USE OF EMERGENT WETLANDS ON MINED LANDS BY THREATENED AND ENDANGERED AVIFAUNA.

by

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ABSTRACT

Loss of natural wetlands is a primary factor in the decline of interior wetland bird populations. Extensive habitat losses have created a need to develop methods to preserve, enhance, and restore wetlands. I evaluated mined areas colonized by emergent wetland vegetation as potential habitat for threatened and endangered interior wetland birds.

Surveys using broadcasts of pre-recorded bird calls conducted at 10 emergent wetlands on 4 coal surface mines in southern Illinois detected 1 state threatened and 2 state endangered birds. Least bitterns (Ixobrychus exilis) were present at all study sites. Bitterns used interiors of dense emergent vegetation more than sparsely distributed vegetation. Common moorhens (Gallinula chloropus), present at 3 of 4 sites surveyed, frequently responded from and were observed feeding at edges of emergent vegetation interspersed with deep open water. Pied-billed grebes (Podilymbus podiceps), present at 2 of 4 sites surveyed, occupied relatively deep (0.5 m) open water areas, edges of emergent vegetation, and sparsely distributed emergent vegetation.

Eight least bittern nests were found in emergent vegetation including 2 in broad-leaved cattail (Typha latifolia), 5 in narrow-leaved cattail (T. angustifolia), and 1 in reedgrass (Phragmites australis). Nests contained a total of 22 eggs, 17 of which hatched (77% hatch success).

Two common moorhen nests were found in reedgrass with high open water interspersion. One moorhen nest contained 9 eggs, all

of which hatched. The second moorhen nest, found after hatch date, may have been used in 1993.

Regional assessment of potential interior wetland bird habitat south of Illinois Interstate 64 identified a total of 8,109 ha of emergent stable water wetlands. Wetland types considered potential habitat were classified by the National Wetlands Inventory (NWI) as: PEM (palustrine emergent) or PUB (palustrine unconsolidated bottom). Water regimes of suitable palustrine emergent wetlands included: seasonally flooded (C), semi-permanently flooded (F), intermittently flooded (G), and permanently flooded (H). Nearly 10% (790 ha) of these wetlands were associated with surface-mining. Evaluation of suitable wetland habitat within 16 km radii of study area centers identified a combined total of 1,832 ha, 57% of which were mine associated.

Mine associated wetlands meet the habitat needs of interior wetland birds for 2 primary reasons: hydrologic stability and robust emergent vegetation structure. Mine land wetlands provided additional wetland habitat that could compensate for loss of natural wetlands in Illinois.

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INTRODUCTION

Natural wetlands once formed an extensive network of habitat for plant and animal communities in the midwest. However, land use changes have seriously impacted wetlands to the point where suitable habitat is lacking in many areas (Eldridge 1992). Although legislation to protect wetlands from drainage and filling was enacted in 1977 under Section 404 of the Federal Clean Water Act, declines in wetland dependent avifauna have continued.

Over half of the original wetland area in the contiguous United States have been lost due to drainage and filling for agriculture and urbanization (Tiner 1984). Palustrine wetlands were reduced by 3.7 million ha from 1950-1970. Wetland types most affected were palustrine forested (2.4 million ha) and palustrine emergent (1.1 million ha) (Tiner 1984). These losses, due mainly to agriculture, make up 10% of all existing palustrine wetlands (Reid et al. 1989).

Nearly 90% of original wetlands have been lost since European colonization in Illinois (Suloway et al. 1992). Emergent wetlands, that contain 30% or more rooted, herbaceous, hydrophytic vegetation, comprise only 0.6% (80,648 ha) of total land in Illinois (Suloway et al. 1992). Although palustrine wetlands have suffered the greatest recent declines (Reid et al. 1989), all wetland types and associated plant and animal communities have been impacted by continuing destruction and degradation (Fredrickson and Reid 1986).

Loss of nesting and foraging habitats severely impacts many wetland dependent avian species (Gibbs and Melvin 1993) and is the primary factor leading to population declines of interior wetland birds such as grebes, bitterns, moorhens, and rails. Kroodsma (1978) reported that most north American bird taxa use wetlands, and one-third require them. Over 50% of all federally threatened and endangered migratory nongame bird populations require wetlands to complete their life cycles (U.S. Fish and Wildlife Service 1987). Wetlands also provide essential life requisites for 26 of Illinois' threatened and endangered avifauna. In addition, 161 Illinois threatened and endangered plants and 41 animals depend on wetlands (Herkert, Illinois Endangered Species Protection Board, pers. commun.).

Mined lands can contribute wetland area and wildlife habitat (Coss 1981, Klimstra 1982). Reclaimed mined land wetlands are constructed to include diverse macrophyte communities, but some sites have been naturally colonized by dense, monotypic stands of reedgrass (Phragmites spp.) and cattail (Typha spp.), which are invasive species characteristic of disturbed areas. Reedgrass and cattail have high propagative potential, reproducing vegetatively by stout creeping rhizomes and stolons, and through seed germination on exposed mudflats (Cross and Fleming 1989). Once established, reedgrass is extremely aggressive, difficult to eradicate, and may quickly re-invade after eradication.

Reedgrass is of limited value to waterfowl because it is a poor food source and prevents growth of more suitable wildlife foods (Bontje and Stedman 1991). Existing wetland management has focused on the creation and maintenance of habitats suitable for waterfowl production (Helmers 1991). However, studies have documented use of reedgrass and other dense emergent macrophytes on mined land wetlands by waterfowl as well as nongame avifauna. O'Leary et al. (1984) reported that nesting waterfowl and their broods used dense cover of terrestrial and emergent vegetation, including cattail. They documented mined land wetland use by waterfowl, wading birds, and shorebirds. Lawrence et al. (1985) also documented avian use and breeding on Illinois surface-mined wetlands.

Pratt (1991) indicated that reedgrass communities colonizing Illinois mine sites supported a variety of wildlife, including several state and federal threatened and endangered species (Pratt 1991). Among the threatened and endangered avian species observed in or near reedgrass dominated wetlands in southern Illinois were great egrets (Casmerodius albus), northern harriers (Circus cyaneus), ospreys (Pandion haliaetus), sharp-shinned hawks (Accipiter velox), and red-shouldered hawks (Buteo lineatus). Reedgrass dominated wetlands also supported several threatened and endangered interior wetland birds which are secretive nongame species closely associated with robust emergent wetland habitats. Species observed by Pratt (1991) included American bitterns (Botaurus lentiginosus), least bitterns (Ixobrychus exilis), common moorhens (Gallinula chloropus), soras (Porzana carolina), Virginia rails (Rallus limicola), and pied-billed grebes (Podilymbus podiceps).

Habitat selection by interior wetland birds is based primarily on water conditions and vegetation structure, rather than plant species composition and seed production (Rundle and Fredrickson 1981). Robust emergent plants that persist in the spring such as bulrush (Scirpus spp.), reedgrass, cattail, and sedges (Carex spp.), are desirable. With extensive losses of natural wetlands, there is increased need to develop methods to replace and restore wetland habitats. Mined areas colonized by wetland vegetation provide stable water habitats with robust emergent vegetation that are preferred by nongame wetland birds. Therefore, mine lands could partially offset loss of habitat from the destruction of natural wetlands.

I evaluated the importance of emergent wetlands occurring on mined areas in southern Illinois as habitat for nongame interior wetland birds, focusing on threatened and endangered species. My goals were to increase knowledge and understanding of habitat use by nongame avian species and to identify mined land wetland management practices that best meet life requisites of these species.

Objectives

1. Determine avian use of reedgrass dominated emergent wetlands established on surface mined lands with emphasis on Illinois threatened and endangered species.

2. Assess the potential contribution of mine land wetlands in meeting habitat needs of nongame wetland birds.

STUDY AREAS

Will Scarlet

Peabody Coal Company's Will Scarlet mine was located 6.4 km southwest of Carrier Mills in western Saline County and southeastern Williamson County, Illinois. The site supported a mixture of upland, wetland, and deepwater habitats totalling approximately 3,200 ha. Will Scarlet was initially mined by Stonefort Coal Company in 1953, prior to enactment of Illinois' Open Cut Land Reclamation Act in 1962. Peabody Coal Company acquired the site in 1967 and actively surface mined it until 1987. Four impoundments representing emergent wetland habitats were selected for study (Appendix A, B, C, D). Sites included 3 unmined wetlands (Pit 10, IC1 and Pit 5) and a post-law slurry wetland development project (Pit 9) (Table 1).

Denmark Mine

Arch of Illinois' Denmark mine was located 2.7 km northwest of Ava in Perry County, Illinois. The site was initially mined by AMAX Coal Co. and was acquired by Arch in 1986. Study areas consisted of 3 emergent wetlands established on inactive slurry impoundments (Table 1, Appendix E). Cells were dominated by reedgrass with some cattail and were separated by a series of levees that supported herbaceous and woody cover.

Table 1. Site characteristics and percent emergent cover for selected mine associated wetlands in southern Illinois in 1993, including Peabody Will Scarlet Pit 10, IC1, Pit 9, Pit 5; Arch Denmark Mine; Consolidation Burning Star No. 5; and Peabody River King 1 Cells IIA and IIB.

Site	Dominant Species	(%)	Water Depth (m)	pH	Size (ha)
P10	*P. australis*	(44)	0.52->1.00	6.3	29.0
IC1	*P. australis*	(18)	0.50->1.00	6.0	10.8
P9	*S. paludosus* *Typha* spp.	(13) (12)	0.06->0.25	5.2	14.0
P5	*C. occidentalis* *J. effusus*	(27) (10)	0.30-0.78	4.7	10.0
Arch	*P. australis* *Typha* spp.	(73) (5)	0.15-1.30	7.0	73.0
No 5	*P. australis*	(61)	0.20-0.70	8.2	14.0
IIA	*P. australis*	(94)	0.15->0.81	7.1	36.0
IIB	*P. australis*	(65)	0.25->1.00	7.3	24.0

Burning Star

Consolidation Coal Company's Burning Star No. 5 mine was located 5.4 km east of Desoto in Jackson County, Illinois. The 262 ha site, mined during 1976-1990, consisted of upland and lowland areas.

A 14 ha permanent impoundment selected for study included emergent wetland habitat bordered by herbaceous upland areas and some woody vegetation (Appendix F). The site was an active slurry impoundment until 1985 when reclamation activities were initiated. Reclamation plans included soil cover ranging from 0.3-1.2 m with some limestone amendments on areas with the greatest amount of acid producing material. Low lying slurry substrates were inundated without amendments. The slurry area contained variable topography supporting upland and lowland vegetation.

The area was planted with tall fescue and naturally colonized by reedgrass prior to reclamation. Reedgrass dominated the site in 1993, invading upland and impounded areas.

