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## BIRD OBSERVATIONS IN FIVE AGRICULTURAL FIELD TYPES OF THE EVERGLADES AGRICULTURAL AREA IN SUMMER AND FALL

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**Abstract.**—The Everglades Agricultural Area (EAA) is a 280,000 ha segment of former Everglades that was drained early in this century and converted to agricultural cultivation. It is near natural Everglades habitat; however, the wildlife of this area remains relatively unknown. We surveyed 18 sites in five agricultural field types for bird presence and abundance from mid-June to December 1999. We compared these EAA sites with four sites at the adjacent Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR) and tallied 4,005 individuals and 72 species within the 9 sites. Flooded habitats such as rice and fallow flooded fields contained a larger numbers of birds and higher species diversity than terrestrial habitats (cane, sod, fallow fields) within the EAA. However, each field type supports a unique assemblage of species and contributes to overall avian diversity of the area. We recommend that flooded habitats be expanded within the EAA, especially on idle lands. There is a need for further study and the inclusion of wildlife in agricultural and restoration planning in the area.

Located between the southern perimeter of Lake Okeechobee and the northern extent of remaining Everglades marsh, the Everglades Agricultural Area (EAA) presents a unique opportunity in which to study wildlife in an agricultural landscape. Despite its prominent place in potential Everglades restoration activities, both as a source of pollution and as an example of wetland destruction (Snyder and David-

son 1994), the EAA has been little studied by wildlife researchers. Extensive documentation of wading bird species in surrounding Lake Okeechobee, Water Conservation Areas, and Everglades National Park exists from both recent studies (Crozier and Gawlik 2003, Russell et al. 2002, Ogden 1994, Smith 1994, Zaffke 1984) and early records of National Audubon wardens (Ogden 1978). Mention of the EAA in this literature is scarce. Smith (1994) included the EAA when he noted the use of sugarcane irrigation ditches by foraging Great Egrets (*Ardea alba*) and Snowy Egrets (*Egretta thula*) from one of the Lake Okeechobee colonies. David (1994) hypothesized that drainage and cultivation of EAA lands resulted in the expansion of Cattle Egrets (*Bubulcus ibis*) observed at Lake Okeechobee in the 1970s.

Although studies have documented habitat use in the EAA, these concentrated on a few areas known to provide habitat. For instance, Townsend (2000) and Turnbull et al. (1989a) documented bird use of rice, while Sykes and Hunter (1978) censused flooded, fallow fields. No study has been made of bird or other wildlife activity in sugarcane or terrestrial habitats that cover the bulk of the EAA landscape. We attempt to provide a representative census of birds in the EAA by providing data on wild birds in five agricultural field types.

#### STUDY AREA

The EAA is a 280,000-ha area of drained agricultural lands that represents approximately 1/7 of the original 1,900,000-ha Everglades habitat (Izuno and Bottcher 1994). This region is bordered by Lake Okeechobee to the north and by Water Conservation Areas 1, 2, and 3 to the south and east. Modern agricultural practices in the EAA began with the onset of drainage in the area in 1906 and intensified after the federal government launched a large drainage campaign in the area in the 1950s (Light and Dineen 1994, Snyder and Davidson 1994).

Today farming in the EAA consists primarily of sugarcane (Snyder and Davidson 1994) grown commercially in large tracts connected by a network of canals, roads, and irrigation ditches. Fallow (exposed, unplanted soil), flooded-fallow (flooded, unplanted soil), and rice fields are also seasonally present in the EAA, primarily in the summer months. Flooded-fallow and rice fields are used in rotation with sugarcane to help rejuvenate the soil. Flooding prevents oxidation of the organic soil matter which results in soil compaction or subsidence, and provides pest and weed control (Izuno 1994, Snyder 1994, Snyder and Davidson 1994). Vegetables of a variety of types are grown over 11% of the area in winter, and a small amount of sod is grown year-round (Snyder and Davidson 1994). Vegetable, sod, fallow, flooded-fallow, and rice fields are scattered sparsely throughout the sugarcane-dominated matrix in their appropriate seasons.

Nearby Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR) provides nearly 60,000 hectares of natural habitat and a series of managed impoundments. The impoundments are rectangular, diked, freshwater habitats that are managed for wildlife. Each consists of a central flooded area that is usually surrounded by a deeper channel next to the surrounding berm. The berms have dirt roads or walking trails on top. Management in the impoundments consists mainly of water-level manipulations and some cutting of aquatic plants. Habitat in the impoundments and surrounding area provides a semi-natural wetland/upland landscape for use by resident and migratory birds.

