including the Mississippi Sound Estuary, the Lake Pontchartrain Basin, the Breton Sound, the Barataria Basin, the Terrebonne Basin, the Atchafalaya Basin, the Vermilion-Teche Basin, and other outlets of the Mississippi River and Tributaries project;
(F) Mitigation of adverse impacts from operations of flood control structures to the Mississippi Sound Estuary, the Lake Pontchartrain Basin, the Breton Sound, the Barataria Basin, the Atchafalaya Basin, and other outlets of the Mississippi River and Tributaries project;
(G) The effects of dredging and river-bottom elevation changes on drainage efficiency;
(H) The economic impacts of existing practices, including such impacts on coastal resources;
(I) Monitoring requirements, including as near-real time monitoring as practicable, and adaptive management measures to respond to changing conditions over time;
(J) The division of responsibilities among the Federal Government and non-Federal interests with respect to the purposes described in paragraph (1); and
(K) other matters, as determined by the Secretary.


Our task is to think about environmental flows in the Atchafalaya River. Our goal is to identify incompatibilities between hydrologic alterations and species and habitat flow needs. We will craft e-flow prescriptions/ recommendations that create adequate conditions for all native species and habitats enough of the time.
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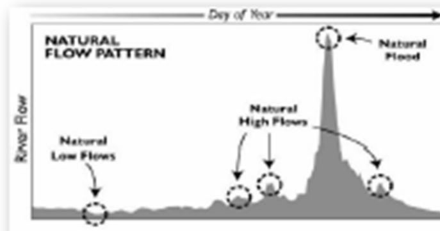
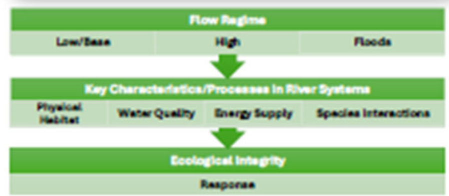
The Science of Environmental Flow Recommendations



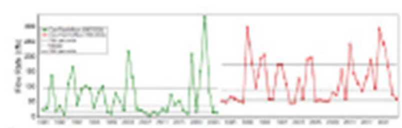


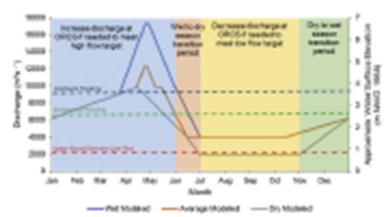
Approach that emerged in the 1990's recommends maintaining the different components of the hydrograph (lows, highs, floods).

E-Flows: The quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (Brisbane Declaration).

Operationalizing E-flows/EPM: Management decisions that manipulate water and land-water interactions to achieve ecological or environmental goals (i.e., U.S. Army Corps of Engineers, USA's largest federal water management entity).

E-flow Recommendations in the Atchafalaya Basin





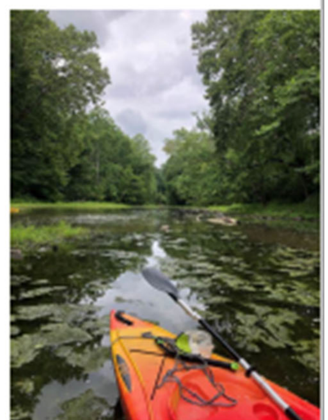
1. *Build Environmental Flow Recommendations based on Ecological Targets (what does the Basin need?)*
   a) ***Forest Health** – conditions for growth and reproduction of bottomland hardwood and cypress forest – healthy forest habitat.*
   b) ***Fish and Crawfish** – conditions for healthy populations and growth of organisms.*
   c) ***Water Quality** – conditions for adequate flooding and draining of the basin where water exchange is an issue. Includes interaction with the coast.*
2. *Testing and monitoring*
   a) *Will develop flow scenario(s) with HEC-RPT*
   b) *Will test scenario(s) with hydrodynamic model (and any other useful tools).*
   c) *Will inform the Lower Mississippi River Comp. Study*

Building Environmental Flow Recommendations

What does the ARB need to be healthy?

- **Key Considerations:**
  - ✓ Components of the hydrograph throughout the year (and/or across years)
  - ✓ Inter-annual variability and wet, dry, and average years
  - ✓ Climate variability (changes in MR flows and SLR)
  - ✓ Be spatially, temporally, and numerically explicit as possible

-
- Focus on the ecological aspects while **recognizing constraints, contingencies, and uncertainties (e.g., 70-30 flow split)**



