SUPPORTING NATURAL COMMUNITIES OF THE MIDDLE CACHE RIVER THROUGH CO-MANAGEMENT

A REPORT OF THE CACHE RIVER WETLANDS JOINT VENTURE PARTNERSHIP

Authors: Patricia Heglund [1], Tracy Boutelle Fidler [2], Doug Blodgett[3], Steve Shults [4], Mike Brown [5], Kathleen Burchett [6], Jody Shimp [7], David Webber [8], John Schuler [9], Mark Guetersloh [10], Gwen White [11]

[1] Patricia Heglund, U.S. Fish and Wildlife Service, 2630 Fanta Reed Rd., La Crosse, WI 54603.

[2] Tracy Boutelle Fidler, Shawnee Resource Conservation and Development (representing The Nature Conservancy), Simpson, IL 62985

[3] Doug Blodgett, The Nature Conservancy, 11304 N. Prairie Road, Lewistown, IL 61542

[4] Steve Shults, Illinois Department of Natural Resources, 11731 State Highway 37, Benton, IL 62812

[5] Mike Brown, U.S. Fish and Wildlife Service, Cypress Creek NWR, Ullin, IL 62992

[6] Kathleen Burchett, U.S. Fish and Wildlife Service, Crab Orchard – Cypress Creek NWR Complex, Marion, IL 62959

[7] Jody Shimp, Illinois Department of Natural Resources, 11731 State Hwy 37, Benton, IL 62812

[8] David Webber, Natural Resources Conservation Service, 502 Comfort Drive, Suite E, Marion, IL 62959

[9] John Schuler, Natural Resources Conservation Service, 502 Comfort Drive, Suite A, Marion, IL 62959

[10] Mark Guetersloh, Illinois Department of Natural Resources, 0139 Rustic Campus Drive, Ullin, IL 62992

[11] Gwen White, U.S. Fish and Wildlife Service, Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative, Bloomington, IN 47403

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EXECUTIVE SUMMARY

A working group of the Cache River Wetlands Joint Venture Partnership (JVP) for the middle Cache River region of Illinois proposed and ranked a set of 34 potential conservation actions that would:

1) Improve the management capability needed to restore and protect ecosystem health

2) Protect or enhance the existing biological integrity and diversity of the middle Cache River, while,

3) Ensuring the system provides compatible recreation opportunities.

The working group, including representatives from Illinois Department of Natural Resources, Natural Resources Conservation Service, The Nature Conservancy and U.S. Fish and Wildlife Service, was established to address management goals for a portion of the Cache River. The area of consideration included the reach from the Post Creek Cutoff, east of the town of Karnak, IL, west to Big Creek near Ullin, IL (hereafter referred to as middle Cache River). Initially, 34 projects were proposed. Similar projects were combined, leaving 28 projects. They are listed in order of importance in Appendix D.

The JVP recognizes there are additional management objectives beyond supporting biodiversity and compatible recreation for this section of the river, including drainage and flood protection. While important to the JVP, addressing such non-biodiversity needs were not the focus of this process, but non-biodiversity related needs were considered to ensure negative impacts would be minimized or avoided by the recommended management actions. Many of the proposed actions discussed in this report should result in improved drainage, flood protection and recreation.

INTRODUCTION

A working group of the Cache River Wetlands Joint Venture Partnership (JVP), including representatives from Illinois Department of Natural Resources, Natural Resources Conservation Service, The Nature Conservancy and U.S. Fish and Wildlife Service, engaged in a process to address management goals for a portion of the Cache River. The area of consideration ranged from the Post Creek Cutoff, east of the town of Karnak, IL, west to Big Creek near Ullin, IL (hereafter referred to as middle Cache River; Fig. 1). The group focused on management concerns expressed by various members of the JVP working group during several teleconferences and two workshops (one held at Cypress Creek National Wildlife Refuge/Shawnee Community College in Ullin, Illinois in June 2014 and one held at Crab Orchard National Wildlife Refuge's Visitors Center in Marion, Illinois in October 2014). Their goals were to:

1. develop a common understanding about the presettlement conditions for the middle Cache River and, in particular, the lower Cache River Land and Water Reserve, a National Natural Landmark, referred to locally and hereafter as Buttonland Swamp;
2. develop a shared understanding of the desired future condition for portions of the middle Cache River;
3. identify potential management actions for the middle Cache River region;
4. outline each agency's role in fulfilling those management goals; and to
5. recommend potential management actions considered important for obtaining the desired future condition for the middle Cache River region to the JVP.

A fundamental goal of the JVP is to preserve, restore and support the natural communities of the region and to restore ecosystem function to the extent possible. Additionally, the JVP wants to ensure that agricultural and social resources are considered in management of the area. All working group members agree that an essential component of the restoration effort is to improve the hydrologic functioning of the middle Cache River.

During the next 10-15 years, the JVP will implement a jointly crafted set of recommended conservation actions for the middle Cache River to protect the existing native biodiversity and restore, to the extent practical, ecosystem processes in the middle Cache River region.

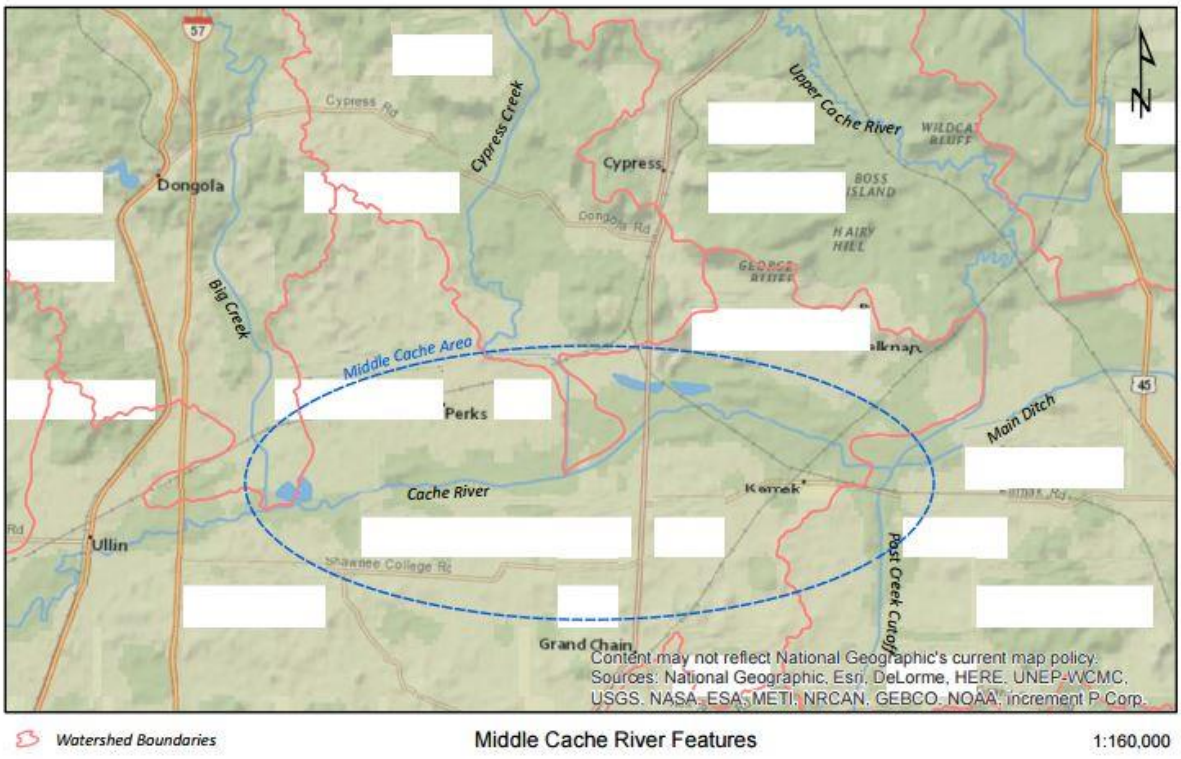

Figure 1. Area discussed in this report, the middle Cache River region of southern Illinois, 2015. The area of consideration ranged from the Post Creek Cutoff, east of the town of Karnak, IL, west to Big Creek near Ullin, IL (See area encircled on the map).

This report provides a summary of the discussions held during the past year and a set of recommended actions for the river and surrounding watershed that, when implemented, would support the existing natural communities of the area and improve the ecological functioning of the system. These recommendations serve as a guide for members of the JVP who will work within their individual authorities to take further supportive action to improve the ecological condition of the middle Cache River. The JVP recognizes there are additional management objectives beyond supporting biodiversity and compatible recreation for this section of the

river, such as drainage and flood protection. While important to the JVP, addressing these needs were not the focus of this process.

BACKGROUND

The middle Cache River is one of Illinois' most important streams and "supports one of the most diverse assemblages of fauna found in any area of the state" (Illinois Department of Natural Resources 1997). The region contains important forest and wetland resources that have been recognized nationally and internationally with multiple designations: a National Natural Landmark (the Lower Cache River Swamp), an Illinois Land and Water Reserve, a Wetland of International Importance (Ramsar Convention 2009). It also is part of the Cache River State Natural Area and Cypress Creek National Wildlife Refuge. However, maintaining the biological diversity of the area is a huge challenge. Changing land use practices and multiple hydraulic alterations to the river and its tributaries during the last century have significantly affected the biological diversity, ecological integrity and functioning of the system (Demissie et al. 2010). Natural resource professionals striving to improve, protect, and restore the river's biological integrity and ecosystem health share a similar vision for the Cache River Watershed. However, resource professionals are unsure about the restorability of certain locations in the middle Cache River, which makes it difficult for partners to coordinate management actions in the river system.

Of the many hydraulic changes to the system, the most influential change occurred when the upper Cache River was severed from the lower portion of the river, forcing its headwaters to drain into the Ohio River via the Post Creek Cutoff (Fig. 2). This segregation altered the timing, frequency, volume, velocity and direction of flow of water in the lower Cache River, effectively eliminating the major formative processes upon which the system depended (Illinois Department of Natural Resources 1997, Demissie et al. 2008).

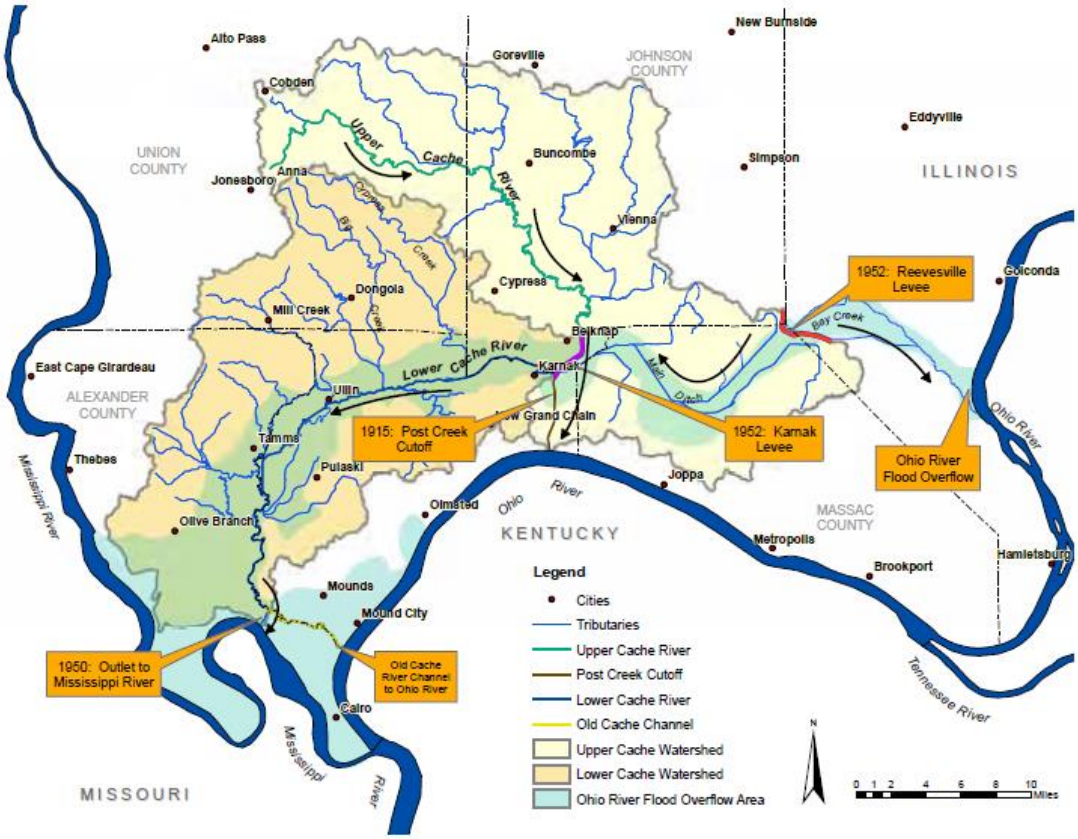

Figure 2. Major changes to the hydrological flow of the Cache River that resulted from the decoupling of the upper Cache River from the lower Cache River (From Demissie et al. 2008).

