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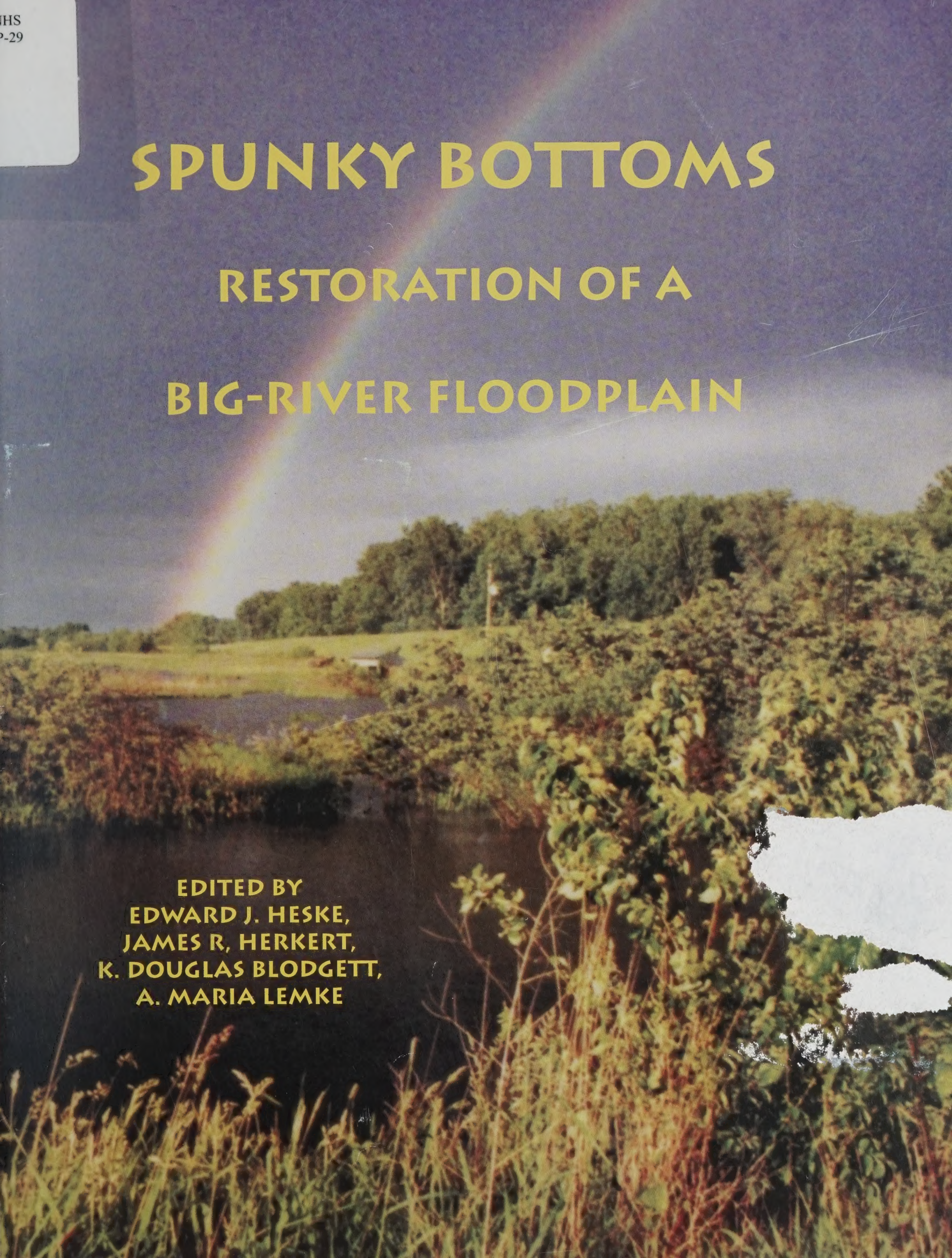

SPUNKY BOTTOMS

RESTORATION OF A BIG-RIVER FLOODPLAIN

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Editing and layout: Thomas Rice and Charles Warwick

Printed by authority of the State of Illinois
P0135716—5M—06-07

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SPUNKY BOTTOMS: RESTORATION OF A BIG-RIVER FLOODPLAIN

Spunky Bottoms pre-restoration in 1998, looking south to north. Photo courtesy of The Nature Conservancy.

Spunky Bottoms after restoration in 2003. Photo courtesy of The Nature Conservancy.

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Preface

Healthy, self-sustaining river systems provide important ecological and societal goods and services upon which human life depends (Postel and Richter 2003). Concern over sustaining these services has stimulated major restoration efforts, and river and stream restoration has now become a world-wide phenomenon (Palmer et al. 2005).

Despite the increased emphasis placed on river restoration, few projects are ever evaluated to assess their performance (Alexander and Allan 2006). There is a clear need to undertake meaningful monitoring of river restoration projects, not only to provide information on the effectiveness of the restorations themselves in ecological terms, but also to provide much needed data to help establish further the science of restoration (Giller 2005).

Ecological success in a restoration project cannot be assessed in the absence of clear project objectives from the start and subsequent evaluation of their achievement (Dahm et al. 1995). The goal of the Spunky Bottoms restoration project is "to restore native plant and animal communities that were characteristic of the Illinois River floodplain and to reconnect the river to the floodplain to allow movement of aquatic organisms" (Blodgett et al., this volume). The research presented in this volume provides an overview of the baseline data that were collected at The Conservancy's Spunky Bottoms restoration project between 1998–2003. These data are intended to form the foundation of our efforts to evaluate progress toward our restoration goal.

Part 1 of these proceedings, provides an introduction to the restoration project at Spunky Bottoms. It begins with a paper by K. Douglas Blodgett et al. that describes the background and initial goals and restoration plans for The Nature Conservancy's floodplain restoration project at Spunky Bottoms. The introduction section also includes a paper by Edwin R. Hajic that explores the interrelationships among Illinois River valley wetlands, adjacent landforms, and the geomorphic processes that shaped these areas. Part 2 provides initial data from research on the aquatic systems of the site. This section includes papers that summarize research on the initial microbial communities (Tim Kelly), nitrogen and bacterial dynamics (Michael J. Lemke et al.), insect emergence patterns (A. Maria Lemke et al.), composition of the dragonfly and damselfly (Odonate) community (Deborah Beal), mosquito species composition and temporal patterns (Robert Novak), and development of the fish community (Mark Pegg et al.). Data from terrestrial systems at the site are presented in Part 3, beginning with a study by Deborah Beal that provides some data on early changes in wetland plant species composition at the site. William Sluis then evaluates transplant survival of cordgrass and lake sedge. Four papers on vertebrates conclude the terrestrial systems section including preliminary surveys of reptiles and amphibians (John K. Tucker and Chris Phillips), small mammals (Edward J. Heske et al.), wetland birds (Tharran Hobson et al.), and waterfowl populations (Michelle M. Horath and Stephen P. Havera) at the site.

As the restoration of Spunky Bottoms continues, we will continue to monitor and evaluate progress towards our goal of restoring a dynamic and diverse floodplain community at the site in the hopes that lessons learned at Spunky Bottoms can inform other large river restoration projects around the world.

—James R. Herkert, Director of Science
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Peoria, IL
1 February 2007

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American lotuses. Photo by Tharran Hobson, The Nature Conservancy.

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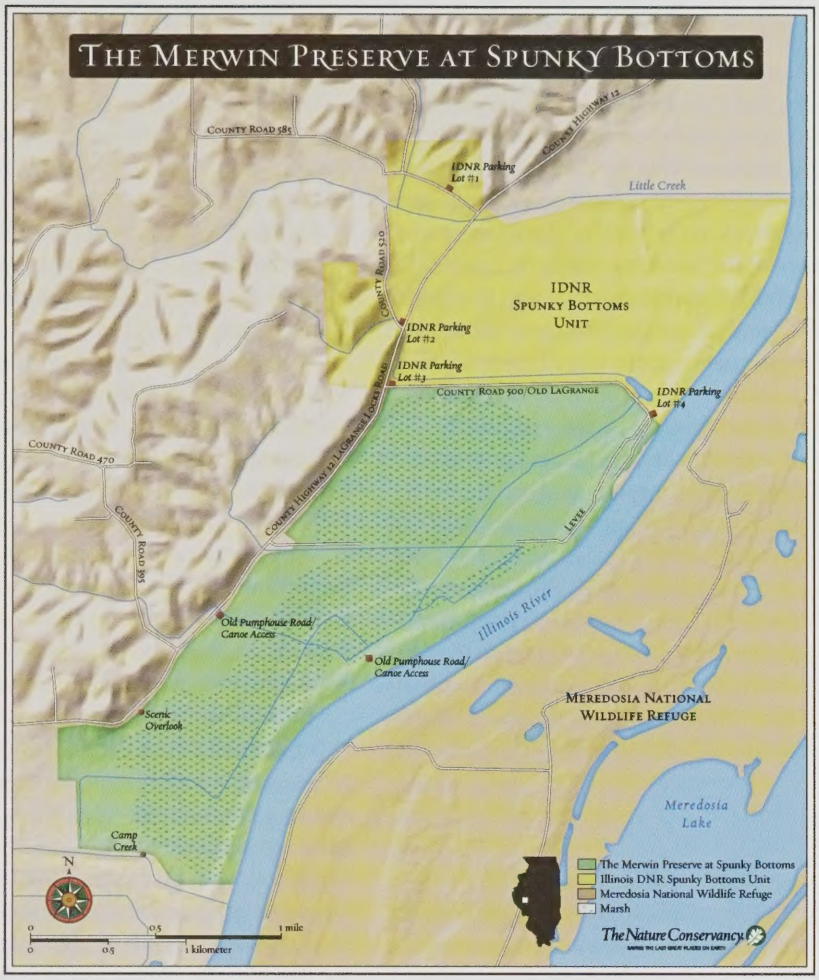
Part 1 — Introduction to Spunky Bottoms



Map courtesy of the Illinois Chapter of The Nature Conservancy.

Scenic overlook at Spunky Bottoms. Photo by Tharran Hobson, The Nature Conservancy.

The Nature Conservancy's Floodplain Restoration Project at Spunky Bottoms

K. Douglas Blodgett, Tharran Hobson, James R. Herkert

Most of the world's 79 large floodplain river ecosystems have been substantially altered by human activities (Sparks 1995), and as a result many lack most of their basic ecological functions (Buijse et al. 2002). These systems, composed of the flowing channels with associated floodplain lakes, backwaters, forests, and wetlands, harbor much of the earth's terrestrial and freshwater biodiversity (Sparks 1995) and are among the most species-rich and productive ecosystems on earth (Ward et al. 1999, Tockner and Stanford 2002). Unlike other wetlands such as lakes, floodplain river systems are characterized by seasonal floods that promote the exchange of nutrients and organisms among a diversity of habitats and thereby enhance biological productivity (Junk et al. 1989, Bayley 1995). Most aquatic ecologists consider this flow regime to be the key driver of river and floodplain wetland ecosystems (Bunn and Arthington 2002). Because many riverine species have life history strategies that have developed in response to natural flow regimes (Bunn and Arthington 2002), alteration of this pattern can have significant impacts on riverine species (Koel and Sparks 2002). Additionally, alteration of flow regimes can reduce the floodplain's ability to remove sediment and nutrients from the system (Tockner et al. 1999) and facilitate the invasion and success of exotic and introduced species (Bunn and Arthington 2002).

The Illinois River is one of the few large floodplain river systems that is believed to retain sufficient ecological integrity to support large-scale restoration (National Research Council 1992), primarily because it still possesses a properly timed flood pulse and retains considerable floodplain habitats (although much of these are behind levees).

In 1998, The Nature Conservancy worked with partners from local, state, and federal agencies; non-government organizations; and academia to develop a conservation plan for conserving the biological diversity of the Illinois River (The Nature Conservancy 1998). That plan identified loss and degradation of floodplain habitat as a key threat to the conservation of biological diversity within the Illinois River ecosystem. The plan identified floodplain restoration as a key strategy for abating this threat. Toward that end, the Conservancy began restoration of the Merwin Preserve at Spunky Bottoms in 1999. It is hoped that restoration and management at Spunky Bottoms will serve as a model for restoring floodplain wetlands and the ecological functions that are needed to conserve the integrity of the Illinois River.

Spunky Bottoms borders the Illinois River in Brown County and is immediately across the river from the U.S. Fish and Wildlife Service's Meredosia National Wildlife Refuge. The Spunky Bottoms project includes the Conservancy's 1,193-acre Merwin Preserve and 833 acres owned by the Illinois Department of Natural Resources (IDNR). Most of the property formerly consisted of bottomland forests, lakes, and wetlands in the natural floodplain of the Illinois River. In 1921, landowners in the area formed the Little Creek Drainage District, allowing them to construct a levee separating the area from the river and to clear and drain the land for farming. Despite early attempts at drainage, part of the area was still covered with trees, brush, and wetlands as late as 1944 when the U.S. Army Corps of Engineers did a survey of the Illinois River floodplain (The Wetlands Initiative 1999). Renewed efforts at draining began in the 1960s with nearly 1,500 acres of the former floodplain eventually being converted to row crop agriculture.

An initial restoration plan for the Conservancy property was completed in 1999 with the cooperation of the U.S. Fish and Wildlife Service, Natural Resources Conservation Service, U.S. Army Corps of Engineers, Illinois Department of Natural Resources, and The Wetlands Initiative (The Wetlands Initiative 1999). The plan refined the restoration goal of the project and developed restoration objectives and activities. The goal of the Conservancy's Spunky Bottoms Project is "to restore native plant and animal communities that were characteristic of the Illinois River floodplain and to reconnect the river to the floodplain to allow movement of aquatic organisms."

Baseline inventories and monitoring of water quality and vegetation began in 1998. Restoration of the Conservancy property began in 1999 when the pumping of water off the property and into the river was significantly reduced, allowing precipitation, groundwater, and tributaries to fill the site to a water surface elevation of approximately 428 ft above mean sea level. Once standing water was present, wetland plant species quickly reestablished. They had either survived in the seed bank during the decades the land was farmed or came into the site by natural dispersal mechanisms.

Later in 1999, approximately 110 acres of upland prairie were seeded and hardwood reforestation began along the elevated sandy ridge near the middle of the property; to date, more than 7,500 trees have been planted. Monitoring was expanded to include fish, amphibians, reptiles, migratory and nesting birds, small mammals, aquatic macroinvertebrates, butterflies, and biting flies and mosquitoes.

In addition to planting native plant species, an important part of stewardship work at Spunky Bottoms has been the control of invasive species. To date, control of invasive plant species has focused on hand application of herbicides, cutting, mowing, and hand collection of seed heads. Targeted invasive species include cattail, reed canary grass, and cottonwood.

Plans are under way for a cooperative project with IDNR, the US Army Corps of Engineers, and the Conservancy to (1) complete restoration on the Conservancy property, (2) initiate restoration on the IDNR property, and (3) construct a managed connection with the river. The connection will be managed to simulate natural water level fluctuations characteristic of floodplain wetlands in the area, promote the restoration and maintenance of natural wetland vegetation, and provide aquatic organisms access between the river and restored aquatic habitats within Spunky Bottoms.

Research and monitoring will continue to be important activities at Spunky Bottoms. Despite thousands of instances where wetlands have been restored or created, there has been very little monitoring associated with these efforts (Kusler and Kentula 1989). Monitoring of wetland restoration efforts can provide important information on rates and patterns of revegetation, recolonization by animal species, and evaluate the usefulness of wetland restorations in providing natural wetland functions. Wetland restoration usually cannot re-create all conditions present before an area was altered or damaged due to the complexity and variation in natural as well as restored systems (Kusler and Kentula 1989, National Research Council 1992). But detailed monitoring of wetland restorations can provide insight into which wetland functions and values can be approximated with wetland restoration. The research contained in this volume summarizes the information gained during initial restoration efforts of the Conservancy property and is meant to provide a baseline against which future changes can be assessed, especially with regard to how communities and species respond to efforts to restore the natural "flood pulse" by periodic connection to the Illinois River.

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Assemblage of quality aquatic vegetation. Photo by Tharran Hobson, The Nature Conservancy.

View from the levee looking east at bottomland hardwood plantings. Photo by Tharran Hobson, The Nature Conservancy.

Spunky Bottoms Geomorphology as a Context for Wetland Restoration

Edwin R. Hajic

The distribution, type, origin, and age of geologic deposits and landforms influence many aspects of river valley resources, including wetlands. The distribution and quality of valley soils, water bodies, plant communities, and other resources are the direct result of interactions among geomorphic processes and environments, landscape position, and other geologic factors (Bettis et al. 1996, Hajic 1987, 2000b, Oliver et al. 1987). In the Illinois Valley, the history of floodplain and wetland evolution reveals the natural trajectory of interrelationships among valley wetlands, adjacent landforms, and geomorphic processes when the seasonal flood pulse of the Illinois River and tributaries was a fundamental geomorphic process. The history also reveals changes in geomorphic environments, processes, and trajectories wrought by agricultural and river transportation concerns. Many wetland features can be engineered. However, understanding prehistoric geomorphic interrelationships, their evolutionary trajectories, and the impacts of historic changes and incorporating them into restoration plans should improve results of restoration projects and reduce expenses. This paper summarizes the geomorphic context, and historic and prehistoric developmental framework upon which planning decisions for Spunky Bottoms can be based and to which results can be compared. Details of how data were obtained and compiled can be found in Hajic (2000a, 2002).

Geomorphology

Spunky Bottoms is bounded on the north and south by alluvial fans deposited by Little Creek and Camp Creek, respectively (Fig. 1). Both are tributary creeks of intermediate size. Two additional alluvial fans, deposited by small intermittent creeks that drain the southeast flanks of Spunky Ridge, are interior to Spunky Bottoms. The alluvial fans provide a moderately to well-drained landscape position within Spunky Bottoms, as well as slope and drainage gradients. However, Spunky Bottoms is dominated by a floodplain landscape that consists of flood basins of low relief and very poor drainage. Four floodplain surfaces are distinguishable based on topographic, morphologic, and associated sediment assemblage characteristics. Alluvial fan and terrace margins, tributary and Illinois River channel belts, natural levees, and the Illinois River define the configuration of individual flood basins. Historic construction of low dikes, ditch spoil, and road embankments have further compartmentalized flood basins.

The oldest floodplain (F1) occurs between colluvial footslopes and floodplain F2 (Fig. 1). It is partitioned by the interior alluvial fans into two distinct, shallow flood basins. The two basins are further defined by a subtle linear rise on the F1 floodplain margin that is the muted expression of a buried natural levee. The basins would have supported wetlands prior to historic alterations to the district. The northeasternmost basin was, and still is, fed by a seep at the foot of the colluvial slope. At some point this basin also received contributions from flooding of Little Creek and other tributaries draining the adjacent headland, either directly by overflow channels or indirectly by sheetflood.

Floodplain F2 lies about 0.15 – 0.30 m (0.5 – 1 ft) below the elevation of the F1 floodplain. The F2 floodplain is flanked on the southeast by a natural levee associated with the younger F3 floodplain (Fig. 1). To the south, the F2 floodplain is truncated by younger lateral migration of the Illinois River and has a younger natural levee deposited on it. Within the project area, the southwestern end of the F2 floodplain is buried by distal alluvial wash of Camp Creek. The F2 surface is essentially featureless with the exception of a shallow basin in the south part of the district (the former Long Lake), and several other small, subtle basins. A comparatively young crevasse splay rises about a meter within the Long Lake basin. It is situated where historic maps suggest Long Lake had a connection with the Illinois River. Little Creek paleochannels, sometimes occupying secondary overbank flood channels, indicate the creek at times flowed across the F2 floodplain to Long Lake.

