AVIAN UTILIZATION OF SUBSIDENCE WETLANDS[1]

Jack R. Nawrot, Pat S. Conley, and Cody L. Smout[2]

Abstract: Diverse and productive wetlands have resulted from coal mining in the midwest. The trend from surface to underground mining has increased the potential for subsidence. Planned subsidence of longwall mining areas provides increased opportunities for wetland habitat establishment. Planned subsidence over a 180 meter (590 foot) deep longwall mine in southern Illinois during 1984 to 1986 produced three subsidence wetlands totaling 15 hectares (38 acres). The resulting palustrine emergent wetlands enhanced habitat diversity within the surrounding palustrine forested unsubsided area. Habitat assessments and evaluations of avian utilization of the subsidence wetlands were conducted during February 1990 through October 1991. Avian utilization was greatest within the subsided wetlands. Fifty-three bird species representing seven foraging guilds utilized the subsidence wetlands. Wading/fishing, dabbling waterfowl, and insectivorous avian guilds dominated the subsidence wetlands. The subsidence wetlands represented ideal habitat for wood ducks and great blue herons which utilized snags adjacent to and within the wetlands for nesting (19 great blue heron nests produced 25 young). Dense cover and a rich supply of macroinvertebrates provided excellent brood habitat for wood ducks, while herpetofauna and ichthyofauna provided abundant forage in shallow water zones for great blue herons and other wetland wading birds. The diversity of game and non-game avifauna utilizing the subsidence areas demonstrated the unique value of these wetlands. Preplanned subsidence wetlands can help mitigate loss of wetland habitats in the midwest.

Additional Key Words: subsidence, wetlands, wildlife utilization.

Introduction

Draining and clearing for agriculture has eliminated more than 85% of wetlands in the United States (Tiner 1984). Illinois has lost an estimated 90 percent of the original 3.2 million ha (8 million ac) of presettlement wetlands. Of the remaining 507,450 ha (1,253,891 ac) of Illinois wetlands, palustrine emergent and palustrine forested wetlands comprise 16 and 62 percent, respectively, of the total wetland acreage (Suloway and Hubbell 1994). Fortunately, the functions and values of wetlands are now appreciated, although the complex nature of these diverse and productive habitats are not completely understood. While current emphasis is placed on wetland protection and preservation, mitigation of some past wetland losses can be achieved through wetland development and enhancement on reclaimed mined lands. Opportunities for wetland/wildlife habitat enhancement on mined lands include shallow water wetlands and littoral zones associated with the reclamation of sediment ponds, final cuts and inclines, stream riparian zones, slurry ponds, within spoil depressions, and underground subsidence areas (Nawrot and Klimstra 1989).

As the emphasis shifts in the Illinois Coal Basin from surface to underground coal extraction methods the opportunities for subsidence associated wetlands will increase. Since commercial underground mining for coal began in 1810 more than 4,000 underground mines underlying more than 283,290 ha (700,000 ac) have operated in Illinois (Guither et al. 1985). Room and pillar underground mining has produced extensive areas of subsidence wetlands in southern Illinois. In one region five underground mines, operating from approximately 1910 to 1960, undermined more than 12,383 ha (30,600 ac) resulting in more than 364 ha (900 ac) of palustrine emergent and shrub-scrub wetlands (Baralt 1994). Although subsidence wetlands associated with room and pillar mines have been unplanned, they provide land use diversity and critical habitats for some of Illinois' threatened and endangered species (Sternburg and Nawrot 1994). As longwall

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[2]Jack R. Nawrot, Associate Scientist, Pat S. Conley, Researcher II, and Cody L. Smout, Student Assistant, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL 62901-6504.

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mining methods replace less efficient room and pillar coal extraction methods more opportunities will exist for preplanning and developing extensive shallow water wetlands.

This paper summarizes the avifauna use of three preplanned longwall subsidence wetland basins in southern Illinois. Data presented in this paper are from a study conducted from February 1990 through October 1991.