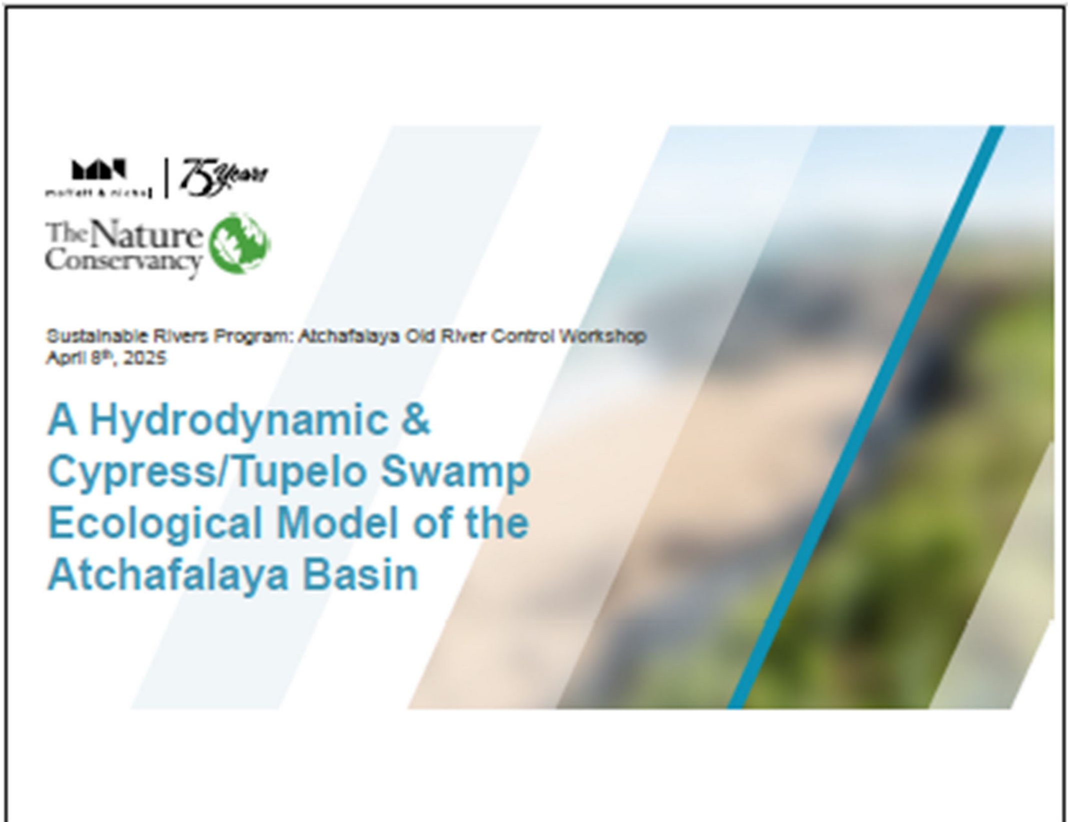
The Process

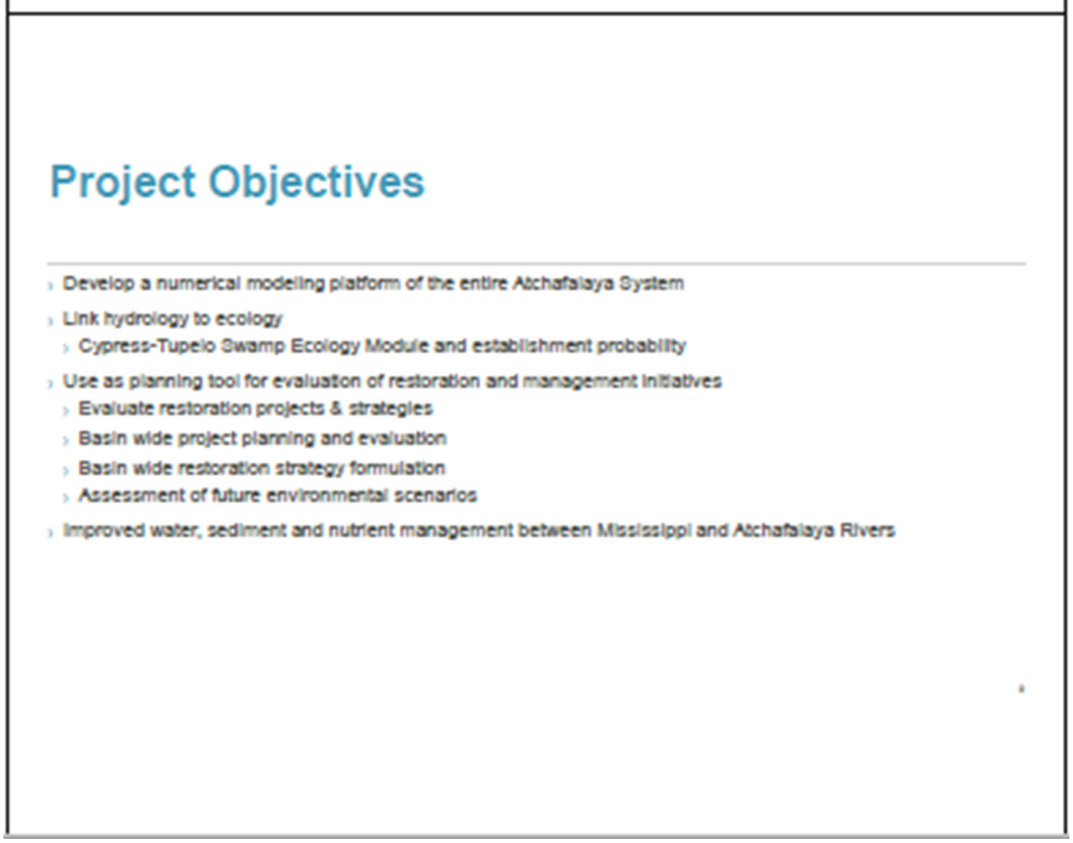
We are here: Step 3 - E-flows workshop (foundation)

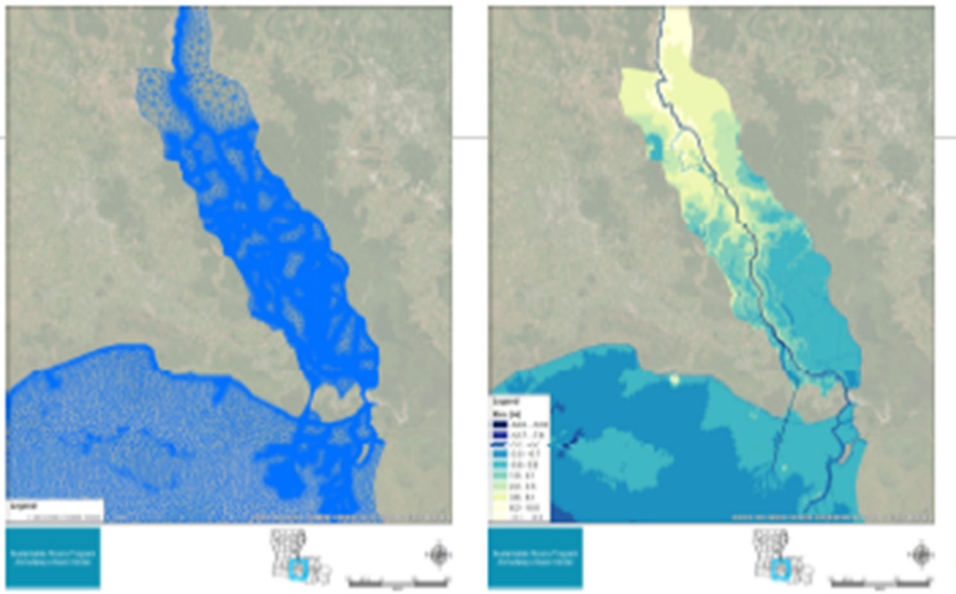
- Ecological and hydrological expertise
- Use HEC-Regime Prescription Tool to help draft the flow prescription
- Subgroup's recommendations combined to create a unified flow prescription or prescriptions for the river.

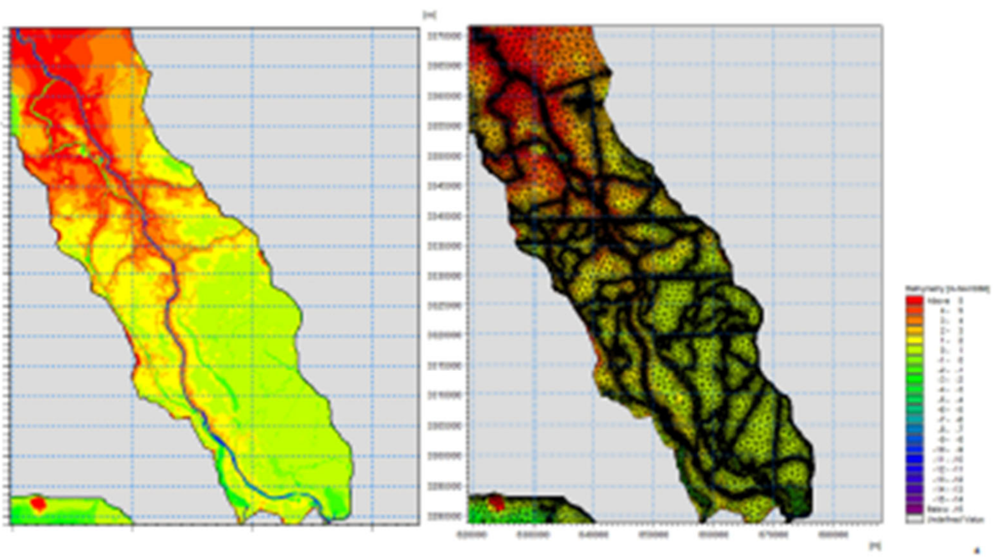
Step 3b – Run scenarios in the Atchafalaya Basin hydrodynamic model.
Step 3c – Develop a report from workshop and a modeling report to inform the LMR Comp Study of Basin needs.

A Hydrodynamic & Cypress/Tupelo Swamp Ecological Model of the Atchafalaya Basin: Kevin Hannegan, Moffatt & Nichol









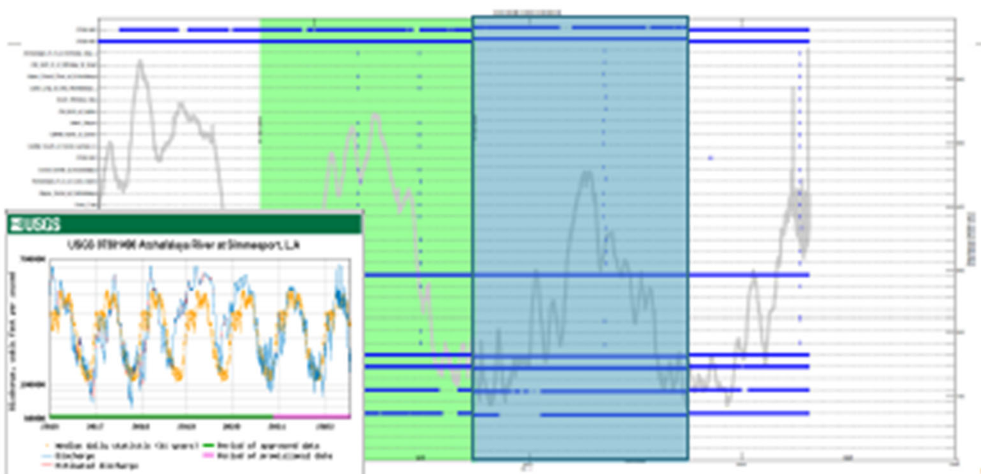
Vertical Features

- PyVF tool developed at LSU (S. Gao) primarily for use in ADCIRC
- Actively being used for Atchafalaya Basin research
- We've used to extract vertical features and local maximum elevations to better represent natural levees and spoil banks in model without increasing resolution and computational expense

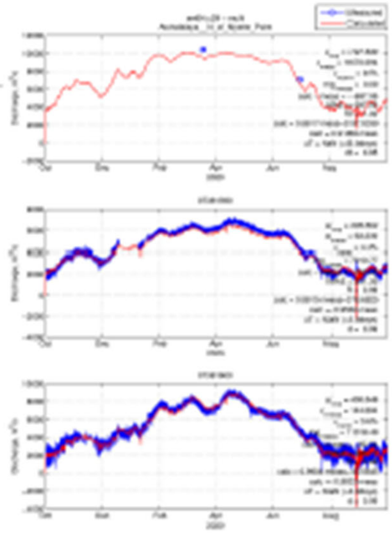

Environmental Modelling & Software

PyVF: A python program for extracting vertical features from LiDAR-DEMs

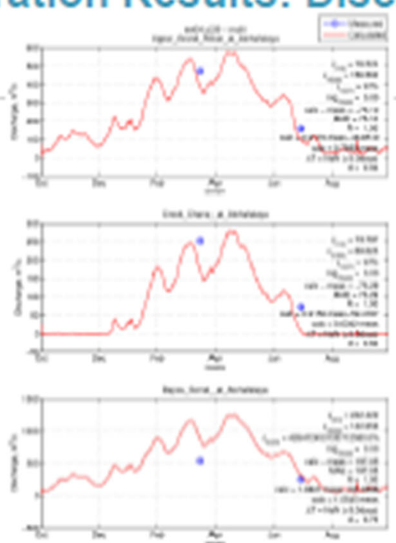
Calibration Period (2020) & Validation (2021)