The F3 floodplain consists of four distinct narrow flood basins isolated by moderately expressed natural levee ridges (Fig. 1). The natural levee ridges are slightly better drained than the surrounding flood basins. The narrow F3 flood basins, representing slivers of former Illinois River channel positions, are in sharp contrast to the broader F1 and F2 floodplains. The southeastern margin of the F3 floodplain is defined by the man-made Illinois River levee that is built upon the youngest natural levee ridge associated with the F3 floodplain. To the northeast, the F3 floodplain is in part covered with sandy dredge spoil, but probably was buried or modified by activity of Little Creek prior to emplacement of dredge soil.

The F4 floodplain consists of narrow areas between the riverside foot of the man-made levee and the Illinois River (Fig. 1). It also flanks tributaries where they are confined by man-made lateral levees, such as along Camp Creek. This floodplain is subject to seasonal inundations and accumulation of overbank sediments and debris. As a result, the F4 floodplain ranges up to about 5 m (15 ft) higher than floodplains isolated from seasonal flooding by man-made levees.

Holocene Floodplain Landscape and Wetland Evolution

A related sediment assemblage underlies each floodplain. The history of the Spunky Bottoms floodplains and associated wetlands is revealed by the geometry, stratigraphic relationships, and depositional environments of different lithofacies of the sediment assemblages (Hajic 1990 b, 2000a, b, 2002). The different floodplain sediment assemblages reflect in part locations of former Illinois River channels. When a channel position is abandoned by lateral migration, atrophication, or avulsion, a new floodplain sediment assemblage begins to form as lacustrine or floodplain sediments fill the former channel. Therefore, floodplain sediment assemblages will vary in terms of basal age of fine-grained fill. However, younger increments of overbank deposits will be shingled across multiple floodplain sediment assemblages, although thicknesses of overbank deposits are likely to vary among different sediment assemblages.

The F1 sediment assemblage aggraded in a perennial body of water with little or no current. Investigations farther down valley suggest this water body was a valley or riverine lake (Hajic 1990b). Aggradation was underway by about 7,000 years before the present (B.P.), and may have commenced about 9,800

B.P., following an episode of downcutting in the Illinois Valley. At some point during this aggradation, a lobe of sediment was deposited by Camp Creek as a fan delta within the lake at the south end of Spunky Bottoms. The smaller interior drainages debouched directly into this body of water as well before becoming subaerially exposed. In general, the bulk of the lower Illinois Valley alluvial fan volume was deposited during the middle Holocene, between about 8,500 and 2,500 B.P. (Hajic 1990a).

Following this very early Holocene valley lake phase, the Illinois River eventually developed as a stable, straight, low gradient river flanked by natural levees and perennial, relatively deep, lateral lakes in the lower part of the lower valley around 8,500 B.P. (Hajic 1990b). The F2 LSA likely represents aggradation associated with this early channel position and its subsequent infilling through the middle Holocene. Initial infilling was under slackwater or lacustrine conditions, probably in a lateral lake. Aggradation of the F1 sediment assemblage continued through the middle Holocene. Towards the end of the middle Holocene, lateral lakes had filled to the point where they became intermittent backwater lakes, with seasonal desiccation and soil formation.

Between about 2,800 and 2,500 B.P., the Illinois River at Spunky Bottoms and elsewhere became more active due to an increase in precipitation resulting in an increase in flood frequency or magnitudes (Hajic 1990b). At Spunky Bottoms this brief phase is represented by the series of truncated and buried chutes and multiple natural levees of the F3 floodplain sediment assemblage. By this time, lateral lakes associated with the F1 and F2 sediment assemblages had evolved into subaerially exposed floodplain and intermittent backwater lakes. The F1 flood basins may have evolved into intermittent lakes or seasonally inundated floodplains somewhat earlier. It was during this brief phase of increased flood activity that the network of secondary flood channels developed on the F2 floodplain. Also during this phase, perennial tributaries incised their fans and extended their channels into flood basins on the F1, F2, and F3 surfaces, in part utilizing channels scoured by flood currents.

From about 2,500 B.P. until EuroAmerican settlement there was little geomorphic change in Spunky Bottoms. The Illinois River apparently stabilized in terms of lateral movement. Sediments delivered by Illinois River floods and tributary streams accumulated extremely slowly compared to previous phases of aggradation, on seasonally inundated floodplains and in intermittent backwater lakes. It is likely that the F3 flood basins intercepted the bulk of sediment input during this phase. Tributary channels remained active beyond older fan limits either because they were adjusted to prevailing conditions or were unable to dramatically change course. With each storm runoff, these tributaries would have either disseminated across their medial to distal alluvial fans or replenished backwater lakes. For the most part, natural levees associated with the F3 sediment assemblage prevented tributary creeks from entering the Illinois River directly.

Pre-EuroAmerican Settlement and Modern Geomorphic Environments

Geomorphic environments immediately prior to EuroAmerican settlement were considerably different than today. Tributary creeks and the Illinois River were unconstrained by artificial means prior to development of the Spunky Bottoms Drainage and Levee District. As a result, late prehistoric patterns of flooding, flood storage, and sediment dynamics that affect the type and location of wetlands would have differed greatly from patterns seen today.

During the late Holocene, and likely continuing into early historic times, Little Creek supplied water, nutrients, and limited sediment to flood basins on the F1, F2, and F3 floodplains when it was flowing to the south or southeast. On the F2 surface, Little Creek fed a small pond that overflowed to Long Lake. When either Long Lake or the adjacent Illinois River attained about 129.8 m (426 ft) in elevation, exchange between the two would occur. At a later time, Little Creek flowed into the oldest flood basin of the F3 floodplain, and could have overflowed into Elbow Lake. At the beginning of the twentieth century, Little Creek flowed northeastward and not into Spunky Bottoms. Until the very late Holocene, Camp Creek flowed to the southeast, well south of Spunky Bottoms. However, a very late avulsion caused the creek to flow eastward and deposit the low fan lobe at the south end of Spunky Bottoms (Fig. 1). This lobe contributed to formation of a basin in the southern end of Spunky Bottoms by blocking off a southern escape route for intermittent backwater lake overflow or receding floodwaters. The Long Lake outlet to the Illinois River was likely contemporary with growth of this fan lobe. During small to moderate storms, runoff from the two small drainages that drain Spunky Ridge to the northwest would have dispersed across and infiltrated medial to distal parts of their alluvial fans, depositing accompanying sediments. During large storms, runoff may have exceeded infiltration capacity of the fans and flowed onto and across F1 or F2 floodplain surfaces. Severe storm runoff, and probably the steady spring-fed discharge of the one tributary, ultimately would have contributed discharge to depressions on the F1 and F2 floodplains, and eventually to the Long Lake basin.

Immediately prior to EuroAmerican alteration of the landscape, the Spunky Bottoms floodplain was subject to a normal seasonal flood regime of the Illinois River, and the suspended sediment load was minor compared to historic times. During high water, water depths would have varied by flood magnitude and elevation of overtopped floodplain and natural levee surfaces. During floods of low magnitude, floodwaters would have backed up into the district through the Long Lake outlet and possibly via Camp Creek as it was hydraulically dammed. F3 flood basins may have been flooded through gaps in associated natural levees. The F2 floodplain in the southern part of the district would have flooded first, becoming more extensive to the north as flood magnitudes increased. Eventually, at least parts of the southwestern F1 remnant would have been inundated. Floods of larger magnitude would have topped the natural levees.

As agriculture and river transportation became more important economic endeavors at the beginning of the twentieth century, changes to the Illinois Valley were required to optimize these endeavors. In the 1920s and 1930s, the Spunky Bottoms Drainage and Levee District was developed as part of a larger program of valley water control and development of farmland. A man-made levee was constructed along the Illinois River. Combined with man-made lateral levees along Camp and Little Creek that were canalized directly to the Illinois River, the seasonal flood pulse into district flood basins was eliminated. These constructions also prevented the two major tributaries from routing storm runoff or canalized flow into Spunky Bottoms, eliminating another major source of replenishment for flood basins. An extensive network of ditches was excavated in the district, leading to two pumping stations located in the northeast and central-east parts of Spunky Bottoms. The two small tributaries were canalized into the ditch network, bypassing their alluvial fans. In some places, ditches follow former flood basins, although the direction of flow during pumping is locally reversed. In other locations, ditches crosscut landforms. In both cases, sediment that is periodically dredged out of and spread beside the ditches serves to further segment original flood basins. The ditch and pump network, combined with field tile emplacement, has effectively drained former intermittent and perennial lake basins, allowing cultivation. When waters rise within the southern part of Spunky Bottoms, pumping can decrease the period of inundation.

Discussion

Levee and ditch construction, tiling, and progressively deeper plowing of increasing upland acreage had a tremendous impact on the trajectory of landscape evolution, the interconnectedness of the pre-EuroAmerican settlement geomorphic environments, and the functions performed by individual landscape components.

With canalization, ditching, and levee confinement of tributaries, alluvial fans of the small and intermediate tributaries no longer were able to serve their primary function as sediment repositories. Instead, sediment was routed past these natural sediment storage facilities into ditches beyond the fans or, in the case of the larger tributaries, directly to the Illinois River. Not only have these alterations to tributaries changed the function of the alluvial fans, but where they have been applied, particularly to intermediate and large tributaries, they have contributed to an increase in sediment yield from tributary valleys. Canalization of Little and Camp creeks across the Illinois River floodplain has resulted in straighter creeks, shortened channel lengths, and increased gradients across the floodplain. In response, Little and Camp creeks likely adjusted to the increased gradients by greater incision upstream and increased erosion in lower order branches of the drainage network, with a concomitant increase in sediment yield. Sediment yield also was augmented by clearing of forests and breaking of upland ground for row crops. It was further aggravated by modern mechanized agricultural practices, elimination of hedgerows, and deep plowing. Confinement by man-made levees routes this increased sediment yield directly to the Illinois River. Simultaneously, wetlands not immediately placed under the plow within Spunky Bottoms were deprived of the upland freshets most of them received from perennial tributaries prior to canalization. However, unlike floodplain surfaces on the riverside of the man-made levee, wetlands and floodplains were spared being overwhelmed by upland-derived sediments. During the late fall and winter months, when the active pump station normally is not operated, the small spring-fed tributary fills ditches in the southern half of the district and eventually floods at least the floor of the Long Lake flood basin. To what degree this would have affected wetlands prior to levee construction is unknown because of the original connection of the Long Lake basin to the Illinois River. Ditching, canalization, levee construction, dredge spoil, and road embankments all contribute to segmentation of the flood basins within Spunky Bottoms, isolating some flood basins and original landscape functions.

Man-made levees that confine the Illinois River have prevented the annual spring flood pulse of the river from entering Spunky Bottoms. This has limited contributions of water and nutrients to floodplain wetlands, and eliminated natural levee construction and floodplain sedimentation within the levees. The collective man-made alterations impacting Spunky Bottoms reduced still further an already extremely low sedimentation rate in flood basins. In contrast, since the man-made levees were emplaced, the suspended sediment load of the river has increased dramatically. Flood basins along the lower-middle and lower Illinois Valley supporting wetlands unprotected by man-made levees, such as the F4 floodplain, have been filling rapidly for the last 100 or so years as a result. With reintroduction of the Illinois River flood pulse into Spunky Bottoms, the challenge will be to limit the effects of relatively large volumes of sediment that will be introduced with the floodwaters.

Floodplains primarily function as temporary storage facilities of floodwaters and longer-term storage facilities of overbank flood sediments. All evidence indicates that prior to settlement, the Spunky Bottom floodplains were in equilibrium with the flood regime of the Illinois River. Seasonally the floodplains had been receiving extremely limited additions of clayey sediment that were incorporated into the soil profile with each dry season. Following levee construction, the only sediment additions of note were through the spreading out of dredge spoil. These changes, coupled with the network of tiles and ditches, have impacted the floodplain soils and drainage patterns.

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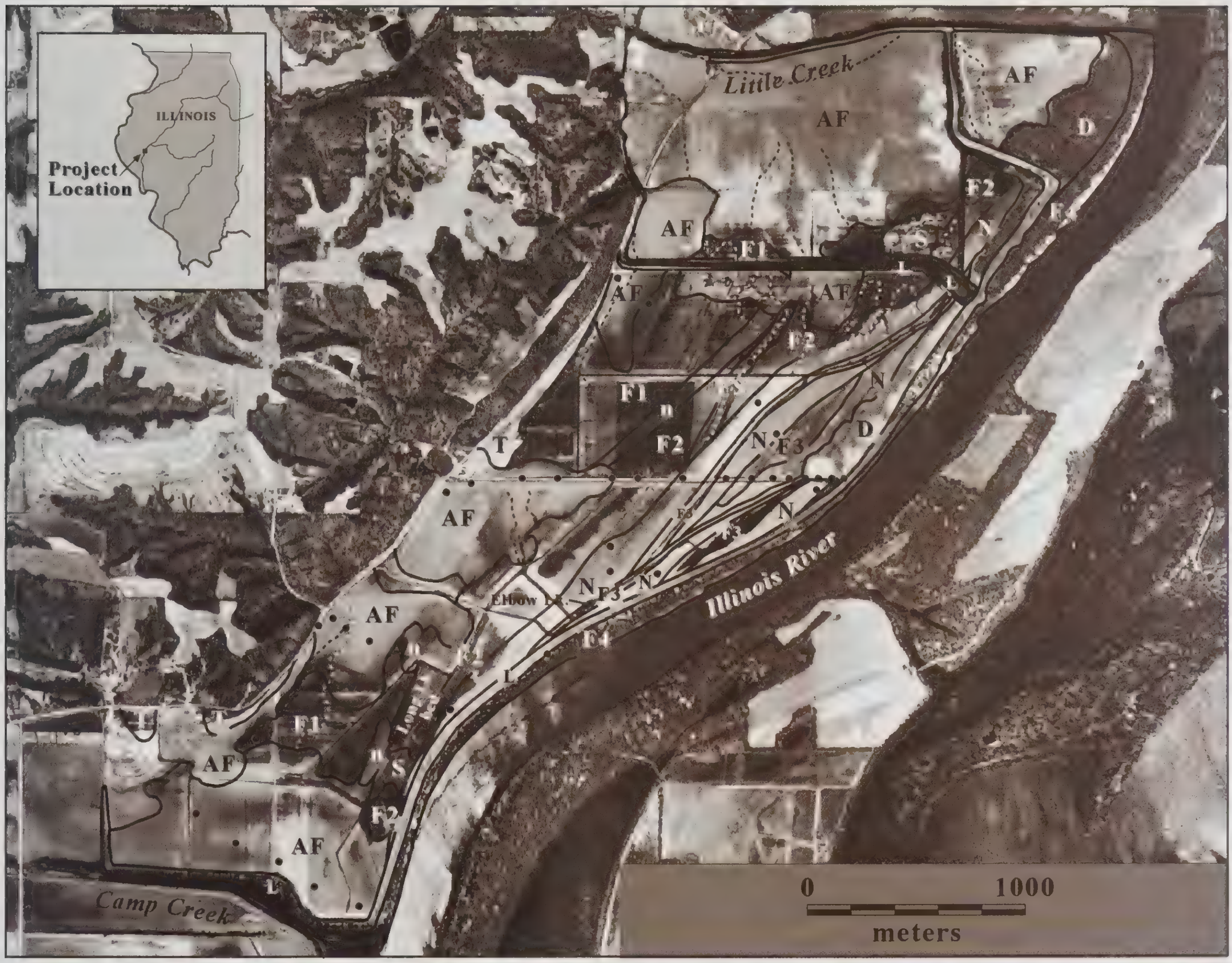

Figure 1. Geomorphology of Spunky Bottoms. T - deglacial terrace; F - floodplains, labeled oldest (1) to youngest (4); FS - secondary flood channel; N - natural levee; n - natural levee, buried; AF - alluvial fan; S - crevasse splay; L - man-made levee; D - dredge spoil. Dotted lines are tributary creek paleochannels. Black dots are core locations.

Fletcher O'Hara with a largemouth bass angled from Spunky Bottoms. Fishery response was remarkable in the first few years. Photo by Matt O'Hara, INHS.

American lotus was one of the early seedbank recoveries.

Coelotanypus spp. (Chironomidae) collected in emergence traps at LaGrange Big Lake, near Spunky Bottoms. Photo by A. Maria Lemke, The Nature Conservancy.

A beaver, Illinois' largest rodent, seen at Spunky Bottoms. Photo by Tharran Hobson, The Nature Conservancy.

INHS researcher monitoring fish populations at Spunky Bottoms. Photo by Kevin Irons, INHS.

Doug Blodgett and Tharran Hobson from TNC displaying largemouth bass from Spunky Bottoms fish monitoring. Photo by Kevin Irons, INHS.

Part 2 — Aquatic Systems

According to the late Frank Bellrose, the Spunky Bottoms site quickly became one of the larger lotus marshes in Illinois. Photo by Tharran Hobson, The Nature Conservancy.

Moon rising over Merwin Preserve at Spunky Bottoms. Cattail, lotus, and other aquatic vegetation combine to produce a myriad of habitats. Photo by A. Maria Lemke, The Nature Conservancy.

Preliminary Assessment of Aquatic Pollution Indicators and Microbial Communities at Spunky Bottoms Restored Wetland

Tim Kelley

Wetlands have often been referred to as "the kidneys of the world" due to their ability to retain water that has been polluted by anthropogenic and other contaminants and improve water quality through natural physical, chemical, and biological processes. This process of remediation removes many contaminants and returns the water to more "natural" conditions. For example, aquatic contaminants such as larger, settleable, and smaller, suspended solids may block natural processes such as photosynthesis and respiration. These contaminants may be reduced by simply passing water through a wetland and physically slowing the water flow enough to allow these solids to slowly settle out to form sediment. Dissolved (e.g., nitrate, phosphate) and volatile solids (e.g., fats, oils, and greases that are converted to gases at lower temperatures than other solids) may be reduced by physical adsorption to wetland component surfaces, or absorption and biochemical metabolism by plants, animals, and microorganisms. Microbial contaminants capable of causing infectious disease (i.e., pathogens) are often a product of animal wastes. Concentrations of pathogenic contaminants may be reduced by settling or through the natural antimicrobial action of ultraviolet sunlight. Microbial communities of wetlands may also contain bacteria that contribute to the cycling of key nutrients such as nitrogen (N) and phosphorous (P). N and P are often considered limiting nutrients that prevent proliferation of microbial communities and may result in algal blooms and the depletion of oxygen vital to the health of aquatic organisms (eutrophication).

In 2000, I conducted a preliminary assessment of the ability of the Spunky Bottoms wetland to remediate common indicators of aquatic pollution such as coliform bacteria, dissolved oxygen (DO), conductivity (increased by ionic compounds like nitrate [NO3-] and phosphate [PO4-]), and potentially associated environmental conditions like temperature and pH. In 2001, I identified microbial communities and bacterial populations that could potentially contribute to biogeochemical cycling of elements (e.g., N and P).

Methods

Aquatic pollution indicators: Seven surface water sampling locations and four existing groundwater wells within the Spunky Bottoms wetland were identified and sampled from one to five times during June–September, 1999 for biotic and abiotic water pollution indicators (refer to Fig. 1 and Table 1 for sampling site locations and sample repetitions). Sites chosen reflect the southeastward flow of water through the wetland. Samples collected were packed on ice and shipped overnight for subsequent laboratory analysis (see Kelley, T.R., and E. Huddleston, 2001, for details). Standard method techniques (APHA, 2000) were used for all water sample analyses and aseptic technique was observed to prevent contamination of samples being analyzed for microorganisms.

