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Managing Wetland Vegetation for Marsh Birds and Waterfowl at Carlyle Lake Wildlife Management Area, IL

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Managing Wetland Vegetation for Marsh Birds and Waterfowl

at Carlyle Lake Wildlife Management Area, IL

(TITLE)

BY

Matthew W. Bowyer

THESIS

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ABSTRACT

The high cost of restoring and managing wetlands warrants careful assessment of their management potential. We designed this study to provide basic information on how seed banks and hydroperiod influence the development of habitat for migratory birds in restored wetlands at Carlyle Lake Wildlife Management Area (CLWMA). The objectives were to: (1) survey the composition of the seed banks; (2) investigate the effects of early- vs. late-drawdowns on the germination and growth of these plants; and (3) monitor the use of these communities by wetland birds during migration and the breeding season. The study was conducted on a marsh complex that included 4 experimental moist soil units. Initially, 2 units were drained in late spring and 2 in early summer; this pattern was reversed during the second year of the study. Seed densities were high in the 4 units, ranging from 14,140 to 21,648 seeds/m^2. Native food plants that are important to wetland birds for food sources, cover, and nesting habitat were all abundant. The timing of drawdowns greatly influenced the composition and growth of wetland vegetation in both years. In the first year, Units drained early were dominated by rice cut-grass, beggar-ticks, and smartweeds. Late-drawdowns favored water primrose and water hemp. In the second year heavy rains throughout the summer caused our drawdowns to be completed later than planned. However, vegetation structure of the impoundments still varied with respect to drawdown timing. Early-drawdowns were favored by water primrose, water plantain, sedges, and smartweeds. Duckweeds, pondweeds, and rice cut-grass all dominated the late-drawdowns. Early-drawdowns supported the majority of birds during fall migration, particularly dabbling ducks. But, this trend reversed during spring migration when late-drawdowns were more heavily

used. Least bitterns and pied-billed grebes were confirmed nesters at the study areas. Several other state threatened or endangered species were also present at the site throughout their known breeding seasons, however, their nesting was never confirmed. We recommend that CLWMA be managed as a wetland complex by varying the drawdown dates in individual units to provide an array of successional stages, plant communities, and vegetative structures for avian species with diverse habitat requirements. We also recommend that more of the CLWMA be managed for moist soil plant production.

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MANAGING WETLAND VEGETATION FOR MARSH BIRDS AND WATERFOWL AT CARLYLE LAKE WILDLIFE MANAGEMENT AREA, IL

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 the availability of seeds and other reproductive plant structures in the soil. Most species that germinate and grow on exposed mudflats and flooded substrates originate from the seed bank and their development is influenced strongly by water depth and hydroperiod. Consequently, the species composition, vegetative structure, and productivity of wetlands are determined by a combination of seed banks 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 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

the seed bank with the composition 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.

METHODS

Study site.—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 West Side Management Unit of the Carlyle Lake Wildlife Management Area (CLWMA), a 1350-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), with the exception of the limited amount of bottomland forest still existing, and areas where dewatering is not possible. All of the CLWMA is flooded in the fall to provide habitat primarily for migratory waterfowl and secondarily for non-game marsh birds.

The study area consisted of 4 impoundments that are individually surrounded by levees. Each unit could be flooded or drained by a series of water control structures and ditches. These 4 impoundments are referred to as the moist soil units (MSUs) throughout the remainder of this manuscript. Prior to the development of Carlyle Lake these areas had been cleared and used for agriculture by local farmers. After the lake was developed in 1967, and the CLWMA was constructed, planting row crops for waterfowl

management was given top priority for the site. The higher areas of the CLWMA were drained 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. Even though only about 385 hectares of land was actually planted to row crops, over 1000 hectares had to be drained to allow access to these row crop "fields" (Whitton 1991). 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 left to drain naturally and serve as moist soil habitat.

Beginning in 1999 these compartments were designated as MSUs and management practices changed. Water levels have been maintained at prescribed depths usually ranging from 5 up to 90 cm in the deeper areas. Flooded conditions in all units usually persisted from early October until late April to provide foraging and resting habitat for migratory waterfowl and marsh birds, then the water was 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, and usage by wetland birds 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 2-3 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.

Density and Species Composition of Seed Banks.—To assess the seed bank 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 this approach is advantageous where heterogeneity is suspected. We expected the density and composition of the seed bank 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, transferred to 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.

Survey of Aboveground Vegetation in Moist Soil Units.—We surveyed the standing vegetation growing in each MSU during August, 1999 and 2000. We sampled vegetation using 20 pairs of 0.25-m^2 quadrats established on each side of the transect, and at 10-m intervals along the 4-50 meter 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).

Utilization of Moist Soil Units by Birds.—From 26 October 1999 until 13 January 2000 and 30 October 2000 until 24 November 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 also conducted from 28 February 2000 through 1 July 2000 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 the borders of each individual 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 call-response censuses using a taped recording of marshbirds played over a loud speaker to better determine the presence and relative abundance of this group. A target species' call was played over a loud speaker for 10 seconds, followed by 10 seconds of silence for a total of 60 seconds. Individuals that responded were identified and their locations were marked on a map. Similar methods for determining marsh bird abundance have been used in a number of other studies including recent studies by Gibbs and Melvin (1997), and Horstman et al. (1998). When we found that individual marsh birds were consistently responding to taped calls from a particular location on successive censuses, those locations were searched for nests.

RESULTS

Density and Species Composition of Seed Banks.—Viable seeds from 23 species of wetland plants were identified in the seed banks 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 better when inundated, especially false pimpernal, tooth-cup, and water plantain (*Alisma plantago-aquatica*). A third group seemed to grew equally well in exposed or flooded soils. This group included blunt spikerush, rice cut-grass, and barnyard grass.

Survey of Aboveground Vegetation in Moist Soil Units.—In 1999, we identified 73 plant species growing in the 4 MSUs including 58 herbaceous species and 15 woody species (Appendix A). Percent aerial coverage was calculated for the 20 species occurring in sample quadrats (Table 2). Although the seed banks 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 seed banks collected from these quadrats. A total of 8 species occurred in the early drawdown units while 19 species were identified in the late drawdown units. However, the species composition and density differed between seed banks and aboveground vegetation. Eight of the 23 (35%) species found in seed banks were not found growing in the quadrats. For example, false pimpernal was the most abundant species in the seed banks of all 4 MSUs, but it was not found in any of the sample quadrats, and was rarely observed on the study areas at the time of sampling. 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.

In 2000, we identified 12 additional herbaceous and 1 additional woody species for a total of 86 plant species growing in the MSUs. Heavy rains throughout the summer caused the drawdowns to progress more slowly than expected, however above ground vegetation still differed between those units drawndown early versus the units drawdown late (Table 3). Early drawdowns were completed by mid-June and some areas of the late drawdowns were never completely drained.

Total species richness for the early drawdown units increased to 24 species (8 species in 1999), while richness in late units dropped to 10 species (19 in 1999) (Table 3). Water primrose, smartweeds, water plantain, and the sedges dominated early drawdowns. Duckweeds *(Lemna minor)*, pondweeds (*Potamogeton nodosus*), and rice cut-grass were favored by late drawdowns. Open water accounted for 32.8% of all cover in the late drawdown units. This standing water throughout the growing season created a more open hemi-marsh type of habitat in the late drawdown units.

Six of 25 (24%) species that were found in the emergent vegetation were not found in the seed bank samples. False pimpernal was found only occasionally in the above ground plots despite its abundance in the seed bank. However, arrowhead (*Sagittaria latifolia*), buttonbush, and pondweed were all present in the above ground vegetation, but were not found in the seed bank.

Utilization of Moist Soil Units by Birds.—A total of 17 weekly censuses were conducted during fall migration and wintering periods. Fourteen surveys were conducted during the winter of 1999-2000; however due to an early and persistent freeze, we were only able to conduct 3 censuses during the winter of 2000-2001. We conducted 22 weekly censuses in the spring and summer of 2000. A total of 123 avian species were observed in the 4 MSUs during the fall migration, winter, and spring migration periods (Appendix B). These included 2 grebe, 20 waterfowl, 14 marshbird (herons, egrets, and bitterns), 12 shorebird, and 75 non-wetland species. Waterfowl, particularly dabbling ducks, were the most commonly detected group of birds using the MSUs during the fall migration and wintering periods (Table 3). Mallards (*Anas platyrhynchos*) comprised

68% of the water birds observed during this period (Tables 4 and 6). 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*) were also abundant (Table 5). Birds such as coots and ring-necked ducks that prefer open water habitats were more prevalent in the late-drawdown units. Dabbling ducks and marshbirds generally used shallow water areas with more vegetative cover.

The 2 early-drawdown MSUs supported the majority (75%) 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 gadwalls were observed in the early-drawdown units. In contrast, 71% of the coots were observed in the late-drawdown units.

This trend reversed during spring migration when birds more heavily utilized late-drawdown units. During this period, 64% of all water birds observed were seen in these units. Fifty-nine percent of coots and 72% of ring-necked ducks, were observed in the late drawdown units, where the vegetation was less dense and large open water areas existed. Dabbling ducks such as mallards, shovelers, green-winged teal (*Anas crecca*), and American wigeon (*Anas americana*) seemed to switch preferences where 65% of them were observed in the late-drawdown units during the spring.

Marshbirds foraged in all 4 MSUs. During fall migration and winter, great blue herons (*Ardea herodias*) were more common in the late-drawdown units (Tables 4 and 6). However, by spring we found few differences in the use of units by this species (Table 5).

Sora rails (*Porzana carolina*) were seen in the dense vegetation of the MSUs during fall migration, however their numbers could not be determined due to low visibility within the dense vegetation in these units.

During the nesting season, we located 7 nests of least bitterns (*Ixobrychus exilis*) and 1 pied-billed grebe (*Podilymbus podiceps*) nest. All nests were located in impoundment C where water remained on the unit well into August. Six of the 7 bittern nests were in patches of water smartweed (*P. amphibium*) that had emerged out of the open water. One nest was in a buttonbush that was surrounded by open water and water smartweed. Mean clutch size for 6 nests (one nest was found after eggs had hatched) was 4.5 eggs/nest. All 7 nests were monitored weekly, and all 7 hatched successfully. Although we did not determine how many of the chicks in each nest survived to fledging, we monitored each nest for at least 1 month after hatching, and no evidence of predation existed at any nest site. No nest success was obtained on the grebe nest. However, one brood of grebes was observed, and grebes consistently called throughout the summer on the study area, so it is likely more nests existed.

Four other state threatened or endangered species were observed using the MSUs throughout their respective breeding seasons, including: black-crowned night herons (*Nycticorax nycticorax*), yellow-crowned night herons (*Nyctanassa violacea*), little blue herons (*Egretta caerulea*) and snowy egrets (*Egretta thula*). Other state threatened and endangered species observed using the MSUs included: American bitterns (*Botaurus lentiginosus*), bald eagles (*Haliaeetus leucocephalus*; federally threatened), northern harriers (*Circus cyaneus*), and osprey (*Pandion haliaetus*).

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 abundant 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 seed banks 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 seed bank 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 much higher than Johnson and Anderson (1986) and Poiani and Johnson (1988), but they are considerably lower than van der Valk and Davis (1978). 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.

Survey of Aboveground Vegetation in Moist Soil Units.—Since the 1970s, 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).

Since the density and composition of seed banks in all 4 MSUs were fairly 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).

We found only limited similarities between the species composition and abundance of the seed bank and aboveground vegetation at CLWMA. Several species that were abundant in the seed bank were rare or absent in the aboveground vegetation. Similar results have been reported by others (Harper 1977, Collins and Wein 1995). For example, false pimpernel was the most abundant species in the seed bank, but it was very rare in our above ground vegetation sampling. During ground searches conducted early in the growing season, we found that false pimpernel was very abundant, but as other

taller plants (e.g. smartweeds, rice cut-grass etc.) began to shade out the smaller pimpernel it became less abundant. It is likely that the pimpernal took advantage of the readily available exposure immediately after drawdown and produced its seeds and then became less productive as the taller more robust plants began to shade it out. By the time we sampled in August, this species was gone. Several other reasons have been proposed to explain the greater diversity of species that are frequently found in seed banks, 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 favorable for their growth, and (3) terrestrial annual seeds often have long dormancy periods causing them to persist in wetland seed banks, an adaptive strategy for species that have only one opportunity to reproduce before they die (Schneider and Sharitz 1986).

The speed of the drawdowns likely had an effect on the MSUs at CLWMA. In this study we were able to conduct very slow drawdowns (2-3 weeks) which are favorable for the germination and growth of many species (Fredrickson 1991). The low abundance of cocklebur in the MSUs when compared to agriculture fields adjacent to the MSUs was likely due to these slow drawdowns. Fredrickson (1991), noted that fast drawdowns greatly increase the potential for cocklebur production in MSUs. By conducting slow drawdowns we were able to reduce the production of unwanted cockleburs.

The production of quality food plants for waterfowl and other marsh birds was excellent in the MSUs. Bellrose and Anderson (1943) found that rice cut-grass was the most important food plant species to waterfowl in the Illinois River Valley. This species

was the most common species in our vegetation sampling on the MSUs at CLWMA. Use of rice cut-grass by waterfowl at CLWMA has been noted by Wright (1978), who commonly found seeds in the gizzards of many species of ducks. Bellrose and Anderson (1943) also found that wild millet, sedges, and smartweeds were very important foods for waterfowl. All of these species were found commonly in the gizzards of the ducks that Wright (1978) examined at CLWMA. Wild millet, sedges, and smartweed were all very common species in our vegetation samples. The presence of these food plants and the heavy use of the MSUs by waterfowl suggest that these units are very important feeding sites for migratory waterfowl.

Utilization of Moist Soil Units by Birds.—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 birds including waterfowl, marsh birds, and shorebirds (Fredrickson and Reid 1988).

Moist soil units are known to attract a variety of wetland birds. Taylor (1977) found 92 species of birds using MSUs in southeastern Missouri. Gibbs et al. (1991) noted that wetlands in Maine were utilized by a variety of non-game birds. Even reconstructed or newly created moist soil habitats attract both waterfowl and non-game wetland birds. Horstman et al. (1998) observed several state endangered species using reclaimed mine ground converted into moist soil habitat in southern Illinois. Hickman (1994) found that use of a severely degraded wetland by all wetland birds increased dramatically after the wetland habitat was improved by clearing invading woody plants

and controlling water levels more efficiently. Wetland birds heavily used a newly constructed wetland in northeastern Michigan shortly after it was completed (Soulliere and Monfils 1996).

Moist soil management appears to provide a viable method of producing waterfowl habitat, while managing for plant community diversity. However, Taylor (1977) reported that managers often express concern that moist soil plants can not provide enough food for large concentrations of waterfowl, consequently, they often continue to prefer row crops to provide habitat for waterfowl. These concerns do not appear to be valid. Impoundments managed for moist soil plant production have been shown to hold greater densities of mallards during fall migration than flooded soybean and rice fields (Twedt and Nelms 1999). Wright (1978) found heavy use of native wetland plants as food by waterfowl in an earlier study conducted on the CLWMA. In this study, about 92% of the 1,215 gizzards taken from ducks harvested in the CLWMA contained native moist soil plants only and no row crop seeds (Wright 1978). This is particularly noteworthy considering that during the 1970's there were no areas within the CLWMA that were intensively managed for moist soil plant production and row crops dominated the area. At that time moist soil vegetation was probably available only on areas that were too wet to plant row crops.

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,

and Wehrle 1992). 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). Not only do managers have to consider managing for spatial heterogeneity to meet diverse habitat requirements of different avian species, but they also have to consider the changing seasonal needs of these species (Humburg et al 1999).

On CLWMA, habitat was provided for a wide array of birds by both early- and late-drawdowns. In some areas, the early-drawdown units produced thick stands of smartweed, beggar-ticks and rice cut-grass. After site personnel mowed small openings into this dense vegetation, a hemi-marsh condition was created. During the fall migration and wintering periods these mowed areas were used heavily by dabbling ducks. However, by spring migration most species of dabbling ducks utilized the late-drawdown units. This could be due to the heavy use of the more favorable early-drawdown units in the fall, and the subsequent depletion of the food resources in those units. Barstow (1957) found that use of ponds by dabbling ducks during spring migration dropped dramatically after heavy use in the fall had significantly reduced available food resources. Since both male and female mallards are known to feed on the most abundant and available foods (Combs and Fredrickson 1996, Gruenhafen and Fredrickson 1990) it is likely that this species would shift its use to late-drawdown units in the spring if these provided more abundant foods.

Diving ducks were more abundant on the study areas during the spring migration than the fall. Ring-necked ducks forage on a variety of invertebrates, insects, and plants during spring migration (Hohman 1985). Moist soil habitats provide abundant amounts of aquatic invertebrates available to feeding water birds (Wehrle 1992, Gray et al. 1999). Ring-necks and lesser scaup (*Aythya affinis)* are also known to feed in flooded fields in the spring (Bellrose 1980). During the spring censuses, 70% of the diving ducks were observed in the open areas of the late drawdown units.

The MSUs at CLWMA provided habitat for many wetland birds in the fall. Like Reid (1989) found in Missouri, rails were common in the dense vegetation of the early drawdown units. Great blue herons foraged the edge of the units for prey. Northern harriers were observed flying low over these units, presumably looking for prey, which might include injured ducks that hunters were unable to recover.

Use of the MSUs by marsh birds appeared to be higher in spring probably due to the heavy use of the CLWMA by waterfowl hunters in the fall. Yellow and black-crowned night herons, little blue herons, great egrets, snowy egrets, and least and American bitterns all used the MSUs for foraging and cover habitat.

The nests of least bitterns and pied-billed grebes were the first confirmed nests in Fayette County (Herkert 1992). Breeding of these species has been confirmed in northeastern Illinois, and in southern Illinois (Heidorn et al. 1991, Horstman et al. 1998). Horstman et al. (1998) found least bittern nests in cattail (*Typha spp.*) and reedgrass (*Phragmites australis*) while Weller (1961) found most bittern nests in *Typha, Scirpus, Carex,* and *Phragmites.* In contrast, nests at CLWMA were found in water smartweed

and buttonbush, suggesting that the species composition of the nest site may be less important than structural features.

Nest success of the least bittern at the CLWMA was higher than other studies done on least bitterns. Thirty-two of 38 (84%) nests were successful in a study conducted by Weller (1961). Horstman et al. (1998), found 8 nests containing 22 eggs of which 18 hatched (77%). Clutch size for the least bittern nests found in the study was consistent with that of the 115 nests in a variety of studies examined by Weller (1961) who found the mean clutch size to be 4.48. However, Horstman et al. (1998) reported smaller clutch sizes (mean = 3.1).

MANAGEMENT IMPLICATIONS

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 (Appendix C). This will provide habitat for food, cover, nesting, and brood rearing 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 importance of disturbance in MSUs cannot be overlooked. Disturbance sets back succession and allows the more desirable food and cover species for wildlife to maximize production and diversity (Fredrickson and Reid 1988). Successional trees such as willow and buttonbush are beginning to invade the MSUs at CLWMA. Although some trees within the units provide good roosting habitat for herons, large thick stands of these trees create more problems than benefits. These thick wooded areas shade and prevent the growth of more desirable herbaceous plants such as wild millets, smartweeds, sedges, and bulrushes.

Autumn tilling is known to produce the greatest seed mass, plant species diversity, and above ground standing crop during the subsequent growing season when compared to disking, mowing or no disturbance (Gray et al. 1999). However, since roto-tilling is tedious, disking can produce similar results, with less effort, on larger areas (Gray Et al. 1999).

Another management option is fire. Laubhan (1995) found that moist soil sites, which were burned in the spring, contained a higher proportion of rice cut-grass than either control sites or sites burned in the fall. Spring burns also reduced undesirable marsh elder, increased seed production and cover of beggar-ticks, and showed no effect on the production of smartweed.

However, some of the areas within the MSUs at CLWMA have large willows that can only be controlled by bulldozing or cutting down large willows and treating the cut stump with a suitable herbicide. These areas should receive top priority for controlling

woody invasive species at CLWMA. This control may mean periodically sacrificing a growing season in each unit; however, the long-term benefits of control outweighs these short-term losses. In addition, these disturbed areas may serve as habitat for shorebirds. For example, Laubhan (1995) burned portions of MSUs in the late summer, then created shorebird habitat by flooding the freshly burned area with a few centimeters of water. These large areas, devoid of vegetation, provided excellent habitat for shorebirds. The same idea could be used for areas that are disked late in the summer at CLWMA.

The creation of more impoundments for moist soil plant production within the CLWMA would benefit wildlife. This would allow for more habitat, and could make it easier to take one unit out of production for a year to control invading willows (Appendix C).

In conclusion, if the management goal at CLWMA continues to be the provision of diverse wetland ecosystems to provide habitat for a diverse assemblage of wildlife species, rather than management solely to provide habitat for dabbling ducks, this can be done by continuing to manage portions of the area for the production of moist soil plant communities. Carlyle Lake Wildlife Management Area is considered one of the best public waterfowl hunting sites in Illinois, but it also provides excellent habitat for a variety of marsh birds and other wetland wildlife. Additional research into the composition and function of restored wetlands may be crucial to further help managers optimize producion and diversity on this unique wetland complex.

LITERATURE CITED

Bailey, A. W. and C. E. Poulton. 1968. Plant communities and environmental relationships in a portion of the Tillamook burn, northwestern Oregon. Ecology 49:1-13.

Barstow, C. J. 1957. A comparative study of availability of waterfowl foods and waterfowl use on a series of clean and turbid farm ponds in Oklahoma. Proceedings of the 11th Annual Conference Southeastern Association of Fish and Game Commissioners. 11:364-372.

Bellrose, F. C. and H. G. Anderson. 1943. Preferential rating of duck food plants. Illinois Nat. Hist. Survey Bull.. 22:417-433.

Bellrose, F. C. 1980. The ducks, geese, and swans of North America. Stackpole, Harrisburg, Pennsylvania.

Benoit, D. L., N. C. Kenkel, and P. B. Cavers. 1989. Factors influencing the precision of soil seed bank estimates. Can. J. Botany 67:2833-2840.

Collins, B. and G. Wein. 1995. Seed bank and vegetation of a constructed reservoir. Wetlands 15:374-385.

Combs D. L. and L. H. Fredrickson. 1996. Foods used by male mallards wintering in southeastern Missouri. J. Wildl. Manage. 60:603-610.

Daubenmire, R. 1959. A canopy coverage method of vegetation analysis. Northwest Science 33:43-64.

Fredrickson, L. H. 1991. Strategies for water level manipulations in moist-soil systems. U.S. Fish Wildl. Serv. Leaflet 13.4.6. 8pp.

Fredrickson, L. H. and F. A. Reid. 1986. Wetland and riparian habitats: a nongame management overview. Pages 57-96 in J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the Midwest: a developing art. Northcentral Section, The Wildlife Society, Madison, WI.

Fredrickson, L. H. and F. A. Reid. 1988. Preliminary considerations for manipulating vegetation. U. S. Fish Wildl. Serv. Leaflet 13.4.9. 5pp.

Gibbs, J. P., J. R. Longcore, D. G. McAuley, and J. K. Ringelman. 1991. Use of wetland habitats by selected nongame waterbirds in Maine. U. S. Fish Wildl. Serv. Res. 9. 57pp.

Gibbs, J. P. and S. M. Melvin. 1997. Power to detect trends in waterbird abundance with call-response surveys. J. Wildl. Manage. 61:1262-1267.

Gray, M. J., R. M. Kaminski, G. Weerakkody, B. D. Leopold, and K. C. Jensen. 1999. Aquatic invertebrate and plant responses following mechanical manipulations of moist-soil habitat. Wildl. Soc. Bull. 27:770-779.

Gruenhagen, N. M. and L. H. Fredrickson. 1990. Food use by migratory female mallards in northeastern Missouri. J. Wildl. Manage. 54:622-626.

Harper, J. L. 1977. Population biology of plants. Academic Press, London. 373pp.

Heidorn, R. R., W. D. Glass, D. R. Ludwig, and M. A. R. Cole. 1991. Northeastern Illinois wetland survey for endangered and threatened birds. A summary of field data: 1980-1989. Natural Heritage General Technical Report #1. Illinois Department of Conservation. 156pp.

Herkert, J. R. 1992. Endangered and threatened species of Illinois: status and distribution, Volume 2 – Animals. Illinois Endangered Species Protection Board, Springfield, Illinois. 142 pp.

Hickman, S. 1994. Improvement of habitat quality for nesting and migrating birds at Des Plaines River Wetlands Demonstration project. Ecol. Engineering 3:485-494.

Hohman W. L. 1985. Feeding ecology of ring-necked ducks in northwestern Minnesota J. Wildl. Manage. 49:546-557.

Horstman, A. J., J. R. Nawrot, and A. Woolf. 1998. Mine-associated wetlands as avian habitat. Wetlands 18:298-304.

Humburg D. D., K. Bataille, D. L. Helmers, and D. A. brunet. 1999. Evaluation of seasonal habitat use by waterbirds on the Missouri River floodplain. Final Report for Federal Aid in Wildlife Restoration Act. Project No. W-13-R-53 (1999).

Johnson, R. G. and R. C. Anderson. 1986. The seed bank of a tallgrass prairie in Illinois. Am. Midl. Nat. 115:123-130.

Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and soil macronutrients. Wetlands 15:159-166.

Mohlenbrock, R. H. 1975. Guide to the vascular flora of Illinois. Southern Ill. Univ. Press, Carbondale. 494pp.

Murkin, H. R., E. J. Murkin, and J. P. Ball. 1997. Avian habitat selection and prairie wetland dynamics: a 10-year experiment. Ecol. Applications 7:1144-1159.

Poiani, K. A., and W. C. Johnson. 1989. Effect of hydroperiod on seed-bank composition in semi-permanent prairie wetlands. Can. J. Botany 67:856-864.

Reid, F. A. 1989. Differential habitat use by waterbirds in a managed wetland complex. Ph. D. Dissertation. University of Missouri-Columbia. 243pp.

Robinson, J. C. 1991. Bird utilization of wetland impoundments at Cross Creeks National Wildlife Refuge, Tennessee. J. Tennessee Acad. Sci. 66:201-204.

Schneider, R. L. and R. R. Sharitz. 1986. Seed bank dynamics in a southeastern riverine swamp. Am. J. Botany 73:1022-1030.

Soulliere, G. J. and M. J. Monfils. 1996. Waterbird use of a constructed wetland complex in eastern upper Michigan (Year 3). Michigan Department of Natural Resources, Wildlife Division Report No. 3262. 12pp.

Taylor, T. S. 1977. Avian use of moist soil impoundments in southeastern Missouri. M. S. Thesis University of Missouri-Columbia.

Twedt, D. J. and C. O. Nelms. 1999. Waterfowl density on agricultural fields managed to retain water in winter. Wildl. Soc. Bull. 27:924-930.

van der Valk, A. G. and C. B. Davis. 1976. The seed banks of prairie glacial marshes. Can. J. Botany 54:1832-1838.

van der Valk, A. G. and C. B. Davis. 1978. The role of seed banks in the vegetation dynamics of prairie glacial marshes. Ecology 59:322-335.

Wehrle, B. W. 1992. Invertebrate resources in Mississippi hardwoods bottomlands, moist soil habitat, and flooded cropland. M. S. Thesis. Mississippi State University. 141pp.

Weller, M. W. 1961. Breeding biology of the least bittern. Wilson Bull. 73:11-35.

Whitton, R. 1961. Waterfowl Management and development plan for Carlyle Lake State Fish and Wildlife Area. Illinois Department of Conservation. Upp. data.

Wolda, H. 1981. Similarity indices, sample size and diversity. Oekologia 50:296-302.

Wright, D. F. 1978. The consumer habits of waterfowl harvested from Carlyle Lake in 1978. Illinois Department of Conservation. Upp. data.

Table 1. Density of viable seeds in the seed banks 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	6895
Tooth-cup	2931	3226	3694	2561	3103
Rusty flatsedge	2438	3226	1576	1921	2290
Blunt spikerush	1453	1822	394	1872	1385
Smartweeds	2561	468	370	345	936
Red-root sedge	911	1108	862	247	782
Rice-cut grass	1773	123	394	197	622
Ditch stonecrop	936	714	99	99	462
Ponygrass	247	74	788	517	407
Butterweed	173	50	542	148	228
Water hemp	221	74	221	50	142
Barnyard grass	197	25	50	148	105
Sedge	25	0	222	0	62
Water plantain	50	0	99	50	50
Beggar-ticks	0	173	25	0	50
Cottonwood	50	25	50	0	31
Ash	25	25	0	25	19
Morning glory	74	0	0	0	19
Skullcap	25	0	25	0	13
Pickerel-weed	25	0	0	0	6
Narrow-leafed cat-tail	0	0	0	25	6
Shepard's-purse	0	0	25	0	6
Sandbar willow	25	0	0	0	6
TOTALS	17,095	21,648	14,140	17,612	17,625

[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

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

Table 3. Mean percent cover of wetland plant species in 4 moist soil units at Carlyle Lake Wildlife Management Area, Illinois during August, 2000.

	Percent cover			
	Early Drawdown		Late Drawdown	
Plant Species[1]	Unit B	Unit D	Unit A	Unit C
Rice-cut grass	1.1	14.9	50.8	0.01
Lemna sp.	0.01	2.7	21.0	30.4
Water primrose	74.7	1.5	3.3	0.0
Polygnum sp.	4.1	16.8	0.1	5.0
Buttonbush	5.7	3.0	4.5	2.1
Pondweed	0.0	0.0	0.4	7.8
Water plantain	0.2	11.1	0.0	0.0
Willow sp.	0.4	0.01	2.8	1.0
Sedges	0.4	14.9	0.0	0.0
Beggar-ticks	0.5	0.2	0.0	0.0
Barnyard grass	0.4	4.4	1.0	0.0
Arrowhead	1.1	0.0	1.3	0.0
Spikerush	0.8	6.6	0.0	0.0
Cocklebur	0.6	0.3	0.0	0.0
Ponygrass	0.0	4.6	0.0	0.0
Ash sp.	0.01	0.5	0.2	0.0
Cattail	2.1	0.0	0.0	0.0
Ammania sp.	0.01	2.1	0.0	0.0
Bulrush sp.	0.0	0.5	0.0	0.0
Scuttlaria	0.0	0.01	0.0	0.0

Table 3. (cont.)

False aster	0.0	0.03	0.0	0.0
Rose mallow	0.0	0.5	0.0	0.0
Lindernia	0.0	0.9	0.0	0.0
Panicum	0.0	1.2	0.0	0.0
Morning glory	0.0	0.1	0.0	0.0
Bare soil	0.0	8.9	0.0	0.0
Open water	0.0	0.0	13.0	52.6

Table 4. 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 5. 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

Table 5. (Cont.)

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)

Table 6. Total number of waterfowl and marsh birds observed in 4 moist soil units at Carlyle Lake Wildlife Management Area during 3 censuses conducted during fall migration, 30 October 2000 – 30 November 2000.

	Early Drawdown		Late Drawdown		
Species[1]	Unit B	Unit D	Unit A	Unit C	Total All Units
Am Coot	60	125	0	600	785
Wood Duck	2	160	0	30	192
Mallard	134	0	0	40	174
Gadwall	40	5	90	1	136
Great Blue Heron	13	12	4	12	41
Am Wigeon	35	0	0	0	35
Pied-billed Grebe	0	1	1	12	14
Black Duck	6	0	0	0	6
Ring Neck	2	0	0	0	2
Great Egret	2	0	0	0	2
TOTAL	294	303	95	695	1387

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. HERBACEOUS SPECIES

Alisma plantago-aquatica	Water plantain
Amaranthus hybridus	Water hemp
Ammannia robusta	Tooth-cup
Apocynum cannabinum	Dogbane
Aster Simplex	Panicled aster
Bidens aristosa	Bearded beggar-ticks
Bidens cernua	Nodding beggar-ticks
Bidens connata	Purplestem beggar-ticks
Bidens discoidea	Few bracted beggar-ticks
Bidens frondosa	Devils beggar-ticks
Bidens tripartia	Beggar-ticks
Bidens vulgata	Tall 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	Sedg

Appendix A. (cont.)

Cyperus erythrorhizos	Red-root flatsedge
Cyperus esculentus	Yellow nutsedge
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
Lemna minor	Duckweed
Leptochloa fascicularis	Sprangletop
Lindernia dubia	False pimpernel
Ludwigia peploides	Water primrose
Ludwigia polycarpa	False loosestrife
Lycopus americanus	Common water horehound
Panicum clandestinum	Deer-tongue grass
Penthorum sedoides	Ditch stonecrop
Polygonum amphibium	Water smartweed
Polygonum hydropiperoides	False water-pepper
Polygonum lapathifolium	Dock-leaved smartweed
Polygonum pensylvanicum	Pennsylvania smartweed
Potamogeton foliosus	Leafy pondweed
Potamogeton nodosus	Longleaf pondweed
Potentilla norvegica	Cinquefoil

Appendix A. (cont.)

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
Setaria viridis	Green bristlegrass
Solidago canadensis	Tall goldenrod
Spirodela polyrhiza	Ducksmeat
Typha latifolia	Common cat-tail
Veronica peregrina	Purslane-speedwell
Xanthium strumarium	Cocklebur

II. WOODY SPECIES

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 bicolor	Swamp white oak
Quercus lyrata	Overcup oak
Quercus macrocarpa	Bur oak
Quercus palustris	Pin oak
Salix interior	Sandbar willow
Salix nigra	Black willow

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. (cont.)

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
Empidonax traillii	Willow flycatcher
Empidonax alnorum	Alder flycatcher

Appendix B. (cont.)

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
Passerina cyanea	Indigo bunting
Phalacrocorax auritus	Double-crested cormorant
Pheucticus ludovicianus	Rose-breasted grosbeak
Picoides pubescens	Downy woodpecker

Appendix B. (cont.)

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
Tringa flavipes	Lesser yellowlegs
Tringa melanoleuca	Greater yellowlegs
Tringa solitaria	Solitary sandpiper
Troglodytes aedon	House wren
Turdus migratorius	American robin
Tyrannus tyrannus	Eastern kingbird

Appendix B. (cont.)

Vireo flavifrons	Yellow-throated vireo
Vireo gilvus	Warbling vireo
Zenaida macroura	Mourning dove
Zonotrichia querula	Harris' sparrow
Zonotrichia leucophrys	White-crowned sparrow

Appendix C. Seven year management plan for the moist soil units at Carlyle Lake Wildlife Management Area, Illinois.

Year	Impoundment A	B	C	D
2001	Early	Mid-season	Early	Late
2002	Late	Early	Early	Mid-season
2003	Early	Early	Late	Mid-season
2004	Mid-season	Late	Early	Early
2005	Early	Mid-season	Early	Late
2006	Early	Early	Late	Mid-season
2007	Late	Early	Early	Midseason

Early—Start drawdown April 15
Mid-season—Start drawdown June 1
Late—Allow water to evaporate out of impoundment. Water should remain until September 01.

OTHER MANAGEMENT CONCERNS:

-Large Willows and other woody growth must be controlled in each of these four impoundments at least once in the next 7 years. This may mean sacrificing a growing season in one of the impoundments for the sake of killing willows. Willows should be removed by sawing or bulldozing and then re-flooded completely inundating the remaining stumps to prevent re-growth of the willows.

-Drawdowns should be slow, daily process and carried out over 2-3 weeks.

-After the larger woody growth in each impoundment has been removed, impoundments should be disturbed if possible every 3 years, i.e. disking an early drawdown. This sets back succession and discourages growth of woody species.

-Late drawdowns should be allowed to evaporate out leaving at least some water in the sub impoundment until at least September 01. This allows for nesting least bitterns and other marsh birds to hatch and raise their young, and it also provides brood habitat for wood ducks, Canada geese, and other waterfowl broods.

-Refer to: Fredrickson, L.H., and T.S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. Resource Publication 148, U.S. Fish and Wildlife Service, Washington, DC. 29pp. for any management questions.

Appendix C. (cont.)

BREAKDOWN OF EACH IMPOUNDMENT:

Impoundment A: ~200 acres. This impoundment has excellent production in the southwest corner where the old agriculture fields are. These areas should be disked every 2-4 years to control any invasion by woody growth. The north half of this impoundment is dominated by large trees and probably can not be managed effectively for moist soil management unless these trees could somehow be removed. The southeast side of this impoundment should have the woody growth removed to maximize production of this unit.

Impoundment B: ~230 acres. This impoundment has widespread willows that should be controlled immediately. Production of wetland plants is good in areas that are not dominated by willows.

Impoundment C: ~250 acres. This impoundment has excellent potential, its production has been excellent in the last 2 years. However, woody control must be started as soon as possible. The west half of this impoundment is the largest most open area of all the moist soil areas, but it has been invaded by willows and buttonbush. These willows and buttonbush should be controlled as soon as possible. The east half of this impoundment is dominated by large trees and can not be effectively managed for moist soil plants. Woody encroachment from the east side into the west side of this impoundment should be pushed back as far as possible.

Impoundment D: ~125 acres. Large willows and trees dominate this impoundment. The old agriculture fields remain open and should be kept open at all costs. Woody growth on the west side of this impoundment should be removed to provide more acres for effective moist soil management.