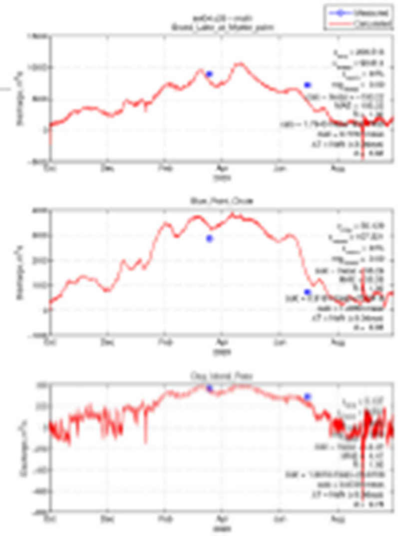
Calibration Results: Discharge – Main Channel



Calibration Results: Discharge

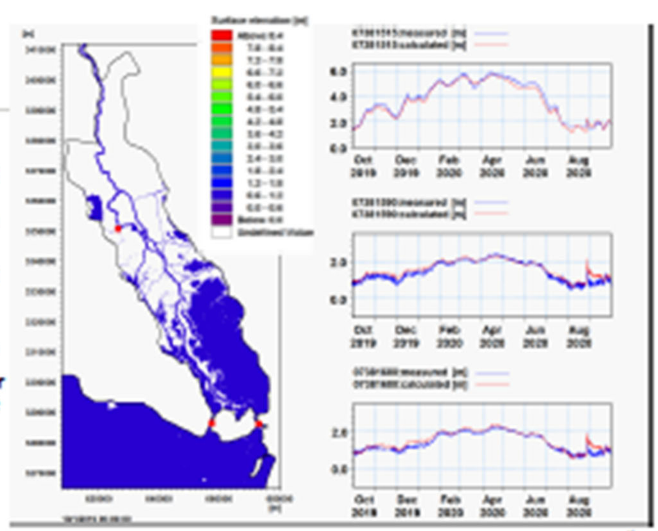


Calibration Results: Discharge

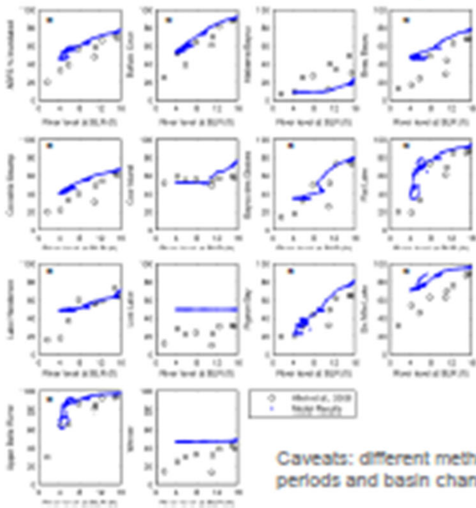


Calibration Summary

- WY2020
- Calibration of flow shows good match in both main channel and secondary channels, with slight under-prediction at some secondary channels
- Calibration of water level shows good match, with general slight underprediction of peak basin water levels, < 20cm at most of the stations
- Great calibration at intermediate water levels where inundation dynamics are more important
- Validated for WY2021



Percent Inundation (Allen et al., 2008)



Caveats: different methods (remotely-sensed water vs. modeled depths), time periods and basin change (1985-2006 vs year 2020), slight model wl errors, etc.

Cypress/Tupelo Swamp Ecology Module

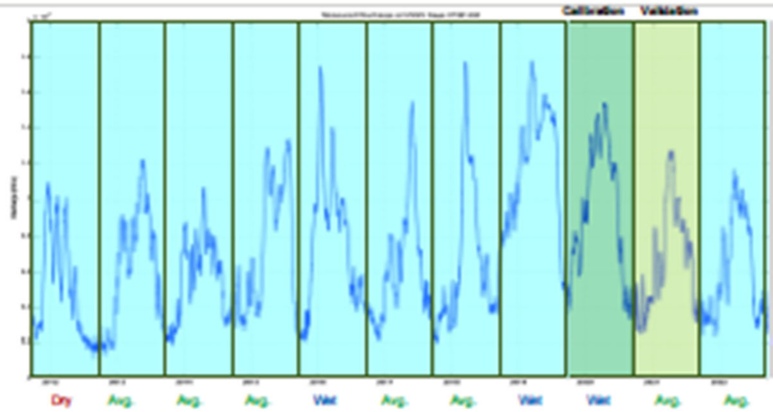
- Year 1
  - Calculate germination potential based on dry duration **(>100 Consecutive Dry Days)**
  - Calculate other germination conditions - inundation for bottomland competition **(<180 Consecutive Dry Days)**
  - Output seedling establishment yes/no
- Year 2
  - Calculate submergence potential based on inundation heights/durations vs. assumed growth rate
    - **100-day period** where water depth is greater than 60 cm
- Year 3
  - Calculate submergence potential based on inundation heights/durations vs. assumed growth rate
    - **100-day period** where water depth is greater than 1 m
  - Calculated "Establishment" – germination and year 1+2 survival

RESEARCH ARTICLE

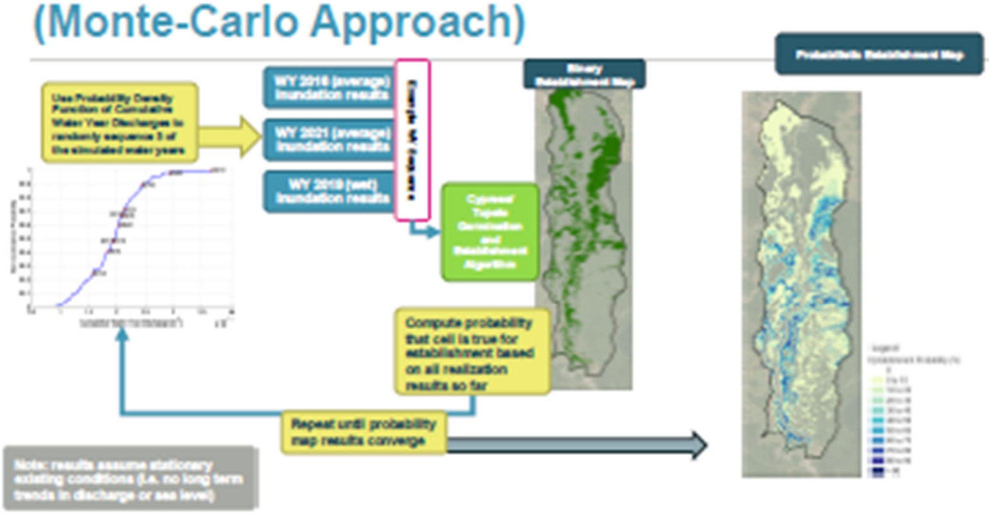
Floodplain conservation in the Mississippi River Valley: combining spatial analysis, landowner outreach, and market assessment to enhance land protection for the Atchafalaya River Basin, Louisiana, U.S.A.

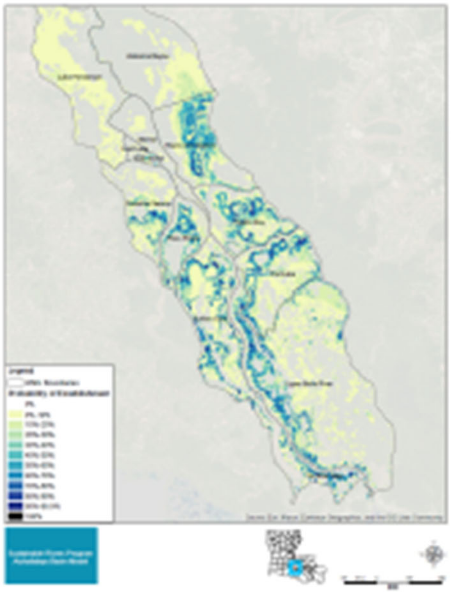
Areas considered optimal for baldcypress regeneration were defined as those exposed to 100–180 CDD during the growing season. Areas having <100 CDD were considered too wet to support baldcypress regeneration. Areas having >180 CDD were assumed to offer a competitive advantage to bottomland hardwood species and would not likely support baldcypress or water tupelo over the long-term.