In the early 1990s, the JVP developed plans to restore a more natural hydrology between the upper and lower Cache River, ensuring a more reliable east-to-west flow of water in this section of the river. This action is often locally referred to as a “reconnection,” though the proposed project would only restore limited water flow. Restoring limited flow in the middle and lower Cache River would be especially beneficial during summer low flow periods. If executed, this project would improve water flow and connectivity between the upper and middle segments of the river, bringing additional dissolved oxygen and nutrients to the system and improving water management capability. The working group agrees that restoring water flow will benefit natural resources of the lower Cache River.

The completion of two reports by the Illinois State Water Survey (Demissie et al. 2008, Demissie et al. 2010) moved the reconnection initiative closer to implementation. The initial plan called for creation or modification of adjustable structures for improved water level management (USACE 2000, Cache River Wetlands Joint Venture Partnership 2014). However, as the partial reconnection concept progressed, a divergence of opinion developed regarding water level management until reconnection could be achieved. The divergence then focused on current management of the middle Cache River, an approximately 2.5 mile section of the river between the Post Creek Cutoff and the mouth of Big Creek.

The JVP agreed to pursue ecological restoration of the middle Cache River, including partial reconnection of the upper and lower river segments (Cache River Joint Venture Partnership 2014). In this 2014 report, the JVP briefly reviewed the ecological condition of the middle Cache River from the Post Creek Cut Off (located east of Karnak, IL) to just below Cache Chapel Road and agreed to implement a series of conservation measures. Within this report, our working group identifies the primary areas of concern among the group members and proposes watershed-scale management recommendations to help sustain biological diversity and improve the ecological functioning of the middle Cache River region.

In addition, the partners agreed to jointly explore future water level management of Buttonland Swamp at a later date. The partners will examine the objectives, management alternatives, and tradeoffs among alternative management actions for the Buttonland Swamp area. They will evaluate the consequences associated with specific actions, and the potential for establishing an adaptive management framework to promote learning in the event that desired future conditions are not being achieved. The outcomes of this work will be captured in a second report from the working group.

CURRENT CONDITIONS

CONSERVATION ESTATE

Within the Cache River Watershed, Illinois Department of Natural Resources, The Nature Conservancy and U.S. Fish and Wildlife Service own land for natural resource protection.

Natural Resources Conservation Service supports conservation through a variety of programs, such as the Wetland Reserve Program (now the Agricultural Conservation Easements Program (ACEP)). Conservation lands form a state natural area, preserve, refuge, and privately restored wetlands. They are:

- The 6,391ha Cache River State Natural Area spans Johnson, Massac and Pulaski counties and includes three distinct management units, which are Little Black Slough, Middle Cache River Swamps and Glass Hill. The lower Cache River swamps management unit includes high quality wetlands, such as Buttonland Swamp.
- The 1,155ha Grassy Slough Preserve, The Nature Conservancy's signature project in the Cache River Wetlands, once was mostly forested wetland and efforts are underway to restore the site to some semblance of its original condition.
- The 6,475ha Cypress Creek National Wildlife Refuge is located in southern Illinois just north of the confluence of the Ohio and Mississippi rivers. It includes seven management units; the Cache River unit encompasses a small portion of the Buttonland Swamp and lands that buffer it.
- The 5,463ha of privately restored wetlands through the Natural Resources Conservation Service's Agricultural Conservation Easements Program are in key locations throughout the watershed.

Also through the Natural Resources Conservation Service (NRCS), landowners are using a variety of conservation practices, such as conservation tillage, buffer strips, grassed waterways and reforestation. Many of these practices are through NRCS' Environmental Quality Incentive Program and Wildlife Habitat Incentive Program. In all, more than 18,210 hectares of private lands in the Cache River Watershed are using some sort of NRCS conservation program.

WATER RESOURCES

The Cache River has been dissected into three segments. The upper Cache drains into the Ohio River through the Post Creek Cutoff. The middle Cache drains through a diversion to the Mississippi River; it also can drain into the Post Creek Cutoff because of the breach in the Karnak Levee. The lower Cache, a section of the river that was abandoned when the diversion was constructed, drains into the Ohio River. (See Fig. 2 for graphic showing major river

modifications). The dissection of the upper Cache from the middle and lower Cache River has put the biodiversity and ecological integrity of the system at risk. Unnatural reductions in the volume, frequency and timing of water flow negatively affect biotic and abiotic processes that in turn affect wetland and aquatic communities (McKay and King 2006, McIntosh et al. 2002). For example, low oxygen levels in the river have been documented, including frequently hypoxic conditions that have led to fish kills (Rantala et al. 2013). Duckweed (*Lemna minor*) cover has increased in the system, likely due to reduced flow and high nutrient levels (Giblin et al. 2014), lowering dissolved oxygen levels (Houser et al. 2013) as plants respire and senesce (Parr and Mason 2003).

Scouring and deposition of sediments during flood events historically formed a meandering, braided river system where "the real channel, [was] scarcely to be defined" (Cache River Drainage Commissioners of Illinois 1905). Extreme flood events and higher velocity flows continuously carved new channels and back waters and sculpted contours in the river bed. This erosion and deposition of sediments formed the basis for the natural communities found in the middle Cache River today. Overall, an altered water regime and increased sedimentation, primarily due to human activities, have affected natural communities of the middle Cache River.

The modern Ohio River flooded the Cache every nine to 18 years prior to the construction of the Reevesville and Karnak levees (Gough 2005). Furthermore, sediment carried in via channelized tributaries has filled old channel scars and other river bottom contours. Continuing sedimentation, low dissolved oxygen, lack of flowing water and deep (>.6 m) and prolonged, or continuous flooding can affect bald cypress (*Taxodium distichum*) mortality (Penfound 1949, Eggler and Moore 1961), recruitment (Williston et al. 1980), and vigor (Dickson and Broyer, 1972, Bratkovich et al. 1994, Hooker and Rogers 1994, Middleton and McKee 2005, Keim and Amos 2012). In addition, modifications to the river also affected fish assemblages (Pitts et al. 2011; Bouska and Whitledge 2014, mussels (INHS 2011), and invertebrates (Rantala et al. 2013) historically associated with these habitats.

Today, concerns about the loss of structural diversity resulting from these perturbations are commonly voiced. Even the existing Cache River channel in the Buttonland Swamp area of the middle Cache River is "probably a remnant of … channelization and dredging" in the 1960s

(Demissie et al. 1990) with altered abiotic processes (i.e., hydrology, sediment deposition) that structure aquatic and plant communities (Oswalt and King 2005).

A variety of other factors influence water in the middle Cache River. Since the division of the Cache River basin into two watersheds, the middle Cache only receives flow from the upper Cache River during large flood events. During low or moderate flows, the middle Cache River section east of the mouth of Cypress Creek cannot sustain flow to the west, the former downstream direction (Demissie et al. 2008). From roughly the confluence of Cypress Creek and Cache River, water flows eastward and out through the breach in the Karnak Levee and into the Post Creek Cutoff, effectively de-watering this section of the river and leaving it completely dry during summer months.

Tributaries to the middle Cache River have had their hydraulics directly modified and their water quality negatively affected by surrounding land-use practices. These tributaries — especially Big Creek — are now the main source of sediment for the middle Cache River (Demissie 1989). Conservation projects in the Big Creek tributary purportedly have resulted in substantial reductions in the amount of sediment entering the middle Cache. Initially, when the authors of this report reviewed recent aerial photographs, visual cues suggested that Limekiln Slough may also be a significant source of sediment to the middle Cache River (Appendix A – aerial mosaic of the middle Cache River) requiring further investigation. After review of Demissie (1989) and consultation with the USFWS Regional Hydrologist, we agree that Limekiln has limited sediment transport capabilities (Josh Eash, Pers. Comm. USFWS, Bloomington, MN).

Within the Cache River Watershed the placement of infrastructure such as culverts, roadways, bridge and railroad abutments, and water control structures have contributed to the reduction of velocity of flowing water and changes to historic deposition of sediment. West of Karnak Levee and the Tunnel Hill weir, two additional weirs influence water levels in Buttonland Swamp (Lower Cache River Swamp National Natural Landmark; Fig. 3), beginning near Route 37 and continuing west past Long Reach Road. Of these two weirs, IDNR manages one weir, and the second weir (the Diehl structure) is managed by IDNR through a memorandum of understanding with a private landowner, who has reserved ultimate authority on the structure's operation and maintenance. Currently, the Diehl Structure is performing as

designed, mitigating the speed of drying that results from drainage activities and extending the duration of the wet period, but is not capable of holding water in the system indefinitely. When water is above 328.4', it spills over the structure and flows west.

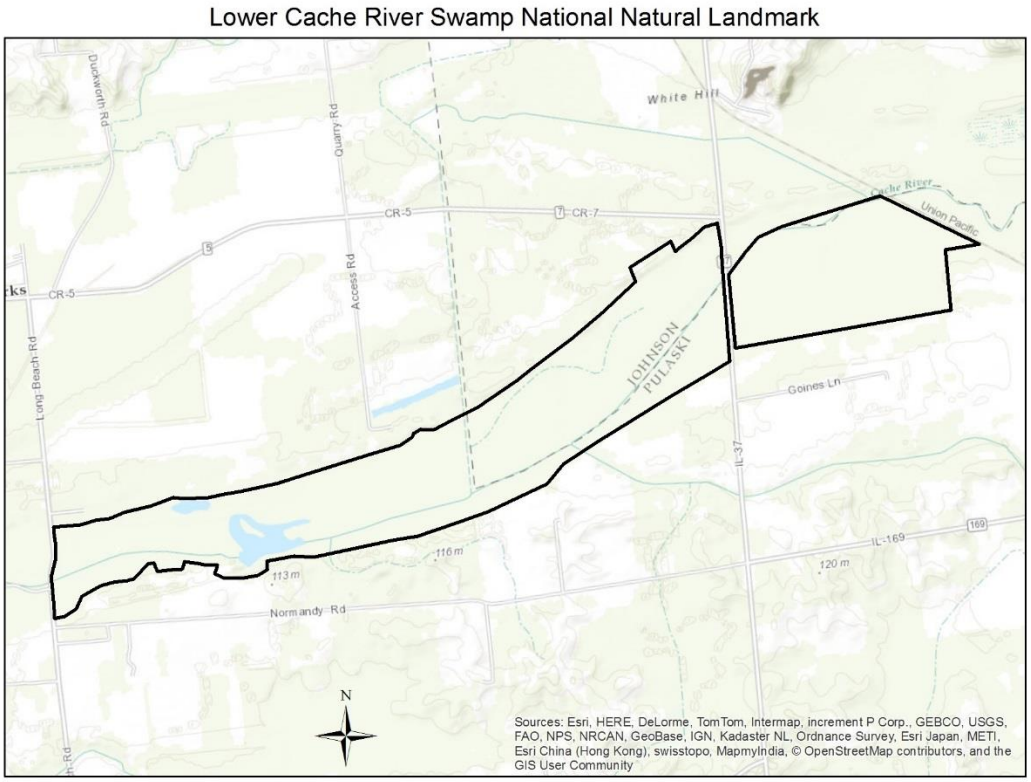

Figure 3. Location of the Lower Cache River Swamp National Natural Landmark, Cache River, IL.

