WILDLIFE HABITAT RELATIONS IN THE EVERGLADES AGRICULTURAL AREA

2003 Report

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EXECUTIVE SUMMARY

The extensive agricultural habitat of the Everglades Agricultural Area (EAA) is situated within a matrix of natural habitat and urban areas of South Florida. This area has not been widely studied and little is known about the wildlife that is found in the EAA or the way this wildlife uses the habitat. A few studies have illustrated the importance of rice fields and flooded fallow fields to birds (Sykes & Hunter 1978,Turnbull *et al.* 1989,Lodge & Clark 1996). A study of the Florida Kingsnake (*Lampropeltis getula floridana*) (Krysko 2002) found that the sugarcane fields of the EAA are the primary habitat for this imperiled species in South Florida. The two years of our study to date have increased the knowledge of the role of the EAA in supporting wildlife in South Florida.

Fish communities in the EAA are similar in numbers, species composition and habitat use to fish elsewhere in southern Florida. Fish are abundant and found in canals, ditches and flooded fields. They readily colonize flooded rice fields and provide an important food source for other vertebrate species, especially the many species of waterbirds that breed in surrounding natural areas.

Species occurrence and abundance of amphibians and reptiles are also high in the EAA. We have found 15 species of amphibians and 21 species of reptiles in our various surveys of the area. Although the EAA seems to be excellent habitat for reptiles, especially snakes, it does not support some amphibian species as well as natural habitat. Abundance is generally less than in the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX) which provided our non-agricultural control study area.

Birds are abundant in the area throughout the year and in all habitats. Peaks in abundance occur during migration and in response to cultivation activities. The highest numbers of birds are found in rice and fallow flooded fields which they use as dispersal or migratory habitat. They are also found in high numbers in habitat associated with sugarcane and in the thousands of kilometers of ditches and edge habitat associated with agriculture.

Mammals are much more abundant in the EAA than in LOX with 11 species found there compared with only two in LOX during our surveys. Both Eastern Cottontail (*Sylvilagus floridanus*) and Marsh Rabbits (*S. palustris*) seem to thrive in the area as do Bobcats (*Lynx rufus*), River Otters (*Lutra canadensis*) and numerous smaller mammals. The juxtaposition of agriculture, edge habitat and ditches and absence of high levels of human disturbance are probably factors that encourage the presence of animals here.

The EAA provides primary, dispersal or migratory habitat for wetland and open upland species. Some species are drawn to specific agricultural habitats such as rice fields, sugarcane, flooded fields or canals/ditches. Other species may be selecting open and herbaceous areas associated with the edge habitat near fields, buildings and canals or ditches. The EAA is a significant landscape in South Florida by virtue of size alone. Although agriculture is not considered to be optimum or even functioning habitat for

most wildlife species, agroecosystems are part of the world and will continue to be so (Vandermeer 1997). Much is unknown about the potential for support of healthy populations of wildlife in the EAA. Yet compared with many large agricultural operations, the EAA, by its size alone and the nature of its crops, manages to support a diversity of wildlife. We hope that future studies will help to elucidate the role of South Florida agriculture in the larger natural system and provide information to the public and managers on how to improve its function in the South Florida landscape.

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INTRODUCTION

The Everglades Agricultural Area (EAA) covers an area of 280,000 ha in southern Florida surrounding the southern end of Lake Okeechobee. It occupies former marsh habitat that was drained beginning at the turn of the century. Agricultural activities occur on approximately 200,000 ha of the EAA with sugarcane present on about 90% of the land. Rice, vegetables and sod are also grown in much smaller quantities. Associated with these agricultural activities are thousands of miles of canals and ditches, and thousands of acres of associated non-agricultural edge habitat.

The EAA is located in southern Florida in the midst of natural areas such as Holey Land and Rotenberger Wildlife Refuges, Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX), Everglades National Park, Big Cypress National Park and a number of water management areas. Extensive reclamation efforts in the natural habitat of the Everglades and South Florida have resulted in scientific studies of hydrology, ecology and natural history of the animal and plants that inhabit the area (e.g. Davis & Ogden 1994). Highly urbanized areas cover much of the land to the east of the EAA and, like most urban habitat (Blair 1996), these areas have lower species richness and diversity as well as high numbers of non-native species.

Agricultural activities are thought to fragment and simplify habitat, decrease the number of native species, increase the presence of exotic species, and potentially contribute to an increase in pollutants (Freemark 1995). However, crops such as rice may provide important habitat for many of the world's waterbirds especially herons and egrets (Fasola & Ruiz 1996, Kushlan & Hafner 2000, Elphick 2000, Tourenq *et al.* 2001, Maeda 2001), but Tourenq *et al.* (2001) emphasizes that they are not always equivalent to natural marsh habitat. Edge habitat in many types of agricultural crops may support a diversity of wildlife (Best *et al.* 1990) and is considered to be an important component of agricultural operations. Fallow, especially flooded fallow, fields are also important for a number of bird species (Sykes & Hunter 1978, Fujioka *et al.* 2001, Elphick & Oring 2003).

A few studies of birds to date in the EAA have documented the use of flooded fields by 59 species of wading birds, herons, egrets, ducks, rails, shorebirds, gulls and other species (Sykes & Hunter 1978), Fulvous Whistling-ducks (*Dendrocygna bicolor*) (Turnbull *et al.* 1989) and use of rice fields by waterbirds (Townsend 2000). A summary report of birds in the EAA provides a list of 68 species of birds known to occur there (Lodge & Clark 1996). A study of Florida Kingsnake (*Lampropeltis getula floridana*) in South Florida documented the presence of this species in the sugarcane fields of the EAA in higher numbers than in natural habitat of the Everglades (Krysko 2002).

We conducted extensive and intensive surveys in both rice fields and sugarcane fields along with associated ditches, canals and edge habitat. These were to document wildlife habitat use. We also conducted surveys for certain taxa, these included a roadside raptor survey and a survey of reptiles and amphibians. These surveys are discussed in the sections below.

WILDLIFE HABITAT USE

Rice fields

Methods: We chose rice fields with differences in management and construction such as edge vegetation, dike or berm construction and canal and ditch layout. Road accessibility also affected the study areas chosen. Each rice field consisted of 8 to 10 units separated by ditches. Ditches and internal units were chosen randomly within each larger rice field. Different management type fields were chosen with two replicates in each for a total of 14 fields, two of which were organically grown. Management differences included edge maintenance and water management as well as general field maintenence. The study began just before the rice fields were flooded and ended as they were drained for harvest. Once the rice field is flooded with approximately 30 cm of water, pumping ceases and the fields remain flooded until a week or ten days before harvest, 80-90 days later. Surveys of fallow and fallow flooded fields followed the same protocol as for rice fields.