Baseline Conditions Runs



Probabilistic Establishment Estimates (Monte-Carlo Approach)

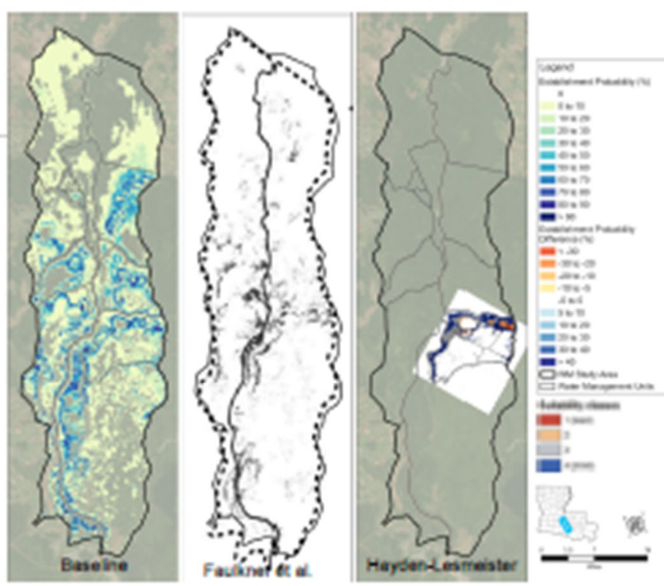




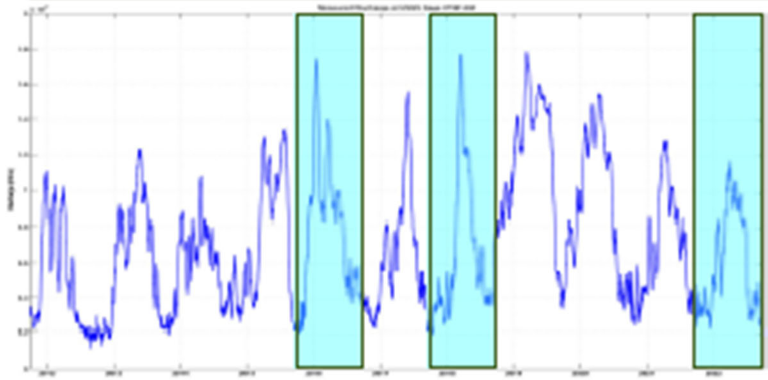
Baseline Establishment Probability

- Monte Carlo Run
  - 1000 3-yr sequences
  - Converged to < 0.05% change in probability for all areas with each additional sequence
- Ares with high probability of establishment (PoE)
  - Bayou DeGlais
  - Pigeon Bay
  - Levees and banks in:
    - Flat Lake
    - Beau Bayou
    - Upper Buffalo Cove
    - Chico Pass/Grand Lake

Literature Comparison



Maximum Establishment: Baseline

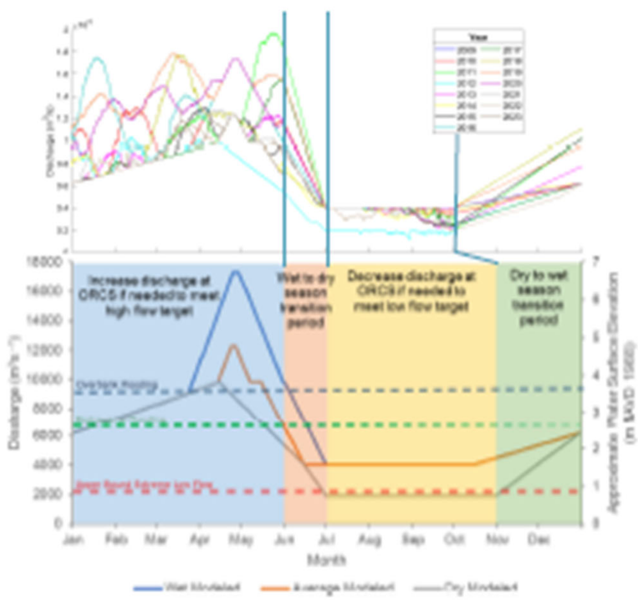


- Baseline - 773km^2 - 2022, 2018, 2016
- Germination
  - Driven by years with extended low flow
- Flood Competition & Non-submergence
  - High flow balance achieved by relatively brief but extreme spring peaks

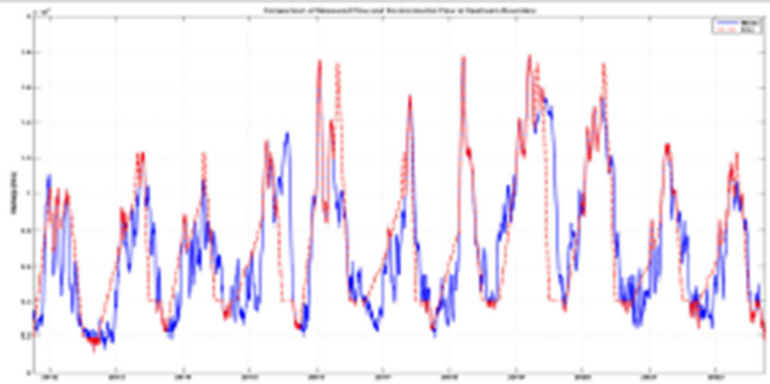
Environmental Flow Processing

- Kozak et al. 2016 flow regime applied to measured discharges
- Modified to begin decreased discharge on 7/1 for all years
- Modified to begin dry to wet transition in October to align with water year (annual run start)

Flow Targets	Water Year Classification	Timing/Duration	Stage at [illegible]	Approximate Discharge at [illegible]	EIR Environmental Flow Component
[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Low flow
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	High flow
[illegible]	Average	[illegible]	[illegible]	[illegible]	High flow
[illegible]	Wet	[illegible]	[illegible]	[illegible]	High flow
[illegible]					
[illegible]	Dry, average	[illegible]	[illegible]	[illegible]	Low flow
[illegible]	Wet	[illegible]	[illegible]	[illegible]	Low flow
[illegible]					
[illegible]	Average	[illegible]	[illegible]	[illegible]	[illegible]
Small flood	Wet	[illegible]	[illegible]	[illegible]	Small flood
[illegible]	Dry	[illegible]	[illegible]	[illegible]	[illegible]

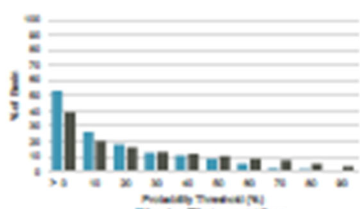


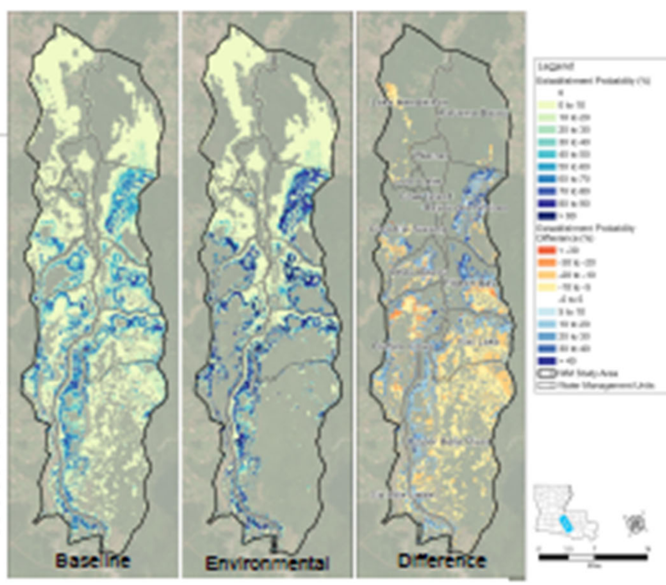
Environmental Flows Runs



Establishment Probability

- Increased probability of establishment for areas where establishment is already likely (>30% at baseline)
- Increased area of > 50% establishment probability
- Reduced total area of potential establishment