BIOLOGICAL RESOURCES

In spite of all the changes to the system, the diversity of the Cache River area truly is impressive. Floodplain forests along the Cache River contain a greater variety of bottomland tree species than any other stream in Illinois (Illinois Department of Natural Resources 1997). Buttonland Swamp hosts bald cypress trees more than 1,000 years old, and 12 individual trees have been recorded as state champions (Illinois Department of Natural Resources 1997, Hayek and Roche 2013).

Reports from surveys conducted in the middle Cache River region list 86 species of freshwater fish, 230 macroinvertebrates, 10 crayfish and shrimp, 52 amphibians and reptiles (Phillippi et al. 1986), 23 mussels (Shasteen 2011), 128 breeding songbirds and 49 mammals (Illinois Department of Natural Resources 1997, Illinois Department of Natural Resources 2011). The Illinois Natural Heritage database records 99 species considered critically imperiled (66 classified as endangered, and 33 as threatened) in the Cache River Watershed (see Appendix B for complete list of species). Additionally, the region hosts a suite of species in greatest need of conservation (Appendix C). *The Illinois Comprehensive Wildlife Conservation Plan & Strategy* recognized the middle Cache River for its "small populations, declining populations, populations dependent on rare or vulnerable habitats, and indicative of the health and diversity of the state's wildlife and habitat resources." (Illinois Department of Natural Resources 2005).

One group of fish species in greatest need of conservation was the focus of a recent study. An analysis of fish in the Cache revealed that the bottomland guild, which depends on bottomland forests, is no longer intact. This is at least partially due to heavy sedimentation and hydrologic alteration of the river (Pitts et al. 2011, Bouska and Whitledge 2014). Preliminary data, collected during the summer of 2014, shows some of the species associated with low to no flow conditions (slack water) remain present in the Cache watershed; additional sampling and a final report is expected in late 2015 following additional spring sampling.

As a testament to the area's statewide significance, there are 62 sites within the Cache watershed recognized by the Illinois Nature Preserves Commission as important for their natural character, including eight dedicated Nature Preserves and 60 Illinois Natural Area Inventory sites. Although the Cache River basin makes up only 1.5 percent of the land area in Illinois, inventory results indicate that it contains 23 percent of the state's remaining high-quality barrens habitat, 11.5 percent of the high-quality floodplain forest habitat and 91 percent of the high-quality forested swamp (Illinois Department of Natural Resources 1997).

LEGAL CONTEXT

The Cache River Wetlands Joint Venture Partnership is composed of Ducks Unlimited Inc., Illinois Department of Natural Resources, Natural Resources Conservation Service, The Nature

Conservancy and U.S. Fish and Wildlife Service. Each of the five organizations, has a unique mission as follows:

- Ducks Unlimited Inc.: Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. These habitats also benefit other wildlife and people.
- Illinois Department of Natural Resources: To manage, conserve and protect Illinois' natural, recreational and cultural resources, further the public's understanding and appreciation of those resources, and promote the education, science and public safety of Illinois' natural resources for present and future generations.
    - Lands legally protected by the Illinois Nature Preserves Commission (INPC) are found within the middle Cache River. The mission of the INPC is to assist private and public landowners in protecting high quality natural areas and habitats of endangered and threatened species in perpetuity, through voluntary dedication or registration of such lands into the Illinois Nature Preserves System. The Commission promotes the preservation of these significant lands and provides leadership in their stewardship, management and protection. Lands can be protected through the INPC as an Illinois Nature Preserve, an Illinois Land and Water Reserve or Natural Heritage Landmark. The middle Cache includes lands protected through the Nature Preserve and Land and Water Reserve programs.
    - Nature preserves are managed to preserve and enhance natural communities and populations of native plants and animals typical of presettlement conditions, using a variety of management techniques. The objectives of the Nature Preserve System are (1) to provide habitat for native plants and animals, (2) to preserve adequate examples of all significant types of natural communities and features occurring in the State (3) to allow and facilitate, dependent upon the landowners' permission, the visitation of the nature preserves for nature observation, study, education, and aesthetic appreciation, in such manner and to such degree as will not modify natural conditions and (4) to provide perpetual protection for the preserve against intrusions.

- The Land and Water Reserves program protects and manages for lands and waters supporting significant natural heritage or archaeological resources. Examples of lands and waters eligible for registration are: (1) Lands and waters included on the Illinois Natural Areas Inventory, (2) habitats of state listed threatened species of animals or plants, (3) areas supporting unusual concentrations of wildlife such as nesting colonies; hibernating colonies; and migration stopover, feeding and rest sites, and (4) restorations of natural communities of plants and animals that existed in Illinois at the time of settlement by immigrants from Europe for which no high quality examples are known within the region.

- Natural Resources Conservation Service: NRCS is committed to "helping people help the land"—their mission is to provide resources to farmers and landowners to aid them with conservation. Ensuring productive lands in harmony with a healthy environment is their priority. With operations in the United States, the Virgin Islands, Puerto Rico, and Guam, their agency touches the lives of a diverse range of individuals.
- The Nature Conservancy: The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends.
- U.S. Fish and Wildlife Service: The U.S. Fish and Wildlife Service's mission is, working with others, to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.
  - The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.
  - U.S. Fish and Wildlife Service adheres to a biological integrity, diversity, and environmental health policy, which is an additional directive for refuge managers to follow while achieving refuge purposes and system mission. It provides for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems.

There are a series of structures and a levee controlling water movement within the middle Cache that have different ownership and management. They include:

- The Karnak Levee was constructed in 1952 for flood control by the Cache River Drainage District. In 1965, operation and maintenance was transferred to Big Creek Drainage District #2. Currently, a portion of the levee, located near the community of Karnak, has been breached, and the U.S. Army Corps of Engineers now considers it in "unacceptable" condition, meaning that it no longer is eligible for federal rehabilitation assistance under Public Law 84-99 for any flood related damages the levee might sustain in the future. The breached section of the levee originally included two 48" pipes, designed to handle local drainage. The single-directional culverts allowed local drainage to flow east to the Post Creek Cutoff/Ohio River but prevented upper Cache and Ohio waters from flowing west and entering the middle Cache River.
- An in-stream stabilization structure, located immediately west of Tunnel Hill Trail, was installed by IDNR at a crest elevation of 326' but has degraded to 324.7'.
- A second in-stream weir, located immediately west of Route 37, is owned and operated by IDNR. The crest elevation is permitted at 328.4', but has degraded to about 327.5'.
- A third in-stream weir is located west of Long Reach Road on private property. The weir, sometimes referred to as the Diehl Dam or the Diehl Structure, is cooperatively managed by IDNR and a private landowner, who has reserved ultimate authority for the structure's operation and maintenance. Its crest elevation is permitted at 328.4'.

CONSENSUS POINTS

The Background section of this document outlines areas of concern among the JVP that initiated the facilitated decision process described in this report so that participants could develop management options for a section of the middle Cache River (Note: Buttonland Swamp will be addressed at a future workshop). Through a series of teleconferences and workshops, participants either reached or re-affirmed mutual consent, or agreement on shared values for the areas, shared concerns about current or future management actions, and identified a

variety of potential restoration measures. The following list captures those points of agreement among partners.

1. The Cache River is a diverse, dynamic system, and, within that system, Buttonland Swamp is a unique and valuable resource that is special to many individuals. Lands within Buttonland Swamp are part of a National Natural Landmark, part of a Ramsar Convention wetland of international importance, and the area is designated as an Illinois Land and Water Reserve. The latter confers some legal protection. The registration agreement states the reserve was established for "the preservation and restoration of wetland and aquatic natural communities along the riparian corridor of the Cache River." Additionally, other lands in the middle Cache are afforded similar protection as an Illinois Land and Water Reserve. And, Section 8 Woods is an Illinois Nature Preserve, which provides an even higher level of protection.
    a. The community of bald cypress (*Taxodium distichum*) and tupelo (*Nyssa sylvatica*) trees found in this stretch of the river is very rare in Illinois, as is the deep water swamp, the only one of its kind in Illinois.
    b. Buttonland Swamp includes a unique assemblage of species. (See Appendix C for a list of species in greatest need of conservation).
    c. The habitat of a Southern deep water swamp is capable of supporting associated fishery (nursery and production).
2. The Cache River sports a diverse array of other natural communities/habitat types, and it is the desire of the working group that the ecological integrity of these communities and the greater watershed is restored to the greatest extent possible (Defined as: "…ecological systems, communities, and species…with sufficient natural composition, structure and function to persist over the long term" *From* Parrish et al. 2003)
3. Continuous flooding and stagnant water are not desirable for wetland communities, such as swamps that depend on seasonal and year-to-year variations in hydrology for growth and regeneration (Dicke and Toliver 1990).
4. Flowing water moves sediments out of the system, while also incorporating oxygen in the river. Both are needed for the health of the system.

5. Ideally the river channel should contain water in all but extreme drought conditions. Improving water flow and biological and hydrological connectivity between the upper and middle segment of Cache River could allow organisms to move between the two. Restoring a more natural hydrologic regime would provide for greater connectivity between the river and its floodplain.
6. The Cache River system once contained greater structural diversity such as meanders, deep water pools, riffles, etc., and there is a desire to restore some of that structure in the system. For example, previous dredging created unnatural banks that impeded connection with the floodplain – these banks could be removed. Restoring more natural contours (e.g. by dredging) within the Cache River channel and off-channel areas, especially where deeper pools historically were located, would remove deposited sediments and restore deep water refugia. Dredging would be particularly beneficial in the area known locally as Long Reach.
7. It is desirable to have the ability to periodically dry out certain natural communities, such as those found in Buttonland Swamp and Limekiln Slough, with the use of adaptively managed structures to achieve desired, yet-to-be-determined conditions. Participants agreed the desired periodicity and timing are unknown at this point. There was discussion that current structures could be used or a new/modified configuration could be employed to allow for greater flexibility in water level management, reducing potential conflict between partners by allowing some areas to be managed independently. The working group's desire was to improve the current hydrologic regime and associated flow with as little reengineering of the system as possible.
8. Some structures on the eastern end of the middle Cache River are acting as grade control structures due to stream instability introduced by the breach in the Karnak Levee. Those structures, including the Tunnel Hill bike trail, should be hardened so that this instability does not further threaten the river and adjacent natural communities.
9. The reduction of undesirable levels of sedimentation entering the middle Cache River via tributaries continues to be a priority.

10. There is interest in further investigating if the density of buttonbush affects recruitment or health of bald cypress, possibly through allopathic properties. Reducing the density of buttonbush has been discussed as a means of supporting tree regeneration, species diversity and improving water flow.

PATH TO A SOLUTION

DESIRED FUTURE CONDITIONS

When the group first met, participants agreed on the area of consideration, identified desired future conditions in the form of goals and objectives for the area, identified potential constraints, and set criteria by which to measure conservation success (Table 1).

Constraints/issues include:

- Managers only partially control the system's hydrology.
- Uncertainty regarding ecological functioning of the middle Cache River prior to river modifications (Fig. 2).
- Natural communities legally protected through the Illinois Nature Preserves Commission.
- North American Waterfowl Management Plan
- Farm Bill policies governing restoration and management actions
- Species recovery plans (e.g. Alligator snapping turtle)

Table 1. Cache River Joint Venture Partnership watershed objectives, criteria for success, general measures, and system drivers.