The structure of the impoundments provides a non-agricultural habitat that has components similar to the agricultural fields.

## METHODS

We surveyed 18 sites in five locations of the EAA and four sites within the Compartment C impoundments of the LNWR bimonthly from mid-June to early December 1999. In the EAA we included sugarcane, rice, flooded-fallow fields, fallow fields, and sod. Sites within LNWR were selected to cover Compartment C geographically. Each site consisted of a rectangular area made up of an approximately 150-200-m length running along an accessible edge of a farm field and the depth that an observer was able to see into a field from that field edge. Every site within the EAA included at least one ditch or canal, as well as any dirt roads and adjacent levees associated with the field area. The method used was modified from the one used by Townsend (2000) to study birds in rice fields.

Sites within the same general location were treated as a unit. These sampling units were visited on consecutive mornings. We counted birds at each site within a unit for ten minutes. During a count, the field edge was treated as a line transect, with the observer walking this length and recording number of individuals, species, location, and activity of birds within the area of the field visible from the transect. Because of their abundance in all agricultural areas Red-winged Blackbirds (*Agelaius phoeniceus*) and Boat-tailed Grackles (*Quiscalus major*) were difficult to census other than as present or absent and so were not analyzed numerically. Weather data such as temperature, wind speed, wind direction, as well as field data such as water level, vegetation height, field condition, and depth of visibility were also recorded during site censuses. The order that each site was visited was rotated each week so that no bias in time of sampling would affect the data. However, all sites were visited within the first five hours after sunrise.

Birds were grouped into guilds according to their feeding habits as raptors, waterfowl, wading birds, shorebirds, or perching birds (Elphick et al. 2001). We determined bird density as the average number of birds per square meter and mean birds per site for each field type. Species diversity was calculated using the Shannon-Wiener index, which indicates the diversity of a sample based on the number of species and the number of individuals. An increase in the index value is interpreted to mean that there are more species and that individuals are distributed more evenly among the species present.

## RESULTS

We observed 72 species of birds between mid-June and December 1999 within the EAA and LNWR within the five different types of agricultural fields and the non-agricultural habitat of impoundments on the refuge (Table 1). The average area surveyed was similar for five of six habitat types. The exception was in sugarcane where the average area was much smaller at just over 6000 m<sup>2</sup>. The field type with the most species was rice followed by sugarcane and impoundment. The highest diversity was also on rice fields, followed closely by flooded-fallow fields. Total number of individuals was greatest on rice followed by flooded-fallow and sugar. The average density of birds was highest in flooded-fallow fields and in sugarcane (Table 1).

The fields of the EAA were used by a variety of birds representing the five identified guilds and within the fields diverse habitats were used. We observed the endangered Wood Stork (*Mycteria americana*),

**Table 1. Field type, observations, number, diversity and density of birds found during summer and fall censuses in the Everglades Agricultural Area.**

Field type	Fallow	Flooded-fallow	Impoundment	Rice	Sod	Sugar	Total
Number of individuals	444	918	562	921	399	761	4005
Number of species	23	30	33	39	20	35	72
No. censuses	17	18	48	61	22	95	
Mean birds per census	26.1	51.0	11.7	15.1	18.1	8.0	
Diversity (Shannon-Wiener)	0.9989	1.1467	0.9337	1.1784	0.7674	0.8407	
Mean site area (m <sup>2</sup> )	25,400	27,409	26,010	22,861	30,002	6,048	
Mean bird density (individuals/m <sup>2</sup> )	0.0010	0.0019	0.0005	0.0007	0.0006	0.0013	

threatened Least Tern (*Sterna antillarum*), and six species of special concern (Florida Fish and Wildlife Conservation Commission 1997) in the EAA.

*Fallow.*—Two swallow species were seen at fallow fields and at no other field type in the EAA (Table 2). Perching birds, such as Mourning Dove (*Zenaida macroura*) and Barn Swallow (*Hirundo rustica*), were commonly found within fallow fields and on utility wires adjacent to fallow fields respectively. Shorebirds, mainly Killdeer (*Charadrius vociferus*), were fairly common within the exposed muck soil of fallow fields. Wading birds, predominantly Cattle Egrets, were sometimes present in fallow fields, particularly when machinery was in use. Wading birds were also seen within and along the edges of irrigation ditches.