Microbial communties and populations: Four surface water sampling locations were identified and sampled during July, 2000 (North Cox, South Market, Main Road, and Pumphouse; Fig. 1). Three additional sites (Middle Creek, Snyder's Landing, and the Illinois River) and the Pumphouse site were sampled during November, 2000 (Fig. 1). Phospholipid fatty acid (PLFA) analysis was used to determine predominant microbial populations and polymerase chain reaction denaturing gradient gel electrophoresis (PCR-DGGE) molecular techniques were used to determine predominant bacterial populations in water samples collected (see Kelley, T.R., and A. Hentzen 2003). Phospholipids are constituents of microbial cell membranes and can be used to identify microbes by comparing their unique profiles to existing PLFA profile databases. PCR-DGGE is a molecular technique used to amplify specific ribonucleic acid (RNA) sequences, isolate them, and sequence them. These unique sequences can then also be used to identify groups of bacteria by comparing results to existing RNA databases.

Results

Aquatic pollution indicators: Concentrations of indicator bacteria (total coliform and *Escherichia coli*) were reduced as water flowed from the North Market, Main Road, and South Cox drainage canals to the pumphouse (Fig. 2, Table 1). The pumphouse was the location from which water was formerly pumped into the Illinois River and had the lowest levels of indicator bacteria among sites sampled within the wetland. *Pseudomonas* and *Bacillus* sp. recovered from water samples during this study are known to participate in N and P biogeochemical cycling. Although results varied, no significant differences were found for other pollution indicators or potentially related factors, including dissolved oxygen, conductivity, total dissolved solids, pH, or temperature (Table 1).

Microbial communties and populations: PLFA and PCR-DGGE analyses indicated a diversity of microbial communities present in the wetland, including fungi, algae, protozoa, diatoms, and bacteria. Biomarkers for Gram-negative bacteria were more abundant than those for Gram-positive bacteria, which was consistent with recovery of Gram-negative coliform bacteria and *Pseudomonas* sp. during 1999. Predominant microorganisms identified by PCR-DGGE included *Flavobacterium* sp., alpha-proteobacteria, *Actinomycetes* sp., *Prochloroccus sp.*, and several unclassified microorganisms. The microorganisms identified have the potential to contribute to biogeochemical cycling of elements such as N, P, and carbon (C). Alpha-proteobacterium include Purple Nonsulfur Bacteria and the Rhizobiaceae Family which contains the genera *Rhizobium*, *Agrobacterium,* and nitrifying bacteria Bradyrhizobiaceae – *Nitrobacter* and *Nitrococcus,* which contribute to the N cycle. Purple Nonsulfur Bacteria are capable of anoxygenic (without oxygen) photosynthesis utilizing a variety of energy sources for metabolism. Also, Bradyrhizobiaceae (*Nitrobacter*, *Nitrococcus*, and *Nitrosospira*) organisms contribute to N geo-recycling, making nitrate readily available for use by plants but also easily leached from the soil or denitrified to N gas. Other flora characterized during this study (*Prochlorococcus*, *Actinmycetes*, and *Flavobacterium* sp. including the *Cytophaga-Bacteroides* group) contribute to the aquatic environment by generating nutrients via photosynthesis or other mechanisms common in many aquatic and soil related organisms.

Conclusion

This study represents only an initial, tentative effort to establish the potential of restored wetlands to remediate aquatic pollutants and contribute to elemental biogeochemical cycling in the environment. However, substantial evidence shows that the microorganisms isolated in this study could contribute to biogeochemical cycling of elements. Additional studies with greater scope and longer time frames could improve the currently limited knowledge of the contributions of wetlands to contaminant remediation and biogeochemical cycles.

Figure 1. Map of wetlands and sample locations. Surface water sampling locations (large black dots), groundwater wells (small numbered circles) at Spunky Bottoms as of 12/31/98.

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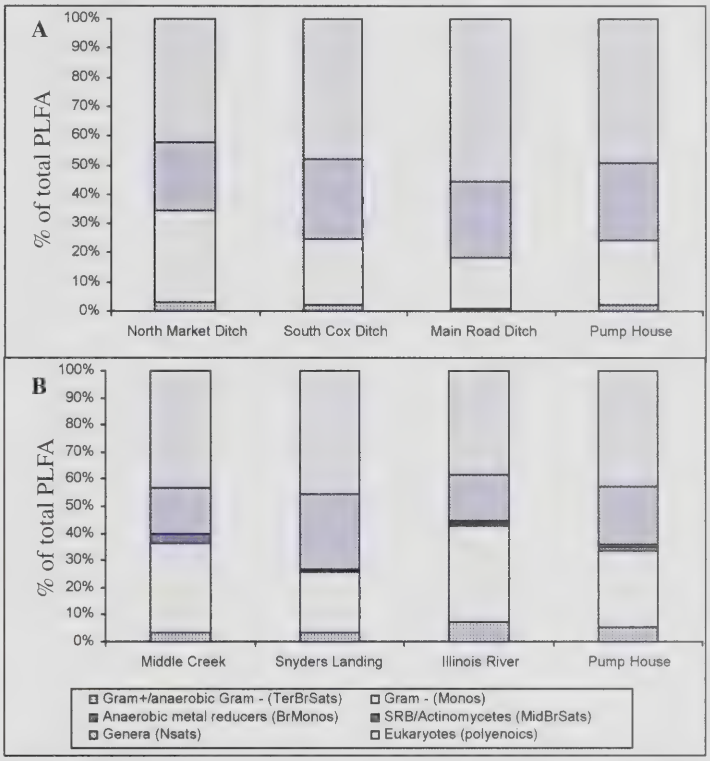

Figure 2. Community composition of aquatic pollution indicators at surface water sampling locations in Spunky Bottoms and the Illinois River.

Table 1. Results of Spunky Bottoms wetland water sample analyses for bacterial and physicochemical indicators (Mean ± 1 Standard Deviation).

	South Cox[1]	Middle Creek[1]	North Market[1]	Main Road[1]	Snyder's Landing[1]	Pump-house[1]	Illinois River[1]	Well spb-5[2]	Well spb-12[3]	Well spb-13[2]	Well spb-19[3]
Total coliform (cfu/ml)	74.9 ± 32.8	34.0 ± 2 0.6	79.1 ± 77.2	36.4 ± 23.5	55.8 ± 47.8	28.9 ± 15.5	22.2 ± 14.8	57.0 ± 26.0	ND*	65.3 ± 44.1	ND
E. coli (cfu/ml)	6.7 ± 4.9	5.75 ± 6.36	7.08 ± 5.98	5.33 ± 4.10	6.90 ± 5.63	3.00 ± 1.10	3.40 ± 2.42	5.0 ± 0.7	ND	6.17 ± 3.98	ND
Temp. (°C)	25.80 ± 1.89	22.47 ± 2.68	27.50 ± 5.05	26.05 ± 3.46	27.00 ± 4.93	26.90 ± 4.04	28.30 ± 0.30	21.15 ± 1.65	23.90	23.15 ± 2.55	24.10
DO	8.03 ±	7.43 ±	2.85 ±	7.00 ±	6.65 ±	7.45 ±	6.73 ±	4.80 ±	3.10	5.15 ±	3.40
(mg/L)	5.71	3.86	1.22	3.43	3.14	5.55	2.62	1.90		1.95	
pH (0-14)	7.41± 0.22	7.26 ± 0.21	7.30 ± 0.19	7.38 ± 0.16	7.40 ± 0.30	7.35 ± 0.19	7.28 ± 0.17	7.14 ± 0.10	7.22	7.17 ± 0.10	7.44
Conductivity (mS)	490.25 ± 35.75	648.33 ± 60.54	591.75 ± 55.60	535.00 ± 131.87	532.25 ± 22.75	469.00 ± 43.97	696 ± 28.99	605.50 ± 28.50	796	655 ± 11	612
TDS (mg/L)	248.75 ± 19.64	331.00 ± 29.20	301.00 ± 29.28	266.25 ± 67.40	267.00 ± 11.11	235.75 ± 23.56	352 ± 10.61	304.50 ± 14.50	401	344.00 ± 0	313

[1] = Sampled five times
[2] = Sampled twice (spb-13 three times for bacterial indicators)
[3] = Sampled once only
*ND = No data generated

Comparison of Nitrogen and Bacterial Dynamics in Spunky Bottoms and LaGrange Floodplain Wetlands

Michael J. Lemke, David Jenkins, Joe Bartletti, Tim Goode

From a biogeochemical point of view, wetlands represent interlaced systems of stark contrast. Surface waters are highly oxygenated due to abundant plant and algae production and are layered immediately adjacent to waterlogged sediments that are anaerobic due to microbial respiration. To understand the nutrient cycles in these systems, we need to understand the microorganisms that thrive under these diverse conditions. Microbes drive nutrient transformation through oxidation and reduction of compounds that fuel their metabolism. In large river systems like the Illinois River, landscape-level floods superimpose another level of temporal complexity on nutrient cycles, cycles that are better described for more stable aquatic systems (Wetzel 2001). Assessment of nutrients and bacteria builds a fundamental understanding of the processes that drive wetland productivity and the ecosystem services (e.g., nitrogen processing) that are critical to the integrity of the Illinois River ecosystem.

We measured and compared several forms of inorganic nitrogen, nitrogen processing rates, and bacterial abundance between two shallow lakes within floodplain wetlands. Spunky Bottoms is under ecological restoration and does not receive river floodpulse waters, whereas the LaGrange Property is in an early restoration state and is affected by the pulse of river flooding. The results of this comparative study yield insights to the function of each floodplain wetland individually, as well as contribute to our growing understanding of the river floodplain system.

Methods

Study sites and sampling: Water and sediment samples (n=3) were collected from the Illinois River and shallow lake sites within two different types of floodplain wetlands along the river. Long Lake (~30 ha; avg. depth 1.0 m) is a clearwater system found in Spunky Bottoms (~468 ha). It was located on the historical floodplain of the Illinois River but remains separated from the river by a levee, thus it maintains water levels from rainfall, runoff, and seepage. Extensive submergent and emergent macrophytes as well as riparian vegetation exist in and around Long Lake (e.g., *Ceratophyllum* sp., *Utricularia* sp., *Lotus* sp., *Potamogeton* sp., *Juncus* spp., *Typha* spp., *Polygonum* sp.,). Located 4 km north of Spunky Bottoms is North Big Lake (~61 ha; avg. depth = 0.5 m), part of the LaGrange wetland mitigation bank (663 ha) owned by the Illinois Department of Transportation. North Big Lake connects to the Illinois River via a large drainage pipe and, during flooding, through a breeched levee on the south shore; it does not have extensive aquatic vegetation, yet does have algal-dominated, turbid waters with riparian vegetation limited to the shoreline (primarily *Polygonum* sp.). Illinois River samples were collected at the south end of the LaGrange Property.

Nutrient and microbiological analysis:
<u>Nitrate-nitrogen (NO_3 - N)</u>: Water samples were filtered (0.22 µm) and analyzed by ion chromatography (IC) and ultaviolet spectrophotometric scanning (UVSS) using standard methods (APHA 1998 – 4500-NO_3). Sediment nitrate was extracted with 0.01 M $CaSO_4$ and filtered through ashed GF/F filters, then analyzed on IC and UVSS (APHA 1998 – 4500-NO_3; Sempre et al. 1993).

<u>Ammonia-nitrogen (NH_3 – N)</u>: Water samples were filtered and analyzed using the phenate method (APHA 1998 - 4500-NH_3). Sediment ammonium was extracted with 2M KCl and filtered through ashed GF/F filters, then analyzed using the standard phenate method. Denitrification rate was measured in sediment samples using the acetylene inhibition method that results in a quantifiable amount of N_2O after incubation (3 hrs) that is subsequently measured on a gas chromatograph with an electron capture capability (Kemp and Dodds 2002). The nitrapyrene inhibition technique (Kemp and Dodds 2002) was used to determine the nitrification rate in sediments in which ammonium was measured (KCl-extracted sediment by phenate method) in paired, replicate samples (inhibited and non-inhibited). The rate is expressed as ammonium loss over the three-to-seven-day incubation per gram dry mass. Water samples from the three sites were measured for total number of bacteria using fluorochromic staining (DAPI technique; Porter and Feig 1980) and counting under 1000X magnification. Concentrations of chlorophyll a were determined by acetone extraction and spectrophotometry (APHA 1998 - 10300-Periphyton; APHA 1998 - 10200H-Chlorophyll).

Results and Discussion

Because of the separation between Spunky Bottoms and the Illinois River, Long Lake did not receive the same influx of nitrate as North Big Lake during river flooding in spring 2002. Although nitrate levels in water decreased in the river and North Big Lake during the fall and winter, levels in North Big Lake dropped below those in the Illinois River, approaching concentrations in Long Lake (Fig. 1A). The simultaneous increase in denitrification rate in sediments, especially in North Big Lake, appears to account for this nitrate decrease (Fig. 2A). Also, North Big Lake sediments showed greater nitrate concentrations than Long Lake and the Illinois River sediments (Fig. 1B), possibly due to greater nitrification rates in summer and autumn (Fig. 2B). It is possible that frequent and strong wind-driven mixing of sediments in North Big Lake accelerated microbial nitrogen processing (Fig. 2) by coupling anaerobic and aerobic processes.

Lack of macrophyte vegetation (i.e., less NH_3 uptake) and high resuspension of sediments from wind turbulence may contribute to the higher concentration of ammonia in water at North Big Lake (Fig. 1C). In sediments, ammonia concentration was similar at all sites except in fall when concentrations in both wetlands were above those in the Illinois River (Fig. 1D). Nitrification rates showed temperature dependence (Fig. 2B) most likely due to thermal stratification in Long Lake (data not shown) while the better mixed North Big Lake (i.e., wind) and the Illinois River (i.e., flow turbulence) showed higher nitrification rates.

The consistent and relatively low pattern of total number of bacteria and algal biomass at Long Lake (Fig. 3A) indicated that this wetland system was more ecologically stable. The inverse relationship between total bacteria number and algal biomass can be explained by vegetation patterns. As aquatic macrophytes become more dominant in the summer, algal numbers fall due to macrophyte exudates, shading, or nutrient competition that can inhibit algal growth (Wetzel 2001: pp. 553–555, 570–571) (Fig. 3A). In contrast, the patterns in Big Lake were more variable, likely due to suspension of particles with high number of adherent microorganisms. The North Big Lake system appeared to be more unstable, as was evident with chlorophyll levels undulating in several seasonal blooms and busts. Macrophytes were largely absent in North Big Lake and so exerted no algal suppression compared to Long Lake.

Restoration efforts at Spunky Bottoms have resulted in dense aquatic vegetation that suppresses sediment resuspension, decreases fluctuation in algal blooms, and likely contributes to nutrient uptake. Even though higher levels of nitrogen found in the Illinois River and Big Lake (LaGrange Property) are likely due to agricultural practices and particle suspension, lake conditions in Long Lake work to decrease nitrate through denitrification. The newly developing LaGrange wetland mitigation bank (North Big Lake) is also processing substantial loads of nitrogen, but is more variable than Spunky Bottoms as a result of its connection to the river and turbulent conditions in the absence of vegetation.

Acknowledgements

We thank the Illinois Department of Transportation for funding to study floodplain wetlands, Dr. A. Maria Lemke for water quality data, and D. Powell and C. Buchanan for technical support.

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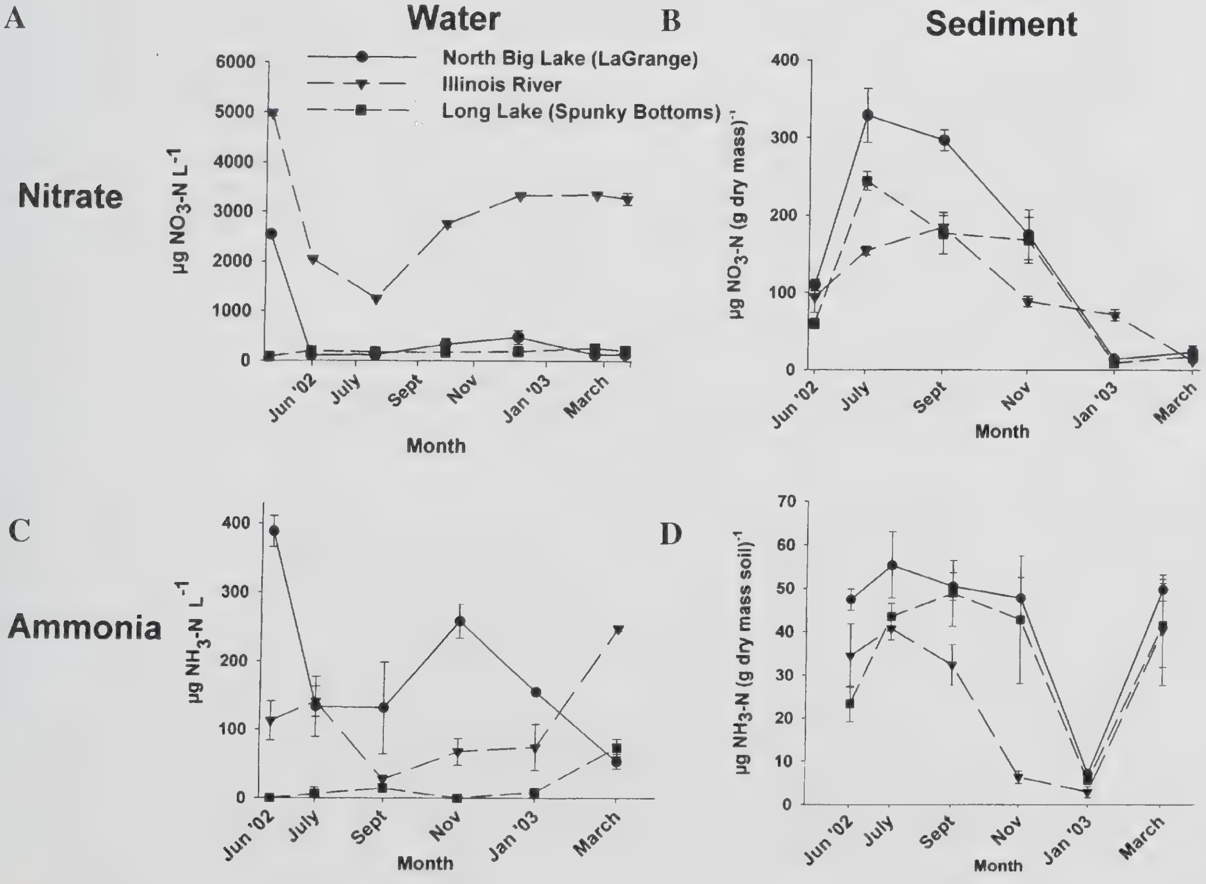

Figure 1. Nitrogen as nitrate (NO_3 - N) in water (A) and sediment (B) from the Illinois River, Long Lake at Spunky Bottoms Reserve, and North Big Lake at the LaGrange Property. Nitrogen as ammonia (NH_3 - N) in water (C) and sediment (D) for the same aquatic habitats (n=3; average ± standard error).