AGENCY	CRITERIA FOR SUCCESS	OBJECTIVES	METRICS	SYSTEM DRIVERS
Ducks Unlimited	Provide waterfowl and wetland waterfowl hunting opportunities	High quality habitat for waterfowl	Number of waterfowl species or waterfowl use days	Hydrology; food resting resources
U.S. Fish and Wildlife Service	Protect wetlands and bottomland hardwoods, biodiversity, endangered species. Provide for public access and recreational opportunities	High biological diversity (presettlement benchmark). Provide compatible recreational opportunities	Number of natural species/communities, community quality measure, Visitor satisfaction	Hydrology, management actions, system alterations, climate, weather
Illinois DNR (Illinois Nature Preserves Commission)	Protect State Natural Area resources and species of greatest conservation need. Ensure the natural quality of natural communities is not degraded. Passive forms of recreation are provided	Presettlement natural communities are protected, and they are healthy and have ecological integrity. Protect threatened and endangered species and species of greatest need of conservation. Provide for compatible recreation	% invasive species, water quality (DO, sediment contaminants), connectivity within the river, % fragmented. Mosaic of natural communities. Evidence of breeding success and dispersal.	Hydrology, management actions, system alterations, climate, weather
Natural Resources Conservation Service	Conservation on private land supports soil health, water quality, air quality, native biodiversity and ecosystems	Sedimentation and nutrients are controlled in Buttonland Swamp. Complementary conservation efforts are made on adjacent private lands, soils are healthy, Wetlands are restored	Soil health, reduce sedimentation and nutrient levels	Hydrology, system alterations
The Nature Conservancy	Protect and restore native biodiversity, as practical provide the full complement of native communities sustained by natural processes, large spatial scale and over time will allow for movement and evolutionary processes	Conservation targets are supported, threats minimized and supportive strategies are in place on the landscape. Support natural communities	Species abundance, species richness, species density. Habitat quality measures.	Hydrology, system alterations

The JVPs objectives are a reflection of the partners' collective values and are restated below as fundamental objectives in regard to desired future conditions (Fig. 4). They are as follows:

Fundamental objective 1: Restore and Protect Ecosystem Health of the middle Cache River Region

- Presettlement ecosystem functioning should be restored where practical
    - Historic hydrograph restored
        - water elevations, flow and timing should mimic presettlement conditions
    - Dynamic wet-dry cycles are restored
    - Dynamic river erosion-deposition processes restored
- Surrounding landscape supports and retains healthy soils
    - Sediment and nutrient inputs to the middle Cache River are reduced to presettlement levels

Fundamental objective 2: Protect Existing Biological Integrity and Diversity of the middle Cache River region

- Natural communities are represented and vigorous (as defined by the Illinois Natural Areas Inventory).
    - Swamp (Specifically, Southern Deep Water Swamp)
    - Shrub Swamp
    - Pond
    - Wet floodplain forest
    - Wet-mesic floodplain forest
    - Mesic floodplain forest
    - Southern flatwoods
    - Mesic upland forest
    - Dry-mesic upland forest
    - Spring
    - Low-gradient river

    - Low-gradient creek
- Conservation targets are represented and vigorous (per "Conservation targets, attributes," The Nature Conservancy 2012)
    - Bottomland Forests
    - Giant Cane
    - Cypress and Tupelo Swamp
    - Migratory Birds
    - Riverine Habitat
- State-listed Threated and Endangered Species are protected (See Appendix B for a complete list of species.)
- Species in Greatest Need of Conservation are protected
    - Large numbers of waterfowl and other migratory and resident birds
    - Natural riverine fish communities represented and healthy
    - Natural riverine invertebrates represented and healthy

Fundamental Objective 3: System provides for compatible recreation opportunities

- Hunting
- Fishing
- Paddling
- Hiking
- Bicycling
- Wildlife observation
- Photography

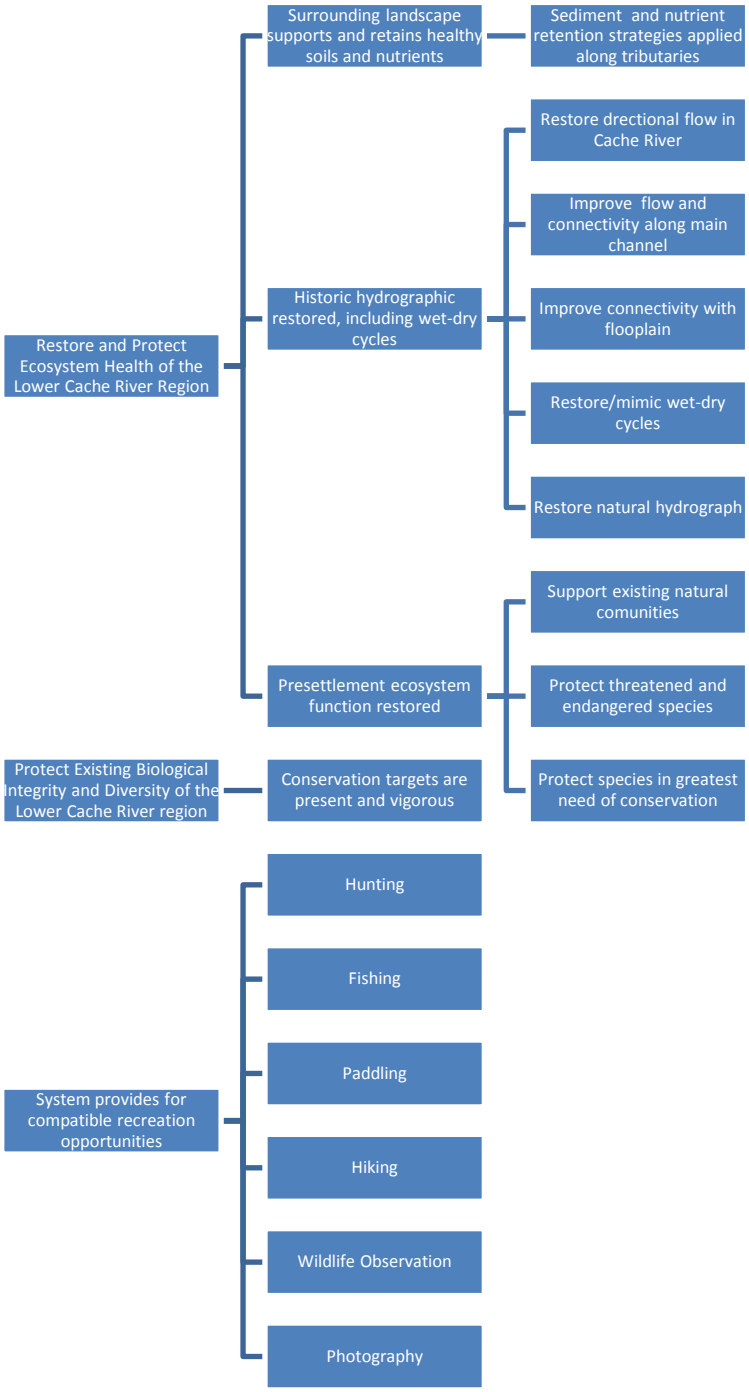

Figure 4. Initial objectives hierarchy for the middle Cache River based on the Cache River Joint Venture desired future condition. Most fundamental objectives are on the left. More detail about the fundamental objectives is provided on the right side of the diagram.

The fundamental objectives, including some that arose from the mission, policies, laws, mandates, and vision of each partner organization, are reflections of the values each organization and individual hold. This set of objectives is for the middle Cache River system as a whole. A future effort will be undertaken to focus on a desired future condition and specific objectives for the Buttonland Swamp area. Understanding collective values and having a well-documented process for prioritizing allowed the group to take a coordinated approach to planning while being forth-coming within the partnership and with stakeholders. Further, understanding priorities will allow the partnership to focus its limited resources on the most critical ecosystem components and will allow them to monitor for desired outcomes and change practices if warranted to ensure success.

CONSERVATION PROJECTS

Based on these objectives, the working group conducted an exercise wherein they carefully examined the middle Cache River system, including its tributaries. For the exercise, the group broke into teams of two. Each team was asked to look at an aerial photo mosaic of the middle Cache River (Appendix A) and identify what, from their perspective, needed to happen within the watershed to achieve the conservation goals the working group identified above. Each team was to act as though they had unlimited resources and blanket support and approval from all stakeholders for any conservation action they deemed important.

In the end, the group identified an initial suite of 34 projects that would address their shared conservation goals (Appendix D). Through the ranking and evaluation process projects with similar themes were combined with like projects resulting in the final list of 28 potential actions described below. Many of these potential projects are conceptual in nature and require further information and analysis before action is taken, whereas a handful have been assessed and are ready to advance into execution. The list of projects defined below include some that have been combined with another action based on similarity of the actions resulting in a reduced number of projects. Combinations are identified in the list. One project was removed from the list because it did not result in ecological improvement but is described in the text due to its importance from a human dimensions perspective. Note that although usually one agency is listed as the lead for a project, all partners share the responsibility of contributing to

the success of each project as their resources and legal authorities permit. See Appendix A for a map of the proposed projects. The number of each project below coincides with the numbering on the figure unless otherwise noted in the description.

1. **Cache Chapel Road Structure:** In the U.S. Army Corps of Engineers' draft *Feasibility Study Report with Integrated Environmental Impact Statement: Alexander and Pulaski Counties Study* (USACE 2000), the Corps examined ecosystem restoration of the Cache River with the goal of mitigating the "degradational effects on the Cache River's fish and wildlife resources" caused by "the adverse impacts from and altered water regime" as a result of prior Corps projects. The draft report suggested the installation of several water control structures. The group proposed a structure be installed at Cache Chapel Road, potentially replacing the current west swamp weir known as the Diehl Structure. The replacement would provide water-level management over a larger portion of the wetlands including Buttonland Swamp and Limekiln Slough. Moving the structure from private to federal property provides greater long-term management stability. Alternately, the Diehl Structure could be retained to provide additional flexibility in water-level management by allowing for different regimes on federal and state properties. A feasibility assessment is not required, as it was modeled by the Illinois State Water Survey. USFWS would be lead for this project.
2. **Long Reach Road Structure:** Relocate the west swamp weir (the Diehl Structure) from its current location (about 0.5 miles west of Long Reach Road) to Long Reach Road. This would provide easier access for maintenance and operations. It also could provide more water-level flexibility by allowing for different regimes on federal and state properties. Depending on the precise location of where this structure is constructed, which could occur on private property, there likely would be benefits in terms of long-term management stability. An assessment is required. IDNR would be the lead.
3. **Diehl Structure Improvement:** As an alternative to projects No. 1 and 2, improve the current west swamp weir (the Diehl Structure). The working group suggested investigating the obtainment of property rights (fee title or easement) for the current location. This would provide greater long-term management stability. Additionally, the

group recommended assessing the structure to determine if physical modifications could improve operations, management or maintenance. This project could be eliminated, depending on the outcomes of Projects No. 1 and 2. Or, it could be retained along with Project No. 1 providing additional flexibility in water-level management by allowing for different regimes on federal and state properties. An assessment is not required, as it was modeled by the Illinois State Water Survey. IDNR would be the lead.

4. **Natural Spring Restoration:** Restore natural springs in Limekiln Slough and other areas to improve flowing water quantity in the Cache River. The springs would be restored by excavating areas that have been covered with silt. Before this project could be initiated, investigating how spring restoration would impact low flows in the Cache River would need to be conducted. Lead would be USFWS.
5. **Limekiln Slough Outlet:** Restore an outlet from Limekiln Slough into the Cache River to allow U.S. Fish & Wildlife Service to manage the system for a mixture of bottomland hardwoods and cypress-tupelo swamp. Some believe past drainage activities (the construction of a berm to support a drag line) resulted in the elimination of a Limekiln Slough outlet, while others believe it historically had a diffuse outlet. Regardless, the current condition may cause periods of prolonged flooding, which then alters the vegetation in the adjacent wetlands. The lack of an outlet likely increases sedimentation rates in the wetlands and certainly is a nuisance to farmers, as it may impede drainage of adjacent agricultural lands. A future outlet could be located near or on a Wetland Reserve Program easement and/or private property. An assessment is required. Lead would be USFWS.
6. **Strategic Management Conservation Protection near Cache Chapel Road (Not pictured):** Restore natural vegetation on agricultural land acquired from willing sellers for conservation protection. These actions may be critical to the success of Project No. 5 (restoring an outlet for Limekiln Slough). Certain parcels may be critical to the success of Project No. 1 (water control structure at Cache Chapel Road) and require the acquisition of flowage rights. Some parcels are currently in the Agricultural Conservation Easement Program, so authorization from USDA NRCS may be required. Prior to European

settlement, some parcels were primarily wetland (bottomland hardwoods, cypress-tupelo swamp, and shrub-scrub) and located near the historic mouth of Big Creek, making this area desirable for restoration. NRCS would be the lead.