Study Area

The three longwall subsidence wetlands are located above the Old Ben No. 25 mine, 3.2 kilometers (2 miles) east of West Frankfort in Franklin County, Illinois (T7S, R3E, sw 1/4 sec. 15 and nw 1/4 sec. 22) (Fig. 1). The underlying coal was mined from March 1984-October 1986 when three east-west, rectangular panels were extracted at a depth of 165 m (540 ft) using longwall mining methods. Planned surface subsidence produced an elevation drop of approximately 1.5 m (3.5 ft) over the panels, resulting in three basins. The three wetland basins ranged in size from 3.9 to 5.7 ha (9.7 to 14.0 ac).

The study site, encompassing 60 ha (150 ac) of the Ewing Creek riparian corridor, included forest 38 ha (95 ac), emergent wetland 15 ha (38 ac), and old field 4 ha (10 ac) communities. The subsidence wetlands, located along Ewing Creek, are frequently flooded (1-2 floods/month) from October through April. Duration of flooding is usually short (1-2 days). However, longer periods of inundation (5-7 days) occur due to backwater flooding of the Big Muddy River. The wetlands hold water longer than unsubsided areas; some portion of the wetlands are permanently inundated. Two of the wetlands undergo extensive summer drawdowns while the third wetland is semipermanently inundated. Depth of inundation ranges from less than 5.1 cm to more than 81 cm (2-32 in). Inundation of the subsidence basins has produced shallow, palustrine, emergent wetlands within the bottomland forest. A distinct boundary exists between the palustrine emergent and forested wetland communities. Zonation of moist soil, emergent macrophyte, submerged, and floating aquatic species occurs in four hydrologic zones within the wetland openings.

Subsidence Wetland 4 (SW4), located over mine panel 4 is the oldest of the basins. SW4 is 411 m (1,350 ft) long with varying width (23-100 m/75-330 ft), and encompasses 3.9 ha (9.7 ac). A majority of SW4 is semipermanently inundated holding water >75% of the growing season. Duckweed (Lemna), dominated the open water plant community. Diverse stands of moist soil and emergent wetland plants occupy the perimeter between the unsubsided forest overstory and floating duckweed. Flood tolerant woody species such as willows (Salix spp.) and red maple (Acer rubrum) are invading the intermittently exposed zone. Density of standing snags averages 100/ha (250/ac) with most snags supporting multiple cavities. Several small 9 m^2 (30 ft^2) islands were constructed at the water's edge in SW4 and the other basins.

Subsidence Wetland 5 (SW5) located north of SW4 is the second oldest basin. SW5 is 640 m (2,100 ft) long, and covers 5.6 ha (12 ac) and supports four distinct hydrologic zones (irregularly, seasonally, regularly, and semipermanently inundated). Wetland SW5 drains directly into Ewing Creek. Plant community zonation is well delineated with seasonally inundated zones characterized by Sagittaria spp. and Cyperus spp. Wild millet (Echinochloa pungens) dominated those zones with less frequent and extensive inundation. SW5 had more standing snags than SW4, but fewer than SW6.

Subsidence Wetland 6 (SW6) located north of SW5, parallels Ewing Creek, which enters the wetland through the west end (Fig. 1). SW6 encompassing 5.7 ha (14.0 ac) is dissected by several elevated zones resulting in five individual basins during drawdown. One section of wetland SW6 occupies previously drained and cleared bottomland habitat. This portion of SW6 lacks standing snags, is semipermanently inundated and supports moist soil vegetation only around the perimeter. Emergent perennials (Phragmites and Typha) form dense stands over much of this area. The majority of wetland SW6 is seasonally inundated and dominated by rice cutgrass (Leersia oryzoides).

