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# Wildlife Habitat Is Similar at Mined Versus Unmined Sites 30 Years Following Surface Mining for Coal in Southern Illinois

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**Abstract:** Riparian ecosystems provide important habitat for wildlife and serve as corridors for animal movements. Surface mining activities clearly impact wildlife habitat by removing vegetation needed by wildlife. However, few studies have assessed longer-term success of habitat restoration in riparian ecosystems following surface mining. During 2012-13, we evaluated microhabitat quality at three stream segments restored 30 years ago following surface mining for coal and one unmined stream segment in Perry County, Illinois. Microhabitat differences were very minor among restored and control stream sites. Of the 41 habitat variables measured, 14 differed among sites, four of which were uncorrelated: canopy cover, overstory hard mast, bare ground, and herbaceous ground cover; thus, restored riparian buffers were comparable to unmined sites, indicating that habitat restoration efforts were successful. Our analysis from data collected at Burning Star 4 mine in Perry County, Illinois, is of value to land managers for it shows how the reclamation process has successfully jump-started wildlife habitat in buffers around streams affected by mining.

**Keywords:** *habitat restoration, riparian, surface mining, wildlife habitat*

Large-scale surface mines in southern Illinois extracted coal from depths of 70 to 95 feet or more during the late 1970s and 1980s. The resulting effects were an altering of the landscape, reconstruction and/or redirection of the watershed, and in some instances, large bodies of water known as final-cut impoundments that were in some cases >1.25 miles in length (Nawrot et al. 2010). While active mining is being conducted, the entire upstream watershed is always diverted around the acreage of the active mining operation. As mining proceeds forward and reclamation progresses afterward, replacement and restoration of stream channels coincides with the processes of soil replacement, revegetation, and the establishment of farm fields, pastures, and upland wildlife habitats. Lands to be affected by mining are bonded and then reclaimed following an approved reclamation plan that requires the restoration of pre-mining capabilities which may include restoration of stream channel systems and riparian zones, crop fields, pasture lands, impoundments, wetlands, forests, and wildlife habitat. Bonds are released when capability standards as specified in the approved plan and the reclamation law are achieved.

Post-disturbance monitoring of the physical, chemical, and biological processes of the stream community is required through the Federal Surface Mining Control and Reclamation Act of 1977 (PL 95-87) (Office of Surface Mining Reclamation and Enforcement 2016). When surface mining disrupts the riparian vegetation and wetland habitat, it must be enhanced, restored, or at least partially replaced to promote fish and wildlife habitat along the affected stream (§. 816.97) (Office of Surface Mining Reclamation and Enforcement 2016). Streams and riparian zones support important functions for wildlife, even if their forms have been altered from historic conditions (Nawrot et al. 2010; Walton 2012). Wildlife habitat is affected directly and indirectly by the ecological processes that take place above and beneath the ground. Healthy

stream corridors aid in physical (hydrological and geomorphological), chemical, and biological landscape-level processes such as transporting water from the watershed to the channel; traveling through the channel, floodplains, and sediment; and eventually delivering water to the local landscape (Fischenich 2006; Scott et al. 2009). Geomorphological processes slowly change and rearrange riparian landscapes by moving woody debris and sediment to create new land forms and provide structural habitat for wildlife (Church 2002; Brierley et al. 2006). Biological processes produce and sustain diverse habitats to support vigorous aquatic and riparian biotic communities, aiding in maintaining predator-prey relationships and genetic diversity, thereby helping to preserve healthy physiological conditions in riparian zones (Ehrenfeld 2000; Fischenich 2006).

Succession describes the natural process of how plant and animal communities change over time after a disturbance, and knowledge of successional changes to riparian zones following restoration is important. Changes in vegetation structure and age promote biodiversity and ecological vigor, which is important to the long-term adaptation of ecosystems. By planting native species important to wildlife in the surrounding area, restoration efforts often "jump-start" succession (Walton 2012). Wildlife will then colonize particular habitats once the vegetation within those areas meets their habitat requirements. Through establishment of native plant communities and construction of similar substrates, it is reasonable to expect that wildlife will utilize previously mined and restored habitats as they would similar habitats on undisturbed sites (Zipper et al. 2011; Walton 2012). One way of gauging whether reclamation was successful is to compare the vegetative communities of reclaimed land with those of nearby land that was not disturbed by mining.

We quantified habitat characteristics for wildlife in restored stream corridors using a focal group of southern Illinois wildlife species to indicate a set of commonly-measured habitat variables that are important to those species. Wildlife species and species-groups chosen include mammals, birds, reptiles, and amphibians. Birds, of course, are not restricted to any one habitat patch but move about freely. The other species groups include carnivores, herbivores, and omnivores; may be terrestrial, aquatic, or aerial; may use both in-stream habitats and wooded corridors; or may spend part of their lives in water and part on land. This set of species and variables includes wildlife that have large and small home ranges and different life history traits. Species included are white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), river otter (*Lontra canadensis*), beaver (*Castor canadensis*), white-footed mouse (*Peromyscus leucopus*), deer mouse (*P. maniculatus*), water snakes (*Nerodia spp.)*, testudines (terrestrial and aquatic turtles), anurans (frogs and toads), migratory birds, ground-nesting birds, raptors, and bats.

Here, we review specific habitat needs for these focal species and species-groups; variables mentioned are those measured in this study. Some focal wildlife species are habitat generalists, while others have more specific habitat requirements. Canopy cover, for instance, is important for a wide array of different species and has been measured for habitat studies of bobcats (Kolowski and Woolf 2002), beaver (Cox and Nelson 2009), white-footed mice (Nupp and Swihart 2001), *Nerodia* species (Cross and Peterson 2001; Pattishall and Cundall 2009), salamander species (Faccio 2003), birds (Saab 1999; Batten and Lawler 2006), and bats (Watrous et al. 2006). Canopy cover has been shown to be an ecological indicator and is useful for distinguishing different plant and animal habitat, and assessing forest floor microclimate and light conditions (Jennings et al. 1999; Lowman and Rinker 2004).

Ground cover such as grasses, herbaceous plants, leaf litter, woody debris, rocks, and bare ground provide substrate, foraging areas, and low cover for many smaller wildlife species such as the white-footed mouse (Adler and Wilson 1987), salamanders (Faccio 2003), *Nerodia* species (Cross and Peterson 2001; Pattishall and Cundall 2009), anurans (Anderson et al. 1999), and both aquatic and terrestrial turtles (Fuselier and Edds 1994; Converse and Savidge 2003; Rizkalla and Swihart 2006). As the summer days get longer and hotter, terrestrial turtles have an increased need for thermoregulatory sites; herbaceous ground cover and shrub structures can help provide shade (Converse and Savidge 2003). Ground cover also

has been measured for bobcats (Kolowski and Woolf 2002), river otters (Bowyer et al. 1995), and migratory birds (Saab 1999).

Variation in vertical foliage structure is a measurement of the density of vegetative cover for habitat suitability for wildlife and can be used for assessing habitat quality for deer (Griffith and Youtie 1988), white-footed mice (Nupp and Swihart 2001), and bobcats (Kolowski and Woolf 2002). Dense foliage under the forested canopy makes flight less navigable, so tall vegetation may exclude some avian species, such as larger raptors, from areas with dense understory.

Understory and overstory stem densities are important habitat characteristics selected by river otters and beaver (Bowyer et al. 1995; Cox and Nelson 2009). Reforested areas on restored streams provide higher-quality habitat than areas with agricultural and grasslands for the river otter. Jeffress et al. (2011) found that river otter occupancy increased with a higher proportion of increasing forested areas present along riparian corridors. Otter presence may be positively correlated with the presence of fish, their main prey, because fish abundance often increases in areas of woody debris (Angermeier and Karr 1984), which is linked to the amount of forested cover along banks and within riparian areas. Trees and the hard or soft mast they produce provide sustenance for ground-nesting birds such as wild turkey (*Meleagris gallpavo*), small mammals like the white-footed mouse, and larger herbivores such as white-tailed deer. Peak acorn production and densities of white-footed mice were highly correlated indicating the importance of mast to small mammals (Ostfeld et al. 1996).