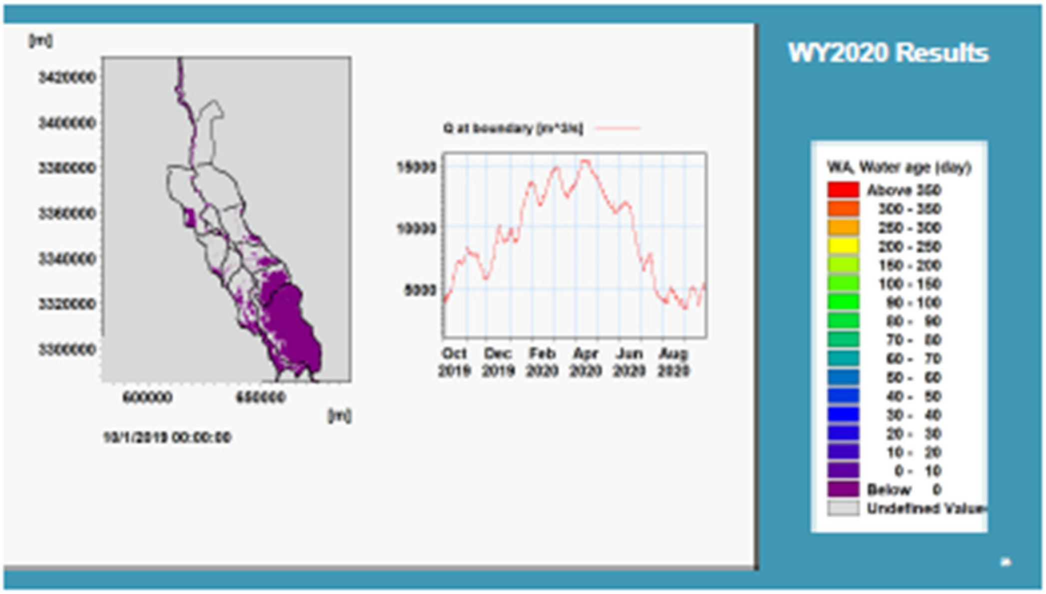


CTSEM Module Conclusions

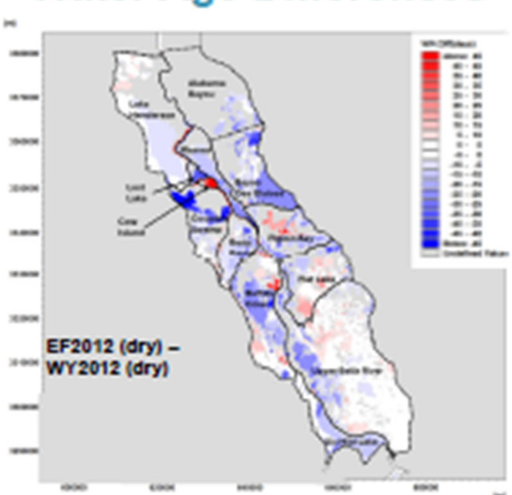
- High probability of establishment along channels & lakes
  - Probability increases with environmental flow implementation due to increased flooding of competing species
- Low but non-zero probability of establishment in backswamps & upper basin
  - Probability decreases with environmental flow implementation due to over-submergence of C/T
- Environmental Flows are overall beneficial for C/T ecology
  - Increase in probable (>50% probability) establishment areas
  - Most benefit from environmental flows during wet years
  - Ideal sequence includes extended dry season followed by two years with brief, extreme spring peaks

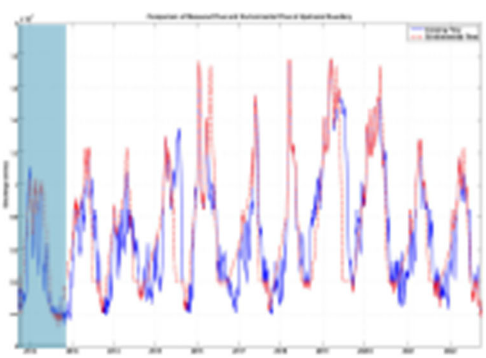
Future Refinements & Analysis

- Hydrodynamic Model
  - Investigate long-term trends with SLR & infilling
  - Monte-Carlo sequencing incorporating varying hydrograph topologies
    - Incorporate Morganza Spillway opening WY into production sequence
  - Consider operation changes at local control structures
- CTSEM Module
  - Investigate sensitivity to depth and duration thresholds
  - Incorporate water quality & flushing considerations
- Optimize environmental flow regime to maximize ecological benefit
  - Most potential for improvement for Dry and Average year prescriptions
  - Loss in southern portion driven by submergence and gains in central portions due to increased flood competition means maximizing establishment is a balance between too much and too little flooding
- Evaluate hydrologic restoration projects and use results to suggest areas where alternative local hydrologic controls could be beneficial