We used two different live traps, minnow traps of 1/8" mesh size and Breder traps for our fish surveys. If a ditch or canal was inaccessible for setting minnow traps, a second choice was randomly selected. Minnow traps were set in the canals and ditches a week before flooding, after the rice had been planted and begun to sprout. Both minnow and Breder traps were then set after the flooding in the fields. Unbaited minnow traps were placed at dusk for overnight surveys. In the early morning both Breder and minnow traps were set for 20 minutes. Breder traps were not left out overnight because it is difficult to assure the availability of fresh air in the enclosed plexiglass body of the trap. Minnow and Breder traps were set side by side in three different spots per field, at the ditch, edge, and mid-field within the rice, only minnow traps were used in the canal. We weren't able to use Breder traps in the canals due to the steepness of the sides and the potential for swifter currents that would sweep them away. Both traps were near the water edge and filled half way with water to allow other aquatic species air to breathe if caught in the traps during the survey. Visual surveys were also conducted for the deeper canals and larger fish. All the fish and invertebrates caught from each trap were identified to species, sexed and aged where possible and counted making note of any deformities or abnormalities.

Bird surveys were conducted during mid-morning when birds were actively foraging. The observation area included one rice field unit and the ditches, dikes and canals directly associated with it. One edge of a field unit was walked and birds were counted for a period of ten minutes. All birds seen or heard in the field were noted. For each species we recorded the number of individuals observed, age, sex, location in the field and activity. Sex and age were determined, if possible, by observing differences in plumage. Breeding plumage, if present, was recorded. Birds flying over the field were also recorded.

Sugarcane

Methods: Five sugarcane fields were chosen based on different ownership and management and based on accessibility. We chose roads that were driveable but had low traffic volume. A road transect was determined with four to six stopping points on each and included stops at ditches within the fields. We censused fish in canals and ditches using the same methods as in rice, but did not use Breder traps. Call count surveys for frogs and toads (anurans) were conducted in the evenings just after sunset. Any calling anurans were identified to species and assigned a number ranging from a single individual to large chorus. Bird surveys began within an hour after sunrise. Point counts were conducted for 5 minutes at each point. All birds seen or heard were recorded, including those flying over. The number of individuals observed, age, sex, location and activity were also recorded for each species. Fish survey protocols were identical to those in rice. Searches of the area were also conducted to find silent individuals as well as to locate mammals or other animals hidden in the vegetation of ditches and fields.

Non-agricultural Habitat

Methods: We conducted surveys with identical protocols in the impoundments of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX) to compare with surveys in agriculture. The survey areas included the impoundments in the refuge that are managed for wildlife and are similar in composition and layout to the agricultural fields. Each impoundment consists of a flooded area with a deeper ditch and/or canal and adjacent road. Our surveys were designed to replicate the surveys we conducted in both rice and sugarcane.

OVERALL RESULTS OF WILDLIFE HABITAT SURVEYS

Fish: We trapped a total of 14,815 fish of 24 different species in rice and sugarcane fields. Eight non-native species were trapped or observed, all at frequencies of less than 0.01 (Table 1). Eastern Mosquitofish (*Gambusia holbrooki*) dominated fish communities in the EAA with an abundance of about 78%. Six other species were present in abundances from 1% to 9%, the rest were present in lower abundances.

We caught the most species in ditches and fewest in the canals. The most common species were caught in multiple locations. Four species were only caught in edge habitat, the Walking Catfish (*Clarias batrachus*), Dollar Sunfish (*Lepomis marginatus*), Largemouth Bass (*Micropterus salmoides*) and Black Acara (*Cichlasoma bimaculatum*). Several were caught or observed only in canals and ditches including Florida Gar (*Lepisosteus platyrhincus*), Blue Tilapia (*Oreochromis aureus*), and Brown Hoplo (*Haplosternum littorale*). There were significantly more fish found in water associated with rice farming than other agricultural operations or non-agricultural habitat (Table 1, Figure 1). Fish were found in the greatest numbers in ditches, canals and edge habitat, least in impoundments and within fields (Appendix 1).

Table 1. Average number of each species of fish in each field type.

Species_Name	Impoundment	Rice	Sugarcane
Armored Catfish	-	1.00	1.00
Warmouth	1.00	-	-
Black Acara	1.33	-	1.17
Bluefin Killifish	2.45	3.63	4.04
Bluegill	2.00	1.20	3.11
Bluespotted Sunfish	1.20	1.50	1.50
Brook Silverside	-	6.00	
Brown Bullhead	-	-	2.00
Dollar Sunfish	-	6.00	-
Eastern Mosquitofish	9.44	16.54	10.14
Flagfish	1.57	4.56	2.47
Florida Gar	-	2.33	1.00
Golden Topminnow	1.27	2.00	1.00
Largemouth Bass	-	-	1.00
Least Killifish	2.79	2.94	2.00
Mayan Cichlid	1.00	-	-
Oscar	-		1.00
Redeye Bass	-	-	2.00
Spotted Tilapia	-	-	1.50
Taillight Shiner	-	-	1.00
Walking Catfish	-	-	1.00
Sailfin Molly	3.21	5.11	6.53

Frogs and Toads: We counted 14 species of frog or toad in all types of agricultural habitat and ten species in non-agricultural habitat (Table 2). The most abundant species was the Southern Toad (*Bufo terrestris)* followed by the Southern Leopard Frog (*Rana sphenocephala*) and Squirrel Tree Frog (*Hyla squirella*). Amphibians were not heard/observed in all areas each month (Figure 2), but LOX had a higher average abundance of anurans in all months where we have data, except in June.

Reptiles: Reptiles were only incidentally observed during our surveys. We counted a total of five species at LOX and 16 species in agricultural fields (Table 3). The Brown Anole (*Anolis sagrei*) was the only exotic species we counted during the agricultural surveys. The most abundant reptiles were Banded Watersnakes (*Nerodia fasciata*), Brown Anoles, Cooters and Ribbon Snakes (*Thamnophis sauritus*).

Six species of exotic reptile or amphibian were counted giving them a composition of about twenty percent of species. Some species such as Greenhouse Treefrogs (*Eleutherodactylus planirostris*) were fairly abundant in the fields while Brown Anoles and geckos were found mainly around buildings.

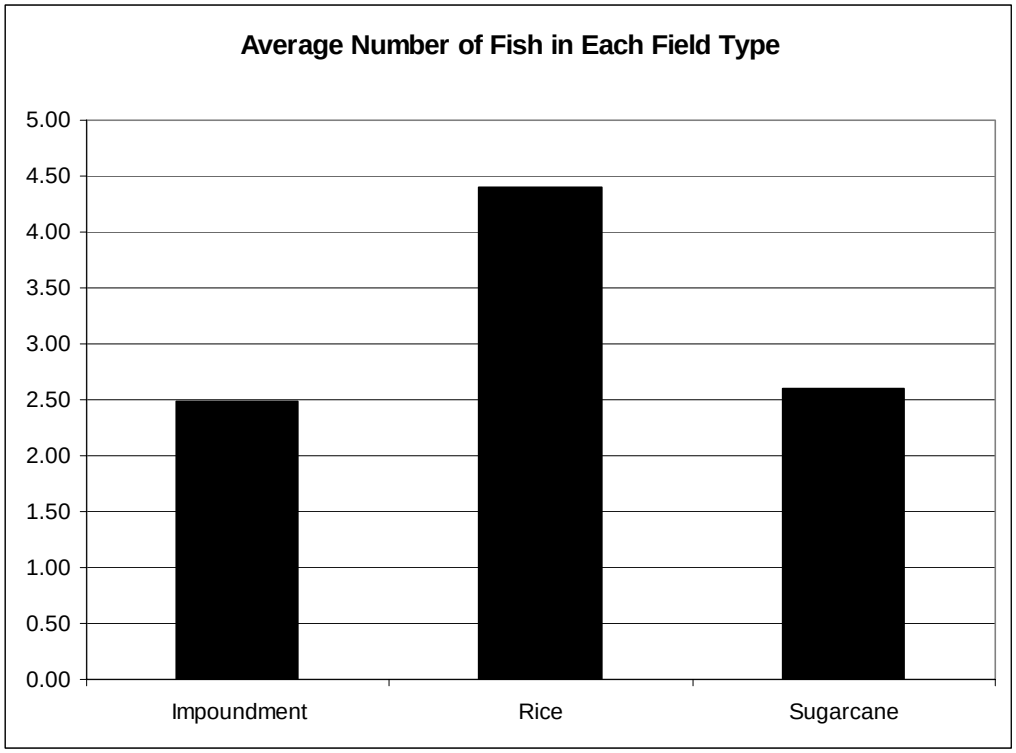

Figure 1. Average number of fish caught in each type of field.

Table 2. Number of times amphibian species were seen relative to the number of visits.

Species Name	Impoundment	Sugarcane
Cuban Tree Frog	1	0
Giant Toad	3	1.5
Green Tree Frog	11	10
Greenhouse Frog	0	7.25
Little Grass Frog	6	8.5
Eastern Narrowmouth Toad	6	15.25
Oak Toad	0	1.25
Peninsula Newt	1	0
Pig Frog	36	13.75
River Frog	0	0.75
Southern Chorus Frog	0	2.5
Southern Cricket Frog	44	10
Southern Leopard Frog	34	34.75
Southern Toad	18	59.75
Squirrel Tree Frog	21	27.75

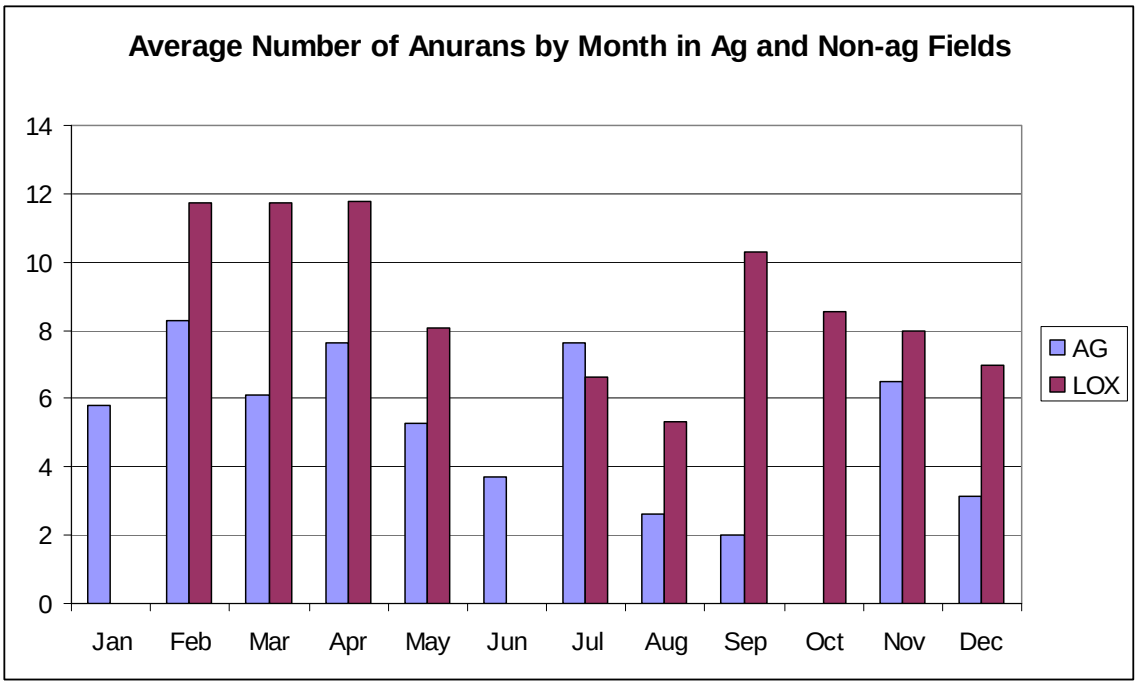

Figure 2. Monthly averages of anurans by monthly occurrence in agricultural and non-agricultural fields.

Table 3. Species of reptile observed in agricultural and non-agricultural habitat.

Agriculture	**Non-agriculture**
American Alligator	American Alligator
Banded Watersnake	Black Racer
Black Racer	Eastern Slender Gladss Lizard
Brown Anole	Florida Cottonmouth
Brown Watersnake	Green Anole
Peninsular Cooter	Peninsular Cooter
Corn Snake	Softshell Turtle
Dusky Pygmy Rattlesnake	
Eastern Garter Snake	
Florida Box Turtle	
Florida Cottonmouth	
Green Anole	
Ground Skink	
Florida Kingsnake	
Ribbon Snake	
Snapping Turtle	
Softshell Turtle	

Birds: We observed 139 species of birds in the various habitats of the EAA including rice fields, sugarcane, canals and ditches, other agriculture and edge habitat (Appendix 2). Sixteen species were shown to be breeding in the area. In addition to those we know were breeding, we suspect breeding in as many as 18 other species. The highest average number of birds was observed in fallow flooded fields followed by rice, sugarcane and impoundments (Figure 3). There were more birds in fallow flooded than any other type of habitat, and more in rice than sugarcane. Impoundments and sugarcane had about the same numbers of birds. Birds showed a pattern of abundance that reflected events correlated with harvest and with migratory habits (Figures 4 and 5). Birds were most abundant in the summer and early fall months. Birds used a variety of microhabitats within each field or impoundment and were found most often in the fields themselves and on berms and edges. Many species utilized open water in ditches and within rice fields or impoundments as well. There were 18 species of bird seen only in fallow or fallow/flooded fields and 16 seen only in sugarcane whereas eight species were unique to impoundments and four unique to rice fields. The species found in fallow flooded fields were primarily waterbirds and occurred during migration while those found in sugarcane tended to be upland species with the exception of a few that were probably utilizing canals adjacent to sugarcane habitat.

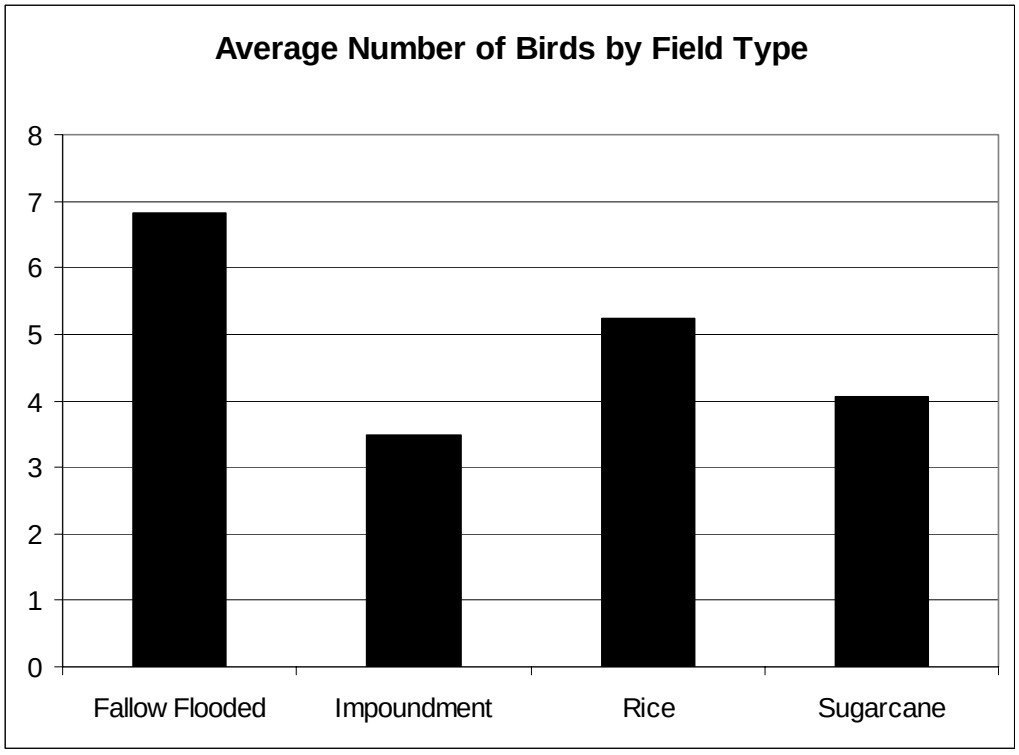

Figure 3. Average number of birds found in each type of agricultural or non-agricultural field.

Table 4. Types of agricultural and non-agricultural fields and the bird species that were only seen in that field type.

Fallow	**Impoundment**	**Rice**	**Sugarcane**
Dowitcher sp.	American Coot	Least Bittern	American Bittern
Ruddy Duck	White-winged Dove	Northern Bobwhite	Crested Caracara
Ring-billed Gull	Great Crested Flycatcher	Lesser Nighthawk	Gray Catbird
Swallow-tailed Kite	Tennessee Warbler	Carolina Wren	Sandhill Crane
Burrowing Owl	Northern Waterthrush		Eurasian Collared Dove
Semipalmated Plover	Red-headed Woodpecker		Bald Eagle
Wilson's Plover	Common Grackle		Blue-gray Gnatcatcher
Ruff	Yellow-rumped Warbler		Red-tailed Hawk
Pectoral Sandpiper			American Kestrel
Semipalmated Sandpiper			Gray Kingbird
Stilt Sandpiper			Eastern Phoebe
Bank Swallow			American Robin
Northern Rough-winged Swallow			Savannah Sparrow
Black Tern			Blue-winged Teal
Common Tern			Palm Warbler
Gull-billed Tern			Prairie Warbler
Least Tern			
Royal Tern			

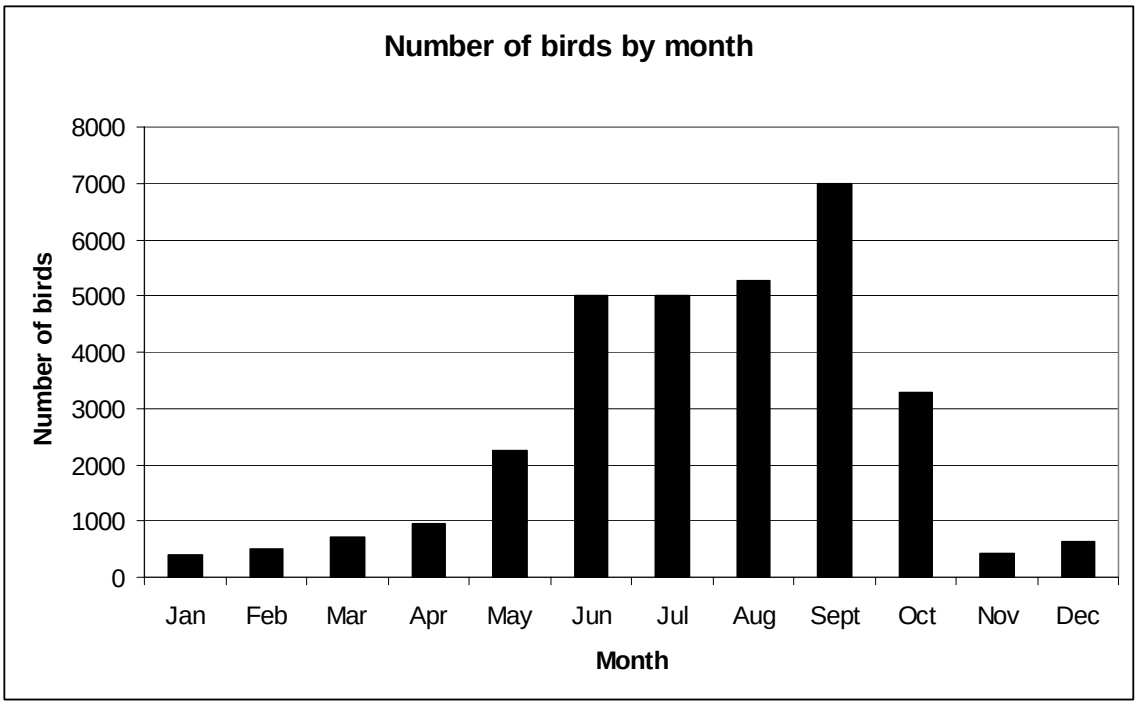

Figure 4. Total number of birds seen each month in agricultural fields.

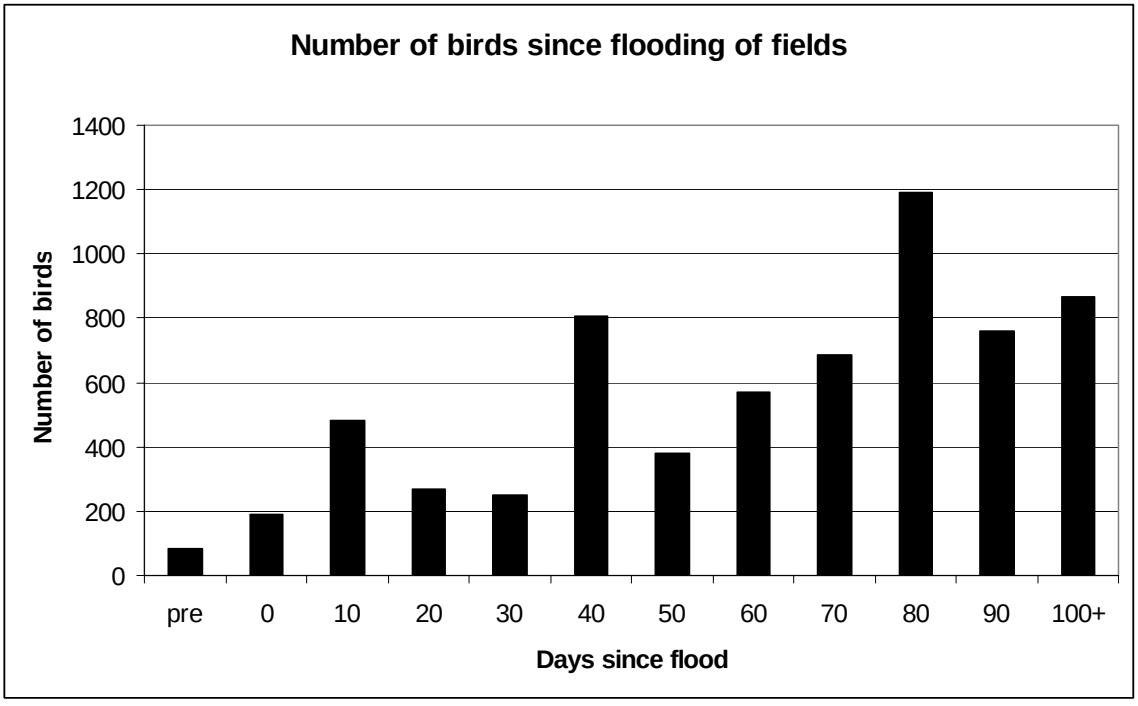

Figure 5. Total number of birds appearing in rice fields in the days after initial flooding.

Mammals

We counted 11 species of mammals in agricultural habitat and two species in non-agricultural impoundments (Table 5). The difference between these two habitats is significant and more striking than other taxa in this study. Mammals were present throughout the year with a peak in spring and early summer (Figure 6). The months of sugarcane harvest activities showed stable or increasing numbers of individuals from the summer.

Table 5. Number of mammals observed in non-agricultural and agricultural fields relative to the number of visits.

Mammal species	Impoundment	Ag
Armadillo	-	0.75
Bobcat	-	4.75
Cottontail	-	15
Marsh Rabbit	3	15
Opossum	1	0
Pig, Wild	-	1.25
Raccoon	-	4
Rice Rat	-	0.5
River Otter	-	1.5
Eastern Gray Squirrel	-	0.25
White-tailed Deer	-	2.25

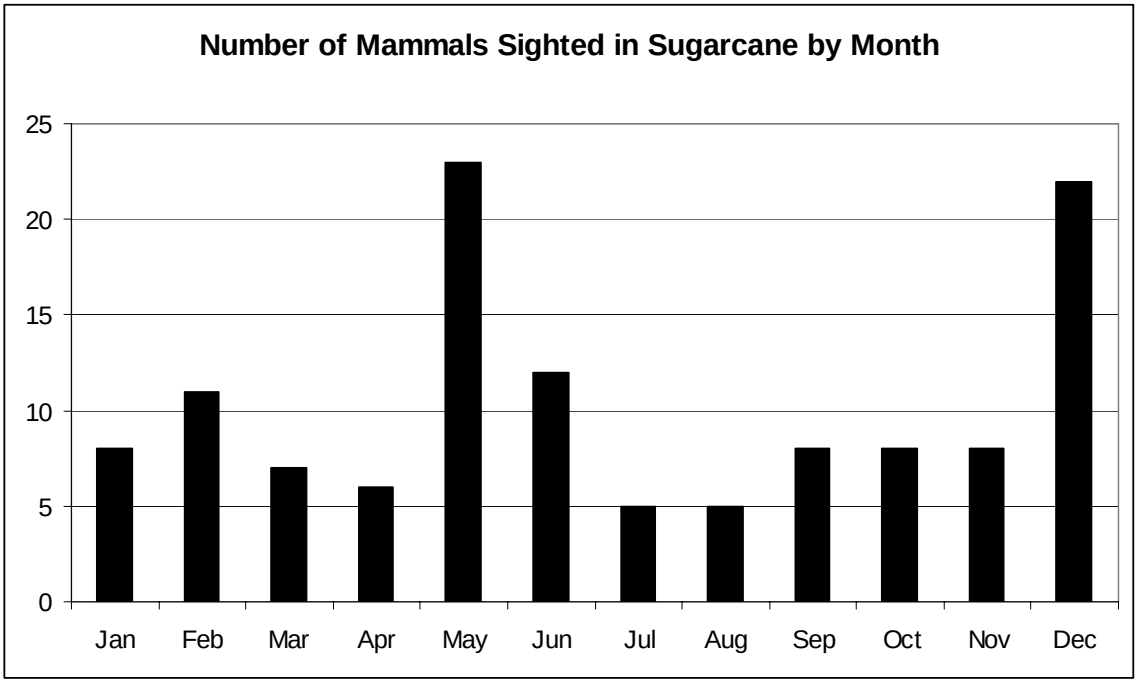

Figure 6. Mammal abundance by month in sugarcane fields.

RAPTOR SURVEYS

Methods: We conducted roadside raptor surveys along SR 27 from the Palm Beach county border to Belle Glade just south of Lake Okeechobee. Raptors were observed, a location was plotted using a GPS, and specific habitat data was recorded including habitat type and perch type selection. Density along the roadside as well as species richness and diversity in each habitat type was calculated. Observations on this survey represent the majority of raptor sightings but we also included raptors seen during other surveys. Owls were generally sighted during our dawn and dusk surveys in sugarcane fields.

Results: Thirteen species of raptor were observed, seven in numbers high enough for statistical analysis (Table 6). Turkey Vultures (*Cathartes aura*), Northern Harriers (*Circus cyaneus*), Red-tailed Hawks (*Buteo jamaicensis*), and American Kestrels (*Falco sparverius*) were more abundant in agricultural than natural habitat. Black vultures (*Coragyps atratus*), Ospreys (*Pandion haliaetus*) and Red-shouldered Hawks (*Buteo lineatus*) were found more often in natural habitat adjacent to SR 27. Choice of perch type was significant with powerlines or poles utilized more frequently than natural perches. We found the relative density of raptors in agriculture to be an average of 1.13 individuals per km and in natural habitat to be 0.61 individuals per km. There were significantly more raptors than expected in agricultural habitat compared with natural habitat ($\chi^2 = 387.43$, $p < 0.001$). All seven species were found in both habitats making species richness equal in agriculture and natural. Each species seemed to exhibit unique patterns of habitat occurrence and perch use.

Table 6. Index of abundance calculated for all species of raptor. Calculations were made based on number of a species observed per kilometer of road X 1000 (Woffinden and Murphy 1977). A * indicates those species used in our analyses.

Species	**Total**	**Index**
American kestrel	554	314.95
Turkey vulture	500	284.25
Red-tailed hawk	128	72.77
Black vulture	96	54.58
Red-shouldered hawk	94	53.44
Osprey	79	44.91
Northern harrier	53	30.13
Sharp-shinned hawk	6	3.41
Merlin	2	1.14
Peregrine Falcon	2	1.14
Bald Eagle	1	0.57
Crested caracara	1	0.57
Short-tailed hawk	1	0.57

INTENSIVE AMPHIBIAN AND REPTILE SURVEYS

Methods: We spent one week from March 8, 2003 through March 13, 2003 surveying a number of sugarcane fields for reptile and amphibian species occurrences. There were 14 people involved from several different organizations. The surveys were organized within and around sugarcane fields just after harvest and followed ditches and canals associated with these fields. All volunteers walked one edge of a ditch/canal and caught or observed any amphibians or reptiles they encountered. All snakes were identified to species and sex and were measured where possible. All other observations were also identified to species and recorded. Photos and GPS locations were taken of all Florida Kingsnakes and other unusual observations.

Results: A final species and individual count was calculated at 28 species and 751 individuals. Of the individual count 454 were brown anoles present mostly around buildings (although a few are seen in agricultural fields) and 30 were various gecko species also present around buildings. Discounting these, a total of approximately 267 individuals of 23 native and 2 non-native species were observed in the agricultural areas of the EAA (Table 7).

Table 7. 2003 Intensive Amphibian and Reptile Survey Observations

Common name	**Total**
American Alligator	27
Banded Water Snake	10
Black Racer	2
Brown Anole	454
Common Snapping Turtle	1
Corn Snake	2
Cottonmouth	8
Cuban Tree Frog	7
Eastern Narrowmouth Toad	1
Everglades Rat Snake	1
Florida Kingsnake	20
Garter or Ribbon Snake	1
Garter Snake	4
Gecko sp.	30
Giant Toad	2
Glass Lizard	1
Green Anole	6
Green Treefrog	2
Peninsula Cooter	8
Pig Frog	42
Red-belly Slider	1
Ribbon Snake	1

Softshell Turtle	1
Southeastern Five-lined Skink	3
Southern leopard frog	18
Southern toad	2
Squirrel tree frog	55
Yellow rat snake	11

DISCUSSION

Agricultural, aquatic and edge areas of the EAA provides habitat for a diversity and abundance of species. Many utilize this habitat for all life history needs from feeding through reproduction while others use it as temporary habitat as they disperse from breeding grounds or migrate or find winter homes. For many species the EAA may provide critical habitat while for others it may be less important than natural areas and the presence of a species is simply a function of migratory or dispersal movement. Rice fields and flooded fields attract thousands of dispersing or migratory birds and likely provide significant benefits to many species.

Rice fields, and to a lesser extent flooded fallow fields, provide habitat for a variety of Florida native and exotic species of fish. Although the timing of the flood events in rice fields is not the same as in natural marshes, the length of the flood is similar to that of short hydroperiod marshes in the Everglades. Most of the fish that would be expected in an inland freshwater system were found in the EAA. The community was strongly dominated by Eastern Mosquitofish, more so than in natural systems, but the suite of species was similar. All species of waterbirds that are usually found in South Florida have been observed in the EAA. This includes three species of duck that are present in rice and flooded fallow fields and breed there: Fulvous Whistling-ducks, Black-bellied Whistling-ducks (*Dendrocygna autumnalis*), and Mottled Ducks (*Anas fulvigula*). A few of the smaller herons and egrets such as the Green Heron (*Butorides virescens*) and both species of night-herons have been seen with young in the EAA. There are not, however, the large clusters of trees that are required for rookeries in the larger birds.

Frogs and toads are found in large numbers in the EAA in canals and ditches associated with both sugarcane and rice but do not seem to be doing as well as in natural or managed wetlands. Their numbers decrease during harvest activities and during periods of time when field ditches and smaller canals are drawn down or dried out. However, they are able to recover during the winter and spring seasons. Reptile populations seem to be healthy and a number of species are found in the abundant edge and aquatic habitat.

The Round-tailed Muskrat (*Neofiber alleni*) was once fairly common in the sugarcane fields of the EAA (Lefebvre 1982). We have had just one possible sighting to date in an area where it was historically found. Muskrat populations have declined throughout the state and the species is currently listed as a species of concern and is tied to declining wetlands throughout the state. Possible reasons for decline in the EAA include shorter field rotations and mechanical harvesting practices (Lefebvre 1982).

Contrary to general expectations for agricultural systems, there did not seem to be a higher number of non-native species than in other South Florida habitats. While they were present, they did not outnumber native species or comprise a significant portion of the species diversity. We found a lot of Brown Anoles and geckos but those were generally around buildings in the Belle Glade area. Occurrence of Cuban Tree Frogs (*Osteopilus septentrionalis*) in fields is spotty; they are found regularly in some areas and not at all in others. Few species of non-native birds have been found in the EAA but, like

the reptiles and amphibians, more may occur near towns and buildings. Fish populations had the largest percentage of non-native species with 33 percent of the species caught or observed being non-native.

Cultivation activities include plowing and sowing of crops, treatment and management of growing crops and harvesting of crops. In sugarcane, harvest also involves burning of the crop before it is harvested mechanically. Cultivation activities provide an opportunity for foraging in species such as Cattle Egrets (*Bubulcus ibis*) that are known to congregate where mechanical farming activities occur and that feed on the insects and small vertebrates that are displaced. Management of the crops is low intensity, generally involving periodic inspections. Spraying of aerial insecticides occurs rarely in non-vegetable crops and rice pests are usually managed by drying out the fields. Sugarcane harvest is a stressful period for the animals that inhabit the fields and contributes to mortality in these animals. However, they are adapted to fire in the ecosystem and most are able to escape the burning fields and find refuge in adjacent canals. Burning practices are designed to leave openings for escape as the fields are not burned on all sides at once; animals in front of the leading edge of the fire can escape through the unburned edge. Turkey Vultures, Black Vultures and occasionally Bald Eagles (*Haliaeetus leucocephalus*) congregate where fields are being burned to prey on fleeing animals. As with any agricultural operation, mechanical harvesting also causes mortality and the vehicles move quickly through the fields. However, most animals quickly re-colonize the fields and their numbers rebound within a few months.

The EAA supports abundant wildlife that require or utilize wetland or aquatic habitat. Birds and fish inhabiting these systems elsewhere in south Florida are found in the EAA as either breeding individuals or transitory visitors. These animals are adapted to shifting wetlands of varying hydroperiods and are capable of moving to find better quality areas (birds) or of quickly colonizing and reproducing in temporary systems (fish). Amphibians seem to do less well in the EAA than non-agricultural habitat. This may be due to the difference between the permanently flooded habitat of LOX and the fluctuating water regime of the EAA, to the application of chemicals to agricultural fields, management practices, or to other unknown differences between agricultural and non-agricultural systems. The widespread agricultural habitat with roadsides and natural berms attracts many wintering raptors in numbers comparable to other areas of North America (Pearlstine *et al.* 2004). The abundance of mammals that feed and utilize brushy areas as well as planted crops attracts a large number of predators such as wintering raptors and local Bobcats. The EAA is also well able to support upland species that utilize the wetland/upland interface such as the Florida Kingsnake and other snake species, the River Otter and Common Yellowthroat (*Geothlypis trichas*). Upland species also did well if they are inhabitants of semi-open, brushy or disturbed areas. Forest dependent species were rarely found in the EAA due to the absence of trees in the agricultural fields. Trees in the EAA are limited to urban areas or scattered trees around farm buildings and offices.

The EAA as an agricultural system provides an array of benefits as well as challenges to the wildlife that live there.

Benefits:

1. Nutrient input increases growth of crops and probably provides benefits for edge and other vegetation as well.
2. Cultivation of crops – A number of animal species benefit from cultivation of crops such as rice. This is probably the most important wildlife crop in the EAA because it provides wetland habitat for a large number of birds and fish. Cultivation of sugarcane and other crops are beneficial to animals that forage in these crops, that follow machinery during planting and harvest, and that prey on animals that live in these fields. This is probably the most important habitat for mammals.
3. The size of the EAA is such that even unplanted areas such as canals, ditches, non-agricultural areas and edges provide a large amount of habitat for a variety of wildlife.
4. Most of the boundary of the EAA is adjacent to natural landscapes or reclaimed wetlands such as the Water Conservation Areas. Animals from these localities may find dispersal or migratory habitat in the EAA.
5. Agricultural fields of the EAA are extensive and are accessed by unpaved roads that are usually gated. This limits access to most of the area and provides habitat that is relatively undisturbed by human use.
6. Flooded fields of the EAA provide surrogate wetland habitat for many birds and other animals. Canals and ditches are also important for aquatic animals.
7. The ability to manage water flow and flooding of the fields is an opportunity to provide for the benefit of wildlife.
8. Sugarcane and rice are both fairly low input agricultural crops. While fertilizer and pesticide application is definitely a concern, these crops are certainly preferable to many other types. A small percentage of the EAA is cultivated in higher input crops such as vegetables and sod.
9. The presence of managers on the EAA limits the possibility of human disturbances such as hunting, harassment, collecting for pets, and littering/polluting.

Challenges presented by habitat in the EAA are generally related to agricultural practices and may be, in some cases, the same as the benefits.

Challenges:

1. While nutrient input is relatively low for agriculture, it is still an alteration of the natural Everglades system and has undoubtedly resulted in artificial habitat and encouraged the proliferation of weedy and non-native species of plants.
2. Cultivation of agricultural crops carries with it a set of intrinsic dangers to wildlife. The use of machinery is a disturbance and is often fatal to animals that inhabit and breed in the fields. Heavy machinery compacts the soil, plowing and sowing disturb the soil and may contribute to erosion. Harvesting, especially using fire, is a high disturbance period in the cultivation cycle. Yearly growth and

plowing cycles are detrimental to some species such as Round-tailed Muskrat that require longer periods of stable habitat.

3. The application of chemicals such as herbicides is not desirable in areas where animals are feeding and reproducing. Pesticides can cause mortality, developmental abnormalities, reproductive disturbances, and low recruitment.
4. Decisions relating to the management of water have as their first priority the benefit of crops. Thus, water may be withdrawn from fields at a critical point in the reproductive or migratory cycle of animals that are dependent on aquatic habitat. Flooding and drying of fields is also out of sync with natural wetlands in the area.
5. Crop type and rotation decisions are made with economic basis, not wildlife. The fluctuating price of rice determines the amount of habitat available for wetland nesting and dispersing birds.
6. Fire control, management styles and control of weedy plants contribute to the clearing of brushy habitat on the edges of fields and ditches. It probably also discourages the growth of trees on upland habitat. The absence of trees in natural clumps and groups does not allow for roosting and breeding of many tree or woodland/forest dependent species.
7. Agricultural operations and associated built areas support common species and non-native species. These systems are less complex and incapable of supporting rare or sensitive species. They are also fragmented and generally disturbed.

Attributes

1. The agricultural fields of the EAA are large and extensive in area. Sugarcane is essentially undisturbed for nearly a year between harvest activities and covers hundreds of thousands of acres. Rice is present throughout three to six months of the spring and summer and covers thousands of acres. Row crops are present on a small percentage of land in rotation with sugarcane or rice. Sod is generally grown in the same fields year after year on a low number of acres.
2. Ditches and canals intersect and connect all habitats of the EAA. They are continuous with Lake Okeechobee to the north and Everglades to the south. Large canals are flooded throughout the year, smaller canals and ditches generally experience a lowering of water level or complete drydown during the year. Management consists of dredging and removal of aquatic vegetation.
3. There is little urbanized habitat within the EAA itself. Farm buildings, barns and pump houses dot the landscape. The towns of Belle Glade and South Bay are located on the south end of Lake Okeechobee and Clewiston is to the north of these.
4. The landscape of the EAA is changing and dynamic, characterized by growing and harvest of crops, plowing and tilling of the land, burning of sugarcane, rotation of crops and flooding and drying of some fields and ditches.
5. Upland and wetland habitat exist in close proximity to each other. Upland habitat is characterized by narrow strips of mostly non-native species that are found on the edges of fields and along ditches and canals. The vegetation is usually brushy

or herbaceous. Wetland habitat is usually associated with rice cultivation or flooding of fallow fields and is connected by a network of ditches and canals.

Linkages

1. Wet and flooded fields provide dispersal habitat for waterbirds from adjacent natural habitat in the Everglades, stormwater treatment areas, LOX, Holeyland and Rotenberger Wildlife Management Areas.
2. Edge and upland may provide corridors and temporary habitat for larger animals moving from southwest Florida to the east. Areas to the west include Big Cypress, Panther Habitat and Fakahatchee Strand.
3. Large canals connect Lake Okeechobee to the north with the Everglades to the south.
4. Ditches, canals and flooded fields that are adjacent to sugarcane or upland edges provide an upland/wetland interface.

Unknowns

1. It is unknown whether the EAA provides source or sink for breeding animals.
2. What are the effects of pesticides?
3. What are the effects of timing and hydroperiod in rice and flooded fallow as well as canal drying and maintenance?

MANAGEMENT RECOMMENDATIONS ARISING FROM THE CURRENT STUDY

Wherever possible we recommend that managers maximize the attractiveness of edge and uncultivated fields for wildlife. Leaving edges unmowed and untreated while allowing brushy vegetation to grow encourages a variety of wildlife. Many species using these edge habitats may be predators of agricultural pests such as rodents and small mammals in sugarcane fields. Herbaceous and brushy growth on the edges of canals also decreases runoff from the fields into these water bodies.

Where there are larger areas of edge or upland that are not in cultivation we would recommend the planting of native trees and plants for the benefit of wildlife.

Water in ditches and in the fields is also a significant habitat for wildlife. Wherever possible, in keeping with overall water management needs, fields should be flooded and rice should be grown where appropriate. It is also desirable to keep water in as many ditches and small canals as possible throughout the year.

We encourage continued limited use of chemical fertilizers and pesticides with the investigation into alternative practices to further limit use of these chemicals.

We believe that limited access to the fields has had benefits for a number of wildlife species, especially those that are sensitive to disturbance such as nesting birds and those that may be collected for the pet trade such as the Florida Kingsnake. Our experience has

been that access is controlled and that managers are very aware of activities in their fields. We encourage the continuation of this practice, especially in the springtime when animals are breeding.

Many of the mammal species that are found in or adjacent to sugarcane fields may benefit from longer rotations in some fields and from lower intensity harvesting activities. We encourage this in fields where economical and management considerations allow.

We recognize that not all these suggestions are economically or practically feasible and yet we hope that managers and owners who value wildlife on their property will find a way to incorporate at least some of them into their management strategies. While agricultural operations cease to exist if they do not prove profitable, they are also a part of the greater landscape and of a local culture in which wildlife is intrinsically valuable. Therefore, we hope that our studies have had and will continue to have practical application for the benefit of wildlife in the EAA.

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Appendix 1. List of fish caught in our study, their relative abundance in Everglades National Park (ENP) (Loftus 2000), and relative abundances in EAA. Other studies 1 = Jordan et al., 2 = Sargent and Carlson 1987, 3 = Ceilley, no date, 4 Porter and Porter 2002, 5 = Kobza et al. 2003. Functional group – Kushlan 1976. c=common, lc=locally common, u=uncommon, r=rare, a=small omnivores and herbivores, b=small, primarily carnivores, c=large carnivores, *=exotic species.

Fish caught in EAA study	**Abundance in ENP natural, created**	**EAA (Relative Abund.)**	**Other studies**	**Locations Caught**
Florida gar *Lepisosteus platyrhincus*	lc, c	10 (0.0007)	low	visual only
Bowfin *Amia calva*	u, c	1 (0)		visual only
Taillight shiner[b] *Notropis maculatus*	r, r	3 (0.0002)	low	ditch, edge
Brown bullhead *Ameiurus nebulosus*	r, u	8 (0.0005)		ditch, edge
Walking catfish* *Clarias batrachus*	u, lc	1 (0)	low	edge
Armored catfish* *Pterygoplichthys multiradiatus*	hypothetical occurrence	3 (0)		canal, ditch, edge
Brown hoplo* *Hoplosternum littorale*	recently introduced	1 (0)		canal
American flagfish[a] *Jordanella floridae*	lc, lc	748 (0.0506)	high	all locations
Golden topminnow[b] *Fundulus chrysotus*	c, u	35 (0.0024)	high	ditch, edge, field
Bluefin killifish[b] *Lucania goodei*	c, -	286 (0.0194)	high	all locations
Eastern mosquitofish[a] *Gambusia holbrooki*	c, c	11544 (0.7813)	high	all locations
Least killifish[a] *Heterandria Formosa*	c, c	573 (0.0388)	high	all locations
Sailfin molly[a] *Poecilia latipinna*	lc, lc	1315 (0.0890)	high/low	all locations
Brook silverside[b] *Labidesthes sicculus*	u, lc	12 (0.0008)	low	ditch, edge
Bluespotted sunfish *Enneacanthus gloriosus*	u, c	15 (0.0010)	none	all locations
Bluegill sunfish[c] *Lepomis macrochirus*	u, c	157 (0.0106)	low	all locations, 2

				in canal, 1 in field
Redear sunfish[c]	u, c	1		canal
Lepomis microlophus		(0)		
Dollar sunfish[c]	c, c	6	low	edge
L. marginatus		(0.0004)		
Largemouth bass[c]	u, lc	1	low	edge
Micropterus salmoides		(0)		
Black acara*	lc, lc	11	low	edge
Cichlasoma bimaculatum		(0.0007)		
Mayan cichlid*	c, c	18	low	ditch only
C. urophthalmus		(0.0012)		
Oscar*	-, c	5		ditch, edge
Astronotus ocellatus		(0.0003)		
Blue tilapia*	lc, c	1		canal
Oreochromis aureus		(0)		
Spotted tilapia*	u, u	6		ditch, edge
Tilapia mariae		(0.0004)		

Appendix 2. Birds observed in the all areas of the EAA with relative abundance and habitat compared with birds from other South Florida habitats. 1 = ENP, 2 = LNWR. For abundance data, no = not present, * = