

BIRD UTILIZATION OF WETLAND IMPOUNDMENTS AT CROSS CREEKS NATIONAL WILDLIFE REFUGE, TENNESSEE

JOHN C. ROBINSON
1470 Creekside Drive #23
Walnut Creek, CA 94596

ABSTRACT

From 7 July 1989 to 15 June 1990, 1861 bird observations were recorded at seven wetland impoundments on Cross Creeks National Wildlife Refuge in Stewart County, Tennessee. For most observations made from early October through 15 June, each bird observation was assigned to one of 19 activity categories. A list of 159 different bird species was compiled. Ten species groups were identified, and 15 rare or vagrant species were listed.

Feeding, resting, and flying were the three most common activities. Waterfowl were observed feeding and resting much more frequently than any of the other species groups. Feeding was also important to the shorebirds-gulls-terns group, especially the shorebirds. Raptors were observed flying more frequently than any of the other species groups. Overall, 300 times as many individuals were observed feeding as flying. Pools 2 and 4 were the most frequently utilized impoundments. Waders were most often found at sites having escape/temporary roost sites, and localized concentrations of fish caused by receding water levels. Pool 4 supported the highest number of waterfowl, raptor, and passerine species. Pools 2 and 4 were the two most important impoundments to the shorebirds-gulls-terns group.

INTRODUCTION

Cross Creeks National Wildlife Refuge (hereinafter "Refuge"), which is managed by the U.S. Dept. of Interior's Fish and Wildlife Service (FWS), initiated a three-year study of the Refuge's wetland management program in 1985. That study sought to analyze the vegetative communities and wildlife species that responded to the manipulation of seasonally flooded impoundments for the expressed purpose of encouraging the growth of plant species associated with mudflats and similar habitats. The results of the study, and two follow-up studies conducted in 1988 and 1989-90, have been prepared as U.S. FWS in-house reports (Robinson 1988, Ferrell 1988, Hale 1990). The data upon which this manuscript is based were extracted from the 1989-90 report.

The Refuge's primary mission is to provide food, water, and refuge for migrating and wintering populations of geese and ducks. Since 1981 the specific practice of managing impoundment water levels to encourage the growth of "moist soil" plants has been employed annually at the Refuge, as a supplement to traditional management practices (e.g., row-cropping) used to achieve waterfowl management objectives. Fredrickson and Taylor (1982) gave some examples of birds that responded to moist soil management in the Midwest.

The goals of this paper are to illustrate how certain impoundments are utilized by birds found on the Refuge, and to depict the wide array of species which respond to the management of wetland impoundments.

STUDY AREA AND METHODS

The Refuge consists of 3586 ha astride the Cumberland River in Stewart County, in northwestern Middle Tennessee. Its interior supports rich bottomlands along the river, while rolling hills and rocky bluffs characterize the outer boundary. Deciduous woodlands dominate many of the surrounding hillsides. Refuge wetland impoundments include 16 managed pools that range in size from 4 to 147 ha, and total about 405 ha (see Figure 1 and Appendix B).

Legend

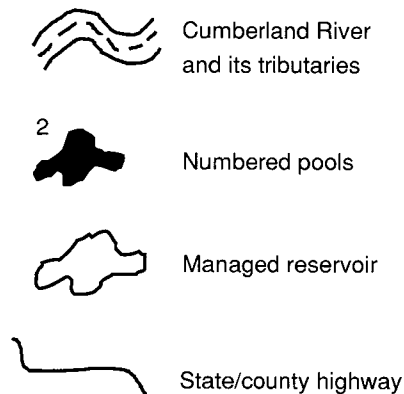


Figure 1. Managed impoundments of Cross Creeks National Wildlife Refuge, Stewart County, TN.

Bird activity within or adjacent to seven of the managed pools was recorded between 7 July 1989 and 15 June 1990. Selected for study were Pools 1, 2, 3, 4, 7, 8, and 12. Weekly bird surveys and opportunistic observations were used to gather the data. The numbers of visits made to each pool were: 31 at Pool 3, 38 at Pool 1, 40 at Pool 7, 41 at Pools 8 and 12, 48 at Pool 2, and 57 at Pool 4.