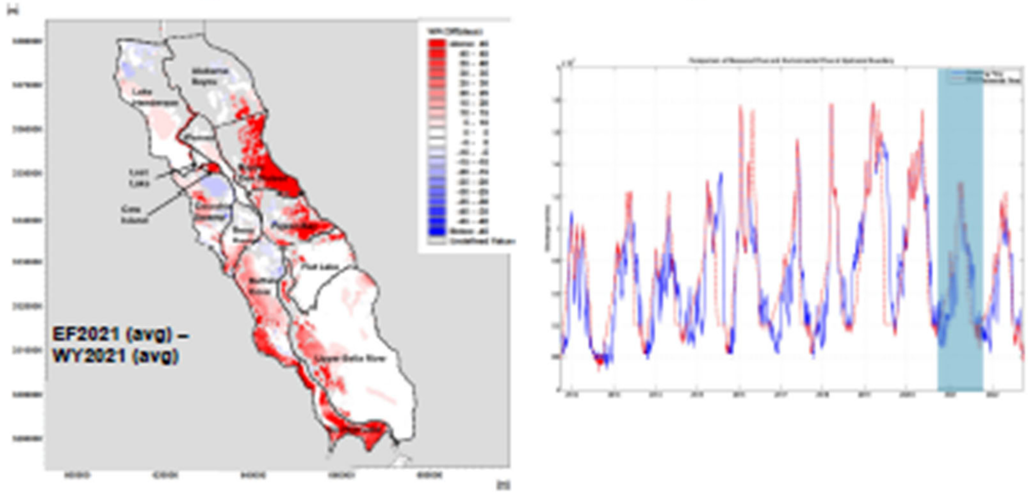


Water Age Differences – Existing vs. Env. Flow

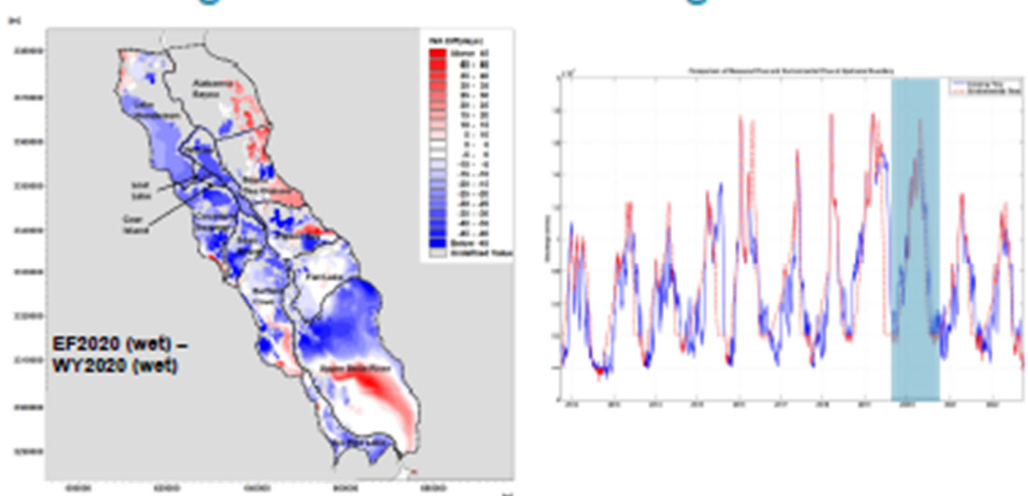


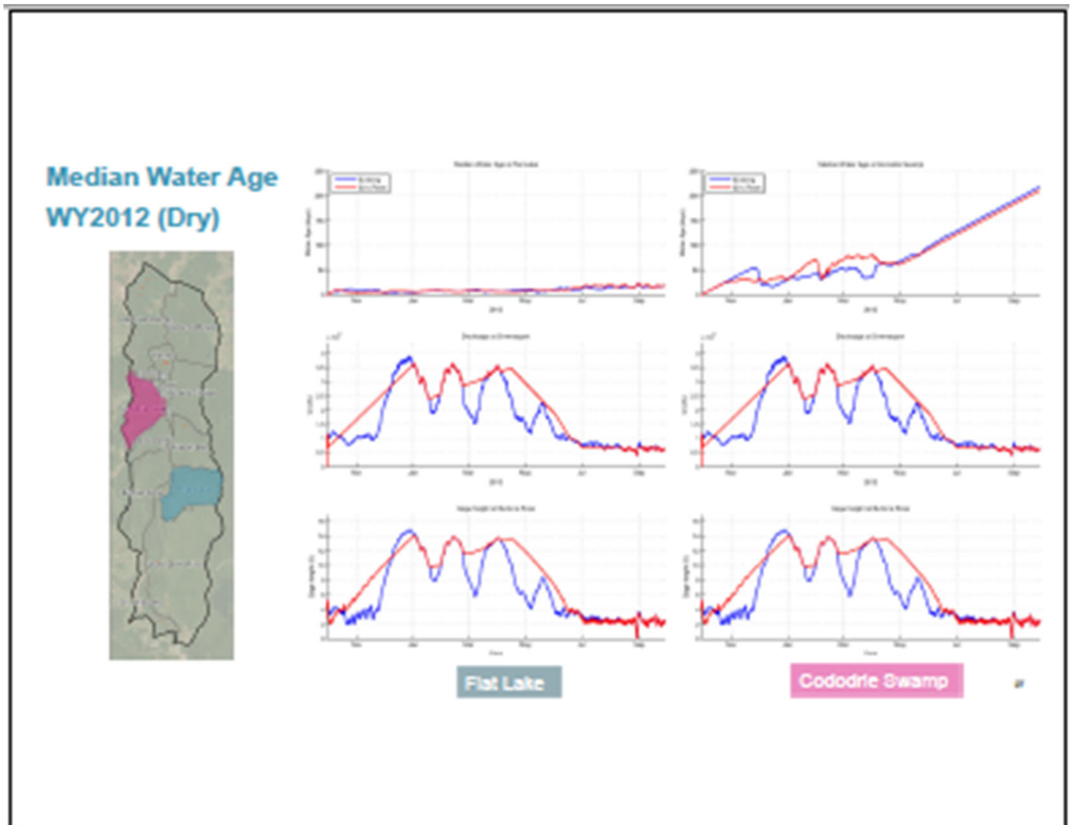


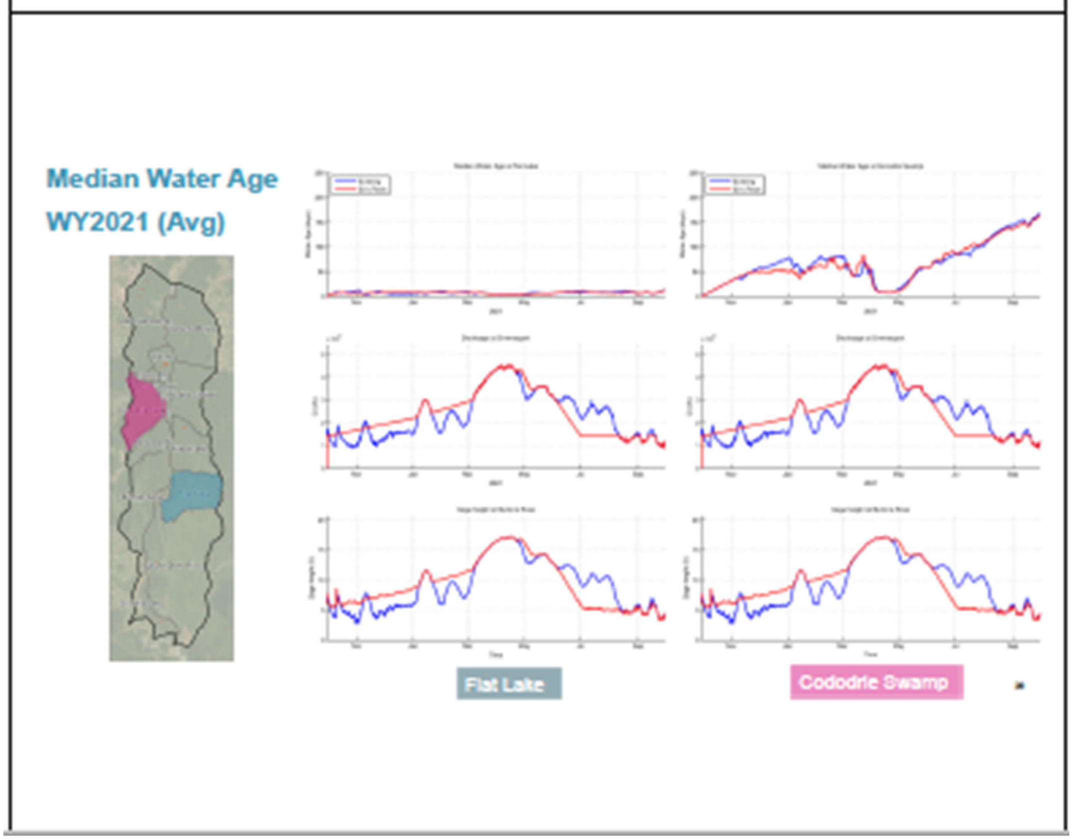
Water Age Differences – Existing vs. Env. Flow



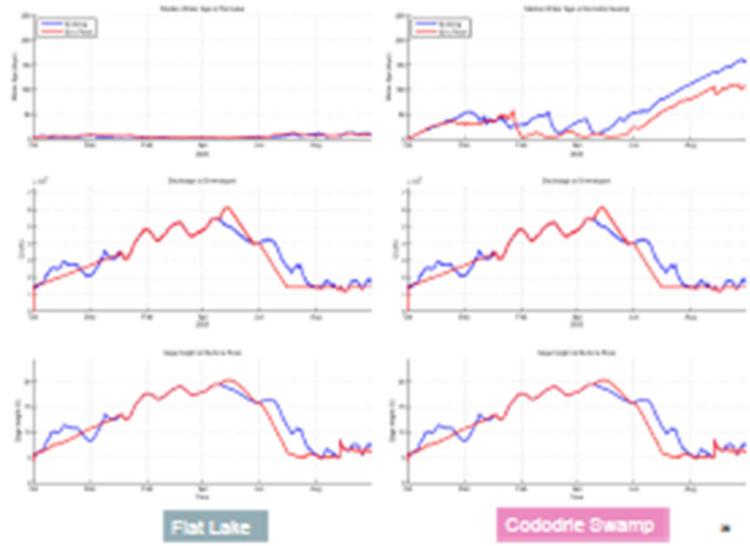
Water Age Differences – Existing vs. Env. Flow




Median Water Age
WY2012 (Dry)
Flat Lake
Cododrie Swamp


Median Water Age
WY2021 (Avg)
Flat Lake
Cododrie Swamp

Median Water Age WY2020 (Wet)



Open Discussion / Questions

REGIME PRESCRIPTION TOOL (RPT)

OVERVIEW AND DEMONSTRATION

What is the Regime Prescription Tool?

Hickey, John & Newbold, S. & Warner, Andrew. (2015). HEC-RPT - Software for Facilitating Development of River Management Alternatives. River Research and Applications. 31. 10.1002/rra.2745.

HEC-RPT — SOFTWARE FOR FACILITATING DEVELOPMENT OF RIVER MANAGEMENT ALTERNATIVES

J. T. HICKEY, S. J. NEWBOLD AND A. T. WARNER

ABSTRACT

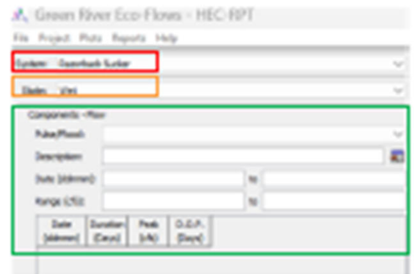
Facilitates information sharing between stakeholders and water managers

What is the Regime Prescription Tool?

- Visualization tool to help develop flow recommendations.
- Software designed to facilitate entry, viewing, and documentation of flow recommendations in real-time, public settings.
- Facilitates communications in group settings by allowing real-time recording and plotting of the recommendations as they are developed.
- Not intended to perform quantitative analyses but aims to complement other software by making it easier to create flow time series that other software packages can import and use in their analyses.
- Recommendations can be exported for analysis in other software.

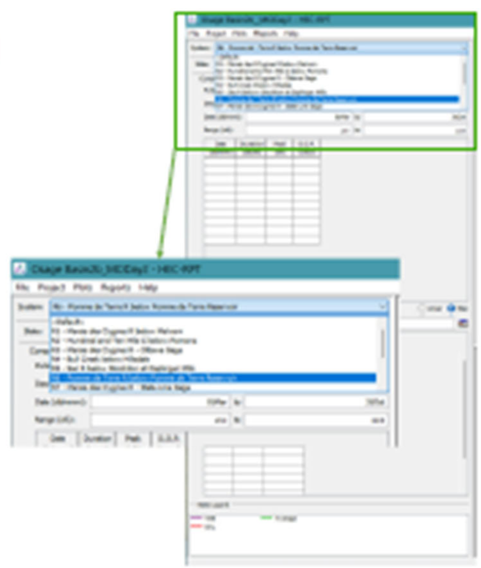
User Inputs/Definitions

- Systems (focus reach or reaches for ecology, river management objectives, etc.)
- States (hydrologic condition, i.e., wet, dry, average)
- Flow components (low flow, pulse flow, flood pulse)
  - Ecological/Environmental targets (e.g., Razorback Sucker)
  - Flow components targeting an ecological "window" (i.e., spawning, seed dispersal)