River King 1

Peabody Coal Company's River King 1 mine was located north of Freeburg, Illinois. Study areas consisted of two emergent wetlands established on inactive slurry impoundments (Cell IIA and Cell IIB). Reedgrass, the dominant wetland vegetation at both sites, occurred as monotypic stands and as areas with a high degree of reed-water interspersion (Appendix G, H). Duckweed was present along reedgrass borders and in areas of high reed-water interspersion.

METHODS

Wetland bird location and occurrence

Surveys to determine presence and habitat use by threatened and endangered interior wetland birds were conducted using playback of recorded territorial and mating calls. Use of playback recordings to obtain vocal responses was necessary due to dense vegetation and the bird's secretive natures. Cassette recordings of calls for each species were made from the Peterson Field Guide to Eastern/Central Bird Songs compact disc (Cornell Laboratory of Ornithology/ Interactive Audio 1990). Avian species included were: American bittern, least bittern, common moorhen, pied-billed grebe, Virginia rail, sora, black rail (Laterallus jamaicensis), yellow rail (Coturnicops noveboracenis), and king rail (Rallus elegans). Cassettes consisted of 5-10 call repetitions for each species interspersed with 10 seconds of silence between calls and 60 seconds of silence between species. Rails were no longer surveyed after they became unresponsive during migration.

Spring surveys were conducted prior to and during breeding seasons (2 April-28 June 1993) for as long as birds remained vocal. A fall field season was initiated on 9 September 1993 to determine wetland use by migrating avifauna. Recordings of avian vocalizations also were played in the fall; however, due to decreased responsiveness, additional methods were employed. Supplemental survey methods included passive observation of areas using binoculars; walking through vegetation attempting to flush birds; and using sudden, loud noises in attempts to startle birds into vocalizing.

Tape recorded call surveys were conducted by playing cassettes from fixed stations positioned to obtain the most complete coverage possible of each study area. Stations were established along levees in open water and at the edge of emergent plant communities, depending on habitat features. Approximately 1 station was established per 5 ha of wetland with 2-5 stations/site depending on size and configuration. Species of any spontaneously vocalizing birds within range of a station were recorded for approximately 5 minutes after sunrise and their locations marked on study area maps. The cassette was then played and all responding birds were recorded and approximate location marked on the map. Following broadcast of all species, approximate locations of vocalizing birds were again marked on maps of study sites for an additional 5-minute period. Use of reedgrass areas by nontarget avian species was also recorded (Appendix I).

Orders of stations surveyed and species broadcast were rotated each field day. Surveys were conducted only on days with wind $\leq$24 kph. Surveys were not conducted on days with moderate to heavy rain due to inhibition of avian response and potential damage to playback equipment.

Nest Searches

Searches for pied-billed grebe, common moorhen, and least bittern nests were conducted 1-28 June 1993 using 3-6 searchers. Searchers were given information on nest type and approximate height to assist in the formation of a search image. Study areas were searched by wading and canoeing through emergent vegetation. Searches were conducted in areas of concentrated avian activity determined from locations of vocal responses. All located nests were marked with flagging tape and monitored to determine nesting progress.

Nest Monitoring

Least bittern and common moorhen nests were monitored every 3-5 days during incubation to determine approximate hatch dates and hatch success. Nest parameters were recorded after fledging including nest diameter, height of nest base above water, distance from nest to nearest open water edge, and water depths at nest site. All measurements were recorded to the nearest cm using a measuring tape with 1 end weighted to facilitate water depth measurements. Lengths and widths of any unhatched eggs were measured to the nearest 0.01 cm using calipers.

Mapping

Black and white prints were made from aerial photograph negatives (1989-1992) of each study site. Wetland plant communities and open water boundaries within wetland habitats were identified, ground truthed, and digitized from photographs using a computer aided drawing program (AutoCAD Release 12, Autodesk, Inc., Bothell, WA). Nest sites, areas of avian activity, and emergent vegetation types were labeled.

Habitat Assessment

The National Wetlands Inventory (NWI) data base for 22 Illinois counties south of Interstate 64 was accessed using PC-ARC/INFO (Environmental Systems Research Institute, Inc., Redlands, CA). Number, area, and perimeter of all palustrine emergent (PEM) wetlands with stable water regimes (NWI codes C, F, G, and H) were determined for all 22 counties. PEMC (seasonally flooded), PEMF (semi-permanently flooded), G (intermittently flooded), and H (permanently flooded) wetlands were chosen due to stable water regimes and presence of persistent emergent vegetation that provided habitat potentially usable by interior wetland birds such as bitterns and moorhens. A minimum size requirement of ≥0.4 ha was included for all wetland types.

Palustrine unconsolidated bottom (PUB) wetlands were defined by Cowardin et al. (1979) as all wetlands with ≥25% cover of substrate particles smaller than stones and a vegetation cover <30%. PUB wetlands on mine lands were selectively included as potential interior wetland bird breeding habitat due to the presence of wide bands of emergent vegetation. However, in unmined areas, PUB impoundments often included small ponds or sewage lagoons which did not contain substantial emergent cover and thus did not meet requirements for suitable habitat (personal observations). Therefore, only PUB wetlands occurring on mine lands were included. Of these wetlands, only 29% of total area was included as potential habitat, reflecting the maximum amount of emergent vegetation which could be present in these wetlands according to the definition used by Cowardin et al. (1979).

An Illinois mine land boundary data base was obtained from the Illinois State Geological Survey (ISGS). Mine boundary coverages were overlain on NWI polygons in PC-ARC/INFO to determine number and total area of emergent wetlands on mine land. Differences in scale between the 2 data bases prevented direct extraction of mine land wetlands. Instead, emergent wetlands located within mine boundaries were selected and total number and area were calculated. Selection was based on shape, configuration in relation to surface mine boundary, and by use of 7 1/2 minute USGS quadrangle maps and NWI maps. Non-mine PUB wetlands were deleted from the selected data set. Total amount of interior wetland bird potential habitat was calculated separately for mine and non-mine lands.

Sixteen km buffer zones centered around midpoints of each study site were created using Map and Imaging Processing Systems (MIPS; MicroImages, Inc., Lincoln, NE). Potential interior wetland bird habitat was calculated within these buffer zones to determine the number and proximity of other wetlands.

RESULTS

Wetland Bird Location and Occurrence

Call recording playbacks detected 3 state threatened and endangered wetland bird species on mine land wetlands. Species responding included common moorhens, least bitterns, soras, and pied-billed grebes.

Birds were generally vocal and responded most frequently to recordings before the nesting season. Vocalization and responsiveness to playback recordings decreased with onset of nesting of common moorhens and least bitterns, and with migration by soras and grebes.

Least bitterns were present at all study sites surveyed. Sites were located on mined lands in 4 southern Illinois counties, suggesting that least bitterns colonized all suitable habitat surveyed regardless of geographic location. Least bitterns first responded to call recordings on 29 April 1993. Peak responsiveness occurred between 14 May-7 June. The latest date least bitterns responded was 16 June (Fig. 1).

Broadcasts of pre-recorded calls increased detection of least bitterns dramatically over passive observation. During 224 call broadcasts at 10 wetlands, bitterns were heard spontaneously vocalizing only 5 times in the 5 minute silent period prior to broadcast and were visually detected on only 2 occasions (8 birds) prior to breeding. In contrast, bitterns responded 35 times following playback of pre-recorded calls (Table 2). However, more spontaneous responses might have been detected if the pre-broadcast silent period had been longer. Locations of least bittern visual and vocal responses revealed greater use of interiors of dense stands of emergent vegetation than open areas with clumped or sparsely distributed vegetation.

Common moorhens were present at 3 of 4 sites surveyed. Although moorhens were detected at Will Scarlet only during migration, they were present throughout the nesting season at Denmark and nested successfully at River King 1. Common moorhens were consistently associated with open habitats. Vocal responses and sightings of moorhens were noted most frequently along wetland margins and in areas where reedgrass was well interspersed with open water and abundant duckweed. Moorhens took cover in areas of emergent vegetation when disturbed, however, they did not respond from interiors of dense vegetation. Mean water depth at common moorhen nest sites and areas of feeding activity was 0.63 m.

Moorhen responses were first noted on 6 May. Peak responsiveness occurred between 19-28 May, although responses were noted through 5 June (Fig. 1). Moorhens did not respond directly to playback recordings during and after nesting, however, spontaneous vocalization resumed after hatching (28 June).

Grebes were present at 2 of 4 study sites surveyed but breeding was not documented at any site. Grebes were first detected on 6 April responding from along reedgrass margins. Grebe response patterns fell into 2 general peak periods with responses heard consistently between 20-27 April, decreasing until mid-May when a second period of vocal activity occurred (Fig. 1). Grebes