7. **Limekiln Slough Sediment Management:** Construct sediment management structures for Limekiln Slough. Determine if it would be useful to build sediment traps to decrease the amount of sediment transported to the wetlands adjacent to the Cache River. The precise form of the sediment traps remains to be determined but could include a catchment basin or created wetlands. An assessment is required. Lead would be USFWS working in collaboration with NRCS.
8. **Limekiln Slough and Goose Pond Dredging:** Investigate dredging of Limekiln Slough channel and Goose Pond, which is a cypress-tupelo area in Limekiln Slough that is adjacent to Cache River. Dredging would remove sediment bars, flow impediments, damaging levels of sedimentation and would provide for improved water flow and transportation of sediment. An assessment is required. USFWS would be lead.
9. **High-priority Conservation Protection (Not pictured):** Increase the buffer of conservation protected lands along the Cache River, with special focus on lands that were wetland prior to European settlement. All agencies will look for acquisition or easement opportunities.
10. **Egner Tract Management:** Create an outlet for U.S. Fish & Wildlife Service's Egner tract that empties into the Cache River below the current west swamp weir (the Diehl Structure). An outlet would allow this area to be managed independently by USFWS for drier conditions to favor bottomland hardwoods. Currently, it has an open canopy of cypress trees. An assessment is required. USFWS would be the lead.
11. **Flood Flow Culverts:** Install additional culverts under Long Reach Road, Route 37 and Urbana/Porterhouse Road to allow for the passage of flood pulses. This should allow flood pulses to pass through the system more quickly and potentially transport more sediment. It is possible it could disperse the flow and reduce flow and energy in the main channel, which may worsen the sedimentation issues in the thalweg (i.e. main channel). An assessment is required. This project would need the authorization and

oversight of county road commission and possibly the State Department of Transportation. IDNR would facilitate discussions and move the process along**.**

12. **Cache River Dredging:** Dredge the existing Cache River thalweg. This would restore the present-day low flow channel and deep water habitat that has been lost due to high levels of sedimentation, thereby improving oxygen levels in the river and allowing for more efficient removal of sediment. This could be important for fish and other aquatic resources, especially during periods of low water. This project would not, however, restore the natural sinuosity of this river. An assessment has been completed. IDNR would be lead.
13. **Unnatural Levee Removal:** Remove unnatural levees along Cypress Creek near its mouth at the Cache River, which theoretically would allow high water flows to disperse through the restored ribbon of forest. This project could bring oxygenated water to this portion of the floodplain. By dispersing the flow, it also would reduce velocity and energy in the main channel affecting sediment deposition rates. Before this project could be executed, an assessment is required to ascertain how water levels might affect forested wetlands and whether the delivery of sediments is affected. IDNR would be lead.
14. **Historic Channel Restoration – Cache River:** Restore old river meanders and side channels along the entire middle Cache River where historic river channels (including oxbows) existed and ensure connectivity to thalweg habitat. This would recreate some of the deep water habitat that has been lost due to high levels of sedimentation, improve oxygen levels in the river and increase habitat heterogeneity. This could be important for fish and other aquatic resources, especially during periods of low water and droughts. An assessment is required. IDNR would be lead.
15. **Buttonbush Removal:** Remove buttonbush in areas of the swamp where open water is desired. Buttonbush may be competing with more desirable species and impacting flow rates and oxygen levels. IDNR would be the lead.
16. **Cypress Creek Riffle Weirs:** Add riffle weirs in Cypress Creek to increase oxygen levels in the water that is entering the Cache River and potentially stabilize the streambanks.

During the driest summer months, Cypress Creek is the sole source of water to Buttonland Swamp and is one of the ways in which additional oxygenation can be provided during drier time periods. In this section of the middle Cache, low oxygen has been documented, as have fish kills. This project could be located in either the current Cypress Creek or a restored historic channel (Project No. 21). An assessment is required. IDNR would be lead.

17. **Historic Channel Restoration - Cypress Creek:** Restore historic Cypress Creek channel, which could re-hydrate wetlands, increase oxygen levels and increase habitat heterogeneity. It would provide important production habitat for invertebrates, a food resource for fishes. It also would provide spawning habitat for fish, including the rare bottomland guild of fish. IDNR would facilitate this action.
18. **Cypress Creek Well:** Install a well along Cypress Creek. This well could pump water into Cypress Creek during periods of no or low flow. This could increase flow rates and oxygen levels to provide better habitat for fish and other aquatic resources; this project would benefit from being paired with Project No. 20, which would speed the normalization of temperature and oxygen levels. This project could be designed to push water into the current Cypress Creek or a restored historic channel (Project No. 21). It too would require an assessment. IDNR would facilitate this action.
19. **Cypress Creek Sediment Management:** Implement conservation practices to decrease the amount of sediments carried by Cypress Creek into the middle Cache River. Some examples of projects include stream bank stabilization, buffers, weirs and retention basins. Some assessments, such as a hydraulic model, have been completed, but additional assessments likely are required. NRCS would be the lead.
20. **Removal of Route 37 Structure:** Remove the Route 37 structure from the Cache River. This weir currently holds water in Buttonland Swamp. The removal of this structure depends on the construction of the east swamp structure (Project No. 28), and the completion of Project No. 1, 2 or 3. An assessment is not required, as it was modeled by the Illinois State Water Survey. IDNR would be lead.

21. **Cache River Streambank Stabilization:** Install weirs in the Cache River to stabilize the streambank between Tunnel Hill Trail and the Karnak Levee. The breach in the Karnak Levee has allowed the Post Creek Cutoff to form a new head cut that is moving westward and threatens forested wetlands owned by Illinois Department of Natural Resources, as well as road and bridge stability. Affected wetlands are registered as a Land and Water Reserve with the Illinois Natures Preserves Commission. A preliminary assessment has been completed, though a project assessment is required. (This project may be unnecessary if the breach in the levee is repaired, see Project No. 29.) IDNR would be the lead.
22. **East Swamp Structure:** The *U.S. Army Corps of Engineers' draft Feasibility Study Report with Integrated Environmental Impact Statement: Alexander and Pulaski Counties Study* called for an east outlet structure, so named because it would allow high water to move quickly off the land and flow eastward through the Karnak Levee and into the Post Creek Cutoff/Ohio River. This structure also would hold water at a specified height, thereby establishing the gradient needed to force water to flow westward during normal and low-flow conditions. This project would place that structure in the Cache River at the Tunnel Hill Trail. An assessment is not required, as it was modeled by the Illinois State Water Survey. IDNR would lead.
23. **Karnak Levee Repair:** Repair the breach in the Karnak levee, which would prevent flood waters and sedimentation from high-magnitude floods, such as 2008 and 2012, from entering the middle Cache River from the Post Creek Cutoff. The Water Resources Development Act of 2007 included language that added a conservation element for the levee's raison d'être. Section 3059 reads: "The Cache River Levee constructed for flood control at the Cache River, Illinois, and authorized by the Act of June 28, 1938 (52 Stat. 1217), is modified to add environmental restoration as a project purpose." Repair of the levee would stabilize the streambank by helping arrest the headcut in this portion of the Cache River, provide flood protection to local communities and rehydrate adjacent wetlands, which are registered as a Land and Water Reserve with the Illinois Natures Preserves Commission. The levee's repair also would prevent Ohio River flood pulses

from entering the middle Cache River, which historically contributed additional sediment dynamics (erosion and deposition) to the Cache. An assessment is not required, as it was modeled by the Illinois State Water Survey. This project would need the authorization and oversight / management of drainage district and potentially others. Therefore, IDNR could facilitate the project discussions and shepherd the process along.

24. **Reconnection Water Flow Structure and Weir:** The *U.S. Army Corps of Engineers' draft Feasibility Study Report with Integrated Environmental Impact Statement: Alexander and Pulaski Counties Study* (USACE 2000) also suggested the construction of a water flow structure and weir**.** While the East Swamp Structure (Project No. 28) would re-establish an east-west gradient, allowing water to flow westward as it once did naturally, it wouldn't provide the "extra" water needed to sustain these flows, particularly during summertime when the Cache River suffers from its lowest dissolved oxygen levels. That "extra" water could come from a water flow structure located on the western portion of The Nature Conservancy's Grassy Slough Preserve, and a weir, located in the Forman Floodway. The diverted water would increase flow rates and oxygen levels in the middle Cache River, especially during periods of little or no flow and may provide a biological connection between the middle and upper Cache River for aquatic organisms. An assessment is not required, as it was modeled by the Illinois State Water Survey. IDNR would be lead.
25. **Historic Channel Restoration – Braided Cache River:** Create a secondary connection pathway to recreate the braided river system, which once flowed in this section of the Cache River. Direct water from the Foreman Floodway to the Cache River through old channels located between Karnak and Belknap. This would require the completion of Projects No. 28 and 30, and likely No. 32. An assessment is required. IDNR would lead.
26. **Conservation Protection at Grassy Slough (Not pictured):** Work with willing sellers to acquire private lands or conservation easements to allow for improved management flexibility. Doing so could provide future flexibility for reconnection alternatives and also

is crucially important for better management at Grassy Slough Preserve. The Nature Conservancy would be the lead.

27. **Big Creek Sediment Management:** Complete additional conservation measures in the Big Creek watershed. Implement conservation practices to decrease the amount of sediments carried by Big Creek into the middle Cache River. Some examples of projects include stream bank stabilization, buffers, weirs and retention basins. Some assessments have been completed, but additional assessments likely are required. NRCS would be the lead.
28. **Big Creek Stabilization:** Stabilize Big Creek, which may include repair or replacement of in-stream weirs and creation of new stream weirs. The weirs of concern were installed after the lower portion of Big Creek was channelized and straightened. The weirs prevent head cutting, provide for stream bank stabilization and reduce the amount of sediment transported into the middle Cache River. Illinois State Water Survey has documented that these weirs are failing. IDNR would be the lead.

One additional project was not included with this list but bears mentioning and it is: **Flood protection improvements for the Village of Karnak (Appendix D, #29).** Community flood protection measures are unlikely to directly enhance the ecology of the middle Cache River, but increased flood protection for the Village of Karnak may make support of other projects more likely. A preliminary assessment has been completed, and IDNR's Office of Water Resources has suggested specific measures. IDNR would facilitate these actions.

Evaluation of Actions

Given the large number of potential actions it was useful to evaluate each of the projects in light of the values or fundamental objectives that the working group articulated early on and in regard to the practicality of implementation. To evaluate projects, the group developed and agreed on six criteria to be used in conjunction with a simple multi-attribute rating technique (SMART) to help prioritize actions within the watershed. Criteria are listed under themes 1 – 6 below. The simple multi-attribute rating technique is based on a linear additive model. The overall value of a given action was calculated as the total sum of a performance score for each

criterion, multiplied by the weight of that criterion. Each criterion is grouped under themes describing the desired actions' general contribution to the protection and conservation of the natural resources of the middle Cache River. The rating values (e.g. 1-2, 1-3, or 1-4, etc.) used to score each action are given for each criterion. Clarification and examples for interpreting each criterion are provided. The weighting process was based on a modified Delphi technique called "direct rating" (Goodwin and Wright 2011). The most important criterion, determined by group consensus, was assigned an importance of 100. The next most important criterion was assigned a weight reflecting its importance relative to the most important criterion and so on. A criterion with no relative importance in the evaluation of an action was given a "0", effectively excluding the criterion from further consideration. It was expected that different individuals in the group could have different relative ratings. We then calculated a weighted average of the values assigned to each action. This step allowed for normalization of the relative importance of the weights summing to 1. Actions were then ordered from most important to those considered less important to the overall conservation of the region.

1. **Theme: Legal Mandates**

    A. **Protects listed species or listed natural communities (Maximize; 1-4)**

    Score each proposed action by evaluating the *degree of impact* an action may have on a particular species or natural community federally listed under ESA, state listed (threatened or endangered only) or ranked by the IL Natural Heritage Program.