Ectothermic species such as aquatic turtles, water snakes, salamanders, toads, frogs, and other herpetofauna have smaller home ranges, limited dispersal capabilities, and require heterogeneity within their habitat so that they may move from areas of higher or lower temperatures for thermoregulation (Walton 2012). Complexity of stream bank substrates have been measured for water snakes (Cross and Peterson 2001; Pattishall and Cundall 2009) and aquatic turtles (Fuselier and Edds 1994), as these provide cover and basking areas. Submerged aquatic vegetation at the edge of banks also provides cover for aquatic turtles, along with seasonal breeding habitat for toads, frogs, and salamanders. A variety of habitat features such as herbaceous ground cover, leaf litter, and decaying logs provide salamanders with the necessary microclimate conditions on the forest floor (Maser et al. 1979; Faccio 2003).

Aerial species such as birds and bats are not necessarily dependent on any specific habitat patch given their ability to fly, but still have specific habitat needs. Trees provide bats with roosting sites in the form of natural and excavated cavities, exfoliating bark, top-outs, splits, and fissures. Live tree species supporting higher number of bat roosts include shagbark hickory, black locust, and sugar maple, while American elm and oak trees were selected for when dead (Waltrous et al. 2006). Migratory birds and raptors also use snags for perching and roosting. Other significant habitat features for Neotropical migrants include the amount of canopy cover, understory and overstory stem densities, and the presence of cavities (Saab 1999; Batten and Lawler 2006).

Research on stream restoration has been ongoing by the Cooperative Wildlife Research Laboratory at Southern Illinois University since the early 1980s (Nawrot et al. 2009), but our knowledge is yet incomplete about how wildlife respond to reclamation in riparian areas. Scientists and land managers must understand the roles that habitat quality and landscape connectivity play in the movement of wildlife over the greater landscape as a naturally-functioning riparian ecosystem provides important habitat and serves as movement corridors (Boutin et al. 2003; Lees and Peres 2008). As part of a larger project assessing stream restoration efforts (Williard et al. 2013), our objective was to compare habitat characteristics of mined vs. unmined stream corridors in Perry County, Illinois, 30 years after the initiation of habitat restoration activities. We wished to assess the success of habitat restoration while providing information to land managers in which to guide future stream restorations and riparian management projects.

Landscapes that have been subject to surface mining and reclamation where the vegetation has been stripped away and later replaced may have been altered by past land use and be of a different quality for wildlife habitat than that of unmined

riparian buffers. We predicted that mined areas would be comprised of more grassland, have smaller trees, and lack the leaf litter and log-wood ground cover compared to unmined riparian buffers. Lack of mature forests also presents issues of hard-mast availability, which species like deer, turkey, and mice rely on for sustenance. Many wildlife species select for stream corridors that are comprised of more forested habitat, therefore restored riparian buffers may not adequately support all of the species of wildlife that would inhabit, disperse, or migrate through the area.

## Study Area

Wildlife habitat was assessed at Burning Star 4 (BW4) mine (Figure 1; BS4 consists of Galum Creek and Bonnie Creek); Pipestone Creek; and Little Galum Creek, an unmined reference site in Pyramid State Park; in Perry County, Illinois. On the western portion of BS4, the 4.3-mile Galum Creek restoration was completed in 1980, and on the eastern side, the 3.7-mile Bonnie Creek restoration was completed in 1997. In 2001, Galum Creek and Bonnie Creek were reconnected to their local watershed with the streams meeting at a confluence at the southern end of the property. The restoration of 4.6-mile Pipestone Creek was completed in 1991 and is now managed, along with Little Galum Creek, as part of Pyramid State Park.

Potential wildlife habitat on restored streams consists of agricultural lands, reforested riparian buffers, and numerous wetlands. During the restoration process, riparian buffers were planted with trees and grasses. Dominant tree species within the riparian buffers included, but are not limited to: oak (*Quercus spp.*), hickory (*Carya spp*.), silver maple (*Acer saccharinum*) and boxelder (*Acer negundo*). Dominant herbaceous plants and grasses observed were goldenrod (*Solidago spp*.), sunflower (*Helianthus spp*.), bush clover (*Lespedeza spp*.), broomsedge (*Andropogon virginicus*), and Virginia wild rye (*Elymus virginica)*.

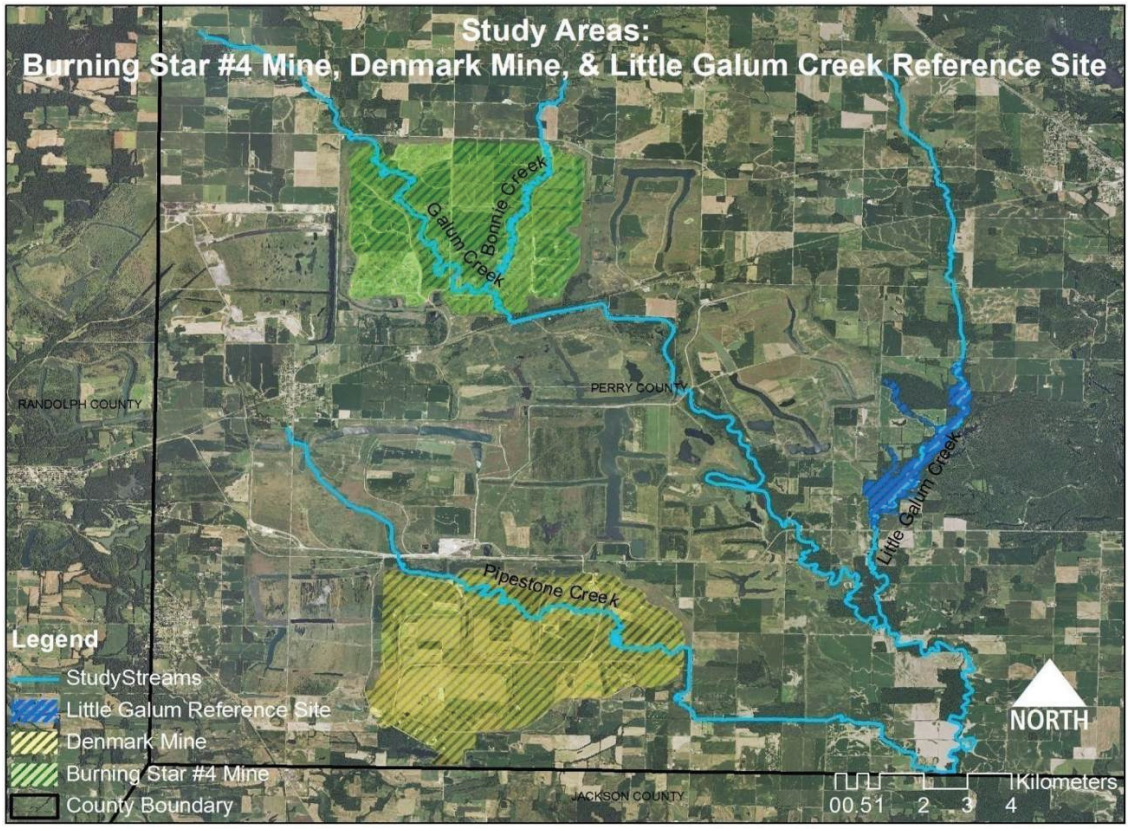


**Figure 1.** Study sites for wildlife habitat measurements at restored and unmined stream sites in Perry County, Illinois, 2012-13.

## Methods

A list of focal wildlife species known to inhabit the study area was used to determine a set of 41 habitat variables to measure (Table 1). Habitat measurements were taken during July-September 2012 and 2013 at 200 plots at Galum Creek, Bonnie Creek, Pipestone Creek, and Little Galum Creek sites. Ground cover was measured by a modified version of the step-point method (Evans and Love 1957); steps were walked on three parallel 20-m transects spaced 10-m apart. Each step was classified to one of the eight following cover types: bare ground, herbaceous (i.e., forb and grass), rock, woody debris, grass, shrub (stems < 1.5 m in height), ground litter, or phragmites. Percent canopy cover was measured with a densiometer at the center of plots, held at elbow height, and facing each cardinal direction. Visual obstruction was measured by the average percent of a 1.5-m cover pole obscured from 10 m away in each cardinal direction (Griffith and Youtie 1988). The cover pole was divided into three sections: low (< 0.5 m), mid (0.5 - 1.0 m), and high (1.0 - 1.5 m) with each section consisting of 10 5-cm sections. Understory and overstory stem densities were measured by the number of woody stems > 1.5 m in height and > 7.5 cm dbh for overstory trees or < 7.5 cm dbh for understory trees. Trees counted were within arm's length (82 cm) of the same three transects as walked for ground cover. While categorizing overstory and understory stem densities, we also categorized whether the tree produced hard mast or soft mast. Hard-mast species were oak, hickory and American beech (*Fagus grandifolia*); other masting trees fell into the soft mast category. Downed logs within an arm's length along each transect were classified as either > 7.5 cm or < 7.5 cm and given a decay class ranking from 1 - 5 (adaptation from Maser et al. 1979). Class 1 logs had intact bark with twigs present and a portion of the tree was still elevated on support points above the ground. Class 2 logs had intact bark, twigs were absent and the texture of the tree was slightly softened; the tree was still elevated but sagging slightly. Class 3 logs had traces of bark, but no twigs, with the tree resting on the ground. Class 4 logs had no bark or twigs with the entire tree on the ground. Class 5 logs were oval-shaped, soft and powdery, and red-brown to dark-brown in color with the entire tree on the ground. Tree species with exfoliating bark, cavities, fissures, snags, and top-outs also were noted because they provide habitat for birds, bats, and other wildlife. Bank vegetation was categorized as the cover type that was the most prominent of the eight cover types used as categories for ground cover.

Differences in variable values among the four study sites were first tested for using Kruskal-Wallis ANOVAs and the Wilcoxon Two-Sample Test for pairwise comparisons when overall ANOVAs were significant ($\alpha = 0.05$ throughout). Correlations were then assessed among significant habitat variables using Spearman rank correlations, to further consider only uncorrelated variables. All statistical analyses were performed using SAS 9.3.

## Results

Overall, microhabitat differences were very minor among sites. Of the 41 microhabitat variables measured, 27 did not differ among sites ($0.0593 \leq P \leq 0.8825$). Fourteen variables differed among sites ($0.0001 \leq P \leq 0.0140$): canopy cover, low vertical vegetative cover, mid-height vertical vegetative cover, overall vegetative cover, understory and overstory stem densities, understory soft mast, overstory soft mast, overstory hard mast, bare ground, herbaceous ground cover, log-woody debris ground cover, grass cover, and leaf litter cover. Four of those variables were uncorrelated (Table 2): canopy cover, overstory hard mast, bare ground, and herbaceous ground cover. Canopy cover was lowest at Bonnie Creek, moderate and similar at Galum Creek and Pipestone Creek, and highest at Little Galum Creek. Herbaceous ground cover did not differ among Bonnie Creek, Pipestone Creek, and Little Galum Creek, and was significantly lower at Galum Creek. Bare ground cover was similar at Galum Creek, Little Galum Creek, and Bonnie Creek, with Bonnie Creek and Pipestone Creek values overlapping. Overstory hard mast was similar between Little Galum Creek and Galum Creek, but Galum Creek overstory hard mast overlapped with Bonnie Creek and Pipestone Creek.

**Table 1**. Habitat variables and description of sampling methods conducted at restored and unmined stream sites in Perry County, Illinois, July–September 2012-13.

