MANAGING WETLAND VEGETATION FOR MARSH BIRDS AND WATERFOWL

FINAL PROJECT REPORT
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INTRODUCTION

Wildlife populations have benefited greatly from state and federal programs to acquire, protect, and manage wetlands. Because of the high cost of developing and managing wetlands, careful assessment of the management potential of these areas is warranted. Successful management requires a basic understanding of the relationships among hydrology, plant production, and subsequent use by wetland birds. However, resource agencies generally lack the specific information needed to understand the complexities of wetland processes for effective management (Fredrickson and Reid 1986).

Productivity in wetlands is tied to the hydrologic cycle and seedbank (seeds, fruits and other reproductive plant structures in the soil). Most species that germinate and grow on exposed mudflats and flooded substrates originate from the seedbank and their development is influenced strongly by water depth and hydroperiod. Consequently, the species composition, vegetative structure, and productivity of wetlands are determined by seedbanks and hydrology and these factors deserve special attention by wetland managers (Poiani and Johnson 1989). This study was designed to provide practical information on the inter-relationships among wetland seed banks, hydrologic regime, subsequent germination of wetland plants, and use of these habitats by wetland birds.

The objectives of this research were to: (1) identify the plant species present in the seed bank of wetland soils at Carlyle Lake, (2) compare the species composition of this seed bank with that of germinating and emergent vegetation in relation to the time of drawdown, and (3) quantify the species composition and abundance of wetland birds using these wetlands during migration and the breeding season.

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METHODS

This research was conducted near the north end of Carlyle Lake, a 10,400-ha U.S. Army Corps of Engineers reservoir located between Vandalia and Carlyle, IL. The study area was a 320-ha portion of the Carlyle Lake Wildlife Management Area (CLWMA), a 7600-ha area managed intensively for migratory waterfowl. The CLWMA is located at the extreme north end of Carlyle Lake and includes a section of the Kaskaskia River bottoms north of the lake. The study area comprised the only land on the CLWMA which was managed exclusively for moist soil plant production. Most of the remaining acreage is managed for row crops (corn, milo, and millet) and most of the bottomland forest is flooded in the fall to provide habitat for migratory waterfowl .

The study area consisted of 4 moist-soil units (MSUs) divided by levees. Each unit could be flooded or drained by a series of water control structures and ditches. Prior to the development of Carlyle Lake these areas had been cleared and used for agriculture by local farmers. After the lake was developed and the CLWMA was constructed, the study area served as flood control compartments. The higher areas of the CLWMA were drained immediately after the close of the waterfowl seasons in order to dry the land for spring planting of row crops to serve as winter foods for waterfowl. However, the land comprising our study area was lower and slow to dry out; consequently this area was planted last, if at all. In most years, a large portion of the study area was aerial seeded to Japanese millet and/or buckwheat. Some areas were planted to corn and milo, while the rest of the area was drained and left idle.

Beginning in 1999 these compartments were designated as MSUs and management practices changed. Water levels have been maintained at prescribed depths from fall through spring to provide foraging and resting habitat for migratory waterfowl and marshbirds, then the water is drained during late-spring or summer (a "drawdown") to encourage the germination and growth of desirable moist soil plants during the summer. Previous research has shown that the timing of drawdowns is a critical factor influencing which plant species grow successfully (Fredrickson and Reid 1986) .

To investigate the influence of the timing of drawdowns on the growth of wetland plants, we drained 2 of the 4 MSUs in late-spring and 2 in mid-summer. Drawdowns are often described in general terms as "early", "midseason", or "late", with early drawdowns initiated before 15 May, midseason drawdowns between 15 May and 1 July, and late drawdowns during July (Fredrickson 1991). On our study area, the 2 early drawdowns were initiated during the first week of May and the 2 late drawdowns started during the last week of June. All drawdowns were conducted slowly, generally taking 3-4 weeks to complete. Early drawdowns were completed by late-May, whereas 1 of the late drawdowns was completed by mid-July and the other in early-August. All 4 MSUs were flooded again slowly starting in late October after the growing season had ended and before the onset of waterfowl migration.

To assess the seedbank present in the top 10 cm of substrate, we collected 20 soil core samples from each MSU during April, 1999. Samples were collected in early spring to maximize the number of seeds that were germinable (Johnson and Anderson 1986). Cores were collected at 10-m intervals along 4 random 50-m transects established perpendicular to the drawdown gradient. We used a stratified-random sampling scheme because these are advantageous where heterogeneity is suspected. We expected the density and composition of the seedbank to vary with the elevation gradient in each unit (Benoit et al. 1989). Core samples were 5 cm in diameter and 10 cm in depth.