WETLAND BIRD RESPONSE DATES

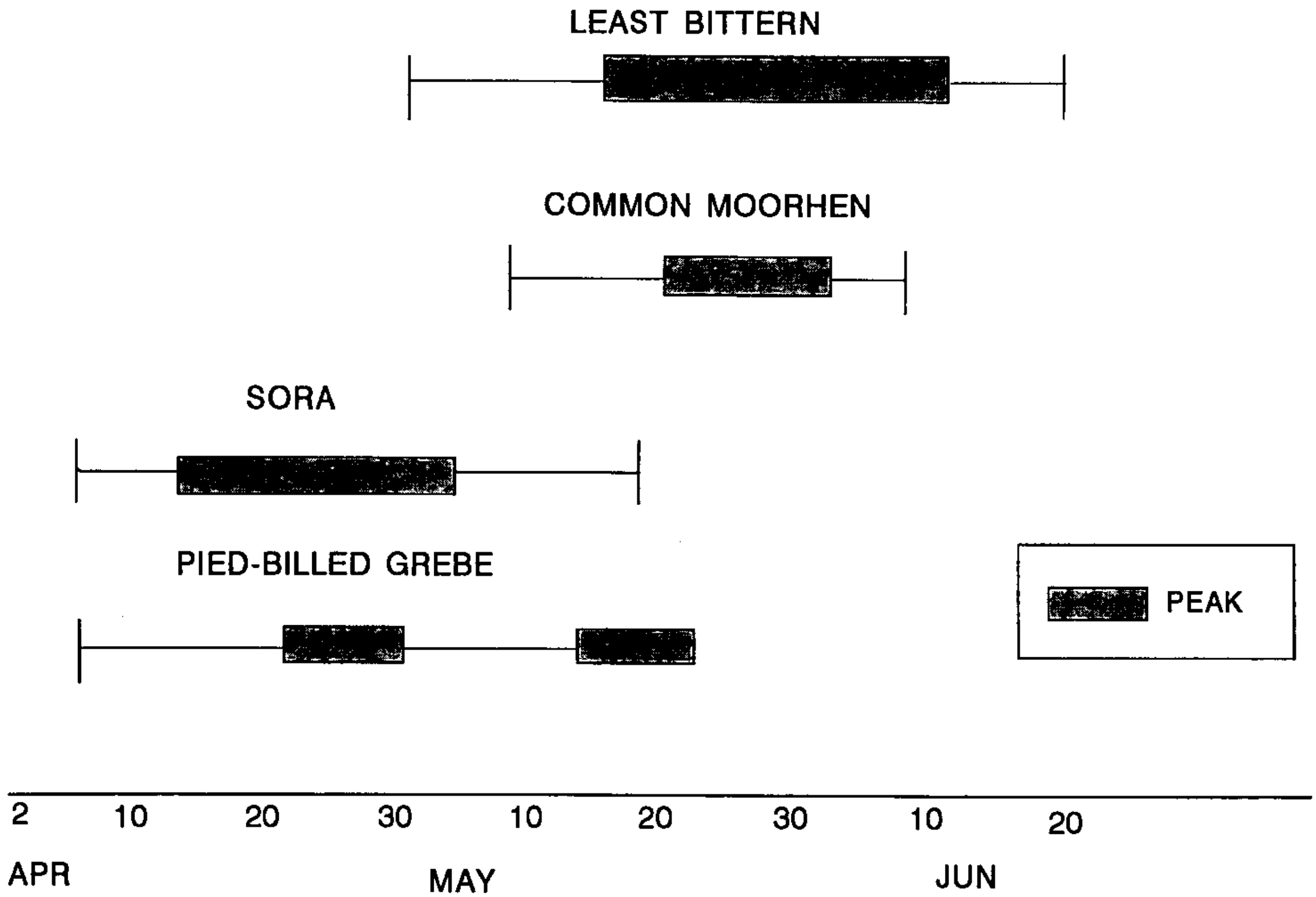

Table 2. Avian vocal responses per call broadcast survey effort at southern Illinois mine associated wetlands in 1993. Only surveys falling within periods of vocal activity were included for each species (n).

Wetland	Least bittern		Common moorhen		Sora		Pied-billed grebe	
2P10	0.40	(20)	0.10	(20)	1.47	(15)	0.15	(20)
IC1	0.42	(12)	0.00	(12)	0.33	(9)	0.00	(12)
P9	0.00	(8)	0.00	(8)	0.00	(6)	0.00	(8)
P5	0.00	(8)	0.00	(8)	0.00	(6)	0.50	(8)
AI	0.07	(15)	0.33	(9)	0.33	(6)	0.78	(9)
AII	0.60	(15)	0.22	(9)	1.00	(6)	0.33	(9)
AIII	0.27	(15)	0.00	(9)	1.33	(6)	0.00	(9)
No 5	0.38	(24)	0.00	(16)	1.42	(12)	0.00	(16)
IIA	0.05	(21)	0.50	(18)	0.50	(6)	0.00	(9)
IIB	0.11	(28)	0.13	(24)	0.63	(8)	0.00	(12)
Total response/ survey 22	0.24	(166)	0.14	(133)	0.83	(80)	0.15	(112)

occupied relatively deep (0.5 m) open water areas, along edges of emergent vegetation, and in sparsely distributed emergent vegetation.

Grebes only used Pit 10 and soft rush (Juncus effusus), buttonbush (Cephalanthus occidentalis), and open water areas at Will Scarlet Pit 5 (Appendix D) during migration; no birds were detected at either site after 27 April. Grebes responded consistently between 13-19 May at Arch Denmark Cell I, indicating that they may have nested at this site (Fig. 1). However, no evidence of nesting was found, and grebes were not detected again after 19 May until fall surveys (9-16 September) were initiated.

Soras were present at 3 of 4 mine sites surveyed. Soras were very responsive and highly mobile, creating some difficulty in distinguishing individual birds. Peak sora response dates were between 12 April-6 May, with up to 12 individuals responding from a single wetland in one day. Soras were present only during migration, and no individuals responded after 17 May (Fig. 1). Soras occupied edges and interiors of reedgrass stands in areas of relatively deep water (from 0.30 m to $\geq$1.2 m deep), but did not respond from open habitats containing sparsely distributed vegetation.

Nest searches and nest parameters

Nest searches focused near centers of avian activity, determined from locations of vocal responses. Searches were not conducted in dry areas due to lack of avian vocal response in these sites during earlier surveys. Eight least bittern nests, containing a total of 22 eggs, were found on 2 different study areas (Table 3). Seventeen eggs hatched (77% egg success). Clutch sizes were 2-5 eggs with a mean of 3.1 eggs and a mode of 2 eggs. One nest, located in an isolated patch of reedgrass may have been abandoned following a wind storm. The nest contained 2 eggs when initially found, but later appeared to have been damaged with the eggs lying cracked at the base of the reeds.

All nests were found in emergent vegetation with 2 nests in broad-leaved cattail (T. latifolia), 5 in narrow-leaved cattail (T. angustifolia), and 1 in reedgrass (Table 4). Cattail was present as a continuous stand at only 1 site (Arch Denmark) and consisted of a concentric band surrounding the edge of a pothole wetland and a linear band bordered by water on one side and reedgrass on the other (Appendix E).

Least bitterns most frequently nested in cattail. Nests located in cattail were a minimum of 1.5 m from open water edges and a mean of 4.2 m from edges.

Although no nests were discovered in reedgrass at River King 1, Burning Star, Will Scarlet Pit 10, or at Arch Denmark, it was likely that breeding was attempted at all of these sites. Patterns and dates of bittern vocal responses were similar between confirmed and unconfirmed breeding sites. Vocal responses, indicating presence of bitterns, were documented at all sites by 14 May. Vocalizations were noted until onset of the breeding season (16 June). As the season progressed, bittern activity became localized, possibly indicating nest establishment. In addition, bittern sightings or late vocalizations at all sites indicated that bitterns were present well into the breeding season.

Mean nest height for least bitterns was 0.96 m (range 0.80-1.35 m) above the water surface, reflecting the tall emergent vegetation. Mean nest diameter was 0.19 m (range 0.15-0.22 m). Mean water depth at nest sites was 0.42 m (range 0.23-0.74 m) (Table 4).

Distances of least bittern nests from open water ranged from 1.5-9.0 m with a mean of 4.2 m. Vegetation interspersion at nest sites ranged from continuous stands of emergent vegetation to large clumps of vegetation interspersed with small open water areas. All nests were well hidden, regardless of distance from open water areas.

Two common moorhen nests were found in reedgrass at Peabody River King 1 Cell IIA. The first moorhen nest contained 9 eggs, all of which hatched. The second moorhen nest, found after hatch date of the first, may or may not have been used in 1993. Both common moorhen nests were floating platform nests between 0.20-0.25 m in diameter, and were found in clumps of reedgrass in areas with high vegetation-water interspersion. Average water depth at moorhen nest sites was 0.63 m.

Moorhens remained in the area after hatching and were still present on 19 July. Birds remained active along the edges of the reeds but only vocalized sparingly and did not respond to playback recordings.

Fall Migration

Surveys conducted in fall 1993 to detect migrating birds at Arch Denmark Cells I, II, and III failed to elicit responses. Walking through emergent vegetation did not flush any birds. However, observations of 4 pied-billed grebes, 3 green herons (Butorides striatus), 7 northern harriers, 3 least bitterns, 2 belted kingfishers (Ceryle alcyon), and 5 great blue herons (Ardea herodias) were recorded (Appendix I).

Quantity and Distribution of Mine Land Wetlands

A total of 8,109 ha of emergent wetlands with seasonal to more permanent water regimes was identified south of Interstate 64. Mine associated wetlands contributed substantially to potential interior wetland bird habitat in southern Illinois south of Interstate 64, comprising 790 ha (9.7%) and spanning 9 southern counties.

All 22 counties included in the analysis contained wetlands that met criteria for inclusion as interior wetland bird habitat. Monroe County, with no mine associated wetlands, had the highest amount of interior wetland bird habitat with 1,201 ha. St. Clair, Alexander, and Randolph counties also ranked high among counties analyzed for potential habitat. Hamilton and Hardin counties had the least amount of wetland habitat of all counties analyzed (Table 5). Mine associated wetlands were primarily distributed in counties that contained the lowest amount of potential habitat overall.

Table 3. Nesting data for Least Bitterns (*Ixobrychus exilis*) on mine land wetlands in southern Illinois between June-July 1993.

Location	Nest no.	Date found	No. eggs	No. eggs hatched	Approx. hatch date
ADC 3[a]	1	16 June	3	3	7 July
ADC 3	2	16 June	0	0	-
ADC 3	3	16 June	4	3	2 July
ADC 3	4	16 June	2	1	28 June
ADC 3	5	28 June	4	4	7 July
ADC 3	6	28 June	5	4	26 July
ADC 3	7	29 July	2	2	2 Aug
WS IC1[b]	8	30 June	2	0	-

[a]ADC 3= Arch of Illinois Denmark Mine, Cell 3

[b]WS IC1= Peabody Coal Co. Will Scarlet Mine, Pit IC1

Table 4. Site characteristics of Least Bittern (*Ixobrychus exilis*) nests found at Mine land wetlands in Southern Illinois between June-August 1993.

Vegetation type	Distance above water (m)	Diameter (m)	Distance to nearest edge (m)	Water depth (m)
Typha latifolia (Broad-leaved cattail)	1.35	0.21	9.0	0.35
T. latifolia	1.09	0.15	5.6	0.30
T. angustifolia (Narrow-leaved cattail)	0.90	0.21	3.9	0.48
T. angustifolia	0.87	0.20	5.3	0.45
T. angustifolia	0.80	0.22	3.4	0.23
T. angustifolia	0.75	0.15	1.5	0.35
T. angustifolia	0.75	0.20	4.8	0.48
Phragmites australis (Reedgrass)	1.17	0.20	a	0.74

[a] nest located in isolated clump of reedgrass

Palustrine emergent seasonally flooded (PEMC) was the most common wetland type overall, comprising 71% (5,747 ha) of total interior wetland bird habitat. However, on mine associated lands, seasonally flooded wetlands totaled only 72 ha (9%) while the most common mine associated wetland type was palustrine unconsolidated bottom (PUB) totalling 584 ha (Table 6). This indicated that mine lands generally contributed stable, deep water wetlands with very few hydrologically dynamic marshes.

Analysis of potential interior wetland bird habitat within 16-km radii of study area centers identified a total of 1,832 ha associated with study sites (Table 7). Fifty-six percent of wetlands meeting criteria for suitable habitat within 16-km radius buffer zones of study sites were on mine associated lands. Buffer zone 1 surrounding Arch Denmark mine included portions of Randolph, Perry, and Jackson counties. There were 230 wetlands within the Arch Denmark radius averaging 1.9 ha and totalling 426 ha, 81% (347 ha) of which was associated with mining. Buffer zone 2 surrounding Burning Star Number 5 mine included portions of Perry, Franklin, Jackson, and Williamson counties. This zone contained 318 wetlands averaging 1.7 ha and totalling 555 ha. Mine associated wetlands comprised 242 ha or 44% of the total.

Buffer zone 3 surrounding River King 1 included portions of St. Clair, Clinton, and Washington counties. Potential habitat within 16 km of River King 1 included 198 wetlands which averaged 1.5 ha and totalled 306 ha. Mine associated wetlands comprised 164

Table 5. Wetland area (ha) potentially suitable as interior wetland bird habitat in Illinois counties south of Interstate 64, based on National Wetland Inventory codes.[a]

County	PEMC	PEMF	PEMG	PUB	Total
Alexander	717	39	0	0	756
Clinton	270	133	0	0	403
Franklin	352	73	0	0	425
Gallatin	167	43	0	76	286
Hamilton	11	7	0	0	18
Hardin	23	2	0	0	25
Jackson	224	60	16	46	346
Jefferson	168	63	7	22	260
Johnson	144	26	0	1	171
Madison	422	111	3	0	536
Massac	173	16	0	0	189
Monroe	1,006	195	0	0	1,201
Perry	162	90	1	131	384
Pope	97	76	0	0	173
Pulaski	172	5	0	0	177
Randolph	545	104	0	70	719
St. Clair	597	294	2	100	993

Table 5. Continued.

County	PEMC	PEMF	PEMG	PUB	Total
Saline	90	194	1	72	357
Union	184	109	0	0	293
Washington	57	38	0	0	95
White	161	69	0	0	230
Williamson	5	4	1	62	72
Total	5,747	1,751	31	611	8,109

[a]PEMC = palustrine emergent seasonally flooded, PEMF = palustrine emergent semi-permanently flooded, PEMG = palustrine emergent intermittently flooded, PUB = palustrine unconsolidated bottom.

ha or 54% of the total. Buffer zone 4 surrounding Will Scarlet mine included portions of Williamson, Saline, Johnson, and Pope counties. This zone contained 244 wetlands which average 2.2 ha and totalled 545 ha. Mine associated wetlands comprised 293 ha or 54% of the total.

Table 6. Wetland area (ha) on surface-mine associated land potentially suitable as interior wetland bird habitat for Illinois counties south of Interstate 64, based on National Wetland Inventory codes.[a]

County	PEMC	PEMF	PEMG	PUB	Total
Gallatin	0	0	0	76	76
Jackson	3	0	0	46	49
Jefferson	2	1	0	22	25
Johnson	0	0	0	1	1
Perry	10	48	0	138	196
Randolph	2	30	0	70	102
St. Clair	48	53	0	97	198
Saline	2	0	0	72	74
Williamson	5	2	0	62	69
Total	72	134	0	584	790

[a]PEMC = palustrine emergent seasonally flooded, PEMF = palustrine emergent semi-permanently flooded, PEMG = palustrine emergent intermittently flooded, PUB = palustrine unconsolidated bottom.

Table 7. Total area (ha) of potentially suitable interior wetland bird habitat on mine and non-mine associated lands within 16 km radii of 4 coal mines in southern Illinois.

NWI Code[a]	Burning Star		River King 1		Will Scarlet		Arch Denmark	
	Mine	Non-Mine	Mine	Non-Mine	Mine	Non-Mine	Mine	Non-Mine
PEMC	1	242	11	94	8	44	10	68
PEMF	3	65	3	48	2	208	28	11
PEMG	0	18	0	0	1	0	0	0
PUB	226	0	150	0	282	0	309	0
Total	230	325	164	142	293	252	347	79

[a]PEMC = palustrine emergent seasonally flooded, PEMF = palustrine emergent semi-permanently flooded, PEMG = palustrine emergent intermittently flooded, PUB = palustrine unconsolidated bottom.

DISCUSSION

Avian Use of Mine Land Wetlands

Least bittern

This study documented habitat use and successful reproduction by state threatened and endangered wetland birds on mine lands in southern Illinois. The state endangered least bittern was present on all mine associated wetlands surveyed, suggesting that these emergent wetlands provided habitat that was consistently selected by bitterns. Least bitterns may be expanding their range in southern Illinois due to an increase of emergent wetland habitat on mine lands (Fink, Illinois Dept. of Conserv., pers. commun.).

Habitat use by least bitterns was similar at all sites surveyed. Vegetation composition of study sites consisted of large expanses of reedgrass with high interior-to-edge ratios. Bittern vocal responses were noted more frequently from interiors of emergent vegetation stands than from edges, or open, sparsely distributed habitats.

Habitat conditions at mine associated wetlands used by least bitterns in southern Illinois were similar to those reported in the literature. Water depths at nest sites and at areas of bittern activity ranged from 0.23-0.74 m deep with a mean of 0.42 m. Murchison (1893) and Nolan (1952) reported that least bitterns experienced extreme annual variations in population size in response to water level fluctuations and densities were highest in very wet years, indicating that deep water wetlands may be a core habitat area for least bitterns. Gibbs and Melvin (1992a) found bitterns in Maine using dense, tall growth of emergent vegetation with water depths averaging 0.23 m (range 0.10-0.50 m). Water depths reported by Weller (1961) ranged from 0.08-0.96 m. Reid (1989) found that mean water depth at bittern flush sites in Missouri was 0.23 m (range 0.07-0.42 m), which was shallower that water depths on southern Illinois mine land wetlands.

Bitterns were reported to nest in the most dense stands of reeds (Aniskowicz 1981, Barnes 1890). Reid (1989) found that least bitterns occupied habitats with vegetation stem densities ≤1,200 stems/m^2, although mean stem density was 287 stems/m^2. Reid (1989) found that 33% of least bittern flush sites were in burreed (*Sparganium eurycarpum*) and 23% were in water smartweed (*Polygonum coccineum*). According to Weller (1961), least bitterns commonly nest in cattail, sedges, and bulrush, although nests have also been found in reedgrass and arrowhead (*Sagittaria* spp.).

Gibbs et al. (1991) found that several species of wetland birds in Maine were frequently associated with beaver- or human-created wetlands that contained extensive emergent vegetation. Positive response by wetland birds to emergent vegetation may be partly due to the high rates of secondary production associated with this vegetation (Gibbs et al. 1991).

Common moorhen

Habitat conditions on southern Illinois mine associated wetlands used by moorhens had higher percent cover (44-94%) of emergent vegetation at some sites (Table 1), but were structurally similar to those reported in the literature. Moorhen habitats in southwestern Lake Erie contained abundant submergent vegetation and equal water-to-vegetation ratios (Brackney and Bookhout 1982). Weller and Spatcher (1965) found that moorhens using wetlands in Iowa preferred a well developed zone of emergent vegetation, but only attempted to nest if water was present.

Pied-billed grebes

Habitats used by pied-billed grebes in southern Illinois also were structurally similar to those in Maine reported by Gibbs and Melvin (1992b) who found that grebes prefer wetlands >5 ha with abundant aquatic bed vegetation and open water interspersed with emergent vegetation.

Sora

Sora habitat use on mine associated wetlands in southern Illinois was similar to that reported by Reid (1989) in Kansas where soras used wetlands that were deeper (range 0.27-0.43 m) and had taller vegetation than habitats used by other rail species. Sora response patterns indicated that mine land wetlands in southern Illinois may provide important feeding habitat for soras during spring migration. Migratory stop-over habitats are essential for temperate rallids to maintain energy for migration and to build body reserves for breeding and territorial defense once they reach breeding grounds (Reid 1989). Drent and Daan (1980) reported that body condition following departure from spring staging areas may by the critical factor limiting avian reproductive output.

Nest Locations and Hatch Success

Least bittern

Seven of 8 least bittern nests were found in cattail, although reedgrass was the dominant vegetation type at all sites and the only emergent species at most sites. Based on the similarity of response patterns of bitterns at all sites, I believe that breeding, or attempted breeding, occurred at all sites. The fact that only 1 nest was found on sites that contained only reedgrass can be partially attributed to the large contiguous search areas and the difficulty of searching. Nest searches were difficult to conduct in reedgrass due to extremely high density and stem rigidity that impaired movement and vision within the stand. Reedgrass stands also contained an abundance of standing senescent vegetation from the previous year's growth. Nests, which are usually constructed of dead vegetation, blend much better in reedgrass stands than in green, vigorously growing cattail stands that do not contain standing senescent vegetation. Cattail stands were also less expansive, making them easier to search in their entirety than reedgrass stands. Thus, difficulties in conducting nest searches in reedgrass likely prevented finding many nest that may have been present. However, the proportion of call responses overall compared to the number of nests found in cattail suggests that this vegetation type, although much less abundant, was highly preferred for nesting.

Least bittern clutch sizes compiled by Weller (1961) from several locations across the United States ranged from 2-6 eggs (mean=4.5). Similarly, Graber et al. (1978) found clutch sizes ranging from 2-7 eggs (mean=4.3) for data combined from northern and southern Illinois. The mean clutch size from mine sites in southern Illinois was lower than those reported in the literature, although there is no data exclusively from southern Illinois to use as a basis for comparison.

Least bitterns lay 1 egg per day with incubation starting with the first or second egg laid and lasting approximately 20 days (Weller 1961). Thus, nests that hatched at Arch Denmark in late July or early August were possible renests or second clutches (Nest 6 and 7, Table 3). Weller (1961) reported an increase in sizes of second clutches and renests in Iowa, suggesting that food availability was higher in mid- than early summer. Gibbs and Melvin (1992a) reported that least bitterns may delay breeding to coincide with peak insect emergence. At nest locations in southern Illinois, early July coincided with a heavy emergence of grasshoppers, a potential bittern food source. Nest 6 contained 5 eggs, exhibiting the larger clutch size trend described by Weller (1961); however, Nest 7 contained only 2 eggs.

Hatch success for least bittern nests containing ≥ 1 egg was 77.3%. Hatch rates reported in the literature varied from 88% success for northeastern Illinois (Graber et al. 1978) to 70% hatch success in Iowa (Kent 1951). Common causes of nest losses in bitterns were abandonment, predation, cannibalism, disease, and high water (Hansen 1984, Kent 1951). Because bittern nests in mine land wetlands were located at least 0.80 m above water, flooding was not a factor affecting nest success. In addition, there was no evidence of predation or cannibalism of eggs since all unhatched eggs remained undisturbed in the nests even after fledging of young.

Common moorhen

Two common moorhen nests were found in reedgrass at River King 1 Cell IIA. One nest contained 9 eggs and all hatched. It was unknown if the second nest was used in the 1993 breeding season since it was found after the hatch date (25 June). The second nest was possibly unused since extra nests and brooding and roosting platforms are often located near moorhen nest sites (Ehrlich et al. 1988). Moorhen young were very mobile, and were observed swimming behind parents within 3 days after hatch.