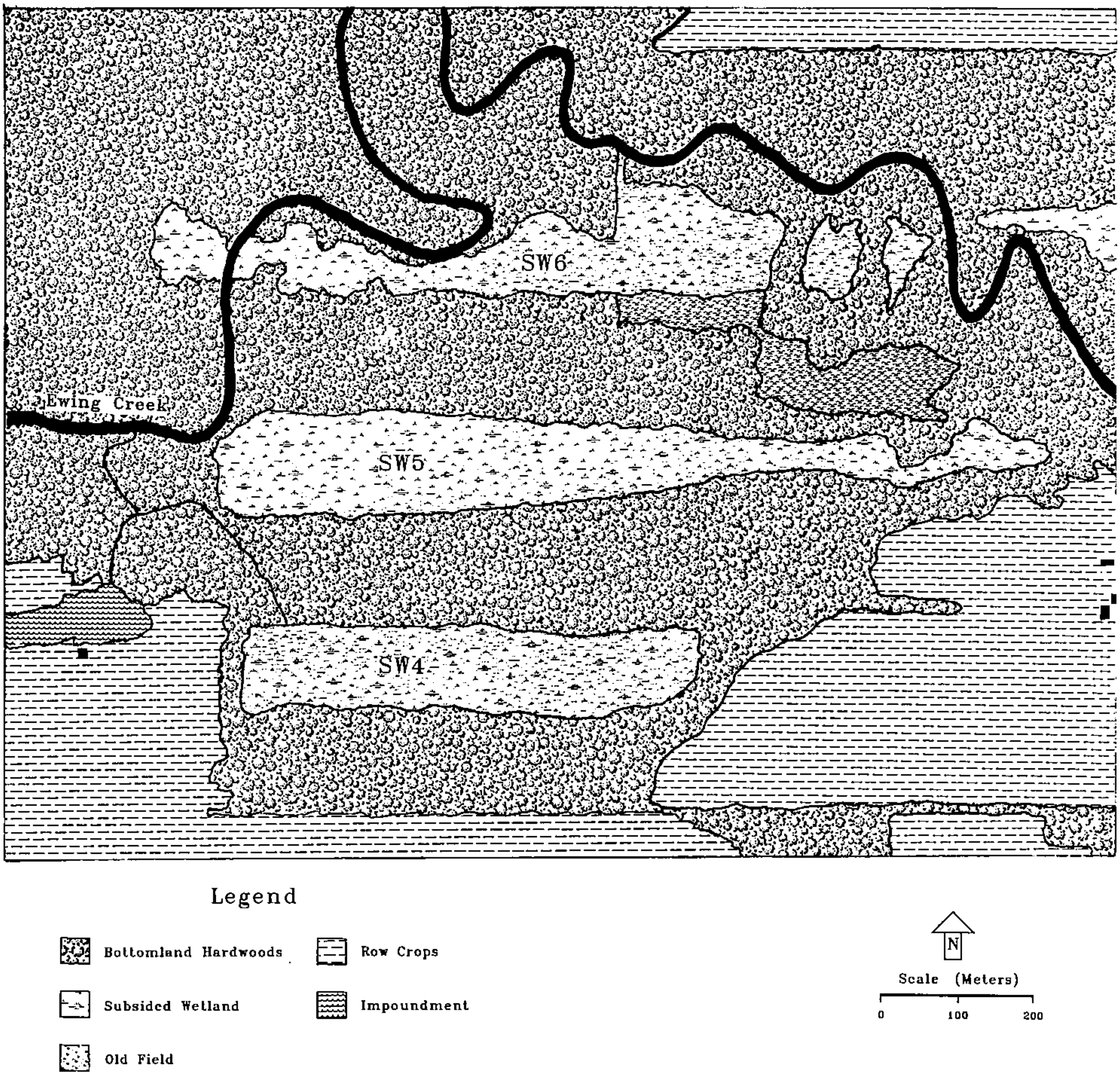

Figure 1. Ewing Creek subsidence wetlands (SW4, SW5, SW6) study area. Franklin County, Illinois.

Methods

Field investigations of the Ewing Creek subsidence wetlands included hydrology, basin topography, vegetation zonation, wetland plant productivity, nest production, snag abundance, nest cavity counts, macroinvertebrate abundance, and avian utilization. Field investigations were conducted February 1990 through October 1991. Bird utilization of the subsidence wetlands was documented during regularly conducted fixed point surveys. The point count method was adapted from Blondel et al. (1981). Survey points, located along the north and south edges of the subsidence openings, were spaced 91 m (300 ft) apart. Surveys were started on alternate end points. Every other point was surveyed to avoid counting individuals twice. Species, number and bird activity were noted. Birds were described as either feeding, loafing, nesting or transitional if the individual left the survey area during the stop.

All birds observed during 10 minute stops at a sample point and the associated 91x46 m (300x150 ft) or .48 ha (1.2 ac) area surveyed, were recorded. Surveys were initiated in the morning (~1/2 hour after sunrise) and completed by mid afternoon. One survey/week was conducted spring and fall; fewer surveys were conducted in winter. Observations were also made from points outside the subsidence wetlands in surrounding live stands of bottomland timber. These "control points" were surveyed to evaluate avian utilization prior to subsidence.

Shannon-Weaver (S-W) diversity indices were calculated for bird survey data. Equation 1 was used to calculate S-W indices where, P_i = # of species observations/# observed all species, and H' is the S-W index.

$$(1) \qquad H' = - P_i \log P_i$$

A high S-W index indicates higher diversity and more even distribution of species numbers or observations (Zar 1984). Relative diversity was calculated using equation (2) to determine proportion of maximum diversity represented where H'max = log # species and J' is the measure of relative diversity.

$$(2) \qquad J' = \frac{H'}{H'max}$$

Results and Discussion

Avian bird surveys conducted between October 1990 and March 1991 identified 55 species using the Ewing Creek study area. Birds using the subsidence wetlands included representatives from 25 taxonomic families (Table 1) and seven major functional guilds (Fig. 2). Functional guilds designations emphasized feeding and habitat affiliations.

Diversity of avian species using the subsidence wetlands was relatively similar for all three basins. Shannon-Weaver diversity index values (Table 2) indicated minimal differences in avian use between wetlands, or differences between the fall 1990 and spring 1991 censuses.

The overall contribution of the Ewing Creek subsidence wetlands to avian utilization is best reflected in the foraging guild data analysis (Fig. 2). Seven avian functional groups (based on feeding/foraging behavior) were supported by the subsidence wetlands. The obvious factor responsible for enhancing the avian diversity and hence the value of the Ewing Creek subsidence wetlands is diversification of habitat by the introduction of a semipermanently inundated aquatic habitat component. The introduction of permanent and semipermanently inundated zones within bottomland areas previously characterized by infrequent, short duration hydroperiods directly increases food production (wetland plants, aquatic macroinvertebrates, fish) and indirectly increases feeding niches for wetland dependent avian wildlife species.

Table 1. Avian species observed within the Ewing Creek subsidence wetlands study area, West Frankfort, IL. Fall 1990 (October–November) and spring 1991 (March–June).

		Number of Observations							
		Fall 1990				Spring 1991			
Common name	Scientific name	Wetland 4	Wetland 5	Wetland 6	Control	Wetland 4	Wetland 5	Wetland 6	Control
Red–headed woodpecker	*Melanerpes erythrocephalus*	9				46	28	12	1
Red–bellied woodpecker	*M. carolinus*	7	4	5	2	4	9	3	5
Yellow–shafted flicker	*Colaptes auratus*	3	9	4	4	12	12	8	2
Hairy woodpecker	*Poicoides villosus*	2	3	3	2	1	1	2	1
Downy woodpecker	*P. pubescens*	2	1		1	3	1	4	
Pileated woodpecker	*Dryocopus pileatus*						2	7	
Yellow–bellied sapsucker	*Sphyrapicus varius*							1	
Mallard	*Anas platyrhynchos*			1			2	2	
Wood duck	*Aix sponsa*		31	6	2	13	8	44	
Blue–winged teal	*Anas discors*					2	8	8	
Northern shoveler	*A. clypeata*							2	
Great blue heron	*Ardea herodias*			2		5	1	109	
Green heron	*Butorides striatus*					6	2	3	
Barred owl	*Strix varia*			1	1			1	
Red–tailed hawk	*Buteo jamaicensis*		1		1	2	2		
Marsh hawk	*Circus cyaneus*				1				
Sharp–shinned hawk	*Accipiter striatus*				1	1			
Turkey vulture	*Cathartes aura*		4	4					
Belted kingfisher	*Megaceryle alcyon*					1	2	2	
Yellow–billed cuckoo	*Coccyzus americanus*				1				
Mourning dove	*Zenaida macroura*	1				2			
Killdeer	*Charadrius vociferous*	5			5	11	4	5	
Solitary sandpiper	*Tringa solitaria*					1	11	4	
Great crested flycatcher	*Myiarchus crinitus*					4	5	3	
Empidonax flycatcher	*Empidonax spp.*						3		5
Red–eyed vireo	*Vireo olivaceus*						1		5
Prothonotary warbler	*Protonotaria citrea*		1			19	16	18	4
Yellow–throated warbler	*Dendroica dominica*							3	1
Common yellowthroat	*Geothlypis trichas*						1	4	
Yellow–rumped warbler	*Dendroica coronata*	7		5				1	
Blue gray gnatcatcher	*Polioptila caerulea*					1	4	6	10
Golden–crowned kinglet	*Regulus satrapa*								5
Carolina wren	*Thryothorus ludovicianus*		2	3	2	1			1
Eastern bluebird	*Sialia sialis*	19	11	7	1	5	11	7	
Carolina chickadee	*Parus carolinensis*	1	3	6	5	16	7	8	23
Tufted titmouse	*P. bicolor*	4	7	1	14	10	11	5	29
American crow	*Corvus brachyrhynchos*			7	10	1	5		3
Blue jay	*Cyanocitta cristata*	3	1	1	4				
American robin	*Turdus migratorius*	1			2		19		2
Tree swallow	*Iridoprocne bicolor*					84	35	10	
Cardinal	*Cardinalis cardinalis*	1	2	4	4	10	5	5	33
American goldfinch	*Carduelis tristis*		1		1			12	4
Dark–eyed junco	*Junco hyemalis*	5	4		32				
Red–winged blackbird	*Agelaius phoeniceus*	14	15	52		57	54	183	42
Common grackle	*Quiscalus quiscula*	4				22	22	4	1
Brown–headed cowbird	*Molothrus ater*	4	4			4	2	1	
European starling	*Sturnus vulgaris*	2				51	26	10	
Song sparrow	*Melospiza melodia*	1	3	2	10		1	9	
Swamp sparrow	*M. georgiana*	1	15	67	3			1	
Fox sparrow	*Passerella iliaca*		4	6	10				
White–throated sparrow	*Zonotrichia albicollis*		8	9	23				
Brown creeper	*Certhia familiaris*				1				1
White–breasted nuthatch	*Sitta carolinensis*	1		1	1			2	
Wood thrush	*Hylocichla mustelina*								2
Indigo bunting	*Passerina cyanea*					3	2	3	1
Total		97	134	197	144	398	323	512	181

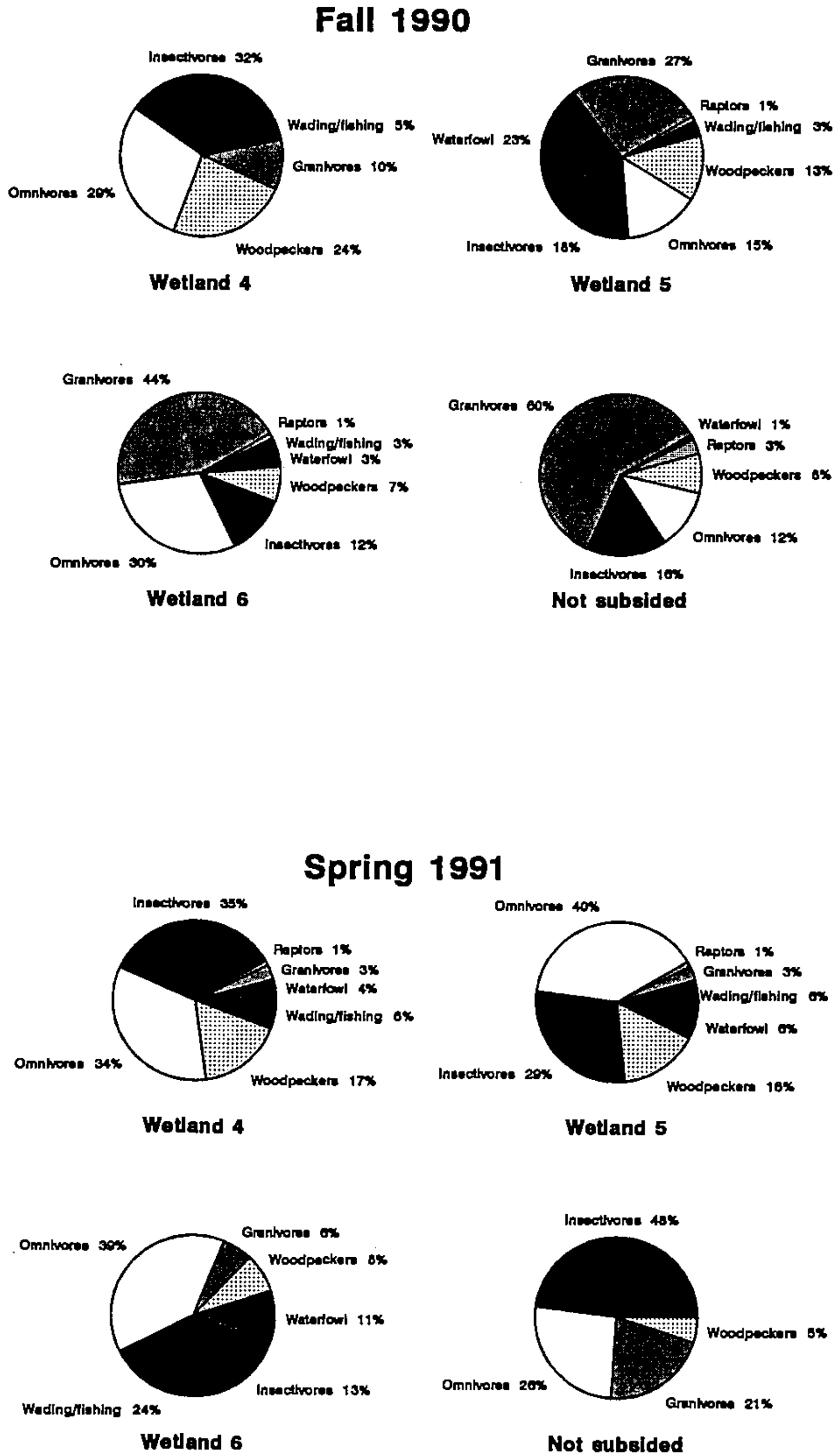

Figure 2. Avian functional guilds utilizing the Ewing Creek subsidence wetlands. Fall 1990 (October–November) and spring 1991 (March–June).

Table 2. Avian Diversity Indices[a] for Ewing Creek Subsidence Wetland openings, West Frankfort, IL, fall 1990 (October-November) and spring 1991 (March-June).

Subsidence Wetland Area	Shannon-Weaver Diversity Index[b]		Relative[c] Diversity Index	
	Fall 1990	Spring 1991	Fall 1990	Spring 1991
4	1.1526(21)	1.1405(30)	0.8732	0.7721
5	1.1262(23)	1.2856(34)	0.8389	0.8395
6	0.9619(23)	1.0414(37)	0.7064	0.6641
Control	0.8213(21)	1.0504(22)	0.8213	0.7824
All Areas	0.8011(45)	1.2543(48)	0.8011	0.7639

[a]Calculated from bird survey data, updated 27 June 1991.
[b]Described in Zar (1984), number of species identified in parentheses.
[c]The proportion of maximum possible diversity.

Comparisons of taxonomic diversity did not reflect substantial differences between the subsidence wetlands. However, some unique differences between the wetlands, reflecting habitat diversification, were noted in the comparison of guild associations. Wading and fishing birds represented almost one-fourth of the avian utilization observed in Wetland 6 during spring 1990 (Fig. 2). An increase of great blue heron nest establishment in the permanently inundated portion of Wetland 6 contributed to the importance of the wading/fishing guild utilization. When initiated in 1990 (four years after subsidence) the Wetland 6 heron rookery supported only 9 nests. During spring 1991, 19 active great blue heron nests were documented in Wetland 6. A total of 25 fledgling great blue herons were observed in the nests during the spring of 1991.

Wetlands 4 and 5 also supported snags suitable for heron nesting; however, no nests were documented in either wetland. Wetland 6 represented a more desirable rookery site due to its direct connection to Ewing Creek which provided a consistent source of forage fish. In addition, excellent heron feeding sites result when summer drawdown conditions trap forage fish in 4 to 5 isolated wetland pools. Waterfowl utilization of Wetland 6 was also enhanced by the diversity of plant communities associated with the perimeters of the drawdown pools. The diverse stands of moist soil annuals and aquatic macroinvertebrates provided excellent brood habitat within subsidence Wetland 6. Three wood duck (Aix sponsa) broods used Wetland 6 during June 1990; four wood duck broods were recorded during June 1991. Wood ducks primarily utilized the semipermanent and seasonally inundated portions of the subsidence wetlands that supported snags. Although most snags contained potential nest cavities, no wood duck nests were recorded in subsidence snag areas. Wood duck nesting was occurring in the adjacent unsubsided bottomland forest. Mallard utilization was greatest in the east portion of Wetland 6 that resulted from subsidence of a previously drained and cleared agricultural field.

The importance of reclaimed wetlands is often viewed only in the context of how many broods of ducks are produced, the presence of heron rookeries, or the abundance of wetland wading birds. The Ewing Creek area demonstrates the value of subsidence wetlands to avian guilds that are not necessarily wetland dependent, but benefit by habitat diversification in general. Exfoliating bark of subsidence associated snags provided excellent foraging habitat for seven woodpecker species. In addition, insectivorous species such as the white-breasted nuthatch (Sitta carolinensis) benefitted by adult and larval insect forms associated with the bark and wood fiber of the decaying snags. A unique benefit of the Ewing Creek subsidence wetlands was the abundant nest cavities provided by decaying snags. Eastern bluebirds (Sialia sialis) and prothonotary warblers (Protonotaria citrea) were two of the most frequently observed songbirds using the subsidence wetlands. Both species nested in snag cavities. Avian species associated with the granivore guild benefitted by the seed production of moist soil annuals. Nutsedge (Cyperus erythrorhizos), smartweeds (Polygonum spp.), wild millet (Echinochloa pungens), and rice cutgrass (Leersia oryzoides) provided an abundant food source in the shallow wetland pools of subsidence wetlands 5 and 6. Swamp sparrows (Melospiza georgiana), American goldfinch (Carduelis tristis), and the indigo bunting (Passerina cyanea) were representative of a diverse group of passerine species which regularly used the subsidence wetland for feeding.

The benefits of habitat diversification provided by subsidence wetlands can be significant on both a local and regional scale, although some aspects such as snag longevity may provide only a temporary benefit. The overall benefit of subsidence wetlands can be compared to the function and values of beaver wetlands or oxbow sloughs which are merely transient wetland types that temporarily diversify habitat during a successional continuum of constant change.

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