Each core was divided into 2 equal parts, spread over plastic flats and placed in a heated greenhouse. One subsample was exposed to the air, but kept moist; the other was kept submerged under 2-3 cm of water to simulate flooded soil conditions (Poiani and Johnson 1989). Seedlings were identified, counted and removed from flats as they developed. Some species were grown to flowering before they could be identified to species. Most seedlings developed during the first few weeks after they were moved to the greenhouse and by August few new seedlings emerged. The number of seedlings in a greenhouse flat was converted to density/m^2 for analyses. A percent community similarity measurement was used to compare the composition of the seed bank in each pair of MSUs (Wolda 1981). Percent similarity is calculated as: PS = (Σ (minimum p_{i1}, p_{i2})) x 100, where p_{i1} is the relative proportion of species i in the first community and p_{i2} is the relative proportion of species i in the second community.

We surveyed the standing vegetation growing in each MSU during August, 1999. We sampled vegetation using 20 pairs of 0.25-m^2 quadrats established on each side, and at 10-m intervals along the 5 transects in each MSU. Each pair of quadrats was within 5 m of the location where a soil core had been collected. Plants in each quadrat were identified to species and categorized into 1 of 7 Daubenmire cover classes: 0-1%, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, and 95-100% (Daubenmire 1959, as modified by Bailey and Poulton 1968).

Wetland plant communities are often dominated by a few common and regular-occurring plant species, with a large number of other species represented by only a few scattered individuals (Fredrickson and Reid 1988). To provide a more complete list of the plant species growing on the study area, we conducted a search on foot of each MSU accompanied by Dr. John Ebinger, emeritus professor of botany at EIU. Any plant that had not been identified previously in our quadrats was added to the species list compiled for the study area, but was not included in any other analyses. Plant species nomenclature follows Mohlenbrock (1975).

From 26 October 1999 until 13 January 2000, we conducted weekly censuses to determine the species composition and abundance of the birds that used each MSU during fall migration and winter. Weekly censuses were conducted also from 28 February through 1 July to assess use of each MSU during spring migration and summer nesting periods. Observers using binoculars and a spotting scope conducted each census from a vehicle driven along the levees that border each MSU. The number and location of all birds found within or immediately adjacent to each MSU were identified and recorded. Because the MSUs differed in size, we scaled the amount of time spent censusing each unit to its size to keep the census effort per unit area constant among compartments. In the spring, we also conducted point counts using a taped recording of marshbirds played over a loud speaker to better determine the presence and relative abundance of this group. When we found that individual herons, egrets, and bitterns were consistently responding to taped calls from a particular location, we searched these sites for nests.

RESULTS

Density and Species Composition of Seed Banks

Viable seeds from 23 species of wetland plants were identified in the seedbanks of the 4 MSUs (Table 1). The species compositions of the 4 seed banks were very similar; the percent community similarity was highest for units C and D (88%) and lowest for units A and D (60%). Seed densities were high in each unit, ranging from 14,140 to 21,648 seeds/m^2 in Units B and C, respectively. False pimpernal (*Lindernia dubia*) and tooth-cup (*Ammania robusta*) were the most prevalent seeds in each of the units. Several native species that are important food-producing plants for waterfowl were abundant in these seed banks including blunt spikerush (*Eleocharis macrostachya*), smartweeds (*Polygonum* spp.), red-root flatsedge (*Cyperus erythorhizos*), rice cut grass (*Leersia oryzoides*), and barnyard grass (*Echinochloa crus-galli*).

Of the 2,919 seedlings that grew from soil samples in the greenhouse, 1,418 (49%) grew from samples that were moist but exposed to the air, whereas 1,501 (51%) grew from flooded samples. Species that developed predominantly in the exposed flats included rusty flatsedge (*Cyperus odoratus*), red-root flatsedge, smartweeds, ponygrass (*Eragrostis hypnoides*), beggar-ticks (*Bidens* spp.) and water hemp (*Amaranthus hybridus*). Other species grew best when inundated, including false pimpernal, tooth-cup, and water plantain (*Alisma plantago-aquatica*). A third group grew equally well in exposed or flooded soils; the latter group included blunt spikerush, rice cut-grass, and barnyard grass.