Habitat Suitability of Mine Associated Wetlands

Mine associated wetlands contained dense, continuous stands of emergent vegetation that were similar to habitat historically occupied by interior wetland birds. Early reports emphasized that interior wetland birds used dense clumps of emergent vegetation and deep water (Larsen 1893, Lux 1892, Murchison 1893, Nolan 1952, Woodruff 1907). Egg collecting expeditions from the late 1800's indicate that least bitterns were historically common in Illinois.

Murchison (1893) reported that bitterns were as common as red-winged blackbirds (Agelaius phoeniceus) in very wet years in Henry

County. Larsen (1893) reported finding 50 least bittern nests in "rushes" in a flooded wet-prairie located in Calumet, Illinois. American bitterns, pied-billed grebes, king rails, and common moorhens also were found nesting abundantly in this same wetland.

Mine land wetlands provide habitat conditions similar to wetlands that interior wetland birds are morphologically and behaviorally adapted to occupy. Behavioral adaptations to densely vegetated areas that prevent frequent sightings of these species include secretive natures, unwillingness to flush, and maintenance of territories by use of distinct vocalization (Faaborg 1976). Feet adapted for grasping vegetation allows least bitterns, rails, and soras to feed in dense emergent vegetation (Weller and Spatcher 1965). Morphological adaptations enabling these species to move through dense vegetation include short legs, laterally compressed trunk, short outer toes, and long curved toenails for grasping emergent vegetation (Hancock and Kushlan 1984).

Survey Protocol

Presence and absence of interior wetland birds in emergent wetlands can be determined using tape recorded surveys. Gibbs and Melvin (1993) found that a minimum of 3 visits per wetland were needed to determine wetland bird use or nonuse with 90% certainty. Wetlands should be visited during times of peak responsiveness. Surveys should not be conducted on days with rain or winds ≥24 kph that could obscure avian vocalizations (Swift et al. 1988).

Although bitterns were vocal immediately after sunrise, Gibbs and Melvin (1993) found that peak vocal responsiveness for bitterns in Maine occurred between 0800-1000. Swift et al. (1980) reported that over half of all least bitterns seen or heard moved toward the observer during call broadcasts. Nesting bitterns in southern Illinois in 1993 discontinued vocalizing and were observed cautiously approaching the tape recorder. Thus, surveys conducted closer to the onset of nesting were most likely to underestimate bittern occurrence.

Moorhens were easier to detect than some wetland birds due to their tendency towards spontaneous vocalization and occupancy of open habitats and vegetative perimeters. The best time to census moorhens was between 19-28 May, although responses were heard as early as late-April (Fig. 1).

Grebes also have very distinct vocalization and responded well to call broadcasts. Grebes rarely breed in southern Illinois (Bohlen 1989), but those that do are early breeders; therefore surveys should begin the first week of April before grebes migrate or discontinue vocalizing.

Soras have a very distinct vocalization and were highly responsive. Surveys in southern Illinois should be conducted during spring migration in April or early May. Soras were responsive from immediately after sunrise throughout early afternoon. Gibbs and Melvin (1993) found that the probability of response by soras increased with time of day until 1000 hours.

Quantity and Distribution of Mine Land Wetlands

Mine associated wetlands potentially suitable for interior wetland birds were distributed primarily in counties that previously had low amounts of emergent stable water habitats. Thus, mine associated wetlands may provide opportunities for wetland birds to expand their ranges into counties that they previously had not occupied.

Analysis of potential interior wetland bird habitat within 16 km radii of study area centers identified a substantial amount of suitable habitat on both mine and non-mine associated lands (1,832 ha total). Non-mine associated habitats were predominantly seasonally flooded wetlands with diverse, non-persistent herbaceous vegetation. Mine associated habitats were predominantly classified as palustrine unconsolidated bottom wetlands that were hydrologically stable, but with low vegetation diversity and low energy depending on substrate characteristics (Cowardin et al. 1979). PUB wetlands meet the habitat needs of interior wetland birds because water is maintained throughout the nesting season, and vegetation structure provides adequate cover and a stable nesting substrate. The proximity of hydrologically stable and hydrologically dynamic wetlands to sites known to support interior wetland birds has the potential to provide suitable habitat in both wet and dry years. Wetlands surrounding study areas could potentially provide increased foraging and nesting opportunities, ample area for dispersal of young, and reduced concentration of predators.

CONCLUSION AND RECOMMENDATIONS

Surface mining in Illinois has increased area of emergent wetlands, one of the state's most severely depleted wetland types (Suloway et al. 1992). Mine land wetlands provide important supplemental habitat for wetland-dependent species. Mine land wetlands located in counties that previously contained few emergent wetlands may provide opportunities for wetland birds to expand their ranges.

This study has shown that mine associated wetlands were used by state threatened and endangered species. Documentation of successful breeding by least bitterns and common moorhens suggests that mine associated wetlands may provide an opportunity for range expansion and possible population increases for these species. A management strategy to maximize the quality and amount of habitat for breeding and migrant interior wetland birds should consider vegetation structure, hydrology, production of food sources, minimum wetland size, and disturbance.

Vegetation

Maintenance of large expanses of robust emergent vegetation is necessary as nesting habitat. Persistent emergent vegetation provides good cover early in the year while tall vegetation enables bitterns to construct elevated nests that reduces vulnerability to flooding and terrestrial predators. Vegetation should extend >100 m from shoreline to minimize predation (Gibbs and Melvin 1992a). Vegetation interspersed with open water feeding areas is especially important for species that feed while swimming, such as pied-billed grebes and common moorhens. Extremely dense vegetation can restrict mobility of these species.

Hydrology

Water must be present from early spring through fall migration to support aquatic food sources. Interior wetland birds are able to utilize deep, stable water levels ranging from 0.2->1.0 m as long as rooted emergent vegetation is not precluded. Partial drawdown of water levels is advisable to concentrate aquatic prey, however, Gibbs and Melvin (1992a, b) recommended avoidance of complete drawdown to prevent die-off of small fish and invertebrate prey species. Also partial drawdown of topographically diverse wetlands potentially provides a variety of water depths and vegetation types attractive to many species of waterbirds.

Food Production

Wetlands containing submerged, decaying, and regenerating vegetation mixed with emergent vegetation concentrate invertebrates, amphibians, and fish which are critical food sources. Fredrickson and Reid (1990) stated that robust emergent vegetation traps heat, resulting in higher water temperature and increased invertebrate production. Therefore, mine associated wetlands that contain large amounts of emergent vegetation have potential to support an adequate prey base.

Macrophyte productivity was not measured in this study, however, Shelton (1992) found that macrophyte productivity of southern Illinois surface-mine wetlands was higher in most instances than natural wetlands and other constructed impoundments. Establishment of aquatic bed vegetation to provide additional substrate for invertebrates could increase invertebrate productivity on surface-mine associated wetlands. In addition, drawdowns or hydrologic designs that promote high energy seed producing moist-soil vegetation would provide increased foraging opportunities for migrating soras and other rallids.

Minimum Wetland Size

Minimum wetland area varies regionally in its effect on habitat suitability for each species. Wetlands ≥0.4 ha supported least bitterns in Maine (Gibbs and Melvin 1992a), while grebes in Iowa were found on wetlands with a minimum size of 5.0 ha (Brown and Dinsmore 1986). However, American bitterns in Iowa were found most often on wetlands >11 ha (Brown and Dinsmore 1986). Minimum wetland size most likely was not a factor in this study since wetlands selected as study areas on southern Illinois mine lands in 1993 were ≥10 ha.

Maintaining large (>10 ha) wetlands with interspersed dense emergent vegetation, submergent vegetation, and open water areas would benefit the largest number of wetland bird species. Surface-mine associated lands often contain complexes of several individual wetlands which could provide a variety or habitats and increased isolation of breeding birds. Reduction of human disturbance, especially wave action caused by motor boats, is important to prevent damage to floating nests of moorhens and grebes.

Research Needs

Interior wetland birds have lost much natural habitat due to wetland drainage. It is important to identify, restore, and preserve remaining habitats so that wetland birds are not forced to survive in remnants of inferior habitat. Continued research into habitat use by interior wetland birds is necessary to increase understanding of these species. While this study documented avian presence and use of reedgrass, including successful breeding by common moorhens and attempted breeding by least bitterns, future research that quantitatively assesses wetland bird use of reedgrass would be beneficial.

State-wide population surveys which provide minimum numbers or presence/absence data for least bitterns and other interior wetland birds are essential to evaluate the status of current populations. An index to least bittern productivity on mine and non-mine sites is important to determine whether mine associated habitats function as population sources or sinks. Successful hatching of bitterns and moorhens indicated that mine associated wetlands do contribute to population increases, however, a study comparing number of eggs laid, growth rates, and fledging success between mine and non-mine associated wetlands could provide insight into productivity. Determination of nest success through fledging of young would require monitoring birds through the highly mobile flightless period when they are vulnerable to predation, drowning, and nutrient deficiencies. Productivity studies combined with population data could provide insight into state-wide population status of these species as well as future management strategies.