All birds found within, immediately adjacent to, or flying over the wetland impoundments were identified. The date, location, species, and number of individuals were recorded for each observation. In early October, 19 activity categories were established, and thereafter the activity of each individual or group of individuals encountered was recorded for most sightings through the end of the survey period.

The species found during the study were assigned to one of 10 groups for analysis. These groups closely followed phylogenetic relationships. A specific analysis of three activity categories (feeding, flying, and resting) was conducted using the 10 species groups and

pool locations as bases for comparison. The relative importance of each of the seven pools to the 10 species groups was also explored. Fifteen rare or vagrant species were listed and are discussed. A statistical analysis of the data was not attempted due to changes made in the protocol used for data collection and the varied degree of adherence (across observers) to such protocol(s) throughout the study period.

Readers who closely monitor the state list of Tennessee birds should note that some sightings of rare species have not been subjected to the formal review process normally used for authentication prior to publication. These sightings were made by several individuals with various levels of expertise. I weighed a number of factors for each noteworthy sighting, and omitted several sightings which seemed questionable.

The nomenclature of all species discussed follows the 6th edition of the Check-list of North American Birds and its supplements (American Ornithologists' Union 1983, 1985, 1989).

RESULTS AND DISCUSSION

Between 7 July 1989 and 15 June 1990, 1861 bird observations of 159 species were made at the seven pools studied. The 159 species were categorized into 10 groups as follows: grebes and cormorants; waders; waterfowl; raptors; gallinaceous birds; rails; woodpeckers; passerine birds; shorebirds, gulls, and terns; and doves, cuckoos, owls, hummingbirds, and kingfishers (Appendix A, Table 1).

Table 1. Representation by species group at each of the surveyed impoundments.

Species Group	Total number of species observed during study	Number of species at each pool						
		Pool 1	Pool 2	Pool 3	Pool 4	Pool 7	Pool 8	Pool 12
Grebes and Cormorants	3	1	1	0	2	2	1	0
Waders	8	4	7	2	7	4	5	2
Waterfowl	23	17	14	11	22	14	13	12
Raptors	13	4	6	3	10	6	7	8
Gallinaceous Birds	2	1	1	1	2	1	1	2
Rails	6	1	4	0	2	1	1	1
Shorebirds/Gulls/Terns	22	7	13	6	12	6	4	6
Doves/Cuckoos/Owls/Hummingbirds/Kingfishers	6	1	3	2	5	2	3	2
Woodpeckers	7	0	1	0	7	1	2	1
Passerine Birds	69	12	20	8	58	8	20	12

Analysis of Bird Activity

Except for the "no activity" category, feeding, flying, and resting were the three activity categories to which a bird observation was most frequently assigned (Table 2). About half of the observations were not assigned to activity categories, primarily because the practice of describing an observed bird's activity was not implemented until October. Other than noting presence or absence of a species, observations assigned to the category of no activity serve little purpose and will not be discussed further.

Table 2 shows that 52 species of birds were observed feeding in

Table 2. Summary of data on 19 activity categories used in the study.

Activity category name	Total number of observations made for each activity category	Total number of species recorded for each activity category
Feeding	489	52
Feeding and Resting	58	13
Feeding and Flying	17	6
Feeding, Resting, and Flying	2	1
Feeding and Swimming	8	4
Feeding and Wading	1	1
Flying (Hovering)	128	36
Nesting	2	2
Perched	20	11
Perched and Flying	1	1
Resting (Standing)	229	37
Resting and Wading	2	2
Resting and Swimming	2	1
Resting and Flying	9	6
Swimming	11	6

Refuge impoundments. The corresponding totals for the flying and resting categories are 36 and 37, respectively. A closer analysis of these data shows a few trends, as depicted in Tables 3 and 4. For example, waterfowl, raptors, passerine birds, and shorebirds/gulls/terns were the four groups most often represented in the data. Moreover, waterfowl were observed feeding and resting much more frequently than any other group. Feeding was also common in the shorebirds/gulls/terns group, especially the shorebirds. Raptors were more frequently observed flying than any other group. The activity of passerine birds was usually not recorded, but it is important to note the many species representing this group that were encountered during the study.

Table 3. The number of species recorded under the three major activity categories (feeding, resting, and flying).

Species group	Total number of species observed during study	Number of species observed by activity category		
		Feeding	Resting	Flying
Grebes and Cormorants	3	1	2	0
Waders	8	4	4	3
Waterfowl	23	21	18	8
Raptors	13	1	2	9
Gallinaceous Birds	2	2	0	0
Rails	6	1	1	0
Shorebirds/Gulls/Terns	22	9	4	2
Doves/Cuckoos/Owls/Hummingbirds/Kingfishers	6	3	1	3
Woodpeckers	7	0	0	2
Passerine Birds	69	10	5	9
Totals	159	25	26	25

Table 4. Distribution of observations by impoundment for each of the three major activity categories (feeding, resting, and flying).

Activity Category	Total number of observations recorded	Total number of individuals per category	Number of records for each pool							
			Pool 1	Pool 2	Pool 3	Pool 4	Pool 7	Pool 8	Pool 12	
Feeding	489	223,183	57	68	67	104	77	62	54	
Resting	229	37,882	21	30	21	84	16	30	27	
Flying	128	721	7	8	3	35	15	31	29	
Totals	846	261,786	85	106	91	223	108	123	110	

Table 4 displays the number of observations by impoundment for each major activity category. Consistent with the Refuge's primary mission, feeding was the predominant activity recorded at each pool. Although the ratio of the total number of observations for the three major categories was 4:2:1 (feeding:resting:flying), the *total number of individuals* observed feeding was over 300 times greater than the number observed flying. The percentage of birds observed in flight was relatively higher at Pools 8 and 12.

A discussion of the trends noted above is in order. It is not surprising that waterfowl, raptors, passerines, and the shorebirds-gulls-terns group dominate the list of species found at these impoundments which are specifically managed for waterfowl and therefore attract a diverse array of ducks and geese. Shorebirds, gulls, and terns depend on water to meet most of their life cycle requirements and regularly occur at wetland sites such as those found on the Refuge; shorebirds in particular show an immediate response to the availability of mudflats during the summer and early fall when water levels are lowered to promote moist soil plant development.

The passerines recorded include a diverse assortment of mostly nongame species that respond positively to open or edge habitats (Blue Jay, Eastern Kingbird, American Pipit, Common Yellowthroat, Indigo Bunting, Northern Cardinal, etc.), or species that frequently occur in the vegetation growing on the dry or moist soils of impoundments in the fall prior to flooding. The list of raptors encountered during this survey includes species that readily utilize carrion (including dead or dying waterfowl), species that regularly prey on fish, and species whose diet is composed partly or largely of small birds (including sparrows and shorebirds). Raptors were most frequently noted in flight probably because they are conspicuous as they search open areas for prey or seek shelter from disturbance.

Many of the needs of the four groups discussed above can obviously be met near or within these wetland impoundments.

Relative Importance of Impoundments to Different Bird Species

Table 1 lists the number of bird species encountered at each pool. Of the 159 species recorded during the study, 127 (79%) were found at Pool 4. Overall, Pools 2 and 8 were also important to a variety of species.

Waders tended to concentrate in areas with nearby escape cover or roost sites (e.g., willow [*Salix*] trees) and receding water levels during the summer or early fall. These conditions existed at Pools 2, 4, 7, and 8. For example, Refuge staff began lowering water levels in Pool 2 on 24 July, and by 12 September 65% of the area was dewatered and only a small pool of water persisted at the western end of the impoundment. These conditions probably caused a concentration of small minnows and other fish upon which the waders fed. Similar conditions occurred

at Pool 7, which was drained between late July and 9 September, and at Pool 8, which was drained in early July and had water over only one-third to one-half of its surface area by mid-September. Conversely, Pool 3, which was dry from July through early November, supported only two species of waders. These results indicate that the presence of wading birds at each of these impoundments was closely tied to the management strategies implemented at each site (i.e., the mere presence of the impoundment did not guarantee that it would be regularly used by a particular species or species group).

Pools 1 and 4 supported the greatest diversity of waterfowl species. Twenty-two of the 23 waterfowl species encountered were recorded at Pool 4. This pool, the largest of the Refuge's 16 managed pools, supports the widest range of water depths and associated shoreline habitats. These factors, in combination with waterfowl management practices, account for its attractiveness to many species of ducks and geese. The many raptors at pool 4 (Table 1) were probably attracted by the wide array of ducks, geese, and small birds and mammals that were, in turn, attracted by the pool's diverse habitats.

Pools 2 and 4 provided habitat for many of the gulls, shorebirds, and terns. The lowering of water levels in Pool 2 during July, and the exposure of a large sandbar in the western end of Pool 4 during the summer and fall (when water levels receded), accounted for many of the shorebird and tern records.

All of the woodpeckers and most of the passerines were also recorded at Pool 4, probably in part because of the rich vegetative habitat diversity along the shoreline of Pool 4; these data may also be biased by the comparatively larger number of opportunistic surveys made at Pool 4 by Refuge volunteers.

The dense vegetative structure provided by moist-soil plants in the fall prior to flooding is important to many nongame species that use wetlands, marshes, or related habitats in migration. The Le Conte's sparrow, sharp-tailed sparrow, marsh wren, swamp sparrow and various other sparrows, blackbirds, rails, and other species seek food, shelter, and refuge in such areas.

Rare or Vagrant Species

The status of each species encountered was compared with the list compiled by Robinson and Blunk (1989). Fifteen rare or vagrant species were identified (Table 5). Species that are rare but becoming more regularly seen at the Refuge include the Snowy Egret, Greater White-fronted Goose, Black-bellied Plover, American Avocet, Willet, and Sharp-tailed Sparrow. At least one Eurasian Wigeon has appeared at the Refuge annually from 1983 through 1987 (Robinson 1990). There is only one previous sighting each for Yellow Rail, Cinnamon Teal, and King Rail in Stewart County, all from Refuge impoundments. Of the three known previous records of Franklin's Gulls in the county, only one has acceptable details. The one Redhead record represents one of very few summer sightings for the state. The Roseate Spoonbill was seen by many observers, was well documented, and represents the second state record. The Yellow-headed Blackbird has not been previously documented for Stewart County.

All of these rare or vagrant species are typically found on or near water, although Yellow Rails and Sharp-tailed Sparrows are occasionally found in drier, upland fields. These records suggest that management of wetland impoundments such as the managed pools found at the Refuge could help meet the needs of some sensitive species of special concern at the state level (e.g., King Rail, Common Moorhen, and Snowy Egret) or of species suffering from declining wetland habitat throughout all or part of their migratory range (this latter group includes most of those species listed in Table 5).

Table 5. Summary of rare or vagrant species occurring at wetland impoundments during the survey period.

Species name	Date observed	Number seen
Snowy Egret	21 July 1989	9
Snowy Egret	23 July 1989	2
Snowy Egret	29 July 1989	4
Roseate Spoonbill	23-24 July 1989	1
Greater White-fronted Goose	19 Sept., 12 Oct., 28 Dec. 1989	3-5
Cinnamon Teal	5-15 April 1990	1-2
Eurasian Wigeon	2 November 1989	1
Redhead	24 July 1989	2
Yellow Rail	22 October 1989	1
King Rail	1 October 1989	1
Common Moorhen	2 May 1990	1
Black-bellied Plover	1 October 1989	7
American Avocet	30 October 1989	1
Willet	10 September 1989	1
Willet	5 October 1989	1
Franklin's Gull	24 July 1989	1
Sharp-tailed Sparrow	1, 20 October 1989	1
Yellow-headed Blackbird	11-15 April 1990	1

CONCLUDING COMMENTS

Awareness of the bird species using wetland impoundments in our area is growing. Wetland managers have a unique opportunity to provide a range of wetland habitats that simultaneously meet the needs of various species groups or species guilds. For example, by maintaining one impoundment in a fully flooded condition throughout the spring and summer while another impoundment is drawn down, habitat is produced that could potentially meet the needs of resident nesting species (rails, bitterns, and ducks) as well as migratory waders, shorebirds, terns, and nongame passerines.

The methods used in this study are also useful in determining the effectiveness of a refuge management program. As discussed, feeding and resting were the two dominant activity categories, especially among waterfowl species. But if a survey were to find that flying outranked other activity categories, it should alert wetland managers to consider that they may need to change wetland management strategies; perhaps disturbance by public use activities, activities on adjacent private land, or a lack of suitable feeding sites is preventing waterfowl from finding the food or sanctuary they require.

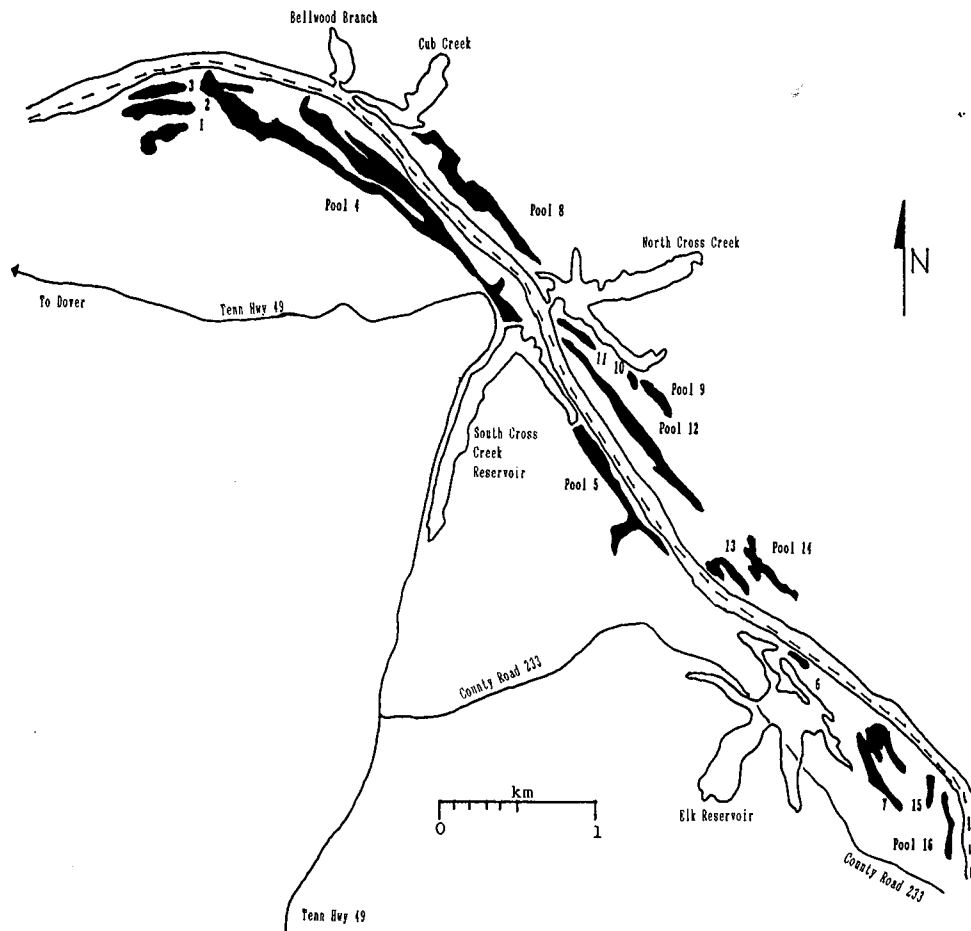
ACKNOWLEDGMENTS

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Appendix A.**Species recorded at wetland impoundments during the survey period.**

Pied-billed Grebe <i>Podilymbus podiceps</i>	Ruby-throated Hummingbird <i>Archilochus colubris</i>
Horned Grebe <i>Podiceps auritus</i>	Belted Kingfisher <i>Ceryle alcyon</i>
Double-crested Cormorant <i>Phalacrocorax auritus</i>	Red-headed Woodpecker <i>Melanerpes erythrocephalus</i>
Great Blue Heron <i>Ardea herodias</i>	Red-bellied Woodpecker <i>Melanerpes carolinus</i>
Great Egret <i>Casmerodius albus</i>	Yellow-bellied Sapsucker <i>Sphyrapicus varius</i>
Snowy Egret <i>Egretta thula</i>	Downy Woodpecker <i>Picoides pubescens</i>
Little Blue Heron <i>Egretta caerulea</i>	Hairy Woodpecker <i>Picoides villosus</i>
Cattle Egret <i>Bubulcus ibis</i>	Northern Flicker <i>Colaptes auratus</i>
Green-backed Heron <i>Butorides striatus</i>	Pileated Woodpecker <i>Dryocopus pileatus</i>
Black-crowned Night-Heron <i>Nycticorax nycticorax</i>	Willow Flycatcher <i>Empidonax traillii</i>
Roseate Spoonbill <i>Ajaia ajaja</i>	Eastern Phoebe <i>Sayornis phoebe</i>
Greater White-fronted Goose <i>Anser albifrons</i>	Eastern Kingbird <i>Tyrannus tyrannus</i>
Snow Goose <i>Chen caerulescens</i>	Horned Lark <i>Eremophila alpestris</i>
Canada Goose <i>Branta canadensis</i>	Tree Swallow <i>Tachycineta bicolor</i>
Wood Duck <i>Aix sponsa</i>	Northern Rough-winged Swallow <i>Stelgidopteryx serripennis</i>
Green-winged Teal <i>Anas crecca</i>	Cliff Swallow <i>Hirundo pyrrhonota</i>
American Black Duck <i>Anas rubripes</i>	Barn Swallow <i>Hirundo rustica</i>
Mallard <i>Anas platyrhynchos</i>	Blue Jay <i>Cyanocitta cristata</i>
Northern Pintail <i>Anas acuta</i>	American Crow <i>Corvus brachyrhynchos</i>
Blue-winged Teal <i>Anas discors</i>	Carolina Chickadee <i>Parus carolinensis</i>
Cinnamon Teal <i>Anas cyanoptera</i>	Tufted Titmouse <i>Parus bicolor</i>
Northern Shoveler <i>Anas clypeata</i>	Red-breasted Nuthatch <i>Sitta canadensis</i>
Gadwall <i>Anas strepera</i>	White-breasted Nuthatch <i>Sitta carolinensis</i>
Eurasian Wigeon <i>Anas penelope</i>	Brown Creeper <i>Certhia americana</i>
American Wigeon <i>Anas americana</i>	Carolina Wren <i>Thryothorus ludovicianus</i>
Canvasback <i>Aythya valisineria</i>	Winter Wren <i>Troglodytes troglodytes</i>
Redhead <i>Aythya americana</i>	Marsh Wren <i>Cistothorus palustris</i>
Ring-necked Duck <i>Aythya collaris</i>	Golden-crowned Kinglet <i>Regulus satrapa</i>
Lesser Scaup <i>Aythya affinis</i>	Ruby-crowned Kinglet <i>Regulus calendula</i>
Common Goldeneye <i>Bucephala clangula</i>	Eastern Bluebird <i>Sialia sialis</i>
Bufflehead <i>Bucephala albeola</i>	Hermit Thrush <i>Catharus guttatus</i>
Hooded Merganser <i>Lophodytes cucullatus</i>	American Robin <i>Turdus migratorius</i>
Common Merganser <i>Mergus merganser</i>	Northern Mockingbird <i>Mimus polyglottos</i>
Red-breasted Merganser <i>Mergus serrator</i>	Brown Thrasher <i>Toxostoma rufum</i>
Black Vulture <i>Coragyps atratus</i>	American Pipit <i>Anthus rubescens</i>
Turkey Vulture <i>Cathartes aura</i>	Cedar Waxwing <i>Bombycilla cedrorum</i>
Osprey <i>Pandion haliaetus</i>	European Starling <i>Sturnus vulgaris</i>
Bald Eagle <i>Haliaeetus leucocephalus</i>	White-eyed Vireo <i>Vireo griseus</i>
Northern Harrier <i>Circus cyaneus</i>	Tennessee Warbler <i>Vermivora peregrina</i>
Cooper's Hawk <i>Accipiter cooperii</i>	Chestnut-sided Warbler <i>Dendroica pensylvanica</i>
Red-shouldered Hawk <i>Buteo lineatus</i>	Magnolia Warbler <i>Dendroica magnolia</i>
Red-tailed Hawk <i>Buteo jamaicensis</i>	Yellow-rumped Warbler <i>Dendroica coronata</i>
Rough-legged Hawk <i>Buteo lagopus</i>	Black-throated Green Warbler <i>Dendroica virens</i>
Golden Eagle <i>Aquila chrysaetos</i>	Blackburnian Warbler <i>Dendroica fusca</i>
American Kestrel <i>Falco sparverius</i>	Pine Warbler <i>Dendroica pinus</i>
Merlin <i>Falco columbarius</i>	Palm Warbler <i>Dendroica palmarum</i>
Peregrine Falcon <i>Falco peregrinus</i>	Bay-breasted Warbler <i>Dendroica castanea</i>
Wild Turkey <i>Meleagris gallopavo</i>	Black-and-white Warbler <i>Mniotilta varia</i>
Northern Bobwhite <i>Colinus virginianus</i>	American Redstart <i>Setophaga ruticilla</i>
Yellow Rail <i>Coturnicops noveboracensis</i>	Prothonotary Warbler <i>Protonotaria citrea</i>
King Rail <i>Rallus elegans</i>	Common Yellowthroat <i>Geothlypis trichas</i>
Virginia Rail <i>Rallus limicola</i>	Scarlet Tanager <i>Piranga olivacea</i>
Sora <i>Porzana carolina</i>	Northern Cardinal <i>Cardinalis cardinalis</i>
Common Moorhen <i>Gallinula chloropus</i>	Blue Grosbeak <i>Guiraca caerulea</i>
American Coot <i>Fulica americana</i>	Indigo Bunting <i>Passerina cyanea</i>
Black-bellied Plover <i>Pluvialis squatarola</i>	Rufous-sided Towhee <i>Pipilo erythrophthalmus</i>
Lesser Golden-Plover <i>Pluvialis dominica</i>	Chipping Sparrow <i>Spizella passerina</i>
Semipalmated Plover <i>Charadrius semipalmatus</i>	Field Sparrow <i>Spizella pusilla</i>
Killdeer <i>Charadrius vociferus</i>	Vesper Sparrow <i>Poocetes gramineus</i>
American Avocet <i>Recurvirostra americana</i>	Savannah Sparrow <i>Passerculus sandwichensis</i>
Greater Yellowlegs <i>Tringa melanoleuca</i>	Le Conte's Sparrow <i>Ammodramus leconteii</i>
Lesser Yellowlegs <i>Tringa flavipes</i>	Sharp-tailed Sparrow <i>Ammodramus caudatus</i>
Solitary Sandpiper <i>Tringa solitaria</i>	Song Sparrow <i>Melospiza melodia</i>
Willet <i>Catoptrophorus semipalmatus</i>	Lincoln's Sparrow <i>Melospiza lincolni</i>
Spotted Sandpiper <i>Actitis macularia</i>	Swamp Sparrow <i>Melospiza georgiana</i>
Sanderling <i>Calidris alba</i>	White-throated Sparrow <i>Zonotrichia albicollis</i>
Semipalmated Sandpiper <i>Calidris pusilla</i>	White-crowned Sparrow <i>Zonotrichia leucophrys</i>
Least Sandpiper <i>Calidris minutilla</i>	Dark-eyed Junco <i>Junco hyemalis</i>
Pectoral Sandpiper <i>Calidris melanotos</i>	Bobolink <i>Dolichonyx oryzivorus</i>
Short-billed Dowitcher <i>Limnodromus griseus</i>	Red-winged Blackbird <i>Agelaius phoeniceus</i>
Common Snipe <i>Gallinago gallinago</i>	Eastern Meadowlark <i>Sturnella magna</i>
Franklin's Gull <i>Larus pipixcan</i>	Yellow-headed Blackbird <i>Xanthocephalus xanthocephalus</i>
Ring-billed Gull <i>Larus delawarensis</i>	Common Grackle <i>Quiscalus quiscula</i>
Herring Gull <i>Larus argentatus</i>	Brown-headed Cowbird <i>Molothrus ater</i>
Caspian Tern <i>Sterna caspia</i>	Orchard Oriole <i>Icterus spurius</i>
Common Tern <i>Sterna hirundo</i>	Pine Siskin <i>Carduelis pinus</i>
Forster's Tern <i>Sterna forsteri</i>	American Goldfinch <i>Carduelis tristis</i>
Rock Dove <i>Columba livia</i>	House Sparrow <i>Passer domesticus</i>
Mourning Dove <i>Zenaidura macroura</i>	
Yellow-billed Cuckoo <i>Coccyzus americanus</i>	
Great Horned Owl <i>Bubo virginianus</i>	