Survey of Aboveground Vegetation in Moist Soil Units

We identified 73 plant species growing in the 4 MSUs including 58 herbaceous species and 15 woody species (Appendix A). Percent areal coverage was calculated for the 20 species occurring in sample quadrats (Table 2). Although the seedbanks were similar in all 4 MSUs, substantial differences were apparent in the aboveground vegetation in the 2 early-drawdown units compared to the 2 late-drawdown units. Species richness was higher in those units drained later (S = 19) compared to the early drawdown units (S = 8). Early drawdown units were dominated by rice cut-grass, beggar-ticks and smartweeds. Dominant species in the late drawdown units were water primrose (*Ludwigia peploides*), water hemp, and rice cut-grass (Table 2). Generally, those species that were most prevalent in the early-drawdown units were the plants that had germinated best in the moist, exposed greenhouse flats, whereas those most frequently observed in the late-drawdown units were species that developed best in the flooded flats.

The species richness of the aboveground vegetation in quadrats was very similar to that found in the soil seedbanks collected from these quadrats; approximately 2 dozen species were found in each. However, the species composition and density differed between seedbanks and aboveground vegetation. Nine of the 23 (39%) species found in seedbanks were not found growing in the quadrats. For example, false pimpernal was the most abundant species in the seedbanks of all 4 MSUs, but it was not found in any of the sample quadrats, and was rarely observed on the study areas. In contrast, species such as cocklebur (*Xanthium stromarium*), buttonbush (*Cephalanthus occidentalis*), and black willow (*Salix nigra*) were found in the aboveground vegetation, but did not germinate from soil samples in the greenhouse

Utilization of Moist Soil Units by Avian Species

A total of 122 species of birds were observed in the 4 MSUs during the fall migration, wintering, and spring migration periods (Appendix B). These included 2 grebe, 19 waterfowl, 13 marshbird (herons, egrets, and bitterns) and 14 shorebird species. Waterfowl, particularly dabbling ducks, were the most abundant group of birds using the MSUs during the fall migration and wintering periods (Table 3). Mallards (*Anas platyrhynchos*) comprised 75% of the water birds observed during this period (Table 3). Waterfowl, grebes, and herons used the MSUs primarily as foraging and resting sites.

American coots (*Fulica americana*) and ring-necked ducks (*Aythya collaris*) were the most common species using the MSUs during spring migration, although dabbling ducks such as mallards, northern shovelers (*Anas clypeata*), blue-winged teal (*Anas discors*), and gadwalls (*Anas strepera*) also were abundant (Table 4). Coots, ring-necked ducks, and lesser scaup were observed most frequently in open areas of the MSUs, where the water was deeper and there was less emergent vegetation. Dabbling ducks and marshbirds generally used shallow water areas with more vegetative cover.

The 2 early-drawdown MSUs supported the majority (79%) of water birds during fall migration. This trend was driven particularly by the heavy use of these units by dabbling ducks. For example, 83% of mallards and 97% of gadwalls were observed in the early-drawdown units. In contrast, 66% of the coots were observed in the late-drawdown units.

This trend reversed during spring migration when late-drawdown units were more heavily utilized by birds. During this period, 64% of all water birds observed during censuses were seen in these units. Birds such as coots and ring-necked ducks that prefer open water habitats were more prevalent in the late-drawdown units during spring migration, but so were many of the dabbling ducks such as mallards, shovelers, green-winged teal (*Anas crecca*), and wigeon (*Anas americana*) which had used the early-drawdown units during the fall and winter.

Marshbirds foraged near the edges of all 4 MSUs. During fall migration and winter, great blue herons (*Ardea herodias*) were more common in the late-drawdown units (Table 3). However, by spring we found few differences in the use of late- versus early-drawdown units by marshbirds (Table 4).

During the nesting season, we located 7 nests of least bitterns (*Ixobrychus exilis*) and 1 pied-billed grebe (*Podilymbus podiceps*) nest in the heavy emergent vegetation of Unit C, an early-drawdown unit. The grebe nest contained 4 juveniles.

DISCUSSION

Density and Species Composition of Seed Banks

Wetland vegetation goes through successional changes following the disturbance caused by fluctuating water levels. During natural or artificial drawdowns, exposed mudflats revegetate rapidly with annual and emergent species. While soils are exposed, annual "mudflat" species (*Bidens, Cyperus, Polygonum, Rumex*) proliferate quickly. With shallow inundation, the mudflat species are replaced by emergent species (*Typha, Scirpus, Sagittaria*), which are followed by submersed and free-floating aquatic species (*Lemna, Spirodela, Ceratophyllum, Naias, Potamogeton*) as flooding continues (van der Valk and Davis 1978, Poiani and Johnson 1988).