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APPENDICES

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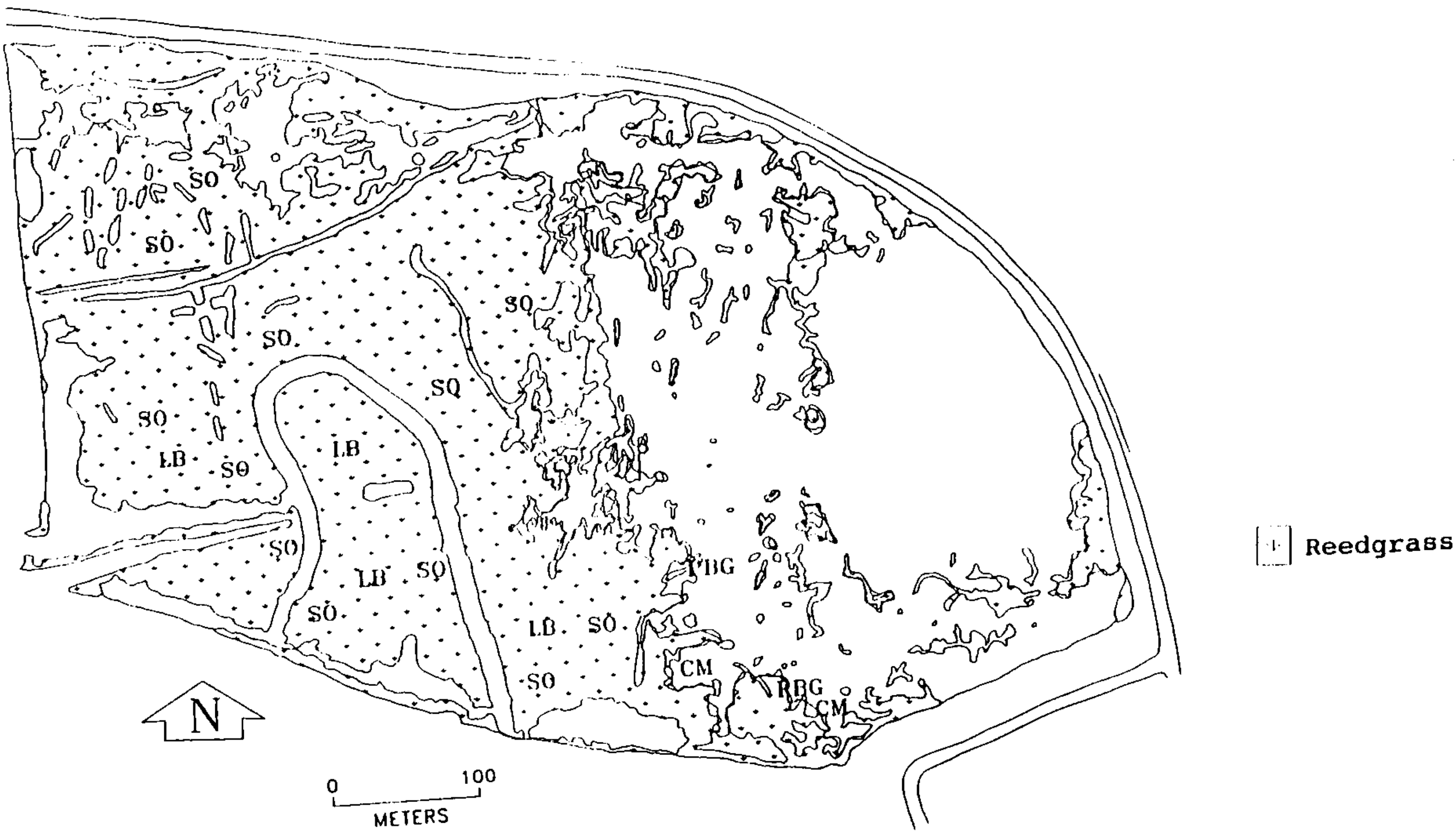
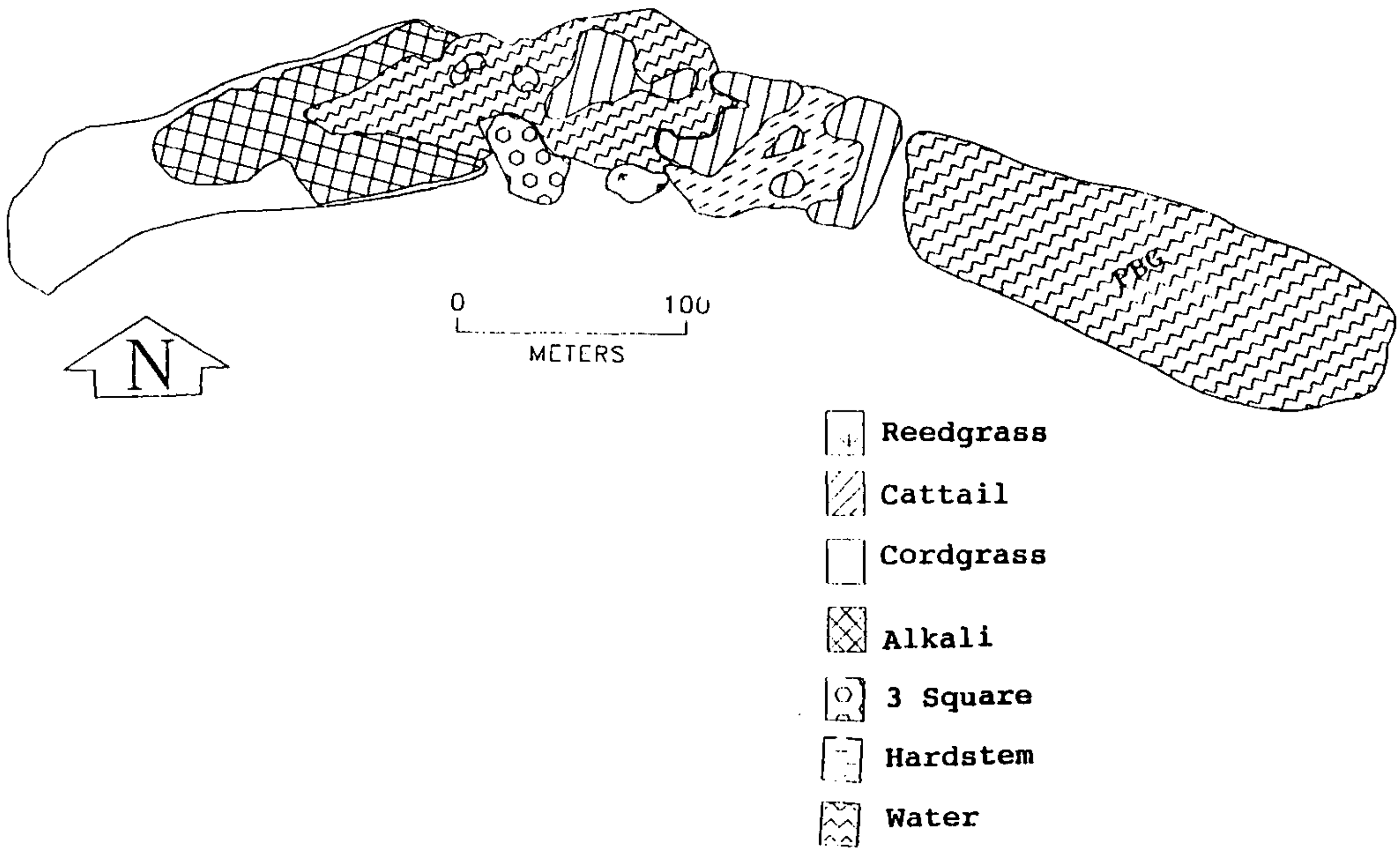
Appendix A. Distribution of emergent vegetation and open water in 1993 at Will Scarlet Pit 10, Peabody Coal Company, Williamson County, Illinois, and approximate locations of responding least bitterns (LB), common moorhens (CM), pied-billed grebes (PBG), and soras (SO). Adapted from Shelton (1992).


SO
LB
PBG
CM
N
0
100
METERS
Reedgrass

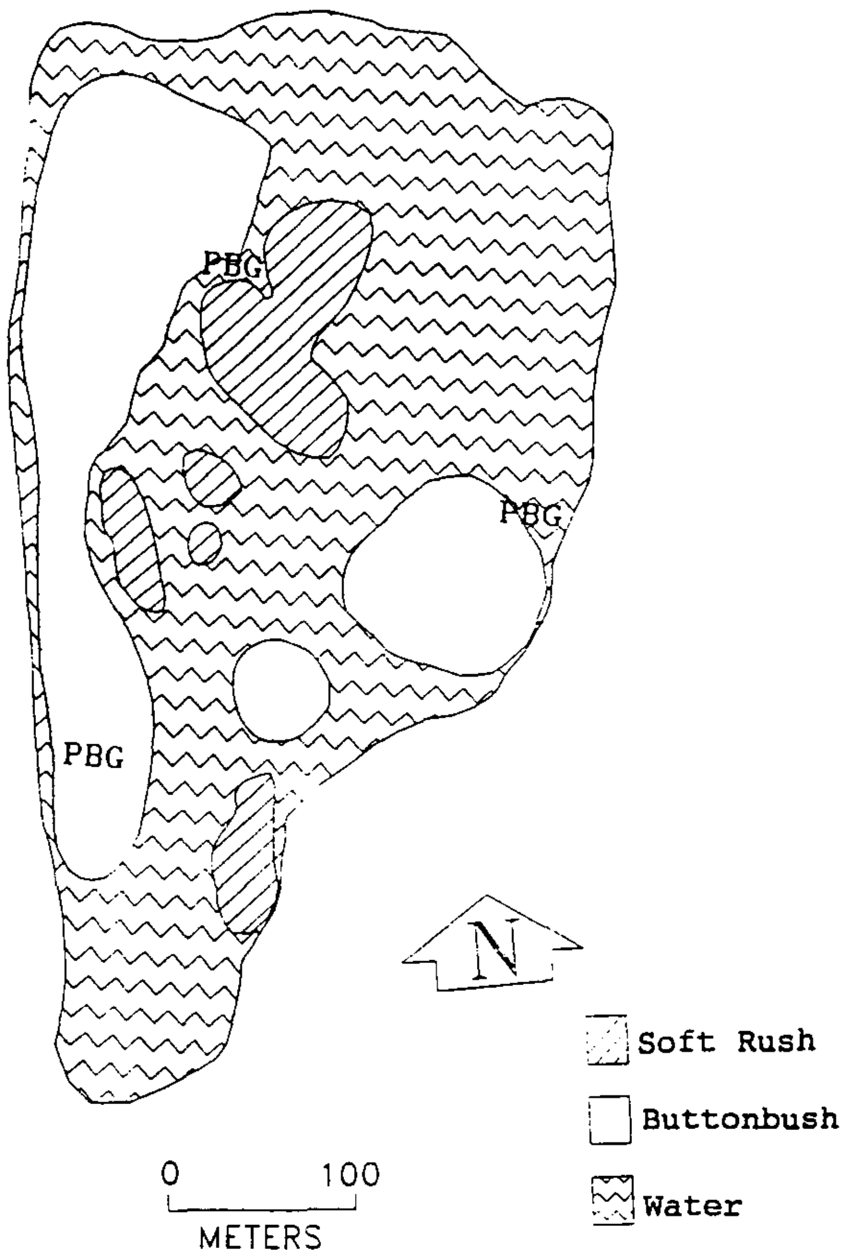
Appendix B. Distribution of emergent vegetation and open water in 1993 at Will Scarlet IC1, Peabody Coal Company, Illinois, and approximate locations of responding least bitterns (LB) and soras (SO). Adapted from Shelton (1992).