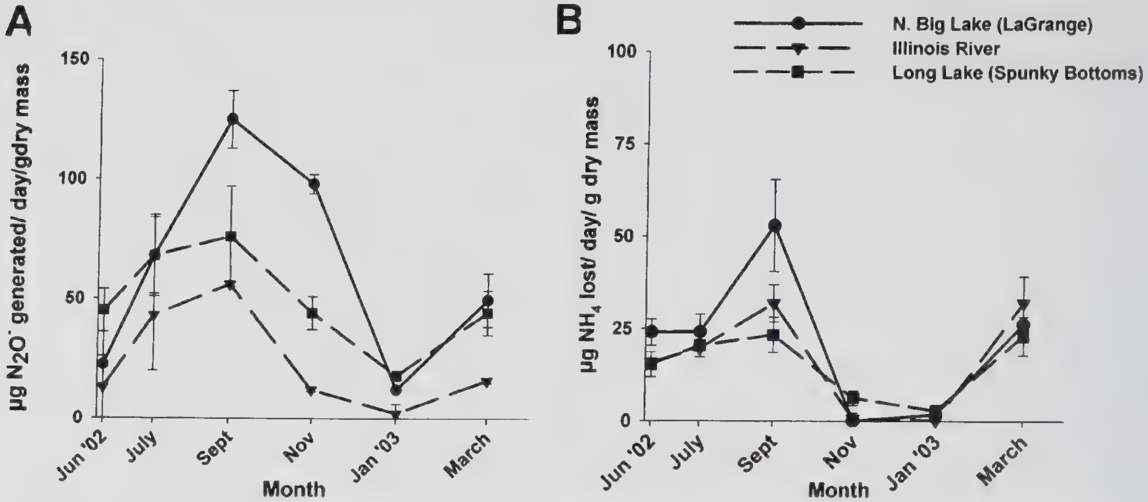

Figure 2. Denitrification (A) and nitrification (B) rates in the Illinois River, North Lake, and Long Lake at Spunk Bottoms Reserve (n=3; average ± standard error).

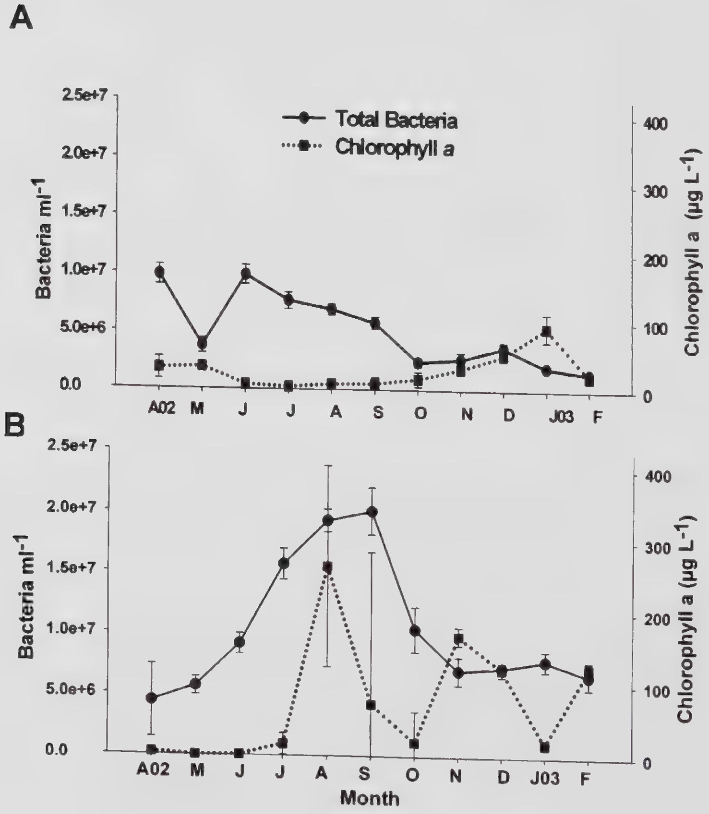

Figure 3. Total bacteria and chlorophyll a in Long Lake (A) at Spunky Bottoms and North Big Lake (B), LaGrange Mitigation Bank for April 2002 to February 2003 (n=3; average ± standard error).

Comparison of Insect Emergence from Spunky Bottoms and LaGrange Floodplain Wetlands

A. Maria Lemke, James A. Stoeckel, Michael J. Lemke

Aquatic insects play an integral role in the energetics of aquatic and terrestrial ecosystems both as consumers and prey items to higher trophic levels (e.g., fish, predaceous insects, birds). Insect emergence is an important process that links the export of energy and nutrients from aquatic to terrestrial ecosystems. In some cases emergence production may exceed terrestrial insect production (Jackson and Fisher 1986) and thus may attract insectivorous bird species to the emergence area (Sweeney and Vannote 1982, Gray 1993). Emerging midges are a major food source for dabbling and diving ducks in northern lakes where peak foraging by ducks coincides with periods of midge emergence (Sjoberg and Danell 1982) and have been associated with the survivorship of nestlings for several bird species (Orians 1964, Street 1977). Monitoring invertebrate community structure also provides important information about physical changes in vegetation and water quality that occur during the development and restoration of wetlands. Because sensitivity to water quality conditions and habitat requirements vary among invertebrate taxa, we can use community composition analyses as a tool to assess and compare the functional and physical health of aquatic ecosystems.

We measured and compared insect emergence between two shallow lakes within floodplain wetlands of the Illinois River that differed in their status of restoration and connectivity to the Illinois River. Spunky Bottoms is a restored wetland isolated from the river by levees and North Big Lake is an unrestored wetland mitigation site that was reconnected to the Illinois River in 2002. The data presented in this paper are one component of a research project designed to investigate the relationship among aquatic invertebrate diversity and production, nutrient dynamics, restoration, and hydrologic connectivity of several floodplain wetlands along the Illinois River.

Methods

Long Lake is a densely vegetated 30-ha pond area located within Spunky Bottoms and has an average depth of 1 m. During this study, Secchi disk visibility ranged from 20 to 103 cm, conductivity averaged 336 ± 5 µS, and pH averaged 8.2 ± 0.04. Emergent and submersed vegetation encompassed much of the pond area from April to November, and included species of *Ceratophyllum*, *Utricularia*, *Lotus*, *Potamogeton*, *Juncus*, *Typha*, and *Polygonum*. This site has been managed by The Nature Conservancy since 1999 and in that time the landscape has been transformed from agricultural land to restored wetland habitat. North Big Lake is a shallow (0.5 m), unvegetated 61-ha pond at the LaGrange wetland mitigation site about 4 km north of Spunky Bottoms. Since 2002, North Big Lake has been connected to the Illinois River through a gravity feed pipe and during flood events. Secchi visibility was 5–16 cm, conductivity averaged 381 ± 3 µS, and pH averaged 8.5 ± 0.03.

Floating emergent traps were used to sample adult insects continuously from March through November 2002 and 2003 (Fig. 1). The traps, modeled after those used by Stagliano et al. (1998) and previously described by Davies (1984), sampled an area of 0.25 m^2 and were designed to move vertically with changing water levels. They were constructed of transparent 1-mm-thick polycarbonate plastic (Lexan) to reduce shading effects (Davies 1984). The tops of each trap were reinforced with inverted polypropylene funnels that connected to inverted screw-top glass jars partially filled with 70% ethanol. Two large openings in the trap walls were screened with 500-µm Nitex netting to allow airflow through the trap and to provide resting areas for emerging insects. Emergence traps were tethered to 2-in PVC pipes, which were secured to cement anchors, and rotated freely over a known water surface area. Six traps were sampled weekly by replacing the removable jars and aspirating the inside of the traps. The contents of the aspiration chamber were combined with that of the jar to produce one sample. All emergent insects were identified to genus, although taxonomic experts verified several to the species level. Daily emergence was calculated by dividing the densities and biomass of animals emerging during a sampling interval by the total number of days in the interval.

Results

Daily mean water temperature patterns were similar between the two sites and ranged from 1°C in January to 32°C in July. Surface and bottom water temperatures were similar during the spring months, with a slight stratification of about 2–5 degrees occurring during the summer. Dissolved oxygen in Spunky Bottoms remained well mixed in the water column from fall through early spring, and stratified from June through October. Oxygen levels ranged from 6 to 12 mg/L in the surface waters from June to September, although levels fell below 2 mg/L in the bottom waters from July to September. Dissolved oxygen in Big Lake generally remained mixed in the water column ranging from 4 to 20 mg/L throughout the year, and rarely fell below 2 mg/L.

The results presented in this paper represent preliminary data from the first year (2002) of a two-year emergence study. Insect emergence began in late March–early April, and continued to increase throughout the summer at both sites (Fig. 2). Twenty chironomid genera, two mayfly genera, and six caddisfly species have been identified from emergent trap samples in Long Lake. Maximum chironomid emergence occurred during September with 108 ± 30 individuals emerging per m^2 of wetland per day (Fig. 2a). Emergence patterns differed among dominant chironomid families (Fig. 2b). The emergence pattern for Chironominae was bimodal with maximum abundances emerging during May and September. In contrast, maximum emergence occurred during mid-summer for Tanypodinae and during fall for Orthocladiinae. Maximum caddisfly emergence occurred in mid-summer, with an estimated 8 ± 2 individuals emerging per m^2 per day (Fig. 2c). Mayfly emergence was more constant throughout the summer, with 2 ± 1 individuals emerging per m^2 of wetland per day.

At North Big Lake, 15 chironomid genera have been identified although only 2 caddisfly individuals (1 genus) and no mayflies have been identified to date. Maximum emergence occurred during mid-summer with 72 ± 7 individuals emerging per m^2 of wetland per day (Fig. 2a). There were no obvious differences in emergence patterns among chironomid families, although maximum densities of Chironominae were higher (7 ± 1) than either Tanypondinae (2 ± 1) or Orthocladinae (1 ± 0).

Discussion

Differences in emergence patterns may be partially explained by the different environments of these two aquatic systems and the different types of chironomids that inhabit them. Increased habitat heterogeneity associated with the extensive vegetation at Spunky Bottoms likely contributed to higher numbers and diversity of emergent insects compared to North Big Lake. One of the most common taxa in Spunky was *Cricotopus* sp., which is a small chironomid typically associated with aquatic vegetation. In addition, higher densities and diversity of caddisflies and mayflies in Spunky Bottoms likely were due to the availability of stable structural habitat. High resuspension of sediments and lack of vegetation in North Big Lake likely prevented the establishment of many species that rely on vegetation and stable habitats. Dominant taxa collected from Big Lake, *Chironomus* and *Procladius*, commonly co-occur in habitats with silt and fine sediments and are more tolerant of mild pollution.

Although these data are preliminary, densities and taxa richness at Spunky Bottoms approach those reported from southeastern wetlands by Stagliano et al. (1998; maximum emergence of 200 ind. $m^{-2} d^{-1}$; 31 chironomid genera) and Leeper and Taylor (1998; maximum emergence of 130 ind. $m^{-2} d^{-1}$; 39 chironomid genera). These data indicate that the establishment of vegetation and stability of the sediments are important components of restoration activities that improve habitat for aquatic insects and increase biodiversity in restored systems. The aquatic link between emergent insects and terrestrial ecosystems suggests that managing and restoring wetlands to enhance aquatic insect diversity and productivity should have subsequent positive effects on terrestrial and aquatic wildlife that use restored riverine floodplain habitats.

Acknowledgements

We acknowledge the University of Illinois-Springfield and the Illinois Natural History Survey for help in getting this study started. We thank taxonomic experts Ed DeWalt (caddisfly, mayfly) and Bohdan Bilyj (chironomid) for identification and verification of specimens.

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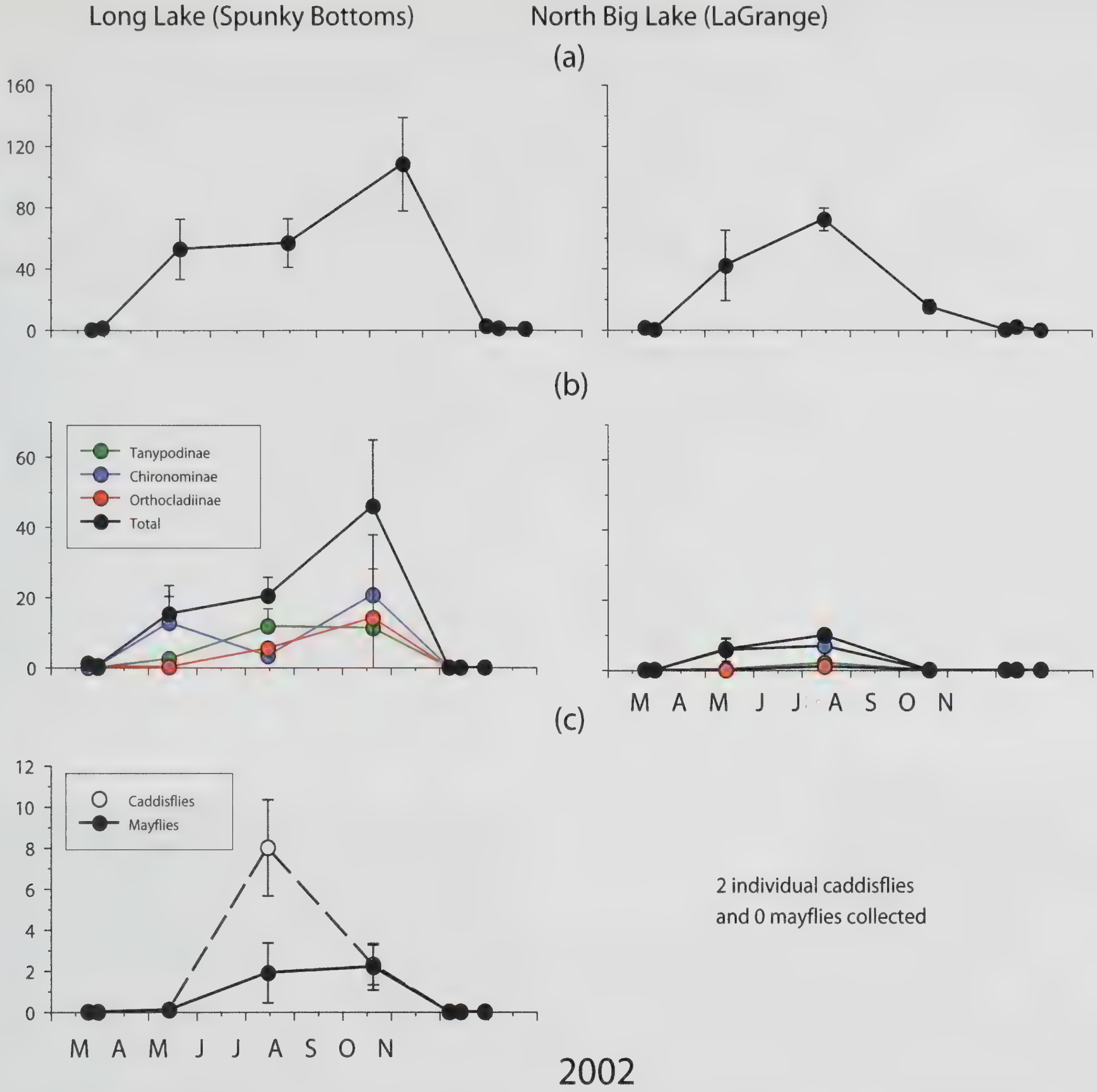
Figure 1. Emergence trap design used to collect adult aquatic insects in Merwin Preserve at Spunky Bottoms. Photo by A. Maria Lemke, The Nature Conservancy.



2 individual caddisflies and 0 mayflies collected

Figure 2. Emergence patterns of (a) male and female adult chironomids, (b) male adult chironomids identified to family level, and (c) caddisflies and mayflies from Long Lake (Spunky Bottoms) and North Big Lake (LaGrange) during March to November, 2002.

Spunky Bottoms Odonate Survey — Fall 2002

Deborah Beal

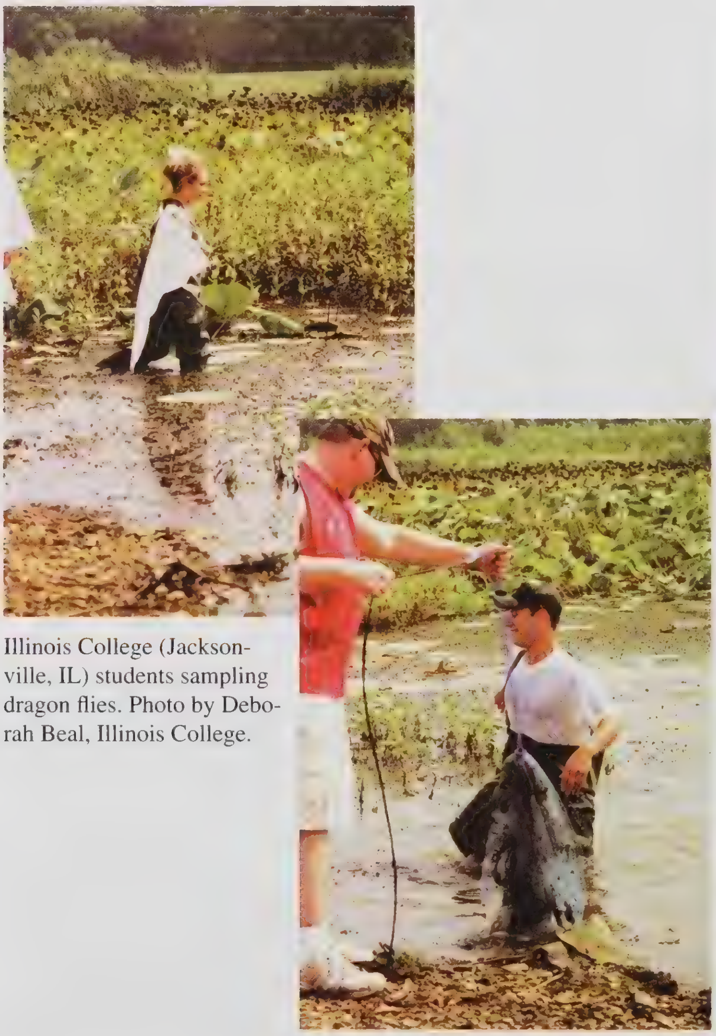
Introduction and Methods

Odonates (dragonflies and damselflies) are often used as indicator species when evaluating habitat quality. Adult and juvenile dragonflies were collected from Spunky Bottoms in fall 2002. Specimens were collected along three 1,000-m transects which were also used to survey plant species (see page 28). Twelve students from a general ecology course at Illinois College, Jacksonville, Illinois, participated in the survey. Students walked the transect line and used light-weight butterfly nets to capture any adult odonates seen. Each specimen was identified in the field. One of each species were kept and mounted as reference specimen. Juvenile odonates are aquatic, so juveniles were collected from the water using dip nets. Stations to sample juveniles were set up every 10 m along the transect line wherever transects crossed areas with water >10 cm deep and a 1-meter-square area was searched. The water depth in the surveyed sections ranged from 10 cm to 48 cm.

Results and Discussion

The greatest number and diversity of odonates was found along Transect 2 (Table 1). This habitat was primarily emergent cattails, rice cutgrass, and reed canary grass. The water depth varied from 15–40 cm. The large number of *Anax junius* was due to a mass emergence. Although we were only able to capture 42, we counted well over 100 individuals. Transect 3 also showed a great deal of diversity but fewer individuals were captured (Table 1). Only eight juveniles were collected, comprising three species: *Argia tibialis*, *Erythemis simplicicollis*, and *Libellula luctosa*. Our difficulty in collecting juveniles was due to our inability to maneuever nets around the vegetation to obtain an adequate sample and a very muddy substrate.

Overall, *Anax junius*, *Erythemis simplicicollis*, and *Libellula luctuosa* were the most common dragonflies. There were fewer damselflies and no species appeared more common than the others. All of the species identified at Spunky are common residents of nearby counties such as Cass, Sangamon, and Morgan.



Illinois College (Jacksonville, IL) students sampling dragon flies. Photo by Deborah Beal, Illinois College.

Halloween pennant (*Celithemis eponina*).

Table 1. Adult odonate survey, fall 2002.