These successional changes depend primarily on the existence of a viable seed bank (van der Valk and Davis 1976, Poiani and Johnson 1988). The soils of the CLWMA have sizable seed banks containing at least 23 species, including large numbers of "mudflat annuals" (*Cyperus, Bidens, Polygonum, Echinochloa, Eragrostis*) and emergent species (*Typha, Sagittaria, Ammania*) which provide the potential for rapid revegetation of the MSUs following drawdowns. The diversity and density of seeds from submersed and free-floating aquatic species were relatively low in all MSUs. The abundance of mudflat species and the relative paucity of these aquatics may be due to the frequent exposure that these soils have experienced over the past decade. Short-lived mudflat annuals often produce large numbers of seed adapted to a 4-5 year dormancy between drawdowns. These life history traits allow them to readily exploit exposed substrates when they are available (Schneider and Sharitz 1986, Poiani and Johnson 1988).

Previous research has shown that the density of seedbanks varies among sites and can be influenced by the frequency of flooding and disturbance, proportion of aggressive and/or weedy species in the community, composition and density of adjacent plant communities, and sampling techniques used by researchers conducting the surveys (Johnson and Anderson 1986). Poiani and Johnson (1988) reported seed densities between 2,800 and 9,400/m^2 in semi-permanent prairie wetlands in North Dakota and Johnson and Anderson (1986) reported a density of 2,019 seeds/m^2 in the seedbank of a prairie remnant in Illinois. However, van der Valk and Davis (1978) found much higher densities (21,445-42,615 seeds/m^2) in the soils of a prairie marsh in Iowa. Given this range of seed densities in Midwestern prairie soils, the abundance of seeds found in the MSUs at CLWMA (14,140- 21,648 seeds/m^2) are quite high. Furthermore, there appears to be an adequate density and diversity of natural wildlife food plants to suggest that it is not necessary for managers to supplement these sites by planting or broadcasting additional food plants.

Vegetational Analysis of Moist Soil Units

Since the 1970's, it has been a common practice for managers to manipulate the hydrologic regime in impoundments to encourage the growth of "moist soil" plants for the purpose of providing food and cover for game and non-game birds (Robinson 1991). Due to the complexities of wetland ecosystems and our limited understanding of the role of abiotic and biotic influences on the development of wetland plant communities this practice is better described as "a learned craft or art than … an applied science" (Fredrickson and Reid 1988). The germination and growth of each species depends on a particular range of favorable conditions including soil temperature and moisture. These conditions fluctuate constantly on a site and determine the timing of germination, development, and reproduction for each species. Some species are known to respond best to early drawdowns (e.g. *Polygonum*), others to late drawdowns (e.g. *Leptochloa*), and some species can germinate under a wide range of environmental conditions (Fredrickson 1991).

Because the density and composition of seedbanks in all 4 MSUs were similar, the substantial differences in the aboveground vegetation in these units appeared to be caused by the timing of drawdowns. Fredrickson (1991) has noted that early-drawdowns generally result in the greatest quantity of seeds produced and allow newly established plants time to establish adequate root systems before summer droughts, minimizing plant mortality. He also reported that slow drawdowns (as conducted on all 4 MSUs at CLWMA) are usually more desirable for plant establishment and wildlife use because the prolonged period of soil saturation creates favorable conditions for moist soil plant germination and establishment and prolongs use by a greater number and diversity of wetland wildlife (Fredrickson 1991).

Although we did not measure seed production during the summer or fall, the species that dominated the early-drawdown MSUs on CLWMA tended to be species that produce large quantities of seed (*Leersia, Bidens, Polyganum*), while fewer seeds would be expected from the plants that dominated the late-drawdown units. In addition, the extent of emergent cover was visibly greater in the early-drawdown units.

We found only limited correlation between the species composition and abundance of the seedbank and aboveground vegetation at CLWMA. Several species that were abundant in the seedbank were rare or absent in the aboveground vegetation. Similar results have been reported by others (Harper 1977). Several reasons have been proposed to explain the greater diversity of species that are frequently found in seedbanks, including: (1) surveys of aboveground vegetation may miss rare or ephemeral species, (2) large numbers of small seeds from terrestrial plants in adjacent communities are dispersed readily into wetlands by wind and other vectors but conditions may not be favor their growth, and (3) terrestrial annual seeds often have long dormancy periods causing them to persist in wetland seedbanks, an adaptive strategy for species that have only one opportunity to reproduce before they die (Schneider and Sharitz 1986).

Utilization of Moist Soil Units by Avian Species

Artificial drawdowns can be useful tools to promote high productivity in MSUs and provide habitat for a diverse bird fauna (Fredrickson and Reid 1986). The vegetation provided in these units can provide food (seeds, tubers, browse), substrate for invertebrates, nest sites, and protective cover for a variety of avian species including waterfowl, marsh birds, and shorebirds (Fredrickson and Reid 1988).