The Regime Prescription Tool
At a Glance

- Systems (focus reach or reaches for ecology, river management objectives, etc.)
- States (hydrologic condition, i.e., wet, dry, average)
- Flow components (low flow, pulse flow, flood pulse)
  - Base is low flow, foundation for the time series
  - *Ecological/Environmental targets*
    - Flow components targeting an ecological "window" (i.e., spawning, seed dispersal)



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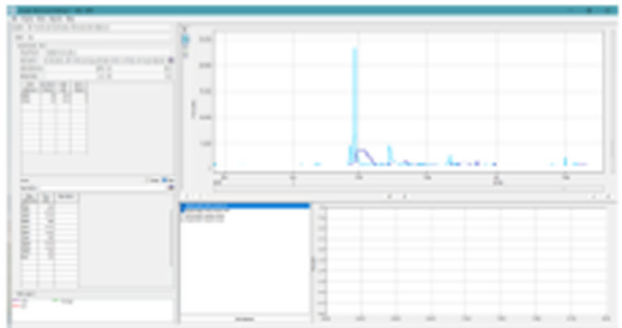

The Regime Prescription Tool
At a Glance

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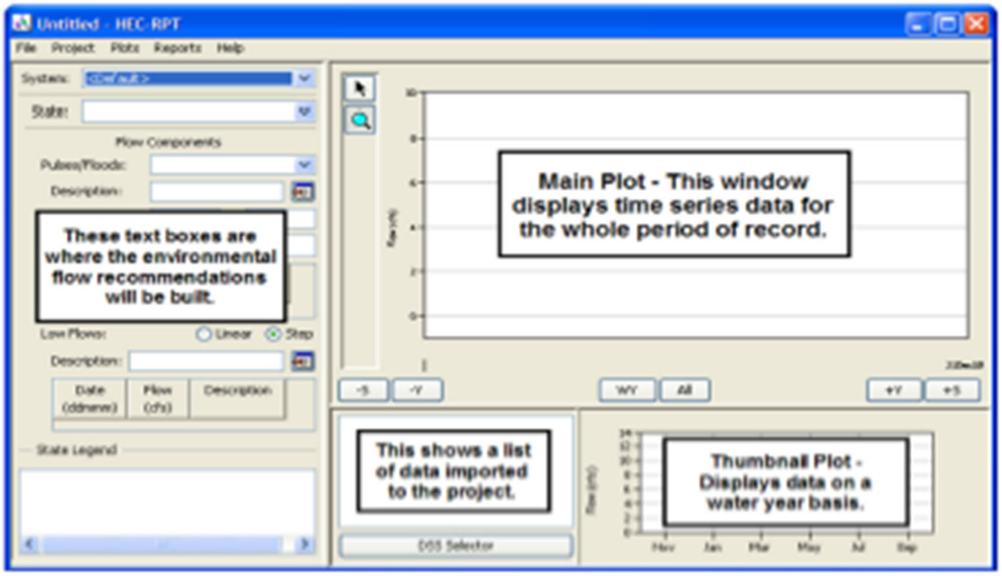
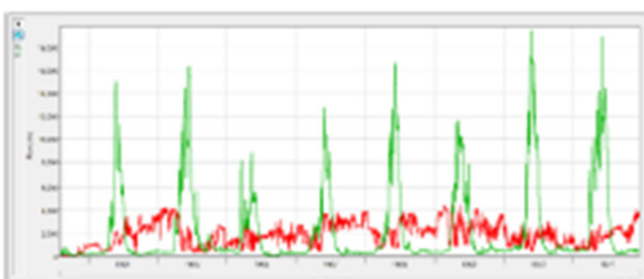
- States (hydrologic condition, i.e., wet, dry, average)
- **Flow components (low flow, pulse flow, flood pulse)**
  - **Base is low flow, foundation for the time series**
  - ***Ecological/Environmental targets***
    - **Flow components targeting an ecological "window" (i.e., spawning, seed dispersal, habitat forming flows)**



Data Used in the Regime Prescription Tool

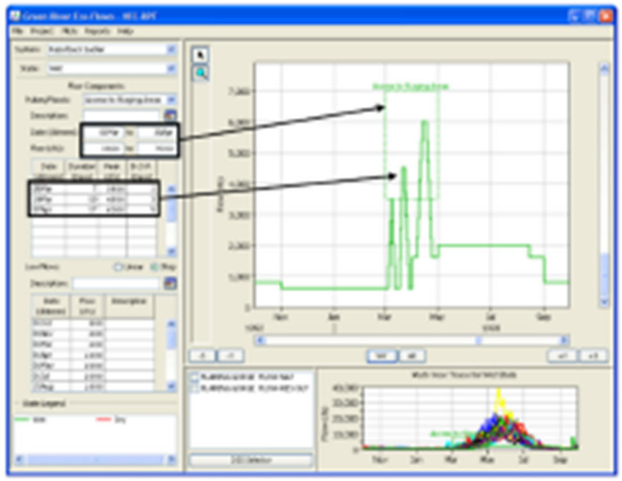
Two hydrographs:

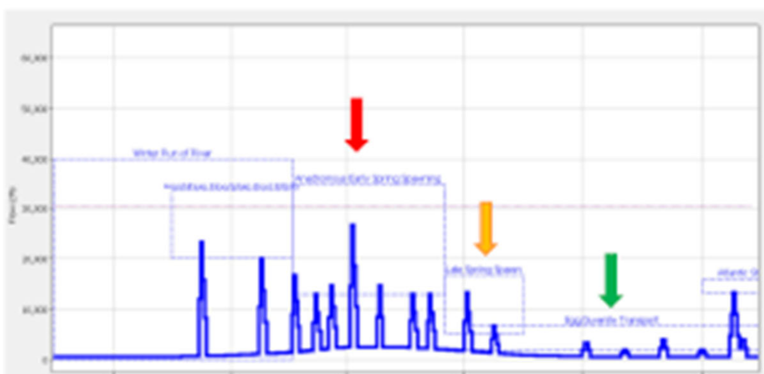
1. **Green** is the natural flow regime.
2. **Red** is the post-impact flow regime.



Example Output

- Plot windows respond to changes made to things like flow components, which makes RPT easy to experiment with and to learn.

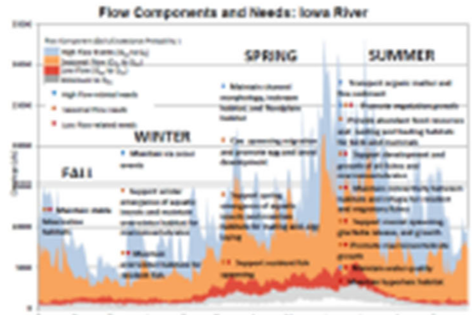




In this example, some of the flow components developed were to enable anadromous fish spawning conditions, late spring spawners, and help fish egg and juvenile fish transport down river.

https://www.hec.usace.army.mil/software/hec-rpt/

The Regime Prescription Tool
At a Glance - Outcomes



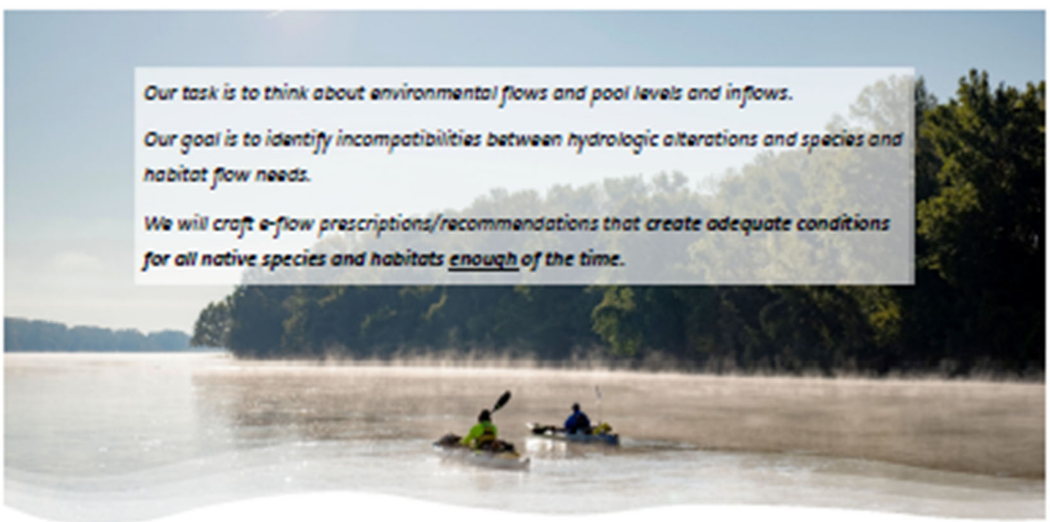
Think about biota – all life stages, habitat:

- What do we know?
- What do we need to know?
- How much low flow?
- How big does this flood need to be?
- How many high flood pulses are important?
- How long do they need to last?

- As a group, develop a flow prescription
  - *Components of the flow prescription*

- Summarize for the larger group the key components of and justification for flow prescriptions.

Don't focus on the constraints or limit your recommendations based on them!



Our task is to think about environmental flows and pool levels and inflows.

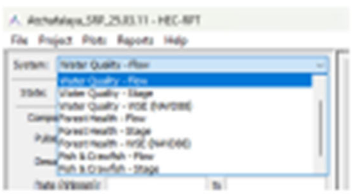
Our goal is to identify incompatibilities between hydrologic alterations and species and habitat flow needs.

We will craft e-flow prescriptions/recommendations that create adequate conditions for all native species and habitats enough of the time.

HEC-RPT File Creation (flow data that we will be using):
Colin Anderson (Moffatt & Nichol) and Joe Baustian (TNC)

HEC-RPT File Creation

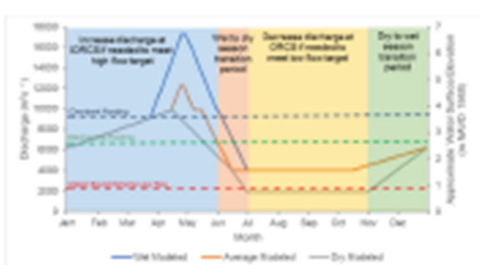
- Three HEC-RPT "Systems"
  - Water Quality, Forest Health, Fish & Crawfish
    - Stage, WSE, Flow

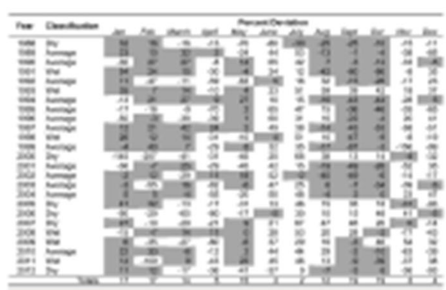


- Five data sources (1991 – 2025)
  - Old River Outflow Channel (USACE – 02600Q)
    - Combined discharge from Old River auxiliary control structure, Old River Lowsill, and the Hydro Electric Plant
  - Simmesport (USGS 07381490)
  - Butte La Rose (BLR) (USGS 07381515)
  - Environmental Flow Regime (Kozak et al., 2016)
  - Moffatt & Nichol modeled results
- Stage to WSE conversion (Kroes et al., 2022) & USACE; data prior to 2009 (Kroes)

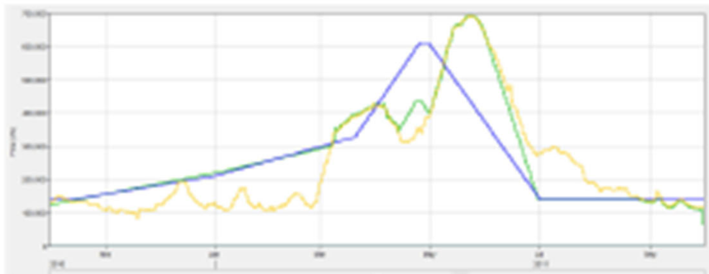
Environmental Flow Regime

- A proposed environmental flow regime to restore habitat within the basin
- Classified water years as wet, dry, and average for 1992 – 2012 (Kozak et al., 2016)
- Basis for M&N Environmental Flow modeling (2011 – 2022)



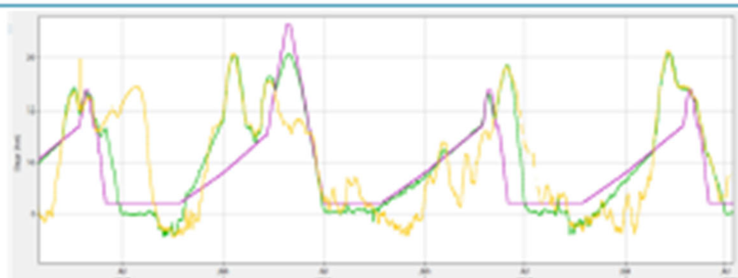


HEC-RPT: Flow

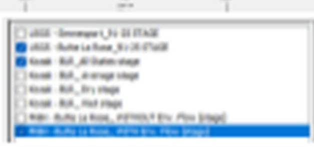


Simmesport Flow – Gold
Environmental Flow – Blue
M&N Environmental Flow - Green

HEC-RPT Stage & WSE



BLR Stage – Gold
BLR Environmental Stage – Purple
M&N Environmental Flow - Green



Citations

- Kozak, et al. (2016). Towards dynamic flow regime management for floodplain restoration in the Atchafalaya River Basin, Louisiana. *Environmental Science & Policy*, 118-128.
- BLR datum conversion
  - Kroes et al., (2022) Hydrologic connectivity and residence time affect the sediment trapping efficiency and dissolved oxygen concentrations of the Atchafalaya River Basin. *Water Resource Research*
- USACE – Simmesport data and datum conversion
  - https://rivergages.mvr.usace.army.mil/WaterControl/stationinfo2.cfm?sid=03045&fid=MLVL1&dt=S

Additional Resources

Appendix B: [illegible]

	Discharge (m³/s)	Stage (m)
Extreme low flow	[illegible]	[illegible]
Low flow	[illegible]	[illegible]
High-flow pulse	[illegible]	[illegible]
Small flood	[illegible]	[illegible]
Large flood	[illegible]	[illegible]

Table 2: The environmental flow prescription for the Atchafalaya River Basin, Louisiana. [illegible]

Flow Targets	Water Year Classification	Timing/Duration	Stage of BLR (m)	Approximate Discharge at Simmesport (m³/s)	IHA Environmental Flow Component
Flood Season					
Early January minimum flow	All	By January [illegible]	2.7	[illegible]	Low flow
Mid-April minimum flow	All	By April 15	4.3	[illegible]	High flow
May 15 minimum flow	Average	Through May 15	4.3	[illegible]	High flow
June 1 minimum flow	Wet	Through June 1	4.8	[illegible]	High flow
Dry Season					
Maximum flow	Dry, average	June 15-October 15	[illegible]	[illegible]	Low flow
Maximum flow	Wet	July 1-October 15	[illegible]	[illegible]	Low flow
Pulses, Floods, Reductions					
Spring high flow	Average	[illegible] days between March 15 and May 15	[illegible]	[illegible]	High flow pulse
Small flood	Wet	[illegible] days between March 15 and May [illegible]	[illegible]	[illegible]	Small flood
Flow reduction	Dry	July 1 - October [illegible]	[illegible]	[illegible]	Extreme low flow

Additional Resources

Table 1. Environmental flow recommendations from scientific literature and reports for the Atchafalaya River Basin used to create the environmental flow prescription in this study.

Source	Purpose	Hydrologic needs of environmental objective
[illegible] et al. 1976	Habitat diversity	Minimum of 7 months of flooding for areas to be dominated by cypress-tupelo
Bryan et al. 1998	Ideal watering and dewatering cycle	In Lower Atchafalaya Floodway: 2.7 m at Butte LaRose by early January, increase to 6.2 m by mid-April; reduce water levels to 1.5 m by mid-June. Prolonged dry periods should coincide with natural climatic drought cycles
Sabo et al. 1999	Hypoxia reduction, aquatic and forest productivity	Annual flood pulse should occur when temperatures are below the median. Low water levels should occur during high temperatures; prolonged low water levels beneficial to aquatic and forest productivity
[illegible] the Basin Committee 2003	Water quantity and quality, socioeconomics	Water begins to flow into backswamp areas at 3.7 m, good overbank flow at 5.2 m. Introduce additional flow January-April if water temperatures are below 20°C; avoid additional flow May-December
Keim et al. 2006	[illegible] forest productivity and regeneration	[illegible] regeneration potential. Widespread artificial planting possible at [illegible] m at Butte LaRose
Hupp et al. 2008	Sedimentation and inundation patterns	Study sites in Lower Atchafalaya Floodway experienced flooding in backswamp areas at 2.8 m at Butte LaRose and banks were overtopped around 3.7 m
Faulkner et al. 2009	Cypress-tupelo natural regeneration potential	Prolonged extreme low-flows ([illegible] m at Butte LaRose) maximize natural and artificial regeneration potential of cypress-tupelo forests
Louisiana Crawfish Promotion and Research Board 2009	Socioeconomics, crawfish harvest and production	Water begins to flow into backswamp areas at 3.7 m at Butte LaRose, good overbank flow at 5.2 m. Crawfish benefit from 3 month summer drought and floodwaters in mid-winter
Alford and Walker 2013	Fisheries production	3.6 m flood stage at Butte LaRose beneficial for fisheries production; 6.1 m flushes hypoxic water and sediment in some areas, deposits sediments and nutrients in others. Fisheries production optimized with approximate stage of [illegible] m for 4.5 months during winter-spring months