    1. Negative impact on listed species or natural communities
    2. No or low impact on listed species or natural communities
    3. Moderate improvement on listed species or natural communities
    4. Great improvement listed species or natural communities

    B. **Protects biological diversity and ecosystem health (Maximize; 1-4)**
    Score each proposed action based on the degree to which you believe the action will either promote or degrade biological diversity and/or restore or degrade ecosystem health.

    1. Negative impact on diversity and ecosystem health
    2. No or low impact on diversity and ecosystem health

3. Moderate improvement on diversity and ecosystem health
4. Great improvement diversity and ecosystem health

2. Immediacy of Need

A. **Degree of public and agency or organizational acceptance (Maximize; 1-4)**

Does the action reduce a socially or politically sensitive issue among the partners or with the public?

1. Known controversy; this action will not resolve a sensitive issue
2. Not currently controversial, but potentially or suspected of raising a controversy
3. Known controversy; this action will resolves a sensitive issue
4. Not controversial and little to no potential for raising a controversy

B. **Threat or Urgency (Maximize; 1-4)**

Does the action mitigate a known or suspected threat to natural resources in the river?

1. No existing threat or potential for a threat to natural resources.
2. Addresses a potential threat to the natural resources but can be dealt with later.
3. Addresses a known threat to the natural resources but can be dealt with later.
4. Urgently needed to stop a known threat to natural resources.

3. Ecology of the System

A. **Ecological Processes**

Does the action restore, improve, mimic or protect (e.g., water flow, timing, velocity, quality (DO, sediment load, nutrient load), elevation) ecological processes or function (e.g., removes sediments/contaminants; creates/restores important habitats such as deep water pools, etc.)?

1. No, little restoration, improvement or protection of ecological processes
2. Medium, restoration, improvement or protection of ecological processes
3. High, restoration, improvement or protection of ecological processes

4. Sustainability

A. **Project is sustainable from a practical standpoint**

Agencies seek to implement an action that will have lasting or long term, positive effects. Thus please score each project based on whether or not you believe the project will require a long term commitment of operating staff or operation and maintenance dollars to keep it functioning as intended.

1. Requires regular upkeep such as maintaining ecological function or operation and management (e.g. Diehl structure requires annual O&M long term)
2. Requires periodic upkeep (e.g. periodic dredging needed to maintain deep water habitats)
3. Self-sustaining, little upkeep projected

5. Cost

A. **Cost ($) of initial project completion.**

Some things maybe be easier to fund than others.

1. High > 1M
2. Medium $200k-1M
3. Low = 0 > Project <200K
4. No

B. **Ecological Cost**

Often actions have negative as well as positive impacts. It is desirable to minimize tradeoffs, such as possible secondary effects. An example may be creating deep water habitat for recreational fishing but that may come at a cost to green tree reservoir type habitat unless managed carefully. The focus here is on long-term consequences, if there are any, to a project in terms of one sort of resource winning while another loses out.

1. Long term negative effects on non-target resources.
2. Temporary or short-term effect on non-target resources
3. No negative effects on non-target resource

6. Project dependency/sequencing.

A. **Project Depends on Another**

A project may be dependent upon another project being completed.

1. Project is dependent on others being done first

2. This is an independent project, does not depend and no projects are dependent on this one.
3. Other projects are dependent on this one

Once the above criteria were finalized, the group then developed a rating scale for each of the criteria, to reflect relative importance among the six items listed. This is the relative weight given to each criteria. Each action was then scored individually by each team member using the 6 criteria and their weights. Scores were then normalized, weighted and summed for each action resulting in a numerical ranking of projects from highest to lowest value based on the criteria.

From this ranked list of actions (Appendix D), the group then developed suites or categories of actions that could be completed in concert to best address their fundamental objectives for the middle Cache River rather than taking each action sequentially. The categories are listed below. Additionally, there is a category called "on-going" that lists projects dealing with conservation protection of lands that are by their very nature opportunistic, dependent on funding, and are free from being directly tied to project work.

RECOMMENDATIONS

CONSERVATION PROJECTS – LISTED BY PRIORITY

Many of these potential projects are still conceptual and require further information and analysis before action is taken, whereas a few have been assessed and are ready to advance to execution. Therefore, projects that currently rank high in priority may be removed or have their priority downgraded as additional information is acquired. In the meantime, the categories provide an initial direction for conservation actions that can be taken now to improve the overall quality of the middle Cache River ecosystem while other proposed projects receive further evaluation.

CATEGORY ONE

Category One projects include those that would have the greatest positive affect on the natural resources of the middle Cache River. These include:

- **Cache River Dredging**
- **Historic Channel Restoration – Cache River**
- **Big Creek Stabilization**
- **Hydrological and Biological Reconnection: Water Flow Structure and Weir**
- **East Swamp Structure**

CATEGORY TWO

These projects are important for stopping sediments before they enter the middle Cache River and stymie the efforts outlined in category one projects.

- **Big Creek Sediment Management**
- **Cypress Creek Sediment Management**
- **Limekiln Slough Sediment Management**

CATEGORY THREE

This project would allow the USFWS to independently manage the Egner Tract.

- **Egner Tract Management**

Strategic Management Conservation Protection near Cache Chapel Road: Agricultural land for conservation protection. This may be critical for project No. 5 (restoring an outlet for Limekiln Slough). Further, the southern end of this parcel may be critical for project No. 1 (water control structure at Cache Chapel Road) for the acquisition of flowage rights. Lastly, the southern end of this parcel is in the Wetland Reserve Program, so authorization from USDA NRCS may be required. The remainder – and majority – of this parcel is being farmed. Prior to European settlement, this parcel was nearly all wetland (bottomland hardwoods, cypress-tupelo swamp, and shrub-scrub) and is the location of the historic mouth of Big Creek, making this area desirable for restoration.

High-priority Conservation Protection: Increase the buffer of conservation protected lands along the Cache River, with special focus on lands that were wetland prior to European settlement.

INFORMATION NEEDS

A few information needs were identified through this process. Needs related to the management or ecology of Buttonland Swamp will be addressed in a follow up workshop. Information needs include determining:

1. if there is evidence of cypress tree regeneration in Buttonland Swamp and providing managers with a better understanding of what controls regeneration.
2. vegetative response of the cypress and tupelo and other natural communities in Buttonland Swamp if land managers dewatered the site periodically.
3. indicators for monitoring improvements in tree health in Buttonland Swamp following management.
4. how sedimentation is affecting cypress trees within Limekiln Slough.
5. if the function of the natural springs at Limekiln is impeded by sedimentation and if so, determining if the springs would benefit from restoration efforts.
6. Ascertain whether or not buttonbush are preventing cypress and tupelo and other plants from regenerating.

UNCERTAINTY

ETIOLOGICAL UNCERTAINTY

It isn't fully known how many of the proposed actions will affect the system or how the system will affect future decisions because of practical, cultural and social issues within the watershed. Managers need to be aware of this type of uncertainty. Monitoring will be invaluable for helping resolve etiological uncertainty.

Partial controllability or Implementation uncertainties

There is uncertainty around the partial controllability of water levels and water flow in the system and further how climate change might affect the system over time. There is uncertainty about the current health of cypress and tupelo in Buttonland Swamp. There is uncertainty about the degree to which sediments and nutrients can be retained in the uplands through restoration actions. Monitoring designed to provide information about the success of projects will be important for learning about and measuring our success and adjusting our management actions.

Partial Observability

Uncertainties related to partial observability arise because components of the system being managed may be measured or observed indirectly. In particular, there is some uncertainty about the presettlement condition and functioning of the Buttonland Swamp. Additionally, the system's ecological drivers have been highly altered, which contributes to uncertainty regarding predicted responses of the system to management actions.

Setting up an Adaptive Management Framework

Adaptive management is appropriate when there is uncertainty about outcomes and/or how to best achieve stated conservation goals and objectives and there is some degree of controllability in situations where management decisions will be made repeatedly, either temporally or spatially. In short, to resolve uncertainty and improve management, there is a need to evaluate the outcomes of management actions and decisions. The structuring of the management problem, the explicit way in which alternatives and outcomes are defined, and the use of monitoring to reduce uncertainty over time, is what differentiates adaptive management from other forms of management followed by monitoring. The partnership's concern about the ecological health of Buttonland Swamp and its associated resources of concern make it well suited for adaptive management. Buttonland Swamp will be dealt with in a future workshop.

NEXT STEPS

In summary, the working group set out to address the following goals:

1. develop a common understanding about the presettlement conditions for the middle Cache River;
2. develop a shared understanding of the desired future condition for portions of the middle Cache River;
3. identify potential management actions for the middle Cache River region;
4. briefly outline each agency's role in fulfilling those management goals; and to
5. make recommendations about the management actions needed to obtain the desired future condition for the middle Cache River region.

All but goal one were reached and detailed in this report. Significant headway was made on goal number one during this exercise. Discussions regarding the middle Cache River indicated that there was agreement about the ecology and history for much of the area. The group agreed to continue to work together to explore future management opportunities for Buttonland Swamp. The outcomes of that future workshop will be captured in a second report from the working group.

Many of the projects outlined in this report are complex and require collaboration within the Cache River Wetlands Joint Venture Partnership (JVP) and, often, external partners. This report should serve as a guide for conservation actions among the JVP, though the specific action taken may be different than what is outlined. As noted previously, many projects are conceptual in nature and additional assessments are needed to fully develop them. For these projects to advance through assessment and into execution, a conservation partner will need to develop them following their own environmental planning processes. The working group took the liberty of identifying potential leads for each of the recommended actions but recognize that each partner will contribute to the greatest extent possible within their legal mandates and available resources. A full listing, in ranked order, of the initial projects (1-34) is provided in Appendix D.

ACKNOWLEDGMENTS

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LITERATURE CITED

Bouska, K.L. and G. Whitledge. 2014. Habitat associations of fish assemblages in the Cache River, Illinois. Environmental Biology of Fish 97:27-42.

Bratkovich, S., Burban, L., Katovich, S., Locey, C., Pokorny, J., Wiest, R., 1994. Flooding and its effect on Trees. USDA, Forest Service, Northeastern Area State and Private Forestry; St. Paul, MN. 55 p.

Cache River Wetlands Joint Venture Partnership, 2014. Unpublished report.

Commissioners, Cache River Drainage. "Report of the board of Cache River Drainage Commissioners of Illinois." Illinois Printing Company, Danville, Illinois (1905).

Demissie, M. 1989. Sediment yield and accumulation in the lower Cache River. Unpublished report. Illinois State Water Survey, Champaign, IL. 22 pp.

Demissie, J., T.W. Soong, R. Allgire, L. Keefer, and P. Makowski. 1990. Cache River Basin: Hydrology, hydraulics, and sediment transport, vol. 1: background, data collection, and analysis. Illinois State Water Survey Contract Report 484. Champaigne, IL.

Demissie, M., L. Keefer, Y. Lian, F. Yue, and B. Larson. 2008. Hydrologic and Hydraulic Modeling for the Cache River for the Purposes of Evaluating Current Conditions and Alternative Restoration Measures. Illinois State Water Survey Contract Report 2008-01, Champaign, IL.

Demissie, M., E. Bekele, Y. Lian, and L. Keefer. 2010. Hydrologic and hydraulic modeling for evaluating alternatives for managed connection of the upper and lower Cache Rivers. Unpublished report of the Illinois State Water Survey, Champaign, IL. 132pp.

Dicke, S.G. and Toliver, J.R., 1990. Growth and development of bald-cypress/water-tupelo stands under continuous versus seasonal flooding. Forest Ecology and Management 33/34: 523-530.

Dickson, R.E. and T.C. Broyer. 1972. Effects of aeration, water supply, and nitrogen source on growth and development of tupelo gum and bald cypress. Ecology 53(4):626-634.

Eggler, W.A. and W.G. Moore. 1961. The vegetation of Lake Chicot, Lousiana, after eighteen years impoundment. Southwestern Naturalist 6:175-183.

Giblin, S.M., J.N. Houser, J.F. Sullivan, H.A. Langreher, J.T. Rogala, and B.D. Campbell. 2014. Thresholds in the response of free-floating plant abundance to variation in hydraulic connectivity, nutrients, and macrophyte abundance in a large floodplain river. Wetlands 34:413-425.

Goodwin, P. and G. Wright. 2011. Decision analysis for management judgment, 4th ed. Wiley and Sons, Ltd.

Gough, S. 2005. Historic and prehistoric hydrology of the Cache River, Illinois. Unpublished report. Little River Research and Design, Murphysboro, IL 49pp.

Hayek, J.C. and M.T. Roche. 2013. The Illinois Big Tree Register. Univ. of Illinois Extension, Tech. Forestry Bull. NRES-1101. Urbana, IL. 10 p.

Hooker, K.L., and V.A. Rogers. "Managing Erosion Control Problems on a Large Multi-use Site." In Proceedings of the Annual Conference on Wetlands Restoration and Creation, vol. 21, p. 87. Environmental Studies Center, Hillsborough Community College, 1994.

Houser, J.N., S.M. Giblin, F.W. James, J.T. Rogala, J.F. Sullivan, and B.R. Gray. 2013. Nutrient cycling, connectivity and free-floating plant abundance in backwaters of lakes of the Upper Mississippi River. River Systems 21(1):71-89.

Illinois Department of Natural Resources. 1997. Cache River area assessment. Volumes I and II. Illinois Department of Natural Resources, Springfield, IL

Illinois Department of Natural Resources. 2005. The Illinois Comprehensive Wildlife Plan and Strategy, Version 1.0. Illinois Department of Natural Resources, Champaign, IL. 353 pp.

Illinois Endangered Species Protection Board. 2011. Checklist of endangered and threatened animals and plants of Illinois. Springfield, IL.

Illinois Natural History Survey. Freshwater Mussels of the Cache River. INHS Technical Report 2011 (44). Prepared of Illinois Department of Natural Resources: Office of Resource Conservation, US Fish and Wildlife Service, and Illinois Natural History Survey. Issued December 16, 2011.

Keim, R.F. and J.B. Amos. 2012. Dendrochronological analysis of baldcypress (*Taxodium distichum*) responses to climate and contrasting flood regimes. Canadian Journal of Forest Research 42:423-436.

McIntosh, M.D., M.E. Benbow, and A.J. Burky. 2002. Effects of stream diversion on riffle macroinvertebrate communities in a Maui, Hawaii, stream. River Research and Applications 18:569-581.

McKay, S.F. and A.J. King. 2006. Potential ecological effects of water extraction in small, unregulated streams. River Research and Applications 22: 1023-1037.

Middleton, B.A. and K. L. McKee. 2005. Primary production in an impounded baldcypress swamp (*Taxodium distichum*) at the northern limit of the range. Wetlands Ecology and management 13: 15-24.

Oswalt, S.N. and S.L. King. 2005. Channelization and floodplain forests: impacts of accelerated sedimentation and valley plug formation on floodplain forests of the Middle Forked Deer River, Tennessee, USA. Forest Ecology and Management 215: 69-83.

Parr, L.B. and C.F. Mason. 2003. Long-term trends in water quality and their impact on macroinvertebrate assemblages in eutrophic lowland rivers. Water Research 37:2969-2979.

Parrish, J.D., D.P. Braun and R.S. Unnasch. 2003. Are We Conserving What We Say We Are? Measuring Ecological Integrity within Protected Areas. BioScience 53:851–860.

Penfound, W. T. 1949. Vegetation of Lake Chicot, Louisiana, in relation to wildlife resources. Proceedings of the Louisiana Academy of Science 12:47-56.

Phillippi, M. A., B. M. Burr, and R. A. Brandon. 1986."A preliminary survey of the aquatic fauna of the Cache River in Johnson and Pulaski counties, Illinois." Final Report to Illinois Department of Conservation, Division of Natural Hertitage. 414pp.

Pitts, K., G.W. Whitledge, and W. Bouska. 2011. Community composition and dissolved oxygen dynamics in a disconnected bottomland swamp. Abstract of a presentation at the American Fisheries Society 141st Annual Meeting, Seattle. <https://afs.confex.com/afs/2011/webprogram/Paper6333.html>.

Ramsar Convention. 2009. The Ramsar Convention on Wetlands. Available at http://www.ramsar.org .

Rantala, H.M., E.A. Scholl, M.R. Whiles, and G.V. Wilkerson. 2013. Predicting the ecological benefits of stream reconnection: a case study of the Cache River, Illinois. Southern Illinois University – unpublished draft.

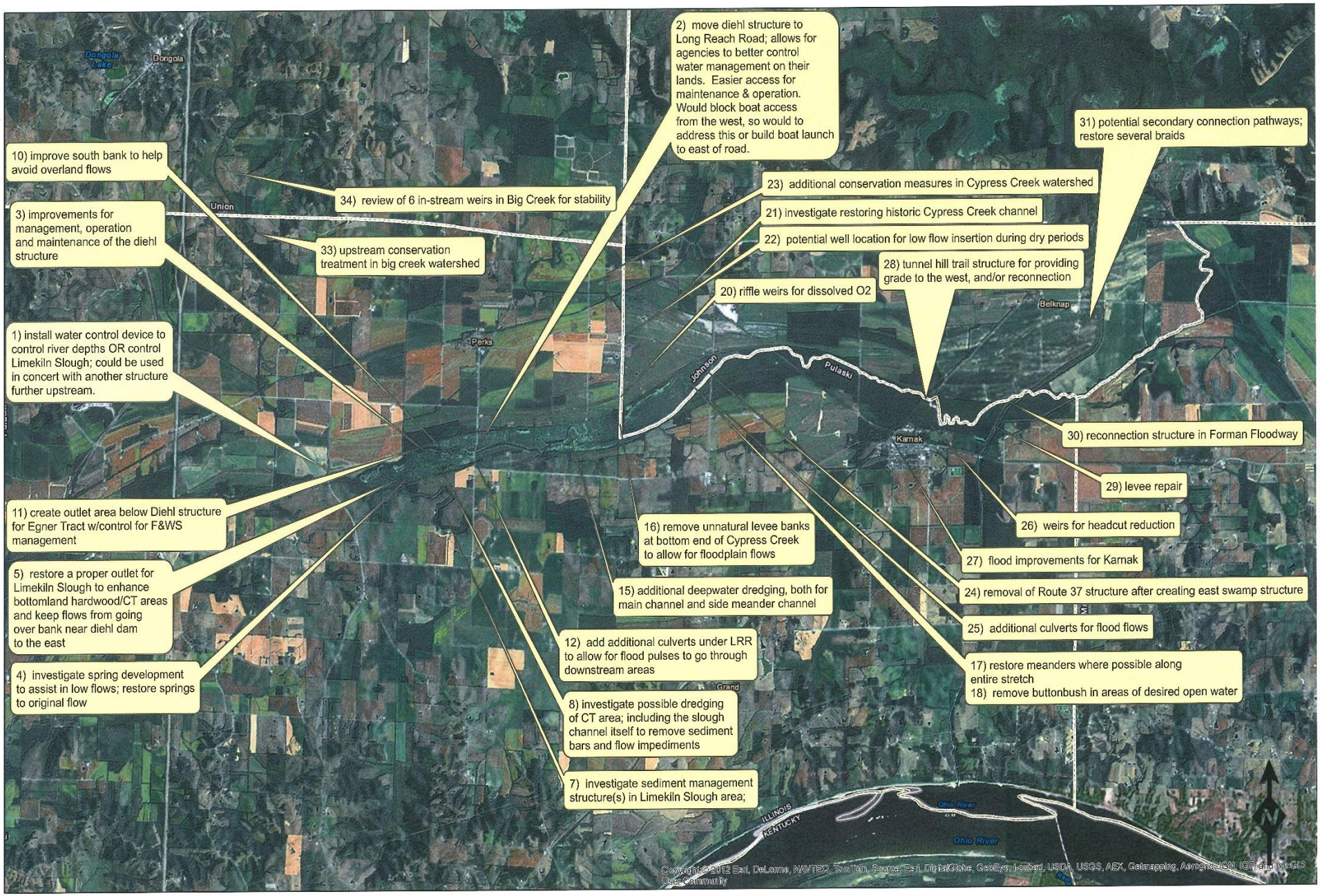
Shasteen, D.K., A.L. Price and S.A. Bales. Freshwater mussels of the Cache River. Illinois Natural History Survey Technical Report 2011 (44). Champaign, Illinois. 16 pp.

U.S. Army Corps of Engineers. 2000. Feasibility study report with Integrated Environmental Impact Statement: Alexander and Pulaski Counties Study, Ecosystem Restoration of the Cache River, Illinois. Unpublished report. USACE St. Louis District, St. Louis, MO.

Williston, H.L., F.W. Shropshire, W.E. Balmer. 1980. Cypress management: a forgotten opportunity. For. Rep. SA-FR8USDA Forest Service. 10 p.

APPENDIX A

General location of proposed conservation actions within the middle Cache River region of southern Illinois, 2015. Aerial photography is circa 2011 (March 16).



Location Map of Alternatives

1:70,000

APPENDIX B

List of state-threatened and endangered species within the Cache River Watershed (per The Nature Conservancy, *Conservation Targets, Attributes and Indicators for the Cache River Watershed,* 2012 and Illinois Endangered Species Board's *Checklist of endangered and threatened animals and plants of Illinois*. 2011)

PLANTS

*Aristolochia serpentaria Var. hastate (*Virginia Snakeroot) *threatened*

*Asplenium resiliens (*black spleenwort) *endangered*

*Bartonia paniculata (*screwstem) *endangered*

*Carex decomposita (*cypress-knee sedge) *endangered*

*Carex gigantea (*large sedge) *endangered*

*Carex intumescens (*swollen sedge) *threatened*

*Carex oxylepis (*sharp-scaled sedge) *threatened*

*Carex reniformis (*Sedge) *endangered*

*Carya aquatic (*water hickory) *threatened*

C*arya pallida (*pale hickory) *endangered*

*Cimicifuga rubifolia (*black cohosh) *threatened*

*Cladrastis lutea (*yellowwood) *endangered*

*Clematis crispa (*blue jasmine) *endangered*

*Clematis viorna (*leatherflower) *endangered*

*Cyperus lancastriensis (*Galingale) *threatened*

*Dennstaedtia punctilobula (*hay-scented fern) *threatened*

*Dichanthelium joorii (*panic grass) *endangered*

*Dryopteris celsa (*log fern) *endangered*

*Eryngium prostratum (*eryngo) *endangered*

*Euonymus americanus (*American strawberry bush) *endangered*

*Glyceria arkansana (*manna grass) *endangered*

*Halesia carolina (*silverbell tree) *endagered*

*Helianthus angustifolius (*narrow-leaved sunflower) *endangered*

*Heteranthera reniformis (*mud plantain) *endangered*

*Hydrocotyle ranunculoides (*water pennywort) *endangered*

*Hydrolea uniflora (*one-flowered hydrola) *endangered*

*Iresine rhizomatosa (*bloodleaf) *endangered*

*Justicia ovata (*water willow) *endangered*

*Lysimachia radicans (*creeping loosestrife) *endangered*

*Melanthera nivea (*white melanthera) *endangered*

*Melica mutica (*two-flowered melic grass) *endangered*

*Melothria pendula (*squirting cucumber) *threatened*

*Panicum joorii (*panic grass) *endangered*

*Phaeophyscia leana (*Lea's bog lichen) *threatened*

*Planera aquatica (*water elm) *threatened*

Platanthera flava var. flava (tubercled orchid) *endangered*

*Quercus montana (*rock chestnut oak) *threatened*

*Quercus phellos (*willow oak) *threatened*

*Quercus texana (*Nuttall's oak) *endangered*

*Rhynchospora glomerata (*clustered beaked rush) *endangered*

*Salvia azurea ssp. pitcheri (*blue sage) *threatened*

*Scirpus polyphyllus (*bulrush) *threatened*

*Spiranthes vernalis (*spring ladies' tresses) *endangered*

*Stenanthium gramineum (*grass-leaved lily) *endangered*

*Styrax americana (*storax) *threatened*

*Styrax grandifolia (*bigleaf snowbell bush) *endangered*

*Thalia dealbata (*powdery thalia) *endangered*

*Tilia heterophylla (*white basswood) *endangered*

*Urtica chamaedryoides (*nettle) *threatened*

ANIMALS

*Acipenser fulvescens (*lake sturgeon) *endangered*

*Circus cyaneus (*northern harrier) *endangered*

Corynorhinus rafinesquii (rafinesque's big-eared bat) *endangered*

*Crangonyx packardi (*Packard's cave amphipod) *endangered*

*Crotalus horridus (*timber rattlesnake) *threatened*

*Cumberlandia monodonta (*spectaclecase) *endangered*

*Cyclonaias tuberculata (*purple wartyback) *threatened*

*Dendroica cerulea (*cerulean warbler) *threatened*

*Desmognathus conanti (*spotted dusky salamander) *endangered*

*Egretta caerulea (*little blue heron) *endangered*

*Ellipsaria lineolata (*butterfly) *threatened*

*Elliptio crassidens (*elephant-ear) *threatened*

*Elliptio dilatata (*spike) *threatened*

*Fusconaia ebena (*ebonyshell) *threatened*

*Gallinula chloropus (*common moorhen) *endangered*

*Gammarus bousfieldi (*amphipod) *threatened*

*Hybognathus hayi (*cypress minnow) *endangered*

*Hyla avivoca (*bird-voiced treefrog) *threatened*

*Ictinia mississippiensis (*Mississippi kite) *threatened*

Ixobrychus exilis (least bittern) *threatened*

*Lanius ludovicianus (*loggerhead shrike) *endangered*

*Lepomis miniatus (*redspotted sunfish) *endangered*

*Lepomis symmetricus (*bantam sunfish) *threatened*

Ligumia recta (black sandshell) *threatened*

*Limnothlypis swainsonii (*Swainson's warbler) *endangered*

*Macrochelys temminckii (*alligator snapping turtle) *endangered*

*Myotis austroriparius (*southeastern myotis) *endangered*

*Myotis grisescens (*gray bat) *endangered*

*Myotis sodalis (*Indiana Bat) *endangered*

*Nerodia cyclopion (*Mississippi green water snake) *threatened*

*Nerodia fasciata (*broad-banded water snake) *endangered*

*Notropis boops (*bigeye shiner) *endangered* Riverine

*Nyctanassa violacea (*yellow-crowned night heron) *endangered*

*Ochrotomys nuttalli (*golden mouse) *threatened*

*Orconectes lancifer (*shrimp crayfish) *endangered*

*Orconectes placidus (*bigclaw crayfish) *endangered*

*Oryzomys palustris (*rice rat) *threatened*

*Pandion haliaetus (*osprey) *endangered*

*Plethobasus cooperianus (*orange-foot pimpleback) *endangered*

*Plethobasus cyphyus (*sheepnose) *endangered*

*Pleurobema cordatum (*Ohio pigtoe) *endangered*

*Pleurobema rubrum (*pyramid pigtoe) *endangered*

*Potamilus capax (*fat pocketbook) *endangered*

*Pseudacris illinoensis (*Illinois chorus frog) *threatened*

*Pseudemys concinna (*river cooter) *endangered*

*Quadrula cylindrica (*rabbitsfoot) *endangered*

*Sternula antillarum (*least tern) *endangered*

*Thamnophis sauritus (*eastern ribbon snake) *threatened*

*Thryomanes bewickii (*Bewick's wren) *endangered*

Tyto alba (barn owl) *endangered*

APPENDIX C

List of species in greatest need of conservation within the Cache River Watershed (per The Nature Conservancy, *Conservation Targets, Attributes and Indicators for the Cache River Watershed,* 2012; Source: Illinois Comprehensive Wildlife Conservation Plan & Strategy, Version 1.0, Appendix I, pp. 306-309.)

Acipenser fulvescens (lake sturgeon) *endangered*

Ammodramus savannarum (grasshopper sparrow)

Anas rubripes (American black duck)

Ardea alba (great egret)

Asio flammeus (short-eared owl) *endangered*

Athya valisineria (canvasback)

Aythya affinis (lesser scaup)

Aythya valisineria (canvasback)

Bartramia longicauda (upland sandpiper) *endangered*

Botaurus lentiginosus (American bittern) *endangered*

Buteo lineatus (red-shouldered hawk)

Buteo platypterus (broad-winged hawk)

Buteo swainsoni (Swainson's hawk) *endangered*

Calcarius pictus (Smith's longspur)

Calidris himantopus (stilt sandpiper)

Caprimulgus carolinensis (Chuck-will's-widow)

Caprimulgus vociferous (Whip-poor-will)

Certhia Americana (brown creeper)

Chaetura pelagica (chimney swift)

Charadrius melodus (piping plover)

Chlidonias niger (black tern) *endangered*

Chordeiles minor (common nighthawk)

Circus cyaneus (northern harrier) *endangered*

Cistothorus palustris (marsh wren)

Cistothorus platensis (sedge wren)

Coccyzus americanus (yellow-billed cuckoo)

Coccyzus erythropthalmus (black-billed cuckoo)

Colaptes auratus (northern flicker)

Corynorhinus rafinesquii (Rafinesque's big-eared bat) *endangered*

Crangonyx packardi (Packard's cave amphipod) *endangered*

Crotalus horridus (timber rattlesnake) *threatened*

Cumberlandia monodonta (spectaclecase) *endangered*

Cyclonaias tuberculata (purple wartyback) *threatened*

Dendroica cerulea (cerulean warbler) *threatened*

Dendroica discolor (prairie warbler)

Dolichonyx oryzivorus (bobolink)

Egretta caerulea (little blue heron) *endangered*

Egretta thula (snowy egret) *endangered*

Ellipsaria lineolata (butterfly) *threatened*

Elliptio crassidens (elephant-ear) *threatened*

Elliptio dilatata (spike) *threatened*

Empidonax trailli (willow flycatcher)

Empidonax virescens (acadian flycatcher)

Euphagus carolinus (rusty blackbird)

Falco peregrinus (Peregrine falcon) *threatened*

Fusconaia ebena (ebonyshell) *threatened*

Gallinago delicatata (Wilson’s snipe)

Gallinula chloropus (common moorhen) *endangered*

Grus Canadensis (sandhill crane) *threatened*

Helmitheros vermiforma (worm-eating warbler)

Hybognathus hayi (cypress minnow) *endangered*

Hyla avivoca (bird-voiced treefrog) *threatened*

Hylocichla mustelina (wood thrush)

Icteria virens (yellow-breasted chat)

Ictinia mississippiensis (Mississippi kite) *endangered*

Ixobrychus exilis (least bittern) *threatened*

Lanius ludovicianus (loggerhead shrike) *threatened*

Laterallus jamaicensis (black rail) *endangered*

Lepomis miniatus (redspotted sunfish) *endangered*

Lepomis symmetricus (Bantam sunfish) *threatened*

Ligumia recta (black sandshell) *threatened*

Limnodromus griseus (short-billed dowitcher)

Limnothlypis swainsonii (Swainson's warbler) *endangered*

Macrochelys temminckii (alligator snapping turtle) *endangered*

Melanerpes erythrocephalus (red-headed woodpecker)

Myotis austroriparius (southeastern myotis) *endangered*

Myotis grisescens (gray bat) *endangered*

Myotis sodalis (Indiana bat) *endangered*

Nerodia cyclopion (Mississippi green water snake) *threatened*

Nerodia eryhrogaster var. neglecta (copperbelly watersnake)

Nerodia fasciata (broad-banded water snake) *endangered*

Notropis boops (bigeye shiner) *endangered*

Nyctanassa violacea (yellow-crowned night heron) *endangered*

Nycticorax nycticorax (black-crowned night heron) *endangered*

Ochrotomys nuttalli (golden mouse) *threatened*

Oporornis agilis (Connecticut warbler)

Oporornis formosus (Kentucky warbler)

Orconectes lancifer (shrimp crayfish) *endangered*

Orconectes placidus (bigclaw crayfish) *endangered*

Oryzomys palustris (rice rat) *threatened*

Pandion haliaetus (Osprey) *endangered*

Passerculus sandwichensis (Savannah sparrow)

Peromyscus gossypinus (cotton mouse)

Phalaropus tricolor (Wilson's phalarope) *endangered*

Plethobasus cooperianus (orange-foot pimpleback) *endangered*

Plethobasus cyphyus (sheepnose) *endangered*

Pleurobema cordatum (Ohio pigtoe) *endangered*

Pleurobema rubrum (pyramid pigtoe) *endangered*

Pluvialis dominica (American golden-plover)

Podilymbus podiceps (pied-billed grebe)

Potamilus capax (fat pocketbook) *endangered*

Protonotaria citrea (prothonotary warbler)

Pseudacris illinoensis (Illinois chorus frog) *threatened*

Pseudemys concinna (river cooter) *endangered*

Quadrula cylindrica (rabbitsfoot) *endangered*

Rallus elegans (king rail) *endangered*

Seiurus aurocapillus (ovenbird)

Spiza americana (dickcissel)

Spizella pusilla (field sparrow)

Sterna antillarum (least tern) *endangered*

Sterna forsteri (Forster's rern)

Sterna hirundo (common tern) *endangered*

Sternula antillarum (least tern) *endangered*

Sylvilagus aquaticus (swamp rabbit)

Thamnophis sauritus (eastern ribbon snake) *threatened*

Thryomanes bewickii (Bewick's wren) *endangered*

Tringa melanoleuca (greater yellowlegs)

Tyto alba (barn owl) *endangered*

Vermiforma pinus (blue-winged warbler)

APPENDIX D

Initial ranking of all projects. The 3 categories of projects arose from this ranking and are the working group's best valuation of how to focus limited resources.

Final Ranking Order	Original Project Number[1]	Project description	Weighted Score
1	15	Cache River Dredging	0.80
2	33	Big Creek Sediment Management	0.75
3	34	Big Creek Stabilization	0.70
4	28	East Swamp Structure	0.69
5	23	Cypress Creek Sediment Management	0.68
6	20	Cypress Creek Riffle Weirs	0.68
7	17	Historic Channel Restoration - Cache River	0.67
8	32	Conservation Protection at Grassy Slough	0.65
9	21	Historic Channel Restoration - Cypress Creek	0.65
10	30	Reconnection Water Flow Structure and Weir - Foreman Floodway	0.65
11	6	Strategic Management- Conservation Protection Near Cache Chapel Road	0.63
12	26	Cache River Streambank Stabilization	0.60
13	7	Limekiln Slough Sediment Management	0.60
14	9	High-priority Conservation Protection along Cache River	0.60
15	14	Project Nos. 9, 13, 14, 19 were combined (See #9)	0.59
16	13	Project Nos. 9, 13, 14, 19 were combined (See #9)	0.57
17	19	Project Nos. 9, 13, 14, 19 were combined (See #9)	0.56
18	8	Limekiln Slough and Goose Pond Dredging	0.56
19	29	Karnak Levee Repair	0.56
20	5	Limekiln Slough Outlet	0.54
21	31	Historic Channel restoration - Braided Cache River	0.52
22	1	Cache Chapel Road Structure	0.50
23	24	Remove Rt. 37 Structure	0.47
24	3	Diehl Structure Improvement	0.47
25	4	Natural Spring Restoration - Limekiln	0.47
26	22	Cypress Creek Well	0.46
27	16	Unnatural Levee Removal	0.45
28	25	Combined this project with #13, 14, 19 and 9 (See #9)	0.43
29	12	Flood Flow Culverts	0.42
30	11	Egner Tract Management	0.42
31	2	Long Reach Road Structure	0.39
32	10	This project was dropped	0.30
33	18	Remove buttonbush in areas of desired open water	0.27
34	27	Flood control improvements - Karnak: This project dropped from the ranking process but is retained as a note in the report	0.16

[1] These numbers coincide with numbered projects on the figure in Appendix C.