There is some general agreement that the maximum diversity and abundance of birds are associated with wetland units that provide a "hemi-marsh" condition, with approximately equal quantities of vegetative cover and open water well juxtaposed. This condition is thought to provide ideal nesting cover for waterbirds, as well as substrates and litter for invertebrate populations (Fredrickson and Reid 1988, Murkin et al. 1997). However, each avian species has its own unique suite of habitat requirements so no single wetland can provide for the needs of all birds throughout the year. For example, red-winged blackbirds (*Agelaius phoeniceus*) prefer shallow areas with dense vegetation, coots prefer deeper-water habitats with interspersed vegetation, dabbling ducks (as a group) are usually found in hemi-marsh habitats, and diving ducks choose deeper water with less vegetation (Murkin et al. 1997).

On CLWMA, habitat was provided for a wide array of birds by both early- and late-drawdown units. The early-drawdown units provided a hemi-marsh condition during the fall migration and wintering periods and were used heavily by dabbling ducks at this time. However, by spring migration most species utilized the late-drawdown units which provided more open and deeper-water habitats with less vegetation. Marshbirds foraged on the peripheries of all units where receding or shallow water caused localized concentrations of fish. It is particularly noteworthy that the dense emergent vegetation which grew in an early-drawdown unit provided critical nesting habitat for least bitterns and pied-billed grebes, 2 of Illinois' threatened species.

CONCLUSIONS

Our results suggest that the MSUs at CLWMA can best meet the habitat requirements of a broad array of game and non-game birds if the area is managed as a wetland complex, a series of different wetland habitats in close proximity, each managed with its own dynamic hydrologic regime (Fredrickson and Reid 1986). This wetland complex can be managed by varying the drawdown dates in a series of MSUs, thus providing a diversity of successional stages, plant communities, and vegetative structures to enhance productivity while providing food, cover, and nesting sites for wetland wildlife species with diverse habitat requirements.

Regardless of the timing of drawdowns, they should be conducted slowly. Fredrickson (1991) recommended slow drawdowns because invertebrates and fish become concentrated and available to foraging birds along the soil-water edge and in shallow water. He also noted that the vast majority of water birds require shallow water for foraging; only 5 of 54 species that use MSUs in Missouri can forage effectively in water deeper than 25 cm.

The management objectives for CLWMA include provision of year-round habitat for a broad array of resident wildlife species, while providing food and cover for migratory birds. Data collected during this study suggest that: (1) large natural seedbanks occur in the soils of the CLWMA, (2) aboveground vegetation differs markedly between units that were drained in May versus July, and (3) both early- and late-drawdowns provide critical winter and migration habitat used by a broad array of avian species. Given these site characteristics future management of the area should be aimed towards maintaining productive and diverse wetland ecosystems rather than to focus on specific target species.

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Table 1. Density of viable seeds in the seedbanks of 4 moist soil units at Carlyle Lake Wildlife Management Area, Illinois.

	No. viable seeds / m^2				
Plant Species[1]	Unit A	Unit C	Unit B	Unit D	Total All Units
False pimpernal	2955	10515	4704	9407	27581
Tooth-cup	2931	3226	3694	2561	12412
Rusty flatsedge	2438	3226	1576	1921	9161
Blunt spikerush	1453	1822	394	1872	5541
Smartweeds	2561	468	370	345	3744
Red-root sedge	911	1108	862	247	3128
Rice-cut grass	1773	123	394	197	2487
Ditch stonecrop	936	714	99	99	1848
Ponygrass	247	74	788	517	1626
Butterweed	173	50	542	148	913
Water hemp	221	74	221	50	566
Barnyard grass	197	25	50	148	420
Sedge	25	0	222	0	247
Water plantain	50	0	99	50	199
Beggar-ticks	0	173	25	0	198
Cottonwood	50	25	50	0	125
Ash	25	25	0	25	75
Morning glory	74	0	0	0	74
Skullcap	25	0	25	0	50
Pickerel-weed	25	0	0	0	25
Narrow-leafed cat-tail	0	0	0	25	25
Shepard's-purse	0	0	25	0	25
Sandbar willow	25	0	0	0	25
TOTALS	17,095	21,648	14,140	17,612	70,495

[1]Scientific names of all plant species are listed in Appendix A.

Table 2. Mean percent cover of wetland plant species in 4 moist soil units at Carlyle Lake Wildlife Management Area, Illinois during August, 1999.