Species	**Transect 1**	**Transect 2**	**Transect 3**
Anisoptera (dragonflies)			
Aeshna constricta		2	1
Anax junius		42	4
Erythemis simplicicollis	14	5	8
Libellula (Plathemis) lydia		6	3
Libellula luctuosa		11	5
Libellula pulchella		8	3
Libellula vibrans		2	1
Pachydiplax longipennis		2	
Perithemis tenera		1	
Sympetrum rubidunculum			1
Symptetrum obtrusum			2
Tramea lacerata		2	1
Zygoptera (damselflies)			
Argia apicalis	4	3	2
Argia tibialis	2	1	1
Enallagma aspersum	3	1	2
Enallagma signatum	1	1	2
Hetaerina americana		1	1
Ischnura verticalis	2	3	
Lestes rectangularis			1
Total number of individuals per transect	26	91	38

Widow skimmer (*Libellula luctuosa*).

Temporal and Spatial Distribution of Mosquitoes at Spunky Bottoms—2000 and 2001

Robert J. Novak

Wetlands have a notorious reputation for producing mosquitoes and other biting flies in prodigious numbers. These insects can disperse hundreds of miles from wetlands into residential and urban areas. In the United States there are 167 described species of mosquitoes in 13 genera. In Illinois we have 10 genera with 65 known species. A majority of these species are currently considered minor regarding noxious behavior to man and even fewer are considered primary transmitters of pathogens causing human diseases. This situation has changed due to the arrival of West Nile Virus (WNV) into Illinois. This virus affects humans but can have major impacts on the morbidity and mortality of wildlife, especially birds. Since it entered the U.S., WNV has been isolated from over 159 species of birds, many species of mammals, and from 39 species of mosquitoes.

The re-establishment and maintenance of wetland habitats such as Spunky Bottoms in proximity to residential communities requires effective and environmentally sound mosquito management. Management of mosquitoes and mosquito-borne diseases must be based on firm biological information in order to ensure the protection of public health, maintain the quality of human life, and protect the health and well-being of wildlife and their environment.

Although Illinois has good taxonomic keys to the mosquitoes of the state, very little ecological information is available, especially along the Illinois and Mississippi rivers. During the flood of 1993 sampling conducted by the Illinois Natural History Survey's Medical Entomology Lab collected 42 species of mosquito along the Illinois River. During this period *Culex tarsalis*, a species considered rare in Illinois was collected in large numbers. This species is the principal transmitter of Western Equine Encephalitis, a disease not yet found in Illinois.

The goal of this study was to determine what species of mosquito are being produced within the re-established wetland at Spunky Bottoms. In addition, I determined the temporal (seasonal) distribution of mosquitoes over the summer months as well as their relative densities. One of the principal questions asked by the public about wetlands concerns the potential for added nuisances problems created by mosquitoes arising from these habitats. To address this question samples were collected over two summers from Spunky Bottoms as well as in the nearby village of Meredosia, approximately 5.5 mi southeast of Spunky, to provide data on species diversity and abundance.

Methods

A total of six sampling stations, three light traps, and three gravid traps, were used for mosquito collections at both Spunky Bottoms and Meredosia. Mosquitoes resting on vegetation also were collected by aspiration about 30 m away from each sampling station. Sampling sites at Spunky Bottoms represented six different types of landscape features. Sampling sites in Meredosia included three sites in domestic locations (back yards) and three sites on the perimeter of the village.

I used carbon dioxide (dry ice)-baited Centers for Disease Control (CDC) light traps to collect adults and standard dipping techniques to collect immature aquatic stages. Light and gravid traps were set up one hour before sunset and the overnight collections were picked up two hours after sunrise the next morning. Collection of mosquitoes by aspiration was done during late afternoons, about two to four hours before sunset, for about 15 minutes per collecting site. The carbon dioxide-baited CDC traps collect primarily host-seeking females of many species, and are the standard method used to establish species composition, temporal distribution, and for arbovirus surveillance. A combination of sampling methods was used because the efficacy of each sampling method varies by mosquito species, habitat, and physiological state of the mosquito (Service 1976, Bidlingmayer 1967). Gravid traps tend to collect primarily gravid *Culex pipiens* complex species as well as significant numbers of female *Aedes triseriatus*, *Ae. albopictus*, and *Ae. aegypti* (Lampman and Novak 1996, Lampman et al. 1997). Alternatively, resting site collections often yield more comprehensive samples of the entire adult mosquito population because these collections include both males and females (Service 1976).

Several traps were run at each site for a 24-hour period. Surveys were repeated about every 10–14 days, or twice a month during the mosquito season. Specimens were sorted by sex, species, and gross physiological state on a chill table and stored at -80°C until identified and counted.

Results and Discussion

Based on two years of sampling at Spunky Bottoms, the greatest production of permanent water species of mosquitoes, *Culex* and *Anopheles* species, occurred along the margins of canals and channels. Mosquito larvae were especially abundant where the vegetation provided shelter. Numerous water-filled muskrat runs also provided sources of large numbers of *Culex* and *Anopheles* larvae. *Culex* larvae were especially abundant during the drier months of both summers when water levels were lower and rotting organic material was abundant. *Anopheles* larvae exhibited very little variation in number, remaining at low levels beginning in April and ending in late September of both years.

The major breeding site for floodwater mosquitoes at Spunky Bottoms was found along the eastern edge of the site, south of the existing pump station and extending to the south levee. The productive area covered approximately four acres. This was one of the lower areas of the site and accumulated two to six inches of water after a rain. There were several other locations with low relief at Spunky, primarily along the east and north levees. A major low area that produced floodwater mosquitoes was found outside of Spunky Bottoms north of the township road and along the west levee of the Illinois River.

Several breeding sites in and directly adjacent to Meredosia were found and sampled during this study. These sites consisted of roadside ditches and areas of low relief along the railroad right- of-ways. Numerous man-made or artificial breeding sites including used tires were also found during our surveys. These sites produced both permanent water species, *Culex* and *Anopheles*, as well as floodwater species after a rain.

A total of 13 species representing 7 genera of mosquito were collected in 2000 and 2001. Tables 1 and 2 list the species sampled at Spunky Bottoms and Meredosia. The 2000 summer season had more total precipitation and more rain events than the drier 2001 season. This is reflected not only in the number of adult mosquitoes collected but also in the diversity of species sampled during the two seasons. The floodwater mosquito *Aedes vexans* was the most abundant species collected during both years at both sites, although the numbers collected at Spunky Bottoms greatly exceeded the numbers collected in the village of Meredosia. *Aedes vexans* is the predominant nuisance mosquito in Illinois. *Culex erraticus*, a bird feeding permanent water species was the next most predominant species found at Spunky Bottoms. This species was absent in 2001 and in very low numbers in 2001 at Meredosia. *Culex pipiens*, considered the primary transmitter of WNV was not collected at either site. This was not unexpected since this mosquito is predominantly an urban-dwelling species.

In terms of WNV, several species of mosquito sampled at Spunky Bottoms, and to a lesser degree at Meredosia, could effectively transmit this pathogen to birds, humans, and other animals. WNV was isolated from *Ae. vexans*, *Cx erraticus*, *An. quadrimaculatus*, *An. punctipennis*, and *Uranotaenia sapphirina* in Illinois in 2002 and 2003. It is yet to be determined what role these mosquito species play in transmitting this virus to birds and other animals or what effect this virus will have on wildlife, especially threatened and endangered species.

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Table 1. Mosquito species collected and identified and their population numbers from six sampling sites in each area by average collected per night and average collected per eight collecting periods during the summer of 2000 at Spunky Bottoms and Meredosia, IL.

	Spunky Bottoms 2000			Meredosia 2000		
Species	Total Collected	Ave. No./Trap	Ave. No./8 Collecting Period	Total Collected	Ave. No./ Trap	Ave. No./ 8 Collecting Period
Oclerotatus hendersoni	8	1	0	2	0	0
Aedes vexans	7694	1282	160	149	25	3
Oclerotatus sollicitans	1	0	0	0	0	0
Oclerotatus trivittatus	7	1	0	0	0	0
Oclerotatus species	9	2	0	0	0	0
Psorophora confinnis	3	1	0	0	0	0
Psorophora cyanescens	25	4	1	0	0	0
Culex species	136	23	3	2	0	0.04
Culex erraticus	785	131	16	9	2	0.19
Culex tarsalis	17	3	0	2	0	0.04
Anopheles quadrimaculatus	102	17	2	37	6	0.77
Anopheles punctipennis	63	11	1	0	0	0
Anopheles crucians	3	1	0	0	0	0
Culiseta inornata	1	0	0	0	0	0
Uranotaenia sapphirina	75	13	2	0	0	0
Total Collected	8929	1488	186	201	34	4.2

Table 2. Mosquito species collected and identified and their population numbers from six sampling sites in each area by average collected per night and average collected per eight collecting periods during the summer of 2001 at Spunky Bottoms and Meredosia, IL.

	Spunky Bottoms 2000			Meredosia 2000		
Species	Total Collected	Ave. No./Trap	Ave. No./8 Collecting Period	Total Collected	Ave. No./ Trap	Ave. No./ 8 Collecting Period
						0
Aedes vexans	1054		0	136		0
Culex species	32	5	1	8	1	0.2
Culex erraticus	11	2	0	39	7	0.8
Anopheles quadrimaculatus	524	87	11	25	4	0.5
Anopheles punctipennis	15	3	0	79	13	1.6
Uranotaenia sapphirina	270	45	6	0	0	0
Total Collected	1906	318	40	287	48	6

Monitoring of mosquito light traps. Photo by Tharran Hobson, The Nature Conservancy.

A night's catch in a mosquito light trap. Photo by Tharran Hobson, The Nature Conservancy.

Fish Community Development During Wetland Restoration of an Agriculturally Impacted Floodplain System, 1999–2003

Mark Pegg, Matt Herbert, A. Maria Lemke

Our objective was to assess changes in fish communities as Spunky Bottoms progresses from an agriculture field/drainage ditch to an isolated wetland complex and ultimately to a connected Illinois River backwater/wetland complex. While this is an ongoing process, we have learned much through the early stages of this restoration process.

Methods

Fishes were sampled annually by boat electrofishing in the fall and by seining in the spring and fall. Electrofishing transects were generally conducted in deeper water with timed runs (~30 minutes) at one to three sites depending on habitat availability each year. Seining was conducted in shallow littoral areas (< 1 m) for 45 minutes at each of three sites. All fishes were identified, measured, and released in the field, except for some small individuals that were preserved to validate identification. The data we present here represent fish collected by electrofishing in fall 1999–2002 and by seining in spring 2000–3 and fall 2001–2.

Results

Using the combined sampling methods, 14 fish species (12 native and 2 exotic) and one hybrid (green sunfish X bluegill) were collected within the Spunky Bottoms wetland complex (Table 1). Electrofishing sampling showed a distinct shift in the community composition of adult fish between 1999 and 2002, as abundances of several dominant species exhibiting disturbance-tolerant life history characteristics declined (e.g., green sunfish, black bullhead, common carp) and abundances of less disturbance-tolerant species increased (e.g., bluegill, largemouth bass, white crappie; Fig. 1).

Fish recruitment was low in 2000 (Fig. 2), with young-of-year for only one species, common carp, collected. However, bluegill, largemouth bass, and white crappie each had good recruiting classes in 2001, likely as a result of the flooding of recently restored vegetated areas in the fall and early winter of 2000. Recruitment of these native species has remained high since 2001 with good year classes of bluegill in 2002 and largemouth bass and white crappie in 2003.

Discussion

Our results suggest a marked change in fish community structure following the inundation of much of the Spunky Bottoms area. Both electrofishing and seine data show that the fish community composition in Spunky Bottoms has shifted from one dominated by common carp to a largemouth bass-bluegill fishery. These changes are probably due largely to the creation of more complex habitat, increased water quality, and increases in invertebrate prey as large areas of terrestrial vegetation were flooded. Inundation of terrestrial vegetation typically results in high growth and recruitment for many fish species, including largemouth bass and bluegill, due to the creation of highly productive, vegetated, littoral habitat. Subsequent years (2002–03) have resulted in a slight decline in recruitment that is typical following water level stabilization in these types of systems. However, recruitment remains higher than pre-restoration conditions suggesting a much-improved system.

Future restoration efforts will focus on reconnecting Spunky Bottoms with the Illinois River. Given the higher diversity of fish species found in the Illinois River, we anticipate increases in the number of fish species due to movement through the connection point/control structure. This increase will likely happen at two scales. First, additional species will establish permanent populations in Spunky Bottoms when given the opportunity. Second, we would expect increased diversity in the spring as floodplain-evolved species move into backwater areas to spawn. The management objectives for the site include this additional use by other species, while still maintaining a quality fish assemblage like that which has already been established through the recent restoration efforts.

Table 1. Species of fishes collected within the Spunky Bottoms wetlands.

Species	1999	2000	2001	2002
black bullhead	X	X	X	X
bluegill sunfish	X	X	X	X
common carp	X	X	X	X
green sunfish	X	X	X	X
largemouth bass	X	X	X	X
smallmouth buffalo	X			
bigmouth buffalo	X	X	X	X
black buffalo		X		X
yellow bullhead	X			X
white crappie		X	X	X
mosquitofish		X		
grass carp			X	
white bass			X	
gizzard shad			X	X

Largemouth bass from Spunky Bottom fish monitoring. Photo by Kevin Irons, INHS.

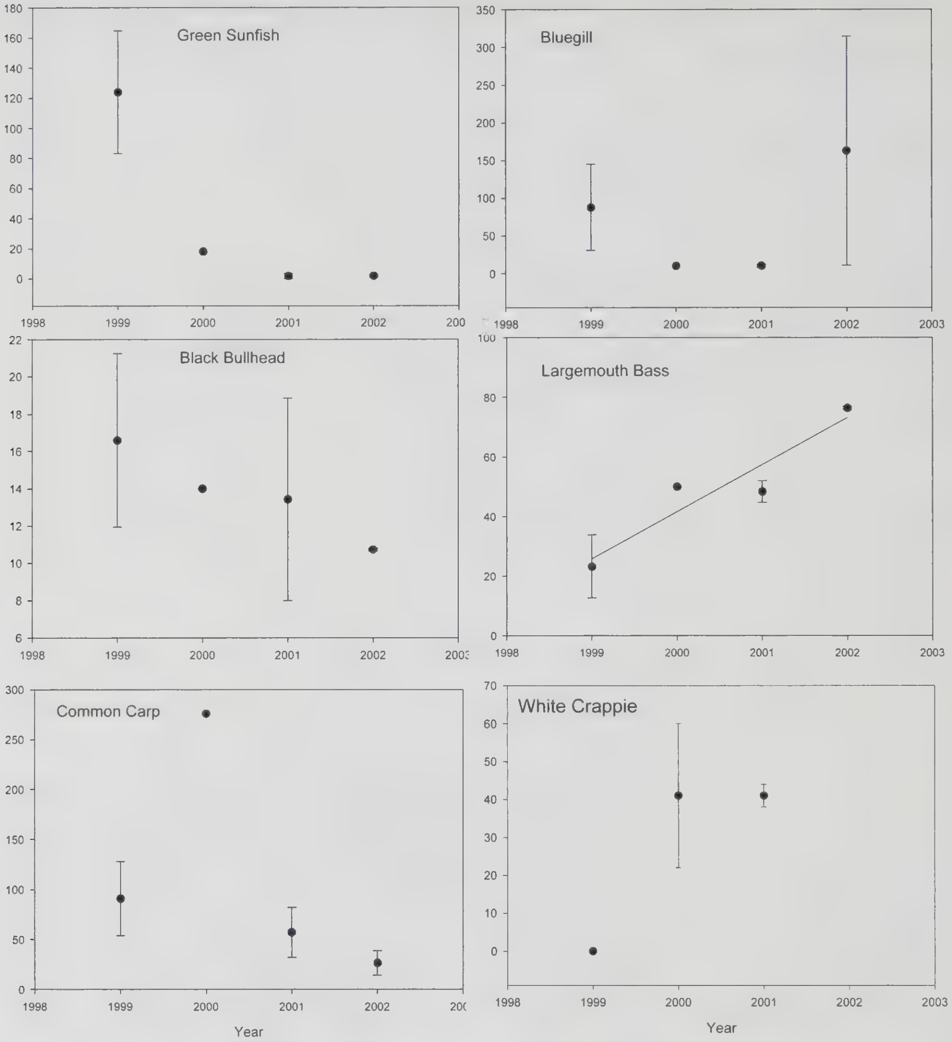


Figure 1. Mean numbers (± 1 Standard Error) of individuals per hour of electrofishing at Spunky Bottoms in fall 1999–2002.

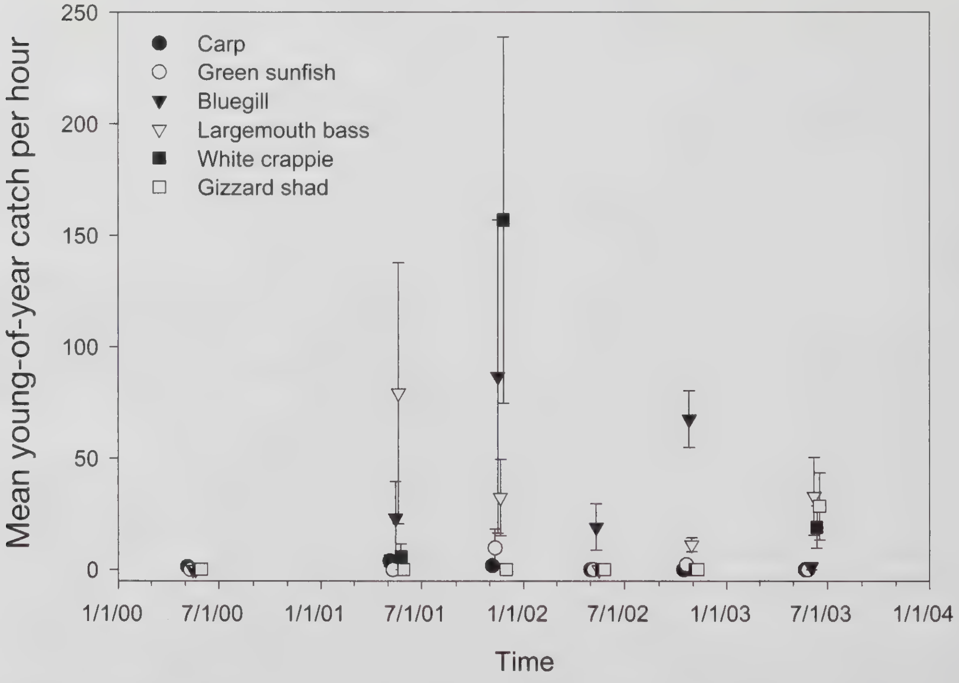
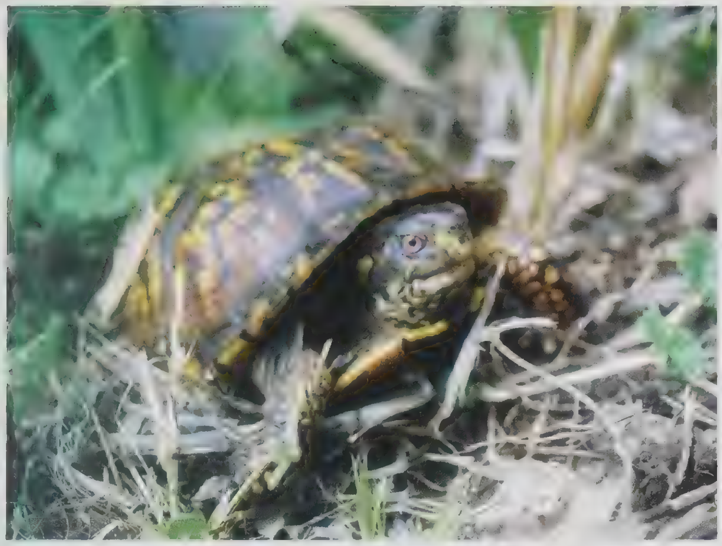


Figure 2. Mean numbers (± 1 Standard Error) of young-of-year fish collected per hour of seining at Spunky Bottoms in spring 2000–2003 and fall 2001, 2002.