LB
LB SO
LB
LB SO
Reedgrass
N
0
100
METERS

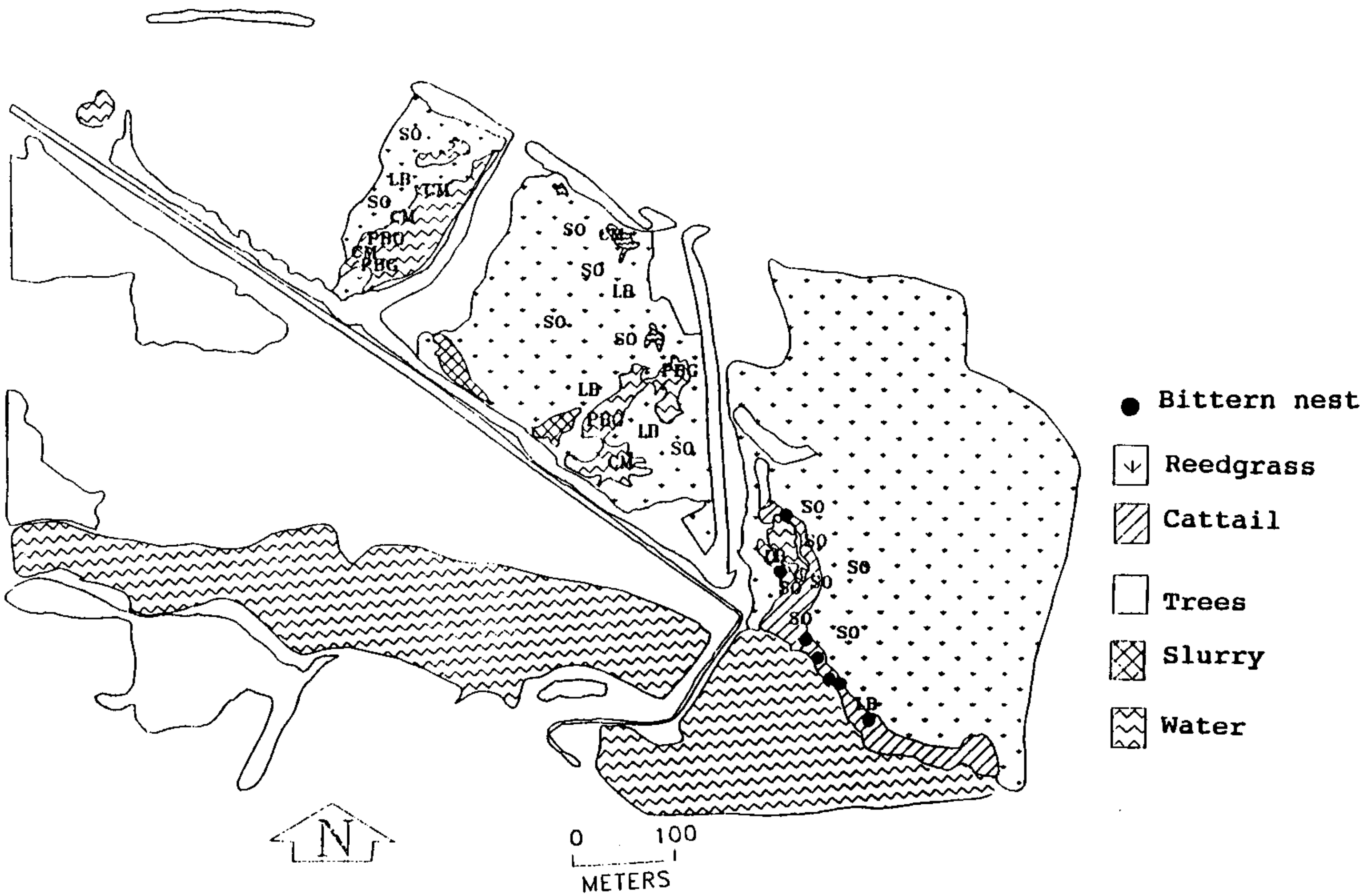
Appendix C. Distribution of emergent vegetation and open water in 1993 at Will Scarlet Pit 9, Peabody Coal Company, Williamson County, Illinois, and approximate locations of observed pied-billed grebes (PBG).


PBG
0
100
METERS
N
Reedgrass
Cattail
Cordgrass
Alkali
3 Square
Hardstem
Water

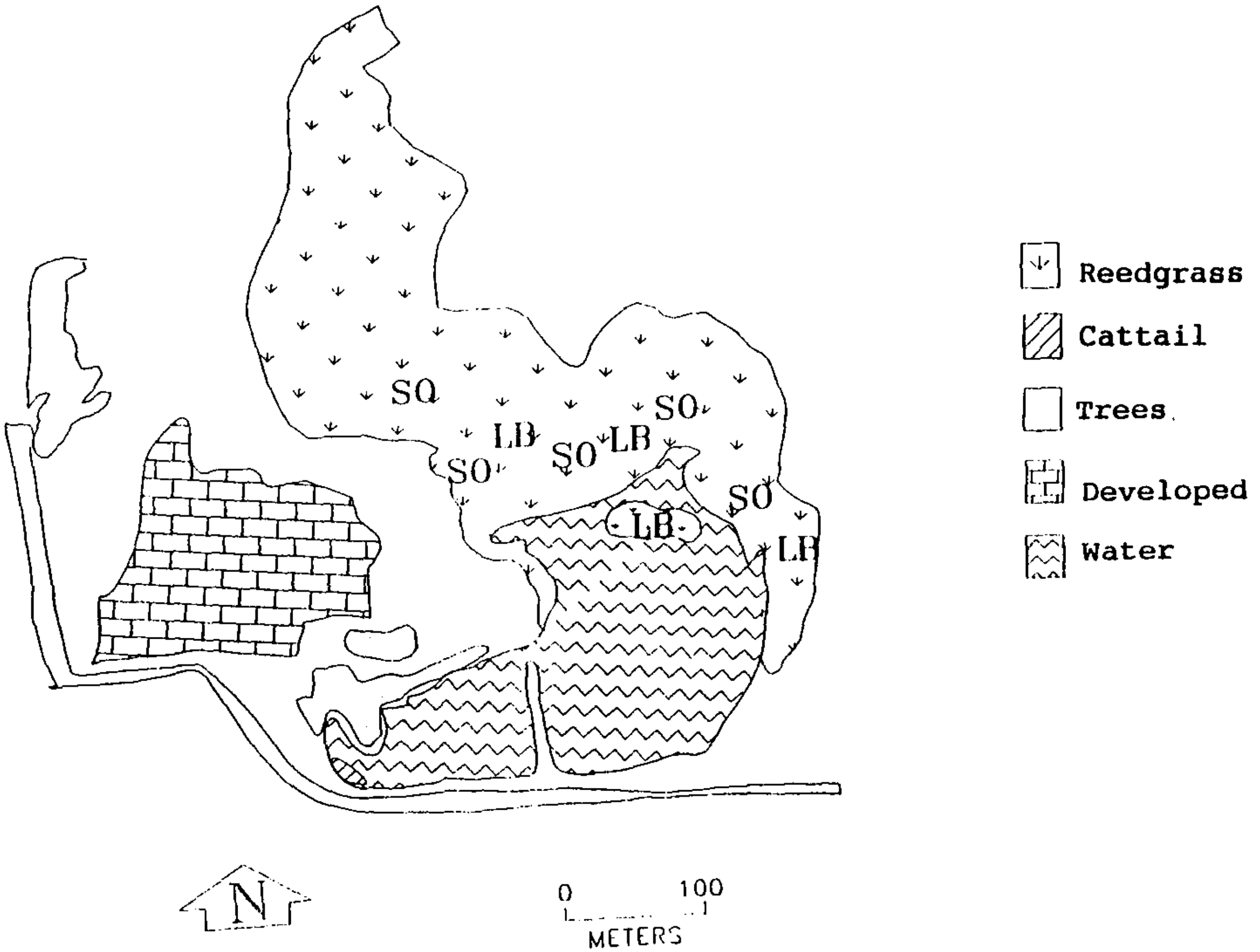
Appendix D. Distribution of emergent vegetation and open water in 1993 at Will Scarlet Pit 5, Peabody Coal Company, Illinois, and approximate locations of responding pied-billed grebes (PBG).


PBG
PBG
PBG
N
Soft Rush
Buttonbush
Water
0
100
METERS

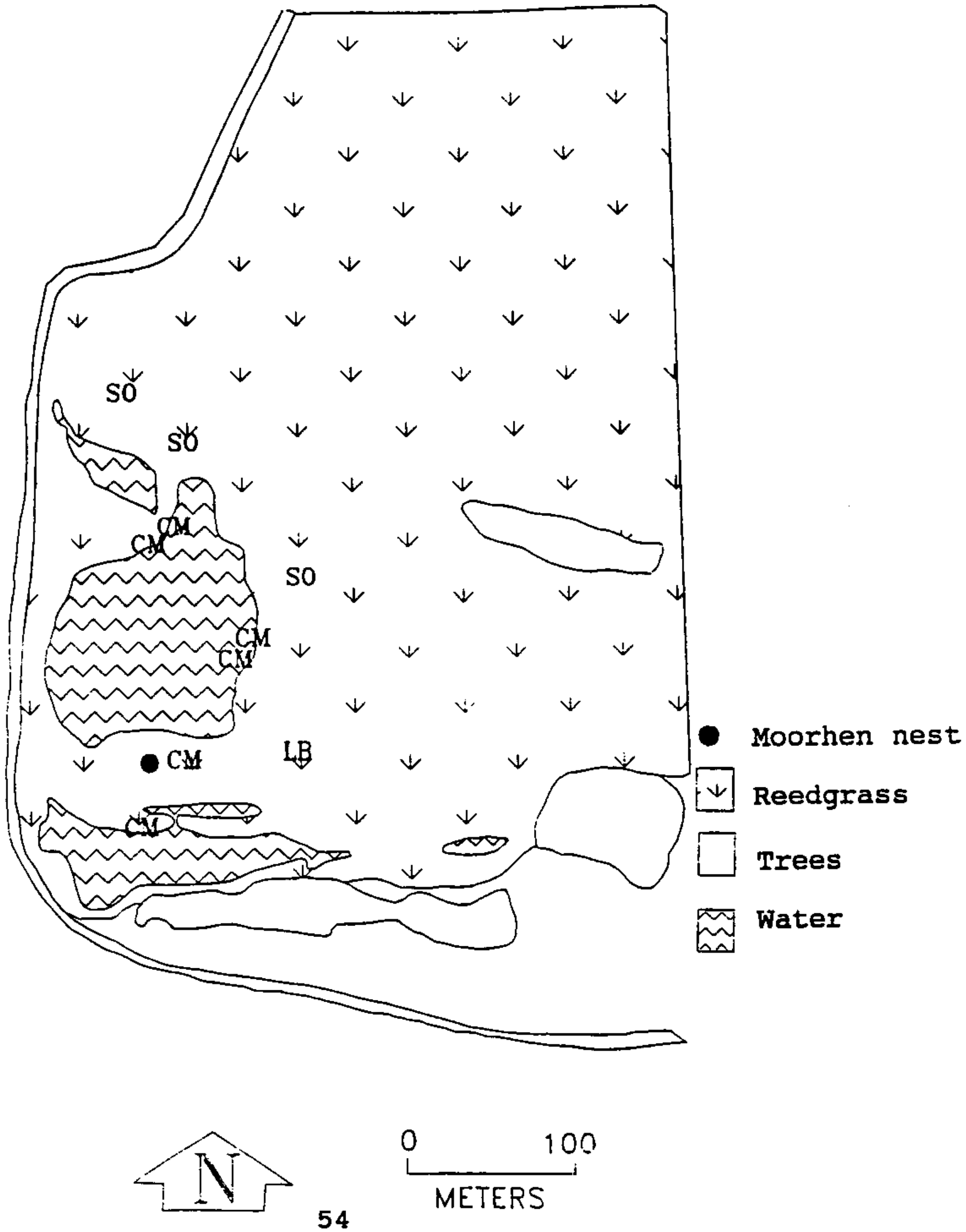
Appendix E. Distribution of emergent vegetation and open water in 1993 at Denmark Cells I, II, and III, Arch of Illinois Coal Company, Perry County, Illinois, and approximate locations of responding least bitterns (LB), common moorhens (CM), pied-billed grebes (PBG), and soras (SO).