	Percent cover			
	Early Drawdown		Late Drawdown	
Plant Species[1]	Unit A	Unit C	Unit B	Unit D
Rice-cut grass	37.2	33.9	5.1	21.3
Beggar-ticks	57.3	25.7	3.3	1.0
Water primrose	0.0	0.0	58.2	0.0
Water hemp	0.0	0.0	10.5	39.1
Smartweeds	0.7	28.4	2.0	13.5
Tooth-cup	0.0	14.2	0.0	0.0
Cocklebur	0.0	0.8	2.9	8.0
Sedges	0.0	0.0	3.8	7.0
Buttonbush	4.6	0.0	0.2	3.2
Black willow	0.0	0.0	2.9	3.0
Barnyard grass	0.5	4.0	0.4	0.1
Ponygrass	0.0	0.0	3.8	0.1
Common cat-tail	0.0	0.0	3.1	0.0
Smooth rose-mallow	0.0	0.0	0.0	1.8
Blunt spikerush	0.0	0.0	1.7	0.0
Water plantain	0.1	0.0	0.4	0.0
Deer-tongue grass	0.0	0.0	0.0	1.3
Common arrowhead	0.0	0.0	1.0	0.0
Morning glory	0.0	0.0	0.5	0.3
Red maple	0.0	0.0	0.1	0.0
TOTAL	100.0	100.0	100.0	100.0

[1]Scientific names of all plant species are listed in Appendix A.

Table 3. Total number of waterfowl and marsh birds observed in 4 moist soil units at Carlyle Lake Wildlife Management Area during 14 weekly censuses conducted during fall migration, 26 October 1999 - 31 January 2000.

	Early Drawdown		Late Drawdown		
Species[1]	Unit A	Unit C	Unit B	Unit D	Total All Units
Mallard	1731	5047	1122	274	8174
American coot	210	115	615	4	944
Gadwall	141	300	15	0	456
Wigeon	62	250	15	0	327
Pintail	0	216	0	2	218
Northern shoveler	0	200	0	0	200
Green-winged teal	5	106	12	75	198
Black duck	11	100	2	0	113
Wood duck	27	0	54	3	84
Great blue heron	11	5	27	9	52
Ring-necked duck	20	0	0	4	24
Lesser scaup	22	0	1	0	23
Pied-billed grebe[2]	6	8	4	3	21
Snow goose	0	3	0	0	3
Bufflehead	0	0	2	0	2
White-fronted goose	0	0	1	0	1
Green-backed heron	1	0	0	0	1
TOTAL	2247	6350	1870	374	10841

[1] The scientific name of each avian species is listed in Appendix B.

[2] Species is designated as a threatened species in Illinois (IL. Endangered Species Protection Board 1999)

Table 4. Abundance of waterfowl and marsh birds observed using 4 moist soil units at Carlyle Lake Wildlife Management Area during 22 weekly censuses conducted during spring migration, 28 February - 1 July 2000.

	Early Drawdown		Late Drawdown		
Species[1]	Unit A	Unit C	Unit B	Unit D	Total All Units
American coot	2230	687	2350	1885	7152
Ring-necked duck	1775	0	480	4176	6431
Mallard	1460	310	1910	1550	5230
Northern shoveler	965	232	906	1145	3248
Blue-winged teal	504	425	925	510	2364
Gadwall	760	45	700	350	1855
Green-winged teal	20	37	390	280	727
American wigeon	145	30	0	355	530
Great blue heron	36	25	61	23	145
Lesser scaup	120	0	0	2	122
Bufflehead	67	4	20	2	93
Great egret	19	20	34	11	84
Pied-billed grebe[2]	12	23	4	24	63
Wood duck	10	0	10	35	55
Little blue heron[3]	0	22	1	23	46
Ruddy duck	21	4	15	0	40
Pintail	6	2	0	26	34
Yellow-cr. night-heron[3]	3	6	1	23	33
Redhead	18	0	0	0	18
Common snipe	3	7	0	8	18
Green heron	7	1	7	2	17
Least bittern[2]	0	17	0	0	17
Black-cr. night-heron[3]	0	4	1	2	7
Sora	1	4	1	0	6

Snowy egret[3]	0	0	6	0	6
Horned grebe	2	0	0	2	4
Hooded merganser	0	0	2	0	2
Black duck	0	0	1	0	1
Tri-colored heron	0	0	1	0	1
American bittern[3]	0	1	0	0	1
TOTAL	8184	1909	7826	10434	28353

[1]The scientific name of each avian species is listed in Appendix B.

[2] Species is designated as a threatened species in Illinois (IL. Endangered Species Protection Board 1999)

[3] Species is designated as an endangered species in Illinois (IL. Endangered Species Protection Board 1999)

Appendix A. Plant species identified in the 4 moist soil units in the Carlyle Lake Wildlife Management Area during surveys conducted during August, 1999.

I. <u>Herbaceous species</u>

Alisma plantago-aquatica	Water plantain
Amaranthus hybridus	Water hemp
Ammannia robusta	Tooth-cup
Apocynum cannabinum	Dogbane
Bidens aristosa	Bearded beggar-ticks
Bidens cernua	Nodding beggar-ticks
Bidens discoidea	Few bracted beggar-ticks
Bidens connata	Purplestem beggar-ticks
Boltonia asteroides	White boltonia
Capsella bursa-pastoris	Shepard's-purse
Carex annectens	Brown fox sedge
Carex blanda	Sedge
Carex crus-corvi	Crawfoot fox sedge
Carex cristatella	Crested oval sedge
Carex frankii	Bristly cat-tail sedge
Carex grayii	Common bur sedge
Carex grisea	Sedge
Carex lupilina	Common hop sedge
Carex muskingumensis	Swamp oval sedge
Carex tribuloides	Awl-fruited oval sedge
Cephalanthus occidentalis	Buttonbush
Cuscuta sp.	Dodder
Cyperus acuminatus	Sedge
Cyperus erythrorhizos	Red-root flatsedge
Cyperus esculentus	Yellow nutsedge

Appendix A. continued.

Cyperus odaratus	Rusty flatsedge
Echinochloa crus-galli	Barnyard grass
Eleocharis acicularis	Least spikerush
Eleocharis macrostachya	Spikerush
Eleocharis obtusa	Blunt spikerush
Elymus virginicus	Virginia wildrye
Eragrostis hypnoides	Ponygrass
Gratiola neglecta	Clammy hedge hyssop
Heteranthera lemisa	Pickerel-weed
Hibiscus laevis	Smooth rose-mallow
Hypericum mutilum	Slender St. John's-wort
Ipomoea lacunosa	Morning glory
Leersia oryzoides	Rice cut-grass
Leptochloa fascicularis	Sprangletop
Lindernia dubia	False pimpernal
Ludwigia peploides	Water primrose
Panicum clandestinum	Deer-tongue grass
Penthorum sedoides	Ditch stonecrop
Polygonum hydropiperoides	False water-pepper
Polygonum lapathifolium	Dock-leaved smartweed
Potamogeton foliosus	Leafy pondweed
Potamogeton nodosus	Longleaf pondweed
Potentilla norvegica	Cinquefoil
Rorippa islandica	Yellow-cress
Rumex crispus	Curly dock
Sagittaria latifolia	Common arrowhead
Scirpus tabernacmontanii	Bulrush
Scirpus validus	Softstem bulrush

Scuttelaria galasrulata	Skullcap
Senecio glabellus	Butterweed
Typha latifolia	Common cat-tail
Veronica peregrina	Purslane-speedwell
Xanthium strumarium	Cocklebur

II. <u>WOODY SPECIES</u>

Acer saccharinum	Silver maple
Acer rubrum	Red maple
Acer negundo	Box elder
Carya laciniosa	King nut hickory
Celtis occidentalis	Hackberry
Fraxinus pennsyvanica var subintegerrima	Green ash
Gleditsia triacanthos	Honey locust
Platanus occidentalis	Sycamore
Populus deltoides	Cottonwood
Quercus palustris	Pin oak
Quercus bicolor	Swamp white oak
Quercus macrocarpa	Bur oak
Salix interior	Sandbar willow
Salix nigra	Black willow
Ulmus americana	American elm

Appendix B. Avian species identified in the 4 moist soil units in the Carlyle Lake Wildlife Management Area during surveys conducted 26 October, 1999 to 1 July, 2000.

Accipiter cooperii	Cooper's hawk
Actitis macularia	Spotted sandpiper
Agelaius phoeniceus	Red-winged blackbird
Aix sponsa	Wood duck
Anas strepera	Gadwall
Anas crecca	Green-winged teal
Anas americana	American wigeon
Anas clypeata	Northern shoveler
Anas acuta	Northern pintail
Anas rubripes	American black duck
Anas platyrhynchos	Mallard
Anas discors	Blue-winged teal
Anser albifrons	Greater white-fronted goose
Archilochus colubris	Ruby-throated hummingbird
Ardea herodias	Great blue heron
Aythya americana	Redhead
Aythya affinis	Lesser scaup
Aythya collaris	Ring-necked duck
Botaurus lentiginosus	American bittern
Branta canadensis	Canada goose
Bubo virginianus	Great horned owl
Bubulcus ibis	Cattle egret
Bucephala albeola	Bufflehead
Buteo jamaicensis	Red-tailed hawk
Butorides virescens	Green-backed heron
Calidris minutilla	Least sandpiper
Calidris melanotos	Pectoral sandpiper

Appendix B. continued.

Calidris fuscicollis	White-rumped sandpiper
Calidris pusilla	Semipalmated sandpiper
Calidris alpina	Dunlin
Cardinalis cardinalis	Cardinal
Carduelis tristas	American goldfinch
Casmerodius albus	Great egret
Cathartes aura	Turkey vulture
Ceryle alcyon	Belted kingfisher
Chaetura pelagica	Chimney swift
Charadrius semipalmatus	Semipalmated plover
Charadrius vociferus	Killdeer
Chen caerulescens	Snow goose
Circus cyaneus	Northern harrier
Coccyzus americanus	Yellow-billed cuckoo
Colaptes auratus	Northern flicker
Colinus virginianus	Northern bobwhite
Contopus virens	Eastern wood-pewee
Corvus brachyrhynchos	American crow
Cyanocitta cristata	Blue jay
Dendroica petechia	Yellow warbler
Dendroica coronata	Yellow-rumped warbler
Dendroica striata	Blackpoll warbler
Dolichonyx oryzivorus	Bobolink
Dryocopus pileatus	Pileated woodpecker
Dumetella carolinensis	Gray catbird
Egretta tricolor	Tricolored heron
Egretta caerulea	Little blue heron
Egretta thula	Snowy egret

Appendix B. continued.

Empidonax traillii	Willow flycatcher
Empidonax alnorum	Alder flycatcher
Empidonax virescens	Acadian flycatcher
Fulica americana	American coot
Gallinago gallinago	Common snipe
Geothlypis trichas	Common yellowthroat
Haliaeetus leucocephalus	Bald eagle
Hirundo rustica	Barn swallow
Icterus galbula	Northern oriole
Icterus spurius	Orchard oriole
Ixobrychus exilis	Least bittern
Larus delawarensis	Ring-billed gull
Limnodromus griseus	Short-billed dowitcher
Lophodytes cucullatus	Hooded merganser
Melanerpes erythrocephalus	Red-headed woodpecker
Melanerpes carolinus	Red-belled woodpecker
Melospoza melodia	Song sparrow
Mergus merganser	Common merganser
Mimus polyglottos	Northern mockingbird
Molothrus ater	Brown-headed cowbird
Myiarchus crinitus	Great crested flycatcher
Nyctanassa violacea	Yellow-crowned night-heron
Nycticorax nycticorax	Black-crowned night-heron
Oxyura jamaicensis	Ruddy duck
Pandion haliaetus	Osprey
Parus bicolor	Tufted titmouse
Parus carolinensis	Carolina chickadee
Passer domesticus	House sparrow

Appendix B. continued.

Passerina cyanea	Indigo bunting
Phalacrocorax auritus	Double-crested cormorant
Pheucticus ludovicianus	Rose-breasted grosbeak
Picoides pubescens	Downy woodpecker
Picoides villosus	Hairy woodpecker
Pipilo erythrophthalmus	Rufous-sided towhee
Podiceps auritus	Horned grebe
Podilymbus podiceps	Pied-billed grebe
Polioptila caerulea	Blue-gray gnatcatcher
Porzana carolina	Sora
Progne subis	Purple martin
Protonotaria citrea	Prothonotary warbler
Quiscalus quiscula	Common grackle
Riparia riparia	Bank swallow
Sayornis phoebe	Eastern phoebe
Seiurus noveboracensis	Northern waterthrush
Setophaga ruticilla	American redstart
Sialia sialis	Eastern bluebird
Sitta carolinensis	White-breasted nuthatch
Spiza americana	Dickcissel
Spizella passerina	Chipping sparrow
Spizella pusilla	Field sparrow
Stelgidopteryx serripennis	Northern rough-winged swallow
Sturnella magna	Eastern meadowlark
Sturnus vulgaris	European starling
Tachycineta bicolor	Tree swallow
Thryothorus ludovicianus	Carolina wren
Toxostoma rufum	Brown thrasher

Appendix B. continued.

Tringa flavipes	Lesser yellowlegs
Tringa melanoleuca	Greater yellowlegs
Tringa solitaria	Solitary sandpiper
Troglodytes aedon	House wren
Turdus migratorius	American robin
Tyrannus tyrannus	Eastern kingbird
Vireo flavifrons	Yellow-throated vireo
Vireo gilvus	Warbling vireo
Zenaida macroura	Mourning dove
Zonotrichia querula	Harris' sparrow
Zonotrichia leucophrys	White-crowned sparrow