An eastern box turtle (*Terrapene carolina carolina*) from Montgomery County. This woodland species was observed in upland habitats bordering Spunky Bottoms. Photo courtesy of John Tucker, INHS.

Prairie coneflowers. Photo by Tharran Hobson, The Nature Conservancy.

Butterfly on swamp milkweed. Photo by Tharran Hobson, The Nature Conservancy.

Henslow's Sparrow. Photo courtesy of B. Attwood.

Western harvest mouse (*Reithrodontomys megalotis*). Photo by Edward J. Heske, INHS.

Butterfly milkweed. Photo by Tharran Hobson, The Nature Conservancy.

Part 3 — Terrestrial Systems

Upland prairie butterfly weed among various prairie species. Photo by Tharran Hobson, The Nature Conservancy.

Upland prairie yellow coneflowers and black-eyed Susan in the first year of the prairie planting in 1999. Photo by Tharran Hobson, The Nature Conservancy.

Changes in Wetland Plant Composition at Spunky Bottoms

Deborah Beal

Introduction

A wetland plant survey was conducted in the fall of 2002 at Spunky Bottoms by students from a general ecology course at Illinois College, Jacksonville, Illinois, and three student interns at Spunky Bottoms. Plants were collected, identified, and herbarium reference sheets were created. Plants were collected along established transects from which a preliminary seed bank had been determined (Sluis 1999).

Methods

We surveyed plants on four transects (Fig. 1). Each transect was 1000 m with plants collected at 10-m intervals. A 1-m^2 grid was laid out and one specimen of each species found within the grid was collected, identified in the field (if possible), placed in a clear plastic bag, and taken back to the lab for further processing. One example of each type of plant was pressed, dried, and mounted on herbarium sheets to serve as permanent reference specimens.

Results

We collected 68 species of plants (Table 1), but most transects did not contain all species. Most of the species present in the seedbank study (Sluis 1999) were present in our survey as well. Reed canary grass (*Phalaris arundinacea*), common cattail (*Typha latifolia*) and pink smartweed (*Polygonum pensylvanicum*) were the only plants found in all transects. Several species such as bluejoint, longhair sedge, creeping sedge, and most of the forb species were only found in one or two transects. Plant species varied with water depth. For example, transects 2 and 3 had water 5–200 cm deep over most sampling sites and had the highest number of aquatic plant species. Transect 1 had less than 1 cm of water for most sampling sites and contained the most "moist soil" type plants such as water parsnip, dogbane, marsh purslane, and water plantain as well as many dicot forbs.

Web site for sharing data sets and providing information for citizen scientists

A Web site (http://www2.ic.edu/beal/WetlandRestoration.html) was created so that research at Spunky Bottoms can be shared among researchers and interested non-scientists. The Web site lists plant species currently present in each transect, gives identifying characteristics of each, and could be used as a tool for other investigators (for example, to compare plant distribution to insects or mammals) or to disseminate information about the project to citizen scientists. The Nature Conservancy is collecting data from all cooperating scientists to put together a metadata set that would be available on the Internet. This would allow comparisons among data sets for analysis of overall biodiversity and correlations among diverse species and various habitat parameters.

References

Sluis, W. 1999. Seedbank study at Spunky Bottoms. Report to the Nature Conservancy, May 7.

American lotus. Photo by Tharran Hobson, The Nature Conservancy.

Bee on swamp milkweed. Photo by Tharran Hobson, The Nature Conservancy.

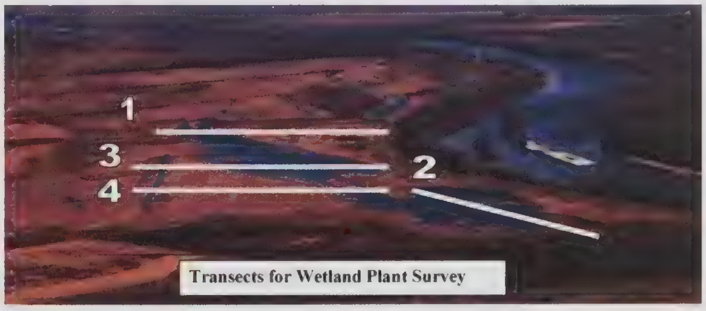


Figure 1. Transects for wetland plant survey. These transects were also used for the Odonate survey, see pages 18 and 19.

Table 1. Wetland plants of Spunky Bottom.

	Transect Number			
	1	2	3	4
Grasses				
Yellow Foxtail (*Setaria glauca*)				x
Barnyard Grass (*Echinochloa crusgalli*)	x			x
Canada Wildrye (*Elymus canadensis*)	x			
Bluejoint (*Calamagrostis canadensis*)			x	
Rice Cutgrass (*Leersia oryzoides*)				
Reed Canarygrass (*Phalaris arundinacea*)	x	x	x	x
Common Reed (*Phragmites australis*)	x	x		
Prairie Cordgrass (*Spartina pectinata*)	x			
Wild Millet (*Echinochloa muricata*)		x		x
Sedges				
Longhair Sedge (*Carex comosa*)	x			
Broom Sedge (*Carex scoparia*)			x	
Strawcolored Nutsedge (*Cyperus strigosus*)	x	x		
Blunt Spikerush (*Eleocharis obtusa*)		x	x	
Squarestem Spikerush (*E. quadrangulata*)	x	x		
Softstem Bulrush (*Scirpus validus*)				x
Green Bulrush (*Scirpus atrovirens*)				x
Creeping Spikerush (*Eleocharis palustris*)				x
Other Monocots				
Common Waterplantain (*Alisma plantago-aquatica*)	x			x
Skunk Cabbage (*Symplocarpus foetidus*)	x			x
Trees/ Shrubs				
River Birch (*Betula nigra*)		x		
Common Hackberry (*Celtis occidentalis*)	x		x	
Button Bush (*Cephalanthus occidentalis*)	x	x	x	x
Green Ash (*Fraxinus pennsylvanica*)				x
Black Willow (*Salix nigra*)		x		x
Dicot Herbs				
Tickseed Sunflower (*Bidens aristosa*)	x			x
Cowbane (*Oxypolis rigidior*)		x		
Swamp Buttercup (*Ranunculus septentrionalis*)	x			
Waterparsnip (*Sium suave*)		x		x
Common Ragweed (*Ambrosia artemisiifolia*)	x			x
Giant Ragweed (*Ambrosia trifida*)		x		
Swamp Milkweed (*Asclepias incarnata*)	x			x
Nodding Beggarticks (*Bidens cernua*)	x			
Devils Beggarticks (*Bidens frondosa*)			x	
Marsh Purslane (*Ludwigia palustris*)		x		
American Bugleweed (*Lycopus americanus*)	x			
Smooth Phlox (*Phlox glaberrrima*)				x
Redroot Amaranth (*Amaranthus retroflexus*)	x			
Whitefield Aster (*Aster simplex*)	x			
Boneset (*Eupatorium perfoliatum*)		x		x
New England Aster (*Aster novae-angliae*)	x			
Sneezeweed (*Helenium autumnale*)		x		
Cowparsnip (*Heracleum lanatum*)		x		
Small White Morning-glory (*Ipomoea lacunosa*)	x			
Common Evening Primrose (*Oenothera biennis*)	x			x
Coville's Phacelia (*Phacelia ranunculacea*)	x			
Heartleaf Plantain (*Plantago cordata*)	x			x
Cespitose Knotweed (*Polygonum cespitosum*)				x
Pinkweed (*Polygonum pensylvanicum*)	x	x	x	x
Curly Dock (*Rumex crispus*)		x		
Great Water Dock (*Rumex orbiculatus*)	x			
Roughleaf Goldenrod (*Solidago patula*)	x			
Cocklebur (*Xanthium strumarium*)		x		x
Water Smartweed (*Polygonum amphibium*)	x			
Ditch-stonecrop (*Penthorum sedoides*)	x			
False Dragon-head (*Physostegia virginiana*)			x	
Spotted Waterhemlock (*Cicuta maculata*)		x		
Indianhemp Dogbane (*Apocynum cannabinum*)		x		
Aquatic Plants—open water				
Common Cattail (*Typha latifolia*)	x	x	x	x
Small Duckweed (*Lemna valdiviniana*)	x	x		
Mosquito Fern (*Azolla filiculoides*)		x	x	
Arrowleaf (*Sagittaria lancifolia*)	x	x	x	
Bladderwort (*Ultricularia* spp.)		x	x	x
Bur-reed (*Sparganium* spp.)				x
American Lotus (*Nelumbo lutea*)		x	x	
Pondweed (*Potamogeton nodosus*)				x
Elodea (*Elodea canadensis*)			x	x

Carex lacustris and *Spartina pectinata* Transplant Survival and Rate of Spread

William Sluis

Introduction

Several wet grassland/marsh complexes were examined in Illinois and Missouri to determine appropriate plant communities for restoration to Spunky Bottoms. Seven communities were determined first by soil moisture and secondly by silt deposition, which reduced species richness (Table 1). A clear distinction could not be made between areas dominated by *Carex hyalinolepis* and *Spartina pectinata* based on soil moisture and silt deposition, so we set up an experiment to determine if they could coexist or if some environmental factor separates them spatially. Spunky Bottoms provided an opportunity to investigate the dynamics between these two species so plants can be planted in appropriate areas.

The ecologies and appearance of *C. hyalinolepis* and *C. lacustris* are very similar and may represent similar ecological functions. The northern edge of the range of *C. hyalinolepis* is central Illinois, while *C. lacustris* is found throughout the state, but is infrequent in the southern half. Either could potentially be used at Spunky Bottoms. We chose *C. lacustris* because it was found on-site in ditches and untilled areas. Both *S. pectinata* and *C. lacustris* spread largely by rhizomes and seeds are difficult to get, so we also examined the survival and rates of spread of plants transplanted from local or on-site populations. This information can help determine the spacing of plants and the amount of time that should be expected for the species to establish.

Methods and Results

Plots were set up in 1999 to examine the survival and rate of spread of transplanted *Spartina pectinata* (cord grass) and *Carex lacustris* (lake sedge) in the pattern shown in Table 2. Seven such plots were set up at random locations within areas appropriate for these species. A groundwater monitoring well was installed near each plot. The fall planting occurred in late September 1999, the spring planting in April 2000. Plants were removed manually by shovel from small local patches in ditches and other noncultivated areas. We collected up to 100 plants per hour, making the process cost effective compared to growing them from seed. The plants were also larger than typical seedlings, making them more tolerant of stress and able to grow rapidly. Most of the soil fell off the plants, so they were essentially bare root when planted. With the exception of a light rain several days after the fall planting, a substantial drought occurred that lasted until March 2000 (Fig. 1). Despite this, survival was 65% for *Carex* and 57% for *Spartina* (Table 3). Season of transplanting did not affect survival of *Spartina*, but *Carex* survived better when transplanted in the spring. However, the difference may be the result of greater susceptibility of *Carex* to the dry weather immediately after transplanting rather than transplanting season.

The plots were intensively sampled in 2002, including the number of shoots, area covered by all shoots of each plant, and any sexual reproduction (Table 4). Some *C. lacustris* had spread to the point of overlapping each other and plants could not be clearly distinguished. In such cases the area of the plant was considered 2 m x 2 m, the distance they were originally planted away from each other. Plot 5 had 18 inches of water at sampling time, which probably killed most of the *Carex* and *Spartina* plants. Only one *Spartina* plant was found growing out of the water there, so this plot was not included in the analysis.

Dispersion patterns differed between species but the species were perfectly rank correlated among plots in terms of number of shoots. In other words, in a plot where *C. lacustris* had more shoots, *S. pectinata* had more shoots also. *C. lacustris* spread rapidly but at a low density, having large spaces between shoots that allowed other species to grow interspersed among their shoots, especially in the drier plots. *S. pectinata* had a much denser form, with shoots growing immediately adjacent to each other and not allowing other species to coexist in many cases.

Both species showed some sexual reproduction. *S. pectinata* showed the most flowering culms at intermediate densities and numbers of shoots with the plants that were most and least dense and with the most and least number of shoots having no sexual reproduction. *C. lacustris* showed no clear trends. Figure 2 shows *C. lacustris* and *S. pectinata* competing with cattails in plot 58.

Acknowlegements

Thanks to Tharrann Hobson for help with planting and water level monitoring. This project was funded by The Wetlands Initiative and The Nature Conservancy.

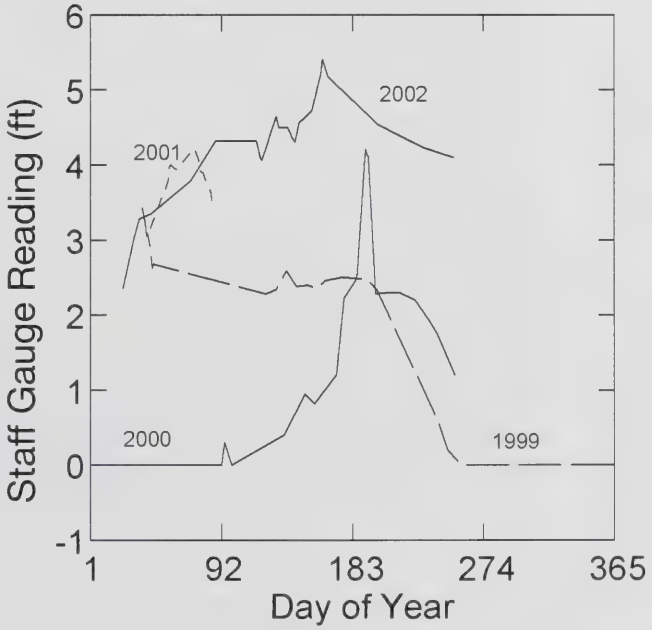


Figure 1. Relative water levels at Spunky Bottoms 1999–2002.

Table 1. Potential plant communities at Spunky Bottoms. Values are mean and (standard error).

Community	**Silt Depth (cm)**	**Water Depth (cm)**	**Species Richness (N)**	**N**
Carex hyalinolepis group	7.50 (1.19)	8.90 (4.55)	3.67 (1.66)	9
Scirpus fluviatilis group	0.90 (0.48)	4.70 (2.73)	3.32 (1.70)	25
Leersia oryzoides group	13.13 (1.20)	15.63 (6.83)	3.25 (0.96)	4
Spartina pectinata group	8.13 (1.20)	8.75 (6.83)	4.25 (0.50)	4
Saturated Soil group	0	-2.5 (5.56)	7.67 (1.211)	6
Unsaturated Soil Group	0	-21.73 (3.80)	10.62 (2.76)	13
VM Woods	0	-4.65 (2.98)	5.57 (1.72)	21

Table 2. Experimental design for *Spartina pectinata* and *Carex lacustris*. Each letter represents an individual plant spaced 2 m in each direction from the next plant.

Fall						Spring					
s	c	s	c	s	c	s	c	s	c	s	c
c	s	c	s	c	s	c	s	c	s	c	s
s	c	s	c	s	c	s	c	s	c	s	c
c	s	c	s	c	s	c	s	c	s	c	s
s	c	s	c	s	c	s	c	s	c	s	c
c	s	c	s	c	s	c	s	c	s	c	s
s	c	s	c	s	c	s	c	s	c	s	c
c	s	c	s	c	s	c	s	c	s	c	s
s	c	s	c	s	c	s	c	s	c	s	c
c	s	c	s	c	s	c	s	c	s	c	s
s	c	s	c	s	c	s	c	s	c	s	c
c	s	c	s	c	s	c	s	c	s	c	s

C = Cordgrass (*Spartina pectinata*), S = Sedge (*Carex lacustris*)

Table 3. Rates of survival (1999–2002) of *Spartina pectinata* and *Carex lacustris* transplants.

	Spartina pectinata		*Carex lacustris*		
Plot Code	Spring	Fall	Spring	Fall	Water Depth (cm)
1	0.33	0.36	0.7	0.47	-22
58	0.37	0.83	0.97	0.47	-46
7	0.78	0.64	0.73	0.97	-57
spb-13	0.97	0.78	0.89	0.48	-58
spb-5	0.75	0.75	NA	0.44	-58
56	0.61	0.56	0.83	0.57	-70
spb-18	0.5	NA	0.83	NA	-92
Mean	0.62	0.65	0.83	0.57	-57.57

Table 4. Rates of spread and reproduction of *Spartina pectinata* and *Carex lacustris*.

Carex lacustris				
Plot	Number of shoots	Mean area (m)	Density shoots/sq m	Sexual Reproduction inflorescences/plant
spb-13	27.935	1.316	21.228	1.612
58	9.000	1.012	8.889	0.000
56	3.850	0.031	124.541	0.000
7	8.976	0.382	23.470	0.000
spb-18	7.727	1.169	6.608	0.211
Spartina pectinata				
Plot	Number of shoots	Mean area (m)	Density shoots/sq m	Sexual Reproduction inflorescences/plant
spb-13	18.656	0.051	368.207	0.000
58	16.921	0.036	470.626	5.026
56	5.395	0.004	1392.489	0.000
7	14.175	0.020	694.364	0.700
spb-18	13.300	0.035	376.547	3.800

Figure 2. *Spartina pectinata* and *Carex lacustris* competing with cattails. Photo by William Sluis, The Wetlands Initiative.

Reptiles and Amphibians at Spunky Bottoms

John K. Tucker, Chris Phillips

Introduction

We conducted an initial inventory of the reptiles and amphibians of Spunky Bottoms. Our major goal was to establish a baseline for continuing assessment as habitat restoration proceeds.

Methods

We employed four techniques. First we walked 100-m transects, which were located in upland prairie (two transects), wet prairie habitats (seven transects), and marsh border habitats (four transects). We identified all reptiles and amphibians observed. We also performed general searches of the various habitats at Spunky Bottoms to collect rare reptiles (particularly snakes). Third, an anuran (frogs and toads) calling survey was performed in March, April, and May. We identified the various species by their calls. Finally, turtles were trapped with 10 hoop traps for two days per month in July, August, September, and October 2000 and in April, May, and June in 2001. We trapped in ditch habitats (four sites), marsh habitats (six sites), pond habitats (four sites), and river habitat (one site).

Results

We observed 322 amphibians in 13 transects for a net abundance of 0.25 anurans per m of transect. Upland prairie had the fewest anurans (0.015 anurans/m). Anurans were most common along marsh and pond borders (0.54 anurans/m), and common in wet prairie habitats (0.15 anuran/m). The cricket frog (*Acris crepitans*) was by far the most common anuran (206 individuals). Our general searches were also productive. We found a total of 10 anurans, 1 salamander, 5 turtles, and 7 snakes (Table 1). We found nearly all of the snake species during their fall migration from Spunky Bottoms to the adjoining upland areas. Our calling surveys allowed us to add three species to the seven found along transects, including two arboreal species, the spring peeper (*Pseudacris crucifer*) and the gray tree frog (*Hyla versicolor*). Turtle trapping added five turtle species. The red-eared slider (*Trachemys scripta elegans*) was the most commonly trapped turtle. Painted turtles (*Chrysemys picta*) also were frequently trapped.

Discussion

Of 23 species collected, 13 were new records for Brown County (Table 1). Spunky Bottoms has a remarkably diverse herpetofauna considering that most of the area being restored was formerly cropland. Anurans were particularly prominent, which might be expected in a wetland-cropland habitat mix.