Appendix B.
Detailed descriptions of each pool surveyed during the study.



Pool No.	Size (ha) ¹	Pool description
1	13	A levee divided Pool 1 into upper and lower units. This pool was dewatered on 24 July 1989. Browntop millet (<i>Panicum ramosum</i>) and milo (<i>Sorghum</i> sp.) were aerially seeded across the pool on 29 July 1989. Common plant species found in the upper unit were nutsedge (<i>Cyperus</i> sp.), ponygrass (<i>Eragrostis hypnoides</i>), and browntop millet; predominant species in the lower unit were red-rooted sedge (<i>Cyperus erythrorhizos</i>), other nutsedge species, and ponygrass. The milo reached about one meter in height and seeded out in October. Water levels were raised to full pool by 12 December 1989.
2	16	Most of Pool 2 was west of the main refuge road and connected to Pool 4 by a ditch east of the main road. In late July water levels were lowered and the impoundment was aerially seeded with browntop millet and milo. These two species, and cocklebur (<i>Xanthium strumarium</i>), comprised over 90% of the vegetation found during the September plant survey. Buttonbush (<i>Cephalanthus occidentalis</i>) and willow (<i>Salix</i> sp.) were scattered at the upper end of the pool (on the east side of the main road) and provided roosting habitat for several species of herons and egrets. Raising of water levels began on 7 December 1989.
3	16	Adjacent to the Cumberland River. Predominant plant species included Japanese millet (<i>Echinochloa crusgalli</i>), duckwheat (<i>Fagopyrum tartaricum</i>), and smartweed (<i>Polygonum</i> sp.). Cocklebur was dense in some areas and hindered growth of the smartweed; the tops of the cocklebur were cut in September to stimulate smartweed growth. Raising of water levels began on 7 December 1989.
4	191	The largest and most diverse of the managed pools on the refuge. Aerial seeding of browntop millet and milo was conducted on 29 July 1989. Nutsedge, ponygrass, and <i>Leptochloa</i> sp. were commonly found along the impoundment edge. Japanese millet, duckwheat, Bidens, smartweed, and fall panicum (<i>Panicum dichotomiflorum</i>) were among the other species that did well in various areas of the impoundment. Water levels varied in the impoundment throughout the study period.
7	45	In the southeast corner of the refuge and adjacent to the Cumberland River. Aerial seeding of browntop millet and milo was conducted on 29 July 1989. Water levels began dropping in late July and the impoundment was dry by early September. Cocklebur, smartweed, and <i>Leptochloa</i> sp. were the predominant species in the pool. The browntop millet and milo failed, probably due to the dryness of the soil. Raising of the water levels began in early November.
8	101	One of two pools located on the north side of the Cumberland River. Water levels were lowered in early July. Aerial seeding of browntop millet and milo was conducted on 29 July 1989. The upper portion of this pool had dense stands of smartweed and nutsedge, with an understory of ponygrass. Nutsedge and fall panicum, with an understory of ponygrass, dominated the lower portion of the pool. Browntop millet did not succeed, and milo occurred in notable amounts only in the lower portion of the pool. Buttonbush and willow occurred along the edges of the pool.
12	49	On the north side of the Cumberland River, this pool was long and narrow. Water levels were lowered in early July. Aerial seeding of browntop millet and milo was conducted on 29 July 1989; however, this seeding was unsuccessful. Nutsedge and ponygrass were the predominant species of plants found in the impoundment.

¹Values listed are approximate; actual sizes of impoundments varied with changes in water level.

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