| Variable | Description and Method | Citation |
|---|---|---|
| Overall Vertical Vegetation | Avg. percent of a 1.5-m high cover pole obscured from 10 m away in each cardinal direction. Cover pole divided by 30 5-cm sections. Data recorded as percentage of 5-cm sections obscured (>50%) by vegetative or structural cover. | Griffith and Youtie 1988 |
| Low Vegetative Cover | Avg. percent of low portion (<0.5 m) of cover pole obscured by vegetative or structural cover. | Griffith and Youtie 1988 |
| Mid-Height Vegetative Cover | Avg. percent of middle portion (0.5-1.0 m) of cover pole obscured by vegetative or structural cover. | Griffith and Youtie 1988 |
| High Vegetative Cover | Avg. percent of high portion (1.1-1.5 m) of cover pole obscured by vegetative or structural cover. | Griffith and Youtie 1988 |
| Bare Ground Cover | Same as herbaceous cover except for bare ground. | Evans and Love 1957 |
| Herbaceous Ground Cover | Hits/steps x 100 using step-point method, walked on three parallel, 20-m transects. Hits = steps along transect resulting in tip of shoe covering herbaceous ground cover. | Evans and Love 1957 |
| Grass Cover | Same as herbaceous cover except for grass cover. | Evans and Love 1957 |
| Rock Cover | Same as herbaceous cover except for rock cover. | Evans and Love 1957 |
| Log/Woody Debris | Same as herbaceous cover except for log/woody debris. | Evans and Love 1957 |
| Litter Cover | Same as herbaceous cover except for areas covered by leaf litter. | Evans and Love 1957 |
| Shrub Cover | Percent cover of shrub stems measured on three 20-m transects. Sampled height range was 1.5 m. | Evans and Love 1957 |
| Canopy Cover | Measured with densiometer at plot center; held 30-45 cm from body at elbow height, facing each cardinal direction. | Kolowski and Woolf 2002, Pattishall and Cundall 2009 |
| Understory Stem Density | Number of woody stems >1.5 m in height and <7.5 cm dbh counted within same three arm's-length transects used for ground cover. | Kolowski and Woolf 2002 |
| Overstory Stem Density | Number of woody stems >7.5 cm dbh counted within three arm's-length transects. Transects same as for understory stem density. | Kolowski and Woolf 2002 |
| Downed Logs >7.5cm | Visual count, then assign decay class. | Saab 1999, Faccio 2003 |
| Downed Logs <7.5cm | Visual count, then assign decay class. | Saab 1999, Faccio 2003 |
| Log Decay Class | 1 = freshly fallen, supported above soil by branch<br>2 = structurally sound, bark covered<br>3 = intact but rot and bark loss beginning, resting on soil<br>4 = soft with little bark remaining<br>5 = almost completely incorporated into soil | Maser et al. 1979 |
| Hard/Soft Mast | Visual account of species.<br>0 = under mast producing age, 1 = soft mast, 2 = hard mast | Nupp and Swihart 2006 |
| Roost Trees | Visual account of number of standing dead snags. | Watrous et al. 2006 |
| Cavities/Bark/Split | Y/N; Presence of trees with loose bark, cavities, splits. | Watrous et al. 2006 |
| Submerged Vegetation | Visual presence. | Fuseliar and Edds 1994 |
| Bank Cover | Percentage; categories same used for ground cover. | Pattishall and Cundall 2009, Lesmeister and Nielsen 2011 |

**Table 2.** Differences in microhabitat variables among restored and unmined stream sites in Perry County, Illinois, July-September 2012-13. Little Galum Creek was the unmined control site. Different letters following mean ± SD values indicate pairwise differences among sites.

| Variable | Galum Creek n = 45 plots | Bonnie Creek n = 35 plots | Pipestone Creek n = 47 plot | Little Galum Creek n = 73 plots |
|---|---|---|---|---|
| Canopy Cover | 0.37 ± 0.34 B | 0.22 ± 0.35 C | 0.37 ± 0.40 B | 0.85 ± .09 A |
| Herbaceous Ground Cover | 0.09 ± 0.10 A | 0.31 ± 0.24 B | 0.21 ± 0.16 B | 0.19 ± 0.10 B |
| Bare Ground Cover | 0.07 ± 0.08 A | 0.04 ± 0.04 A | 0.01 ± 0.03 B | 0.06 ± 0.10 A |
| Overstory Hard Mast | 0.01 ± 0.01 A | 0.01 ± 0.04 A,B | 0.01 ± 0.02 B | 0.01 ± 0.01 A |

## Discussion

This 30-year-post-mining assessment of wildlife habitat within the restored riparian buffers of Galum, Bonnie, and Pipestone Creeks in southern Illinois demonstrates that habitat conditions over that time period are suitable and highly desirable for many of the focal groups of southern Illinois wildlife that were used for the basis of the assessment. Previous research has shown that reclaimed mine lands can provide ample and suitable habitat for the many species of wildlife in the Midwest, including common, threatened, and endangered species (Lannoo et al. 2009; Zipper et al. 2011). Our results indicate that these restored riparian buffers are comparable to that which might be found on lands that have not previously been exposed to surface mining. These successful restoration processes, such as reforestation of the riparian buffers, combined with planting native grasses, shrubs, and herbaceous plants, aid in sustaining the wide diversity of wildlife species that disperse throughout, reside within, or migrate through southern Illinois. We recognize that choice of the control (i.e., not previously mined) stream segment (in our case, Little Galum Creek) was very important and that just because a stream segment is on unmined ground does not imply that it was unaffected by human activity. Certainly some habitat modifications, such as earlier tree cutting, prior channelization, and adjacent farming activities, made our unmined site less than pristine wildlife habitat, as such occasions are rare on the Illinois landscape. However, we believe our control site was certainly adequate for the comparisons presented herein.

Site-level microhabitat variables measured for this study were chosen for the general wildlife species and groups of species known to inhabit southern Illinois. Approximately 80-88% of the ground cover and forest understory at all four creeks was composed primarily of grasses, herbaceous plants, and litter cover which indicates they all provide important ground cover for small mammals, reptiles and amphibians (Adler and Wilson 1987; Cross and Peterson 2001; Nupp and Swihart 2001; Pattishall and Cundall 2009). Mammal runs were present at the northern end of Bonnie Creek, even in the mowed area, and predated turtle shells were also found within that area, providing evidence that those and other wildlife use this predominately grassy corridor. Overstory stem density is an important habitat characteristic for large mammals, small mammals, aquatic mammals, reptiles, amphibians, and birds (Anderson et al. 1991; Bowyer et al. 1995; Saab et al. 1999; Nupp and Swihart 2001; Kolowski and Woolf 2002; Pattishall and Cundall 2009), and did not differ between restored and unmined streams. We similarly found no differences among streams

for vertical vegetative cover, which is important for large, small, and aquatic mammals (Bowyer et al. 1995; Nupp and Swihart 2001; Kolowski and Woolf 2002).

The minor differences in habitat characteristics we observed among sites were likely due to differences in forest age among sites, such that the forest at the unmined Little Galum Creek site was considerably older than the restored stream sites. Little Galum Creek had the highest percentage canopy cover at 85%, more than double that of the restored streams, and there was a much greater likelihood of encountering snags, cavities, and mature trees with fissures and loose bark such as shagbark hickory (*C. ovata*), black locust (*Robinia pseudoacacia*), sugar maple (*A. saccharum*), and sycamore (*Platanus occidentalis*).

While taking field measurements around these restored wetland areas, we observed great egrets (*Ardea alba*) perched in mature baldcypress trees (*Taxodium distichum*), double-crested cormorants (*Phalacrocorax auritus*) drying their wings on snag structure that had been placed in the water, deer browsing on new growth, and birds perched on trees that will eventually become a closed-canopy forest. These restored riparian buffers contained many young oak trees that with time will mature into healthy bottomland hardwood forest similar to that observed at the reference site. Wildlife species will benefit at different times from early-successional habitat in restored stream corridors (Walton 2012). During succession, in general, grasslands change to mixed understory, and mixed understory transitions to mature closed canopy forest where soft mast recedes and hard mast tree species begin to shade out the ground vegetation. Some wildlife species will benefit from the change, move about, and begin to colonize new areas, and other species will leave and find early-successional habitat that will suit their needs over time (DeGraaf and Yamasaki 2003; Walton 2012). Had these areas been planted entirely to row-crop agriculture, wildlife habitat value would be considerably limited.

## Management and Policy Implications

Our analysis from data collected at Burning Star 4 mine in Perry County, Illinois, is of value to land managers for it shows how the reclamation process has successfully jump-started wildlife habitat in buffers around streams affected by mining. Corridors at Bonnie Creek could be improved upon through additional reforestation, as they had the least canopy cover and the most herbaceous plants and bare ground cover. Corridors at Bonnie Creek also were the narrowest, so our recommendation for future restoration projects with wildlife habitat as a strong interest is to implement wider corridors since they provide more surface area for wildlife (Johnson and Buffler 2008). While canopy cover was much higher at the unmined control site, all streams had similar levels of hard mast trees within the overstory; as these forests grow, the restored streams will increase in the amount of wildlife habitat to further resemble a forest that has never been mined. For wildlife to persist in an area, all elements of habitat must be present for their specific and unique utilizations; rotting logs, an assortment of hard and soft mast trees of multiple ages and species, leaf litter, and herbaceous plants are all necessary to supply the local wildlife with habitat (Maser et al. 1979; Converse and Savidge 2003; Faccio 2003; Nupp and Swihart 2001). Over time and with proper land management, including proper plantings during reclamation and post-reclamation management, it is reasonable to believe that these restored forests will grow to have those similar characteristics of the unmined forests.

Lastly, 95% of land is privately owned in the state of Illinois and more private landowners should take advantage of incentives offered from Illinois Department of Natural Resources and the U. S. Department of Agriculture. These agencies provide opportunities for landowners in Illinois to enhance the wildlife habitat on their own private properties via grants, free trees, and/or yearly rental payments for restoring forests, grasslands, and wetland habitats on private property.

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