The large number of cricket frogs (*Acris crepitans*) is an important feature of Spunky bottoms. This species is thought to be in decline in Illinois. However, at Spunky *A. crepitans* occurred at an overall frequency of 0.29 frog/m, an unusually high abundance.

Some species were not found. We did not find any of the sand prairie specialists such as the Illinois chorus frog (*Pseudacris streckeri illinoensis*), the western hognose snake (*Heterodon nasicus*), or the Illinois mud turtle (*Kinosternon flavescens spooneri*). The sandy habitats that these species require are not present at Spunky or on the western bank of the Illinois River. We also did not collect Blanding's turtle (*Emydoidea blandingi*), a prairie pothole specialist. This species, which occurs nearby, would be suitable for reintroduction to Spunky Bottoms, because the prairie marsh habitat it needs is exactly the habitat being returned to Spunky.

The turtle fauna of the site was disappointing and dominated by the red-eared slider (*Trachemys scripta elegans*), a species characteristic of large river habitats. We caught no map turtles (*Graptemys* species), yet three species (*G. geographica*, *G. pseudogeographica*, *G. ouachitaensis*) occur in nearby counties. These species are river turtles and less likely to inhabit backwater areas without a direct connection to the river.

One interesting discovery was a female red-eared slider larger than any red-eared slider ever collected. She had a carapace length of 302 mm (about 12 inches), which is quite large compared to the usual female carapace length of 225 mm (about 9 inches). This specimen set a new record for Illinois and for the subspecies (Tucker et al. 2006). Similarly a male slider was a record breaker with a carapace length of 261 mm. We also caught a female painted turtle (*Chrysemys picta*) with a carapace length of 195 mm, another new Illinois record.

Can we predict the impact of the restoration on the herpetofauna? Providing a more natural hydrology and possible later reconnection with the Illinois River will have a profound effect on the herpetofauna. At present the dominant aquatic habitats (ditches and ponds) likely restrict the diversity of the turtle fauna. The turtle fauna can be expected to become more diverse through possible reintroduction of Blanding's turtle and addition of map turtles as hydrology becomes more natural. Moreover, better hydrology should allow water snakes to become more abundant. We caught none during our surveys. Water snakes are important because they prey on larger species of anurans such as bullfrogs, which can negatively impact populations of smaller anuran species. We expect that future herpetological surveys will test our predictions and provide important insights into the value of river restoration in general.

Reference

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A water snake *(Nerodia* spp.) crossing in front of the pump house, photographed after the survey.

Table 1. Species of reptiles and amphibians observed at Spunky Bottoms.

Toads and Frogs	
Bufo woodhousii fowleri	Fowler's Toad
Bufo americanus	American Toad
Pseudacris triseriata	Western Chorus Frog**
Pseudacris crucifer	Spring Peeper**
Acris crepitans	Cricket Frog
*Hyla versicolor**	Gray Treefrog**
Rana blairi	Plains Leopard Frog
Rana catesbeiana	Bullfrog
*Rana clamitans**	Green Frog
Rana sphenocephala	Southern Leopard Frog**
Salamanders	
Ambystoma tigrinum	Tiger Salamander
Turtles	
Apalone spinifera	Spiny Softshell**
Chelydra serpentina	Common Snapping Turtle**
Sternotherus odoratus	Musk Turtle**
Trachemys scripta elegans	Red-eared Slider
Chrysemys picta	Painted Turtle**
Snakes	
Storeria dekayi	Brown Snake**
Thamnophis sirtalis	Eastern Garter Snake**
Thamnophis proximus	Western Ribbon Snake**
Elaphe vulpina	Western Fox Snake**
Elaphe obsoleta	Black Rat Snake
Coluber constrictor	Blue Racer
Lampropeltis calligaster	Prairie King Snake**

* Heard calling at site in 2000 and 2001 but not captured.

** County records.


A black rat snake (*Elaphe obsoleta*) with freshly laid clutch of 16 eggs. This species is an important predator on small mammals, birds, and their eggs. Photo by John K. Tucker, INHS.


The bullfrog (*Rana catesbiana*) is Illinois' largest frog and frequently encountered at Spunky Bottoms. Photo by John K. Tucker, INHS.


The common snapping turtle (*Chelydra serpentina*) was a new record for Brown County. Photo by John K. Tucker, INHS.


This five-lined skink (*Eumeces fasciatus*) was found at Spunky Bottoms after the survey was completed and was another county record for Brown County. Photo by John K. Tucker, INHS.

Small Mammals: You Built It, They Came

Edward J. Heske, Jason M. Martin, Tharran Hobson

Introduction

Small mammals (a term often referring primarily to rodents and shrews) comprise more than half of the species of mammals worldwide, with over 2,200 species of rodents and over 400 species of shrews. In Illinois, 32 of the about 60 mammal species that occur in the state are rodents or shrews. Thus, small mammals are a diverse, important, and inherently interesting component of biodiversity (Figs. 1–3). Small mammals also are ecological links in biological systems. As consumers of the vegetative parts of plants, seeds, and arthropods, small mammals both respond to their environment in terms of their distribution and abundance, and influence the plant communities in which they live. For example, herbivory by voles (*Microtus* sp.) can have a considerable effect on plant species diversity in prairie restorations (Howe et al. 2002). Small mammals also constitute a major prey base for many owls, raptors, snakes, and carnivorous mammals. Many of these larger species that are attractive to viewers of wildlife would not inhabit an area if no small mammal prey were available.

Our goal in this study was to monitor colonization of restored habitats at Spunky Bottoms by small mammals. Because no introductions of small mammals were conducted, this monitoring documents the ability of small mammals to reach and establish populations at these newly restored sites without intervention. We began our monitoring in fall 2000. At this time, restored cropland had been out of production for two years.

Methods

Three habitat types were selected for monitoring: upland prairie, wet prairie, and tree-planting areas that were similar to wet prairie at the time of our surveys, but will be managed as wooded wetlands as succession proceeds. Three replicates of each type of habitat were selected for sampling, distributed as widely as possible throughout the preserve. In addition to these nine sites, we sampled three agricultural fields adjacent to Spunky Bottoms. Surveys of adjacent agricultural fields should indicate what small mammal assemblages would be like in the absence of restoration.

We established one 500-m transect in each of the 12 survey sites. One end of each transect was permanently marked with a metal post to enable resampling of approximately the same areas over time. Two Sherman (HB Sherman Co., Tallahassee, FL) live traps baited with mixed birdseed were placed within 2 m of trap stations spaced at 10-m intervals along each transect for a total of 100 traps per transect. Traps were set on day 1, checked on day 2, then checked again and picked up on day 3 of a survey yielding 200 trap-nights per transect and 600 trap-nights for each habitat type. Trapping was conducted at the end of September or in October in 2000, 2001, and 2002 as fall is the season when many species of small mammals reach their greatest abundance and cooler daytime temperatures reduce the risk of animals overheating in traps, .

From each small mammal captured, we recorded species, sex, approximate age (juvenile or adult), weight, and reproductive condition. All individuals were marked on first capture by clipping a small patch of fur on the rump so that recaptured animals could be identified. Animals were examined and released at the capture site with the exception of house mice, *Mus musculus*, in 2000, which were killed by cervical dislocation.

Results

We captured 326 small mammals in our survey in 2000, 74 in our survey in 2001, and 128 in our survey in 2002. After three surveys, we had recorded 10 species of rodents and shrews, plus a long-tailed weasel (Table 1). This list includes all species of small mammal expected in these habitats in this part of Illinois, except the thirteen-lined ground squirrel, Franklin's ground squirrel, southeastern shrew, and least weasel (Table 1). The species and number of individuals varied by type of habitat (Table 2). Species richness and abundance of small mammals was much greater in all restored habitats compared to that in agricultural fields. More species were captured in upland prairies (nine) than in wet prairies (four), tree-plantings (six), or agricultural fields (three), and the abundance of small mammals in restored habitats was more than four times that in agricultural fields. Row crops had been harvested at the time of our surveys, and only house mice, deer mice (*Peromyscus maniculatus*), and white-footed mice (*P. leucopus*) were captured in fields with corn or soybean stubble.

Discussion

Our surveys demonstrate that individuals of almost all species of small mammal anticipated to inhabit Spunky Bottoms can reach there without intervention. Franklin's ground squirrels were recently listed as a state-threatened species in Illinois (Illinois Endangered Species Protection Board 2005), are difficult to locate in general (Martin et al. 2003), and may not occur in the vicinity. Spunky Bottoms is located at the northern edge of the range of southeastern shrews, and this species also may be uncommon. Small shrews such as this also are difficult to capture in Sherman traps and typically must be surveyed by using pitfalls (Kirkland and Sheppard 1994). We expect thirteen-lined ground squirrels to colonize upland prairie habitat at Spunky Bottoms eventually, although this species is more common in habitats with shorter vegetation (Hoffmeister, 1989).

Voles (primarily *M. ochrogaster*) and deer mice, important prey species, were common in our surveys, suggesting that Spunky Bottoms could provide a source of prey for species at higher trophic levels. A few other species such as southern bog lemmings (*Synaptomys cooperi*) and meadow jumping mice (*Zapus hudsonius*) were only captured once or a few times. Thus, although potential colonists reached Spunky Bottoms, it is not clear that immigration is sufficient or the habitat is of suitable quality for populations of these species to become established. The decrease in abundance recorded in our second and third surveys also may reflect changes in habitat quality. For example, voles prefer dense ground cover and rely on green vegetation for food. Although wet and upland prairies provided good cover, many parts of our transects were dominated by foxtail (*Setaria glauca*) or big bluestem (*Andropogon gerardii*) which do not provide a good food source for voles, or tall, weedy vegetation that had died and dehydrated by the time of our surveys. Succulent green vegetation near ground level appeared sparse, particularly in the later years of our surveys, and prescribed burns or other management interventions may be required to promote and maintain good cover and forage. In future studies, small mammal surveys should be linked to data on vegetation in restored sites.

House mice, an undesirable, exotic species, were the most numerous small mammals in our survey in 2000, but other native species that are more readily utilized as prey (e.g., prairie voles) seem to be doing well. It will be interesting to note whether house mice decline in abundance as populations of native species become established. The overall diversity of species of small mammals detected in our surveys provides an optimistic outlook for establishment of a thriving mammalian assemblage. The answer to the question, "If we build it, will they come?" appears to be a resounding "yes." Now, to keep them there, management needs to assure that the vegetative component of the habitat remains diverse and provides good food as well as cover.

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Figure 1. How can anyone not love a prairie vole? Photo by Edward J. Heske, INHS.

Figure 2. Western harvest mouse. Photo by Edward J. Heske, INHS.

Figure 3. Prairie deer mouse. Photo by Edward J. Heske, INHS.

Table 1. Species of small mammals captured at Spunky Bottoms in autumn live-trapping surveys, 2000–2002.

Scientific name	Common name
Blarina brevicauda	Northern short-tailed shrew
Cryptotis parva	Least shrew
Microtus ochrogaster	Prairie vole
Microtus pennsylvanicus	Meadow vole
Synaptomys cooperi	Southern bog lemming
Peromyscus maniculatus	Deer mouse
Peromyscus leucopus	White-footed mouse
Reithrodontomys megalotis	Western harvest mouse
Zapus hudsonius	Meadow jumping mouse
Mus musculus	House mouse
Mustela frenata	Long-tailed weasel
Some "missing" possibilities:	
Sorex longirostris	Southeastern shrew
Spermpohilus tridecemlineatus	Thirteen-lined ground squirrel
Spermophilus franklinii	Franklin's ground squirrel
Mustela nivalis	Least weasel

Table 2. Number of individuals of species of small mammals captured in four habitat types during live-trapping surveys in autumn 2000–2002. Three transects each were in upland prairie, wet prairie, and tree-plantings in Spunky Bottoms, and in three adjacent agricultural fields.

Species	Upland prairie	Wet prairie	Tree-planting	Agricultural field
House mouse	90	87	32	9
Prairie vole	33	43	64	0
Meadow vole	1	0	0	0
S. bog lemming	1	0	0	0
Deer mouse	20	18	36	21
White-footed mouse	5	4	25	8
W. harvest mouse	9	0	17	0
M. jumping mouse	0	0	1	0
N. short-tailed shrew	4	0	0	0
Least shrew	3	0	0	0
Total	167	152	175	38

Wetland Bird Response to Habitat Restoration at Spunky Bottoms Preserve

Tharran Hobson, James R. Herkert, P. Richard Ware, Robert Randall

Introduction

The loss of wetland habitats has been severe in the United States, especially in the midwestern states where wetland losses often exceed >85% of the original wetland acreage (Dahl 1990). As a result of these losses, populations of many wetland associated species have declined (Igl and Johnson 1997) and the conservation of wetland species has become increasingly dependent on the creation of new wetlands through wetland restoration. Although the goal of many wetland restoration/mitigation projects is to replace lost wildlife habitat, monitoring and analysis of the wildlife habitat value of restored wetlands has traditionally been relatively scarce (Kusler and Kentula 1989, National Research Council 1992) but has received increased attention in recent years.

Because birds are generally conspicuous and relatively easy to monitor, they are often considered to be useful in evaluating wetland restorations (Galatowitsch and van der Valk 1994). Studies of restored wetlands have shown that wetland size and isolation are important factors influencing bird use of restored sites (Brown and Dinsmore 1986, Hemesath and Dinsmore 1993). Studies have also shown that, in some instances, birds respond quickly to wetland restoration colonizing new sites soon after the hydrology is restored (Brown and Smith 1998), and that bird populations in restored wetlands are often very similar to those found in natural wetlands (Ratti et al. 2001).

In order to evaluate bird species response to wetland restoration at Spunky Bottoms, we initiated an annual bird monitoring program in 2000.

Methods

Bird populations at Spunky Bottoms have been monitored during the breeding season since 2000. Birds are monitored using point counts, which are distributed throughout the property. Twelve points have been established throughout the preserve with the distribution intended to capture representative habitats found within the site. Four points are included in the three major habitat types. Habitats included upland tallgrass prairie, which accounts for approximately 130 acres of the total 1,193 preserve acres, a 220-acre bottomland hardwood forest restoration, and approximately 600 acres of wet prairie or sedge meadow. For uniformity and comparison to other surveys, notations are made for three-, five-, and six-minute time intervals. Counts are taken at each census point location five times per year between May 15 and June 15 and all birds seen or heard at each point are recorded.

Results

Between 2000 and 2003, 83 species of birds have been detected at Spunky Bottoms, including 7 grassland species, 20 wetland species, 53 shrubland or forest species, 2 exotic species, and the habitat-independent, brood-parasitic Brown-headed Cowbird (Table 1). The 10 most commonly encountered birds at Spunky Bottoms have been Red-winged Blackbird (55.0% of all birds encountered), European Starling (4.8%), Indigo Bunting (3.7%), American Crow (2.8%), Common Yellowthroat (2.4%), Northern Bobwhite (2.0%), Red-bellied Woodpecker (1.8%), American Goldfinch (1.7%), Dickcissel (1.7%), and Canada Goose (1.6%). In addition to the commonly encountered species listed above, several rare or declining species have been observed during the summer bird monitoring, including the state-endangered American Bittern (observed in 2002), Black-crowned Night-Heron (2002), and Yellow-headed Blackbird (2003), and the state-threatened Least Bittern (2002–2003) and Pied Billed Grebe (2001–2003).

Colonization of the Spunky Bottoms restoration by birds has been quick with 45 bird species being detected in the first field season of 2000 just 17 months after restoration began in January 1999. By 2001, the cumulative number of bird species that had been detected during summer bird monitoring at Spunky Bottoms was 56, 70 species by 2002 and 83 through 2003. The average number of species detected per day (total for all 12 census points) ranged from 25 to 45 and increased as the restoration matured (Fig. 1). The mean number of wetland bird species encountered per day also has increased with time (Fig. 2). The total number of individuals encountered per day (total for all 12 census points) has ranged from 179 to 510 and has also tended to increase as the restoration matured. The number of individuals for wetland bird species has also tended to increase with time since restoration began, but was highest in 2002.

Discussion

The newly restored wetlands at Spunky Bottoms have supported a high diversity of bird species and an abundance of individuals. The response of birds to restoration at this site was very quick as has been reported in other studies of restored wetlands (Hemesath and Dinsmore 1993, Brown and Smith 1998). Included in the diversity of birds colonizing this site are a number of rare and declining wetland bird species. Regionally declining wetland birds utilizing the restored wetlands at Spunky Bottoms include American Bittern (-5.8% per year population decline in the Midwest region), American Coot (-4.8%/year), and Red-winged Blackbird (-1.0%/year) (Sauer et al. 2003).

Red-winged Blackbirds comprised a very large portion of the birds encountered at Spunky Bottoms, with this species accounting for 55% of all individuals encountered. The large dominance of a single species that we found at Spunky Bottoms appears to be fairly typical of the Midwest. Fletcher and Koford (2003) report that the same species, the Red-winged Blackbird, accounted for 47% of all individuals encountered during a three-year study of restored wetlands in north-central Iowa. Red-winged Blackbirds also dominate (42% of all birds encountered, 1991–2003) at Goose Lake Prairie, a large native prairie remnant with numerous associated wetlands located in northeastern Illinois (J. Herkert, unpublished data).

There are also signs that the restoration at Spunky Bottoms may be contributing to regional biodiversity. Seven species of wetland birds that have been observed at Spunky Bottoms, American Bittern (2002), American Coot (2001–2003), Black-crowned Night-Heron (2002), Great Egret (2001–2003), Least Bittern (2002–2003), Marsh Wren (2003), and Swamp Sparrow

(2002), were not recorded from within the stretch of the Illinois River valley that runs between Bath and Meredosia during the 1986–1991 Illinois Breeding Bird Atlas (BBA) project (includes evaluation of all BBA records from Brown, Cass, Mason and Schuyler counties; Illinois Department of Natural Resources, unpublished data). Thus, Spunky Bottoms is providing habitat for a number of wetland species that are rare within the region. Based on Breeding Bird Atlas records for this same stretch of the Illinois River, wetland birds that do occur in the region but have yet to be recorded at Spunky Bottoms during the breeding bird survey include Blue-winged Teal, Northern Pintail, Ruddy Duck, Sora, and Spotted Sandpiper. Of these, Sora rails are suspected to nest at Spunky based on spring and summer sightings.

Staff and volunteers expect to continue the breeding bird census for the foreseeable future. Data collected have and will be used to guide adaptive management decision making at the preserve as well as serving as a data reference site for other studies.

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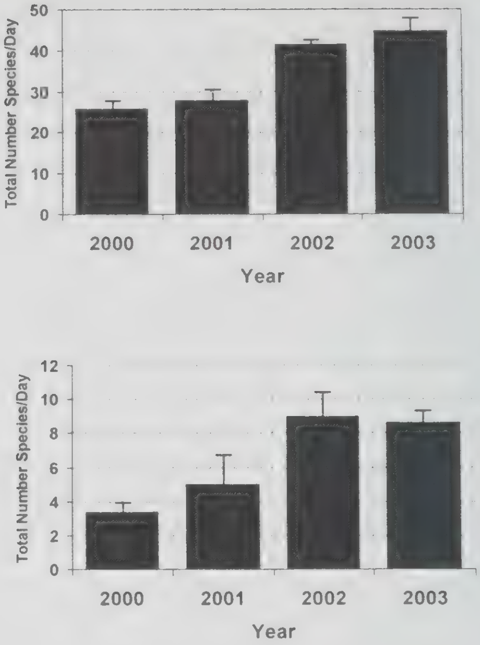

Figure1. Comparison of total number of species detected per day (total of 12 census points) by year (top graph) and total number of wetland bird species detected per day (bottom graph).