*Flooded-fallow fields.*—Five species of birds were seen in flooded-fallow fields and in no other habitat type. These included the American White Pelican (*Pelecanus erythrorhynchos*) and Double-crested Cormorant (*Phalacrocorax auritus*), commonly deeper water birds (Table 2). Bird abundance in flooded-fallow fields was almost evenly split between waterfowl and wading birds. Waterfowl, which consisted mostly of Common Moorhens (*Gallinula chloropus*), Anhingas (*Anhinga anhinga*), Mottled Ducks (*Anas fulvigula*), and American Coots (*Fulica americana*), were mainly observed in open water of flooded-fallow fields. Anhingas were often seen on vegetated levees, and Common Moorhens and American Coots were frequently flushed from field edges. Though dominated by Great Egrets, a variety of wading birds typified flooded-fallow fields including Glossy Ibis (*Plegadis falcinellus*), Wood Stork, and a wide array of herons and egrets. Wading birds were most commonly seen on vegetated levees separating flooded-fallow fields, but were also common in open water and at its edge. Shorebirds such as small terns, Black-necked Stilt (*Himantopus mexicanus*), Black Skimmer (*Rynchops niger*), Greater Yellowlegs (*Tringa melano-leuca*), Lesser Yellowlegs (*Tringa flavipes*), and Killdeer used open water or, occasionally, open-water edges, roads, and vegetated levees of flooded-fallow fields. Rarely, perching birds such as Common Yellowthroat (*Geothlypis trichas*), Palm Warbler (*Dendroica palmarum*), and swallows were glimpsed flitting around the vegetation at the water's edge or perched on utility wires.

*Impoundments.*—Eleven species of birds were unique to the non-agricultural impoundments of LNWR (Table 2). In part this seems to be due to the more permanent nature of non-impoundment vegetation such as brush and trees of large size lining the impoundments as well as the matrix of grasses and open water. Also, the impoundments are part of a much greater natural area comprising LNWR. Common Moorhens were observed most often and were found predominately in

Table 2. Bird species that were found in only one type of habitat are listed during summer and fall censuses in the Everglades Agricultural Area.

Fallow	Flooded-fallow	Impoundment	Rice	Sod	Sugar
Bank Swallow ( <i>Riparia riparia</i> )	Black Tern ( <i>Chlidonias niger</i> )	Grasshopper Sparrow ( <i>Ammodramus sava-</i> <i>narum</i> )	Roseate Spoonbill ( <i>Platalea ajaja</i> )	Northern Mockingbird ( <i>Mimus polyglottos</i> )	Yellow-rumped Warbler ( <i>Dendroica coronata</i> )
Tree Swallow ( <i>Tachycineta bicolor</i> )	Black-crowned Night-Heron ( <i>Nycticorax nycticorax</i> )	American Wigeon ( <i>Anas americana</i> )	Semipalmated Sand- piper ( <i>Calidris pusilla</i> )	Black-bellied Plover	Merlin ( <i>Falco columbarius</i> )
	American White Pel- ican	Blue-winged Teal	Sedge Wren ( <i>Cistothorus platensis</i> )		Peregrine Falcon ( <i>Falco peregrinus</i> )
	Double-crested Cormo- rant	Red-shouldered Hawk	Blue Jay ( <i>Cyanocitta cristata</i> )		Swainson's Warbler ( <i>Limnothlypis swainso-</i> <i>nii</i> )
	Black Skimmer ( <i>Rynchops niger</i> )	Northern Cardinal ( <i>Cardinalis cardinalis</i> )			Eastern Towhee ( <i>Pipilo erythrophthal-</i> <i>mus</i> )
	Common Tern ( <i>Sterna hirundo</i> )	Pileated Woodpecker ( <i>Dryocopus pileatus</i> )			Eastern Phoebe ( <i>Sayornis phoebe</i> )
	Greater Yellowlegs ( <i>Tringa melanoleuca</i> )	Common Snipe ( <i>Gallinago gallinago</i> )			Eastern Kingbird ( <i>Tyrannus tyrannus</i> )
		Lincoln's Sparrow ( <i>Melospiza lincolni</i> )			Barn Owl ( <i>Tyto alba</i> )
		Purple Gallinule			

open water. Other waterfowl species including Blue-winged Teal (*Anas discors*), Mottled Duck, and Ring-necked Duck (*Aythya collaris*), were observed in some abundance in open water and the edges of tall grasses. Wading birds including Great Egret, Glossy Ibis, Little Blue Heron (*Egretta caerulea*), and Tricolored Heron (*Egretta tricolor*), occurred in or at the edge of flooded, tall grasses such as cattails (*Typha latifolia*) and pickerelweed (*Pontederia cordata*). A few perching birds (various species) were present mainly at field edges. Red-shouldered Hawk (*Buteo lineatus*) represented the only raptor species observed in impoundment sites, and these were observed on four occasions perched on trees or hunting over impoundment grasses.