SO
LB
CM
PBG
Bittern nest
Reedgrass
Cattail
Trees
Slurry
Water
N
0
100
METERS

Appendix F. Distribution of emergent vegetation and open water in 1993 at Burning Star 5, Consolidation Coal Company, Jackson County, Illinois, and approximate locations of responding least bitterns (LB) and soras (SO).


SO
LB
SO
LB
SO
SO
LB
SO
LB
Reedgrass
Cattail
Trees
Developed
Water
N
0
100
METERS

Appendix G. Distribution of emergent vegetation and open water in 1993 at River King 1 Cell IIA, Peabody Coal Company, St. Clair County, Illinois, including approximate locations of responding least bitterns (LB), common moorhens (CM), and soras (SO).



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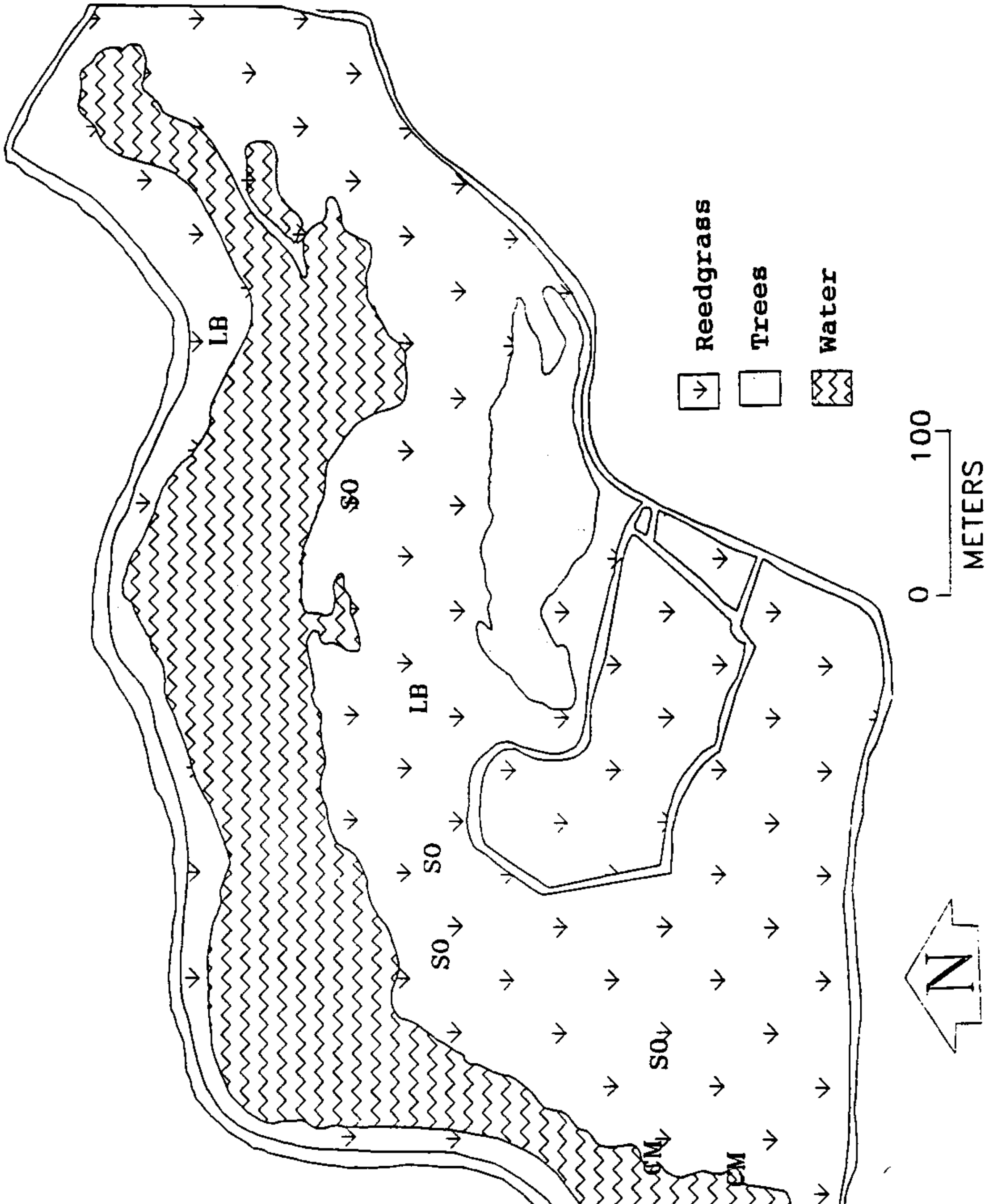
Appendix H. Distribution of emergent vegetation and open water in 1993 at River King 1 Cell IIB, Peabody Coal Company, St. Clair County, Illinois, including approximate locations of responding least bitterns (LB), common moorhens (CM), and soras (SO).


Reedgrass
Trees
Water
0
100
METERS
N
LB
SO
LB
SO
SO
SO
CM
CM

Appendix I. Habitat association of avifauna observed on mine lands at all study sites in 1993. Sightings of all species other than interior wetland birds were incidental.

Common name	Scientific name
Reed Associated:	
Least bittern (E)	*Ixobrychus exilis*
Common moorhen (T)	*Gallinula chloropus*
Sora	*Porzana carolina*
Pied-billed grebe (E)	*Podilymbus podiceps*
King rail	*Rallus elegans*
Common yellowthroat	*Geothlypis trichas*
Red-winged blackbird	*Agelaius phoeniceus*
Marsh wren	*Cistothorus palustris*
Northern cardinal	*Cardinalis cardinalis*
Prothonatary warbler	*Protonotaria citrea*
American goldfinch	*Carduelis psaltria*
Blue-winged warbler	*Vermivora pinus*
Song sparrow	*Melospiza melodia*
Yellow-breasted chat	*Icteria virens*
Indigo bunting	*Passerina cyanea*
Open water:	
Belted kingfisher	*Ceryle alcyo*

Appendix I. Continued.

Common name	Scientific name
Green heron	<u>Butorides</u> <u>striatus</u>
Great blue heron	<u>Ardea</u> <u>herodias</u>
Black-crowned night-heron	<u>Nycticorax</u> <u>nycticorax</u>
Little blue heron (E)	<u>Egretta</u> <u>caerulea</u>
Eastern kingbird	<u>Tyrannus</u> <u>tyrannus</u>
Tree swallow	<u>Tachycineta</u> <u>bicolor</u>
Bank swallow	<u>Riparia</u> <u>riparia</u>
Barn swallow	<u>Hirundo</u> <u>rustica</u>
Cliff swallow	<u>Hirundo</u> <u>pyrrhonota</u>
Northern roughwing swallow	<u>Stelgidopteryx</u> <u>serripennis</u>
Osprey (E)	<u>Pandion</u> <u>haliaetus</u>
Double-crested cormorant (E)	<u>Phalacrocorax</u> <u>auritus</u>
Canada goose	<u>Branta</u> <u>canadensis</u>
Blue-wing teal	<u>Anas</u> <u>discors</u>
Mallard	<u>Anas</u> <u>platyrhynchos</u>
Woodduck	<u>Aix</u> <u>sponsa</u>
American coot	<u>Fulica</u> <u>americana</u>
Gadwall	<u>Anas</u> <u>strepera</u>
Ring-necked duck	<u>Aythya</u> <u>collaris</u>
Ring-billed gull	<u>Larus</u> <u>delawarensis</u>

Appendix I. Continued.

Common name	Scientific name
Upland woody or herbaceous vegetation:	
Eastern phoebe	*Sayornis phoebe*
Eastern wood peewee	*Contopus virens*
Swainson's thrush	*Catharus ustulatus*
Indigo bunting	*Passerina cyanea*
Black-bellied cuckoo	*Coccyzus erythropthalmus*
Brown thrasher	*Toxostoma rufum*
Blue-gray gnatcatcher	*Polioptila caerulea*
White-eyed vireo	*Vireo griseus*
Robin	*Turdus migratorius*
Eastern meadowlark	*Sturnella magna*
Field sparrow	*Spizella pusilla*
Song sparrow	*Melospiza melodia*
American tree sparrow	*Spizella arborea*
Common grackle	*Quiscalus quiscalus*
American crow	*Corvus brachyrhynchos*
Red-tailed hawk	*Buteo jamaicensis*
Turkey vulture	*Cathartes aura*
Northern harrier (E)	*Circus cyaneus*
Common yellowthroat	*Geothlypis trichas*
Brown-headed cowbird	*Molothrus ater*

Appendix I. Continued.

Common name	Scientific name
Carolina wren	_Thryothorus ludovicianus_
Northern parula	_Parula americana_
Blue jay	_Cyanocitta cristata_
Rufous-sided towhee	_Pipilo erythrophthalmus_
Northern oriole	_Icterus galbula_
Orchard oriole	_Icterus spurius_
Grey catbird	_Dumetella carolinensis_
Eastern bluebird	_Sialia sialis_
Ruby-throated hummingbird	_Archilochus colubris_
Pileated woodpecker	_Dryocopus pileatus_
Red-headed woodpecker	_Melanerpes erythrocephalus_
Red-bellied woodpecker	_Melanerpes carolinus_
Downy woodpecker	_Picoides pubescens_
Common flicker	_Colaptes auratus_
Northern bobwhite quail	_Colinus virginianus_
Common snipe	_Gallinago gallinago_
Mourning dove	_Zenaida macroura_
Great horned owl	_Bubo virginianus_
Carolina chickadee	_Parus carolinensis_
Yellow-breasted chat	_Icteria virens_
Yellow-rumped warbler	_Dendroica coronata_

Appendix I. Continued.

Common name	Scientific name
Palm warbler	*Dendroica palmarum*
Wilson's warbler	*Wilsonia pusilla*
Mudflat:	
Killdeer	*Charadrius vociferus*
Spotted sandpiper	*Actitis macularia*