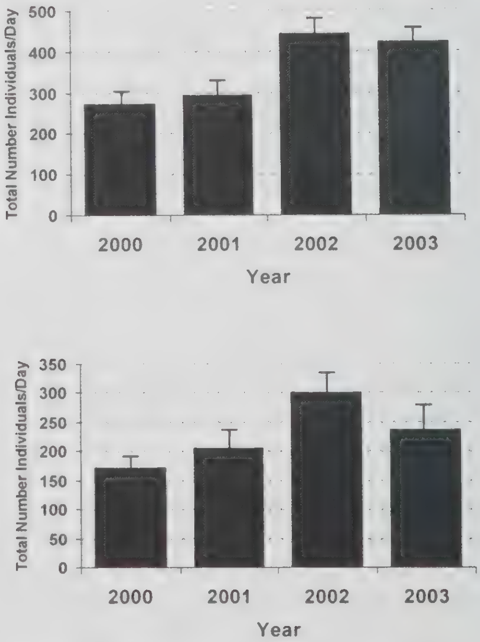

Figure 2. Comparison of (a) total number of individuals detected per day (total of 12 census points) by year (top graph) and total number of wetland bird individuals detected per day (bottom graph).

Table 1. List of bird species recorded at monitoring points at Spunky Bottoms between 2000–2003. Only birds recorded within 50-m of a monitoring station are included in the list.

Species	2000	2001	2002	2003
American Coot			X	
American Crow				X
American Goldfinch	X	X	X	X
American Robin	X		X	X
Baltimore Oriole		X	X	X
Black-capped Chickadee				X
Blue Jay		X		X
Brown Thrasher		X		
Brown-headed Cowbird	X		X	
Cedar Waxwing				X
Common Grackle	X		X	
Common Yellowthroat	X	X	X	X
Dickcissel	X	X		X
Double-crested Cormorant				X
Downy Woodpecker				X
Eastern Bluebird	X			X
Eastern Kingbird	X			
Eastern Meadowlark	X			X
Eastern Phoebe		X	X	
Eastern Wood-Pewee		X		X
Eurasian Tree Sparrow				X
European Starling		X		X
Gray Catbird	X	X	X	X
Great Blue Heron				X
Great Crested Flycatcher		X	X	X
Green-backed Heron			X	
House Wren				X
Indigo Bunting	X	X	X	X
Mourning Dove			X	
Northern Bobwhite	X	X		X
Northern Cardinal			X	X
Northern Flicker			X	X
Northern Rough-winged Swallow	X	X		
Orchard Oriole			X	X
Prothonotary Warbler				X
Red-bellied Woodpecker			X	X
Red-eyed Vireo				X
Red-headed Woodpecker				X
Red-winged Blackbird	X	X	X	X
Ruby-throated Hummingbird				X
Sedge Wren			X	
Song Sparrow	X	X	X	X
Tree Swallow	X	X		
Tufted Titmouse				X
Warbling Vireo				X
White-breasted Nuthatch				X
Willow Flycatcher				X
Wood Duck			X	X
Yellow-billed Cuckoo				X
Yellow-breasted Chat				X

Waterfowl Populations at Spunky Bottoms

Michelle M. Horath, Stephen P. Havera

Introduction

The Illinois Natural History Survey began conducting periodic aerial inventories of the Illinois and Mississippi River floodplains in 1948 (Havera 1999). Spunky Bottoms was included as one of the 50 areas regularly inventoried in the Illinois Valley during the same day on a weekly basis during fall 1998–2000, 2002 and spring 1999–2001. The inventories were conducted from a fixed-wing aircraft flying standardized transects at approximately 200 km/hr (120 mph) and 80 m (250 ft) in elevation. Numbers of the various species of waterfowl identified were estimated.

Spunky Bottoms lies within La Grange Pool and currently consists of 820 ha (2,026 ac) of which 393 ha (972 ac) are enrolled in the Wetland Reserve Program (TNC 2003). The cessation of pumping from the drainage and levee district created wetlands and attendant aquatic and moist-soil plant communities with invertebrate populations that were attractive to various species of waterfowl.

Fall

Use-days (one bird present for one day summed from 1 September to15 December each year) were determined for the species of waterfowl observed during fall (Table 1). The highest number of use-days occurred in 1998 when 158,525 were estimated and the second highest (14,053) occurred in fall 2002. Beginning in 1999 hunting and research activities on the area occurred on a more regular basis, both of which likely influenced waterfowl use (Havera 1999, Havera et al. 1992). Mallards (*Anas platyrhynchos*) typically expended the most use-days on the site. Spunky Bottoms hosted up to 1.1% of the fall waterfowl use-days for La Grange Pool during the study period.

The percent species composition of the site indicated some variation among years for the different species, but Mallard use remained high (Table 1). The species groups that used Spunky Bottoms were similar to those for La Grange Pool (Table 2). Dabbling ducks comprised over 90% of the use-days spent in La Grange Pool during the study interval, and the most common dabbling duck was the Mallard.

Spring

Use of Spunky Bottoms by waterfowl in spring was also variable among years with the most use occurring in 1999 (Table 3). As in fall, Mallards were the most common species utilizing the site, but the presence of diving ducks, particularly Lesser Scaups (*Aythya affinis*) and Ring-necked Ducks (*A. collaris*), was more noticeable in spring (Table 3). This same pattern was apparent in La Grange Pool where the presence of diving ducks in general was higher in spring than in fall (Tables 2 and 4). Migration in spring is more protracted than in fall. The bottomland lakes are attractive to diving ducks while dabbling ducks often spread out to take advantage of temporary habitats created by spring rainfall in floodplain and nonfloodplain fields. Spunky Bottoms provided up to 2% of the spring use of waterfowl documented for La Grange Pool during 1999–2001.

Discussion

Spunky Bottoms occupies an important location for migratory waterfowl in La Grange Pool. It lies immediately across the Illinois River from the U.S. Fish and Wildlife Service's Meredosia Refuge, and much of the floodplain to the south is incorporated in drainage and levee districts nearly to the confluence of the Illinos River with the Mississippi. Consequently, habitat provided in Spunky Bottoms could be important for migratory waterfowl in both spring and fall.

The habitat that historically was mostly responsible for the noted bountiful wildlife and fish populations in the Illinois Valley was the freshwater marshes of the lateral bottomland lakes. The marshes were veritable clear-water gardens of aquatic plants (Bellrose et al. 1979, Havera and Bellrose 1985, Havera 1999). Unfortunately, because of unnaturally fluctuating water levels, excessive sediment loads, and several species of carp, clear-water marsh habitat currently occurs in only a few isolated areas along the river. Spunky Bottoms has a unique opportunity to replace some of this limited essential habitat.

As an example, the Hennepin-Hopper area, a drainage and levee district near Henry, Illinois, in Peoria Pool, underwent initial restoration in spring 2001. This site consists of 1,050 ha (2,600 ac) of which 526 ha (1,300 ac) was water in early 2002, an area similar in size to Spunky Bottoms. After cessation of pumping, the Hennepin-Hopper lake area was colonized by a variety of desirable aquatic plants, such as American wild celery (*Vallisneria americana*), pondweeds (*Potamogeton* sp.) and water star grass (*Zosterella dubia*). As a result, the site became a magnet for a diverse collection of waterfowl species dependent upon aquatic vegetation and invertebrates. Our aerial inventories on the nonhunted Hennepin-Hopper site in fall 2002 revealed waterfowl use-days of approximately 690,000 along with almost 370,000 for the American Coot (*Fulica americana*), a species that feeds upon aquatic vegetation. Additionally, the species composition was only 27% Mallards while species that feed upon aquatic vegetation, such as the Northern Pintail (*Anas acuta*) (17%), American Wigeon (*A. americana*, 9%), and Gadwall (*A. strepera*, 21%), were common and the planktivorous Northern Shoveler (*A. clypeata*, 7%) was numerous. Use-days for these species at the Hennepin-Hopper area represented between 44 and 66% of those for the entire Peoria Pool. The opportunities for Spunky Bottoms to provide a similar haven are apparent.

Acknowledgments

Katie Roat, Illinois Natural History Survey, assisted with the preparation of the manuscript. Funding for aerial inventories was provided in part by Federal Aid in Wildlife Restoration Project W-43-R, the Illinois Department of Natural Resources, Illinois Natural History Survey, and U.S. Fish and Wildlife Service, cooperating, and by The Nature Conservancy.

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Table 1. Fall use-days and percent species composition of various species of waterfowl aerially inventoried at Spunky Bottoms, 1998–2000, 2002.

			Year					
Species	1998	%	1999	%	2000	%	2002	%
Dabbling Ducks								
Mallard (*Anas platyrhynchos*)	121,905	76.9	653	33.5	1,090	35.7	10,773	76.7
American Black Duck (*Anas rubripes*)	3,250	2.1	0	0.0	0	0.0	0	0.0
Northern Pintail (*Anas acuta*)	18,550	11.7	0	0.0	255	8.3	1,345	9.6
Blue-winged Teal (*Anas discors*)	0	0.0	158	8.1	140	4.6	0	0.0
Green-winged Teal (*Anas crecca*)	1,400	0.9	65	3.3	465	15.2	975	6.9
American Wigeon (*Anas americana*)	0	0.0	0	0.0	0	0.0	0	0.0
Gadwall (*Anas strepera*)	4,720	3.0	0	0.0	975	31.9	0	0.0
Northern Shoveler (*Anas clypeata*)	6,500	4.1	0	0.0	0	0.0	960	6.8
Diving Ducks								
Lesser Scaup (*Aythya affinis*)	0	0.0	0	0.0	0	0.0	0	0.0
Ring-necked Duck (*Aythya collaris*)	0	0.0	0	0.0	0	0.0	0	0.0
Canvasback (*Aythya valisineria*)	0	0.0	0	0.0	0	0.0	0	0.0
Ruddy Duck (*Oxyura jamaicensis*)	2,200	1.4	400	20.5	0	0.0	0	0.0
Mergansers								
Hooded Merganser (*Lophodytes cucullatus*)	0	0.0	675	34.6	130	4.3	0	0.0
Total Duck Use-days	158,525		1,950		3,055		14,053	
% Dabbling Ducks	98.6		44.9		95.7		100	
% Diving Ducks	1.4		20.5		0		0	

Table 2. The percent species group composition of fall use-days for Spunky Bottoms and La Grange Pool of the Illinois River, 1998–2000, 2002.

		Year		
	1998	1999	2000	2002
Spunky Bottoms Area				
Dabbling Ducks	98.6	44.9	95.7	100.0
Diving Ducks	1.4	20.5	0.0	0.0
Mergansers	0.0	34.6	4.3	0.0
La Grange Pool				
Dabbling Ducks	92.9	95.8	95.3	94.2
Diving Ducks	7.0	4.1	4.6	5.5
Mergansers	0.0	0.1	0.1	0.3

Aerial view of Spunky Bottoms. Photo by Michelle M. Horath, INHS.

Table 3. Spring use-days and percent species composition of various species of waterfowl aerially inventoried at Spunky Bottoms, 1999–2001.

	Year					
Species	1999	%	2000	%	2001	%
Dabbling Ducks						
Mallard (*Anas platyrhynchos*)	122,323	62.2	250	38.8	20,088	43.5
American Black Duck (*Anas rubripes*)	2,480	1.3	0	0.0	0	0.0
Northern Pintail (*Anas acuta*)	23,610	12.0	0	0.0	5,450	11.8
Blue-winged Teal (*Anas discors*)	0	0.0	0	0.0	0	0.0
Green-winged Teal (*Anas crecca*)	12,520	6.4	0	0.0	0	0.0
American Wigeon (*Anas americana*)	0	0.0	0	0.0	488	1.1
Gadwall (*Anas strepera*)	6,000	3.1	0	0.0	0	0.0
Northern Shoveler (*Anas clypeata*)	6,435	3.3	0	0.0	2,063	4.5
Diving Ducks						
Lesser Scaup (*Aythya affinis*)	3,100	1.6	0	0.0	5,850	12.7
Ring-necked Duck (*Aythya collaris*)	20,120	10.2	0	0.0	11,750	25.5
Canvasback (*Aythya valisineria*)	0	0.0	0	0.0	475	1.0
Ruddy Duck (*Oxyura jamaicensis*)	0	0.0	0	0.0	0	0.0
Mergansers						
Hooded Merganser (*Lophodytes cucullatus*)	0	0.0	395	61.2	0	0.0
Total Duck Use-days	173,368		250		28,088	
% Dabbling Ducks	88.2		38.8		60.8	
% Diving Ducks	11.8		0.0		39.2	

Table 4. The percent species group composition of spring use-days for Spunky Bottoms and La Grange Pool of the Illinois River, 1999–2001.

	Year		
	1999	2000	2001
Spunky Bottoms Area			
Dabbling Ducks	88.2	38.8	60.8
Diving Ducks	11.8	0.0	39.2
Mergansers	0.0	61.2	0.0
La Grange Pool			
Dabbling Ducks	73.5	89.1	64.5
Diving Ducks	17.2	9.1	32.7
Mergansers	9.3	1.8	2.8

Good habitat for ducks at Spunky Bottoms. Photo courtesy of Michelle M. Horath, INHS.

Dabbling ducks at Chautauqua National Wildlife Refuge. Photo courtesy of Michelle M. Horath, INHS.

Part 4 —Summary

Adaptive Restoration

Edward J. Heske, James R. Herkert

When planning a restoration project such as Spunky Bottoms for a large-river floodplain, several approaches could be taken and many potentially confounding factors need to be considered. One approach might involve tearing down the levees that separate the floodplain from the Illinois River and "letting nature take its course." However, such an approach would subject the area to the fluctuating water levels of the Illinois River, which would impede the development of wetland vegetation within the area. Another approach that could avoid the impacts of fluctuating river levels would be to maintain the separation established by the levee and restore a wetland that is isolated from the river and charged by groundwater, rainfall, and runoff. However, such an approach would not allow the floodplain to provide its typical functions of storing floodwaters, capturing sediment, processing nutrients, and providing breeding or overwintering habitat for species living within the river. A third approach could involve using gates and pumps to establish a managed flood-pulse cycle that hopefully mimics a natural cycle. This type of approach might allow the area to provide some of the typical floodplain functions, while also minimizing the detrimental effects of fluctuating river levels during the growing season. Arguments can be made for any of these rehabilitation strategies, often depending upon the goals and functions desired and the particular types of organisms that become the focus of attention (e.g., breeding habitat for ancient fishes, providing floodplain functions, stopovers for migrating waterfowl).

Unfortunately, the problems confronting such a restoration project also are daunting. In many cases, locks and dams along the river maintain an elevated water level for much of the year resulting in a river that is "perched," which means that the water level is higher than the elevation of the land behind the levee, and removal of the levee would result in inundation. In agricultural regions, upland fields are typically tiled and ditched so that water from heavy rain events is rapidly moved into the river, causing spikes in water levels throughout the year. Thus, without intensive management via gates and, in some cases, pumps to regulate influx and drawdown of river water, it is often impossible to re-create a "natural" cycle of spring flooding followed by gradual drawdown and summer drying (the "flood-pulse" cycle commonly referred to) when modern large rivers no longer have a "natural" hydrology.


Decurrent false aster (*Boltonia decurrens*) an endangered species that colonized Spunky Bottoms. Photo by Tharran Hobson, The Nature Conservancy.


Controlling encroachment by woody plants with modified herbicide wicker. Photo by Tharran Hobson, The Nature Conservancy.

Further, modern rivers in agricultural regions are often laden with silt that could fill in floodplain areas and choke out many types of plants and aquatic life. Water quality, particularly levels of agricultural chemicals and pesticides, also is a concern. Many exotic and/or invasive species such as various species of carp or invasive reed canary grass can threaten to dominate a system. How should we proceed to minimize these threats and produce an attractive wetland or floodplain, full of thriving native species, providing important ecosystem services, and hopefully providing many recreational and sporting opportunities as well? Do we need to plan extensive re-introductions of the flora and fauna, or will natural communities be able to establish themselves after a basic topological and hydrological foundation is established, perhaps including some initial restoration of selected plant communities?

The contributions in this volume document the very rapid development of a diverse and significant wetland community at Spunky Bottoms. In less than five years after being removed from active agricultural production, the wetlands at Spunky Bottoms now host over 250 species. This impressive total includes a wide variety of taxa including at least 68 species of plants, 83 species of birds, 14 species of fish, 11 species of mammals, 10 species of frogs and toads, 5 species of turtles, 7 species of snakes, and 12 species of dragonflies (see articles in this volume by Beal, Heske at al., Hobson et al., A. Maria Lemke et al., Novak, Pegg et al., and Tucker and Phillips). This list also is preliminary, as many taxonomic groups were not surveyed (e.g., many types of arthropods and other invertebrates, large mammals), some

Prescribed burns are required to maintain prairie plant diversity. Photo by Tharran Hobson, The Nature Conservancy.

surveys only sampled diversity and did not attempt to produce complete species lists (e.g., terrestrial plants), and many additional species have appeared over time since these surveys were conducted.

Additionally, there is substantial evidence that the site contains the microorganisms necessary for biogeochemical cycling of elements (Kelley, this volume) and there also are signs that the wetland is already working to reduce nitrate levels in the water through denitrification (Michael J. Lemke et al., this volume). These early results are very encouraging and document the very quick establishment of many wetland features and functions early on in the restoration process. It was exciting to document how many species of native plants, especially the communities of aquatic plants, and how many species of the native fauna came back on their own following the initial restoration activities. In one particularly encouraging trend, a fish community originally dominated by common carp gradually transformed to a largemouth bass-bluegill fishery. Of course, persistent attention from managers is still required to combat other invasives such as reed canary grass, to curtail encroachment by cottonwoods, and to maintain plant diversity in the restored upland prairies that are becoming dominated by perennial grasses.

The next step in the restoration of Spunky Bottoms is the Phase II restoration effort to re-establish a functional connection between the Illinois River and the floodplain wetlands at the site. To accomplish this goal the U.S. Army Corps of Engineers, Illinois Department of Natural Resources, Natural Resources Conservation Service, and The Conservancy are working together to design and build an innovative managed reconnection structure in the levee that will enable the river to reclaim its floodplain at appropriate times of the year. As of this writing in May of 2007, we are waiting for Congress to pass the Water Resources Development Act that will authorize the proposed work at Spunky Bottoms. After authorization is received by the passage of the Water Resources Development Act, work will begin on implementing the Phase II restoration plan that has already been completed.

As the second phase of restoration proceeds at Spunky Bottoms, continued research and monitoring will be essential to evaluate and document the changes that take place as a result of the river connection. By re-establishing the historic connection between the floodplains at Spunky Bottoms and the Illinois River, The Nature Conservancy and its partners hope to restore even more of the vital functions that these floodplain wetland areas have historically played, and provide the opportunity for riverine species to gain access to a healthy and diverse floodplain wetland along the Illinois River.

The initial responses of the native flora and fauna to Phase I of the restoration of Spunky Bottoms are a source of great optimism. Few people driving by this attractive mosaic of wetlands, wet prairies, and upland prairies would think that less than a decade ago this scenic natural area was a field of row crops, much like the land still in production to the north and south of the restoration project. Large-scale restoration projects often are not well documented and often do not include monitoring of the responses of a variety of taxa. Thus, the lessons learned are often unavailable to scientists and managers. In this volume, we attempted to archive results of a variety of early surveys and other studies following the initial stages of the restoration of Spunky Bottoms in the hope that these data, especially when combined with results from other restoration and rehabilitation efforts, might help to inform and guide future floodplain restoration projects. We anticipate that future monitoring at Spunky Bottoms after re-connection to the Illinois River will be equally enlightening.

Sunset over Spunky! Photo by Tharran Hobson, The Nature Conservancy.

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ISBN 978-1-882932-13-9
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