*Rice Fields.*—Four bird species were observed in rice and in no other habitat type (Table 2). Waterfowl (especially Common Moorhen) were relatively abundant in flooded rice. Cattle Egret and a variety of other-wading birds including Roseate Spoonbill and Wood Stork, were common in rice fields undergoing drainage. Shorebirds, usually Black-necked Stilt, Lesser Yellowlegs, and Killdeer were relatively rare in rice.

*Sod.*—We saw Black-bellied Plovers (*Pluvialis squatarola*) on sod fields and nowhere else in the EAA (Table 2). Killdeer were the most common birds observed in sod. Wading birds, predominantly Cattle Egrets, and perching birds, mainly Barn Swallow and Palm Warbler, were fairly abundant. Almost all of these birds were sighted on or over the sod itself rather than in associated ditches or edges.

*Sugarcane.*—Although sugarcane was the field type we most frequently visited (95 site visits), the area of sugarcane fields sampled at each site visit was smaller than that of other areas and consisted primarily of edge habitat. This was due to limited visibility into the dense cover of maturing sugarcane that resulted in a census of only a thin strip of cane along the transect length and the air above the cane. We observed nine bird species in sugarcane fields that were primarily upland species not found elsewhere (Table 2). Perching birds, predominantly Common Yellowthroat and Palm Warbler, were the dominant birds observed mainly in sugarcane. Some wading birds were observed in association with sugarcane, especially Cattle Egrets in fields that were being harvested. We often saw Great Egrets and other wading birds in ditches, along ditch edges and roads, and in grassy areas adjacent to sugarcane fields. We observed waterfowl such as common Moorhen and Purple Gallinule (*Porphyryla martinica*) in and at the edges of irrigation ditches and canals. We saw Killdeer and an occasional King Rail (*Rallus elegans*) or Black-necked Stilt on the road, road edge of the muddy or grassy edge of cane fields, and rarely in the sugarcane. Raptors occasionally perched either within or on owl boxes or were seen hunting within the sugarcane.

## DISCUSSION

Results of this six-month study reflect a high degree of bird activity and species richness in all habitats censused. The highest numbers of species, individuals, and diversity occurred in flooded fields, including rice, highlighting the importance of flooded habitat in the EAA. However, upland habitat was also important in supporting a diversity of wildlife. Some sites within the EAA averaged higher bird densities per site visit and total numbers of bird observations than sites within the Loxahatchee National Wildlife Refuge, an area managed for wetland fauna. We recommend future studies to determine how this pattern reflects seasonal fluctuations in agricultural fields. Flooded-fallow and rice fields are only present through part of the year whereas habitat availability within LNWR is fairly consistent throughout the year. Additional information is needed on the breeding biology, habitat preferences, prey base, and mortality of birds in this area in order assist with agricultural and conservation decisions. Investigations into non-avian species using this region are also important and should be initiated.

The agricultural areas of the EAA have been a part of the landscape for over 50 years and have been used by birds probably since they were established. Bird use of agricultural area as habitat has, in general, been little studied (Best et al. 1990, Perkins et al. 2000) but clearly birds use agricultural fields to varying degrees. Rice and flooded-fallow fields are especially important for waterbirds and some landbirds (Sykes and Hunter 1978, Twedt and Nelms 1999, Kushlan and Hafner 2000, Fujioka et al. 2001, Maeda 2001), although they may not be surrogates for natural areas (Tourenq et al. 2001). While other types of agriculture provide habitat for birds, edges and/or adjacent habitats influence species diversity in a particular field (Best et al. 1990, Freemark 1995). We did not consider fields as separate from edge habitat and would like to do so in the future.

Especially needed are investigations into agents of wildlife mortality in the EAA. Potentially the EAA is functioning as a bird sink by attracting birds to feed and use land that is potentially hazardous to their survival. The report by Turnbull et al. (1989b) of illegal pesticide buildup in wildlife tissues, and Smith's (1994) mention of nestling mortality at Lake Okeechobee due to a nematode infection caused by ingestion of prey from polluted EAA ditches (Spalding et al. 1994), raise the question of mortality risks within the EAA. Additionally, Sykes and Hunter (1978) and Turnbull et al. (1989a) raised questions on how cultivation practices such as timing and methods of harvest and flooding affected the reproductive success of birds nesting within the EAA.

Because of greater abundance and diversity on flooded fields we recommend that flooded habitat be increased where management per-

mits. We also recommend that edge habitat be maintained with minimal disturbance. Alternatives to traditional pesticides also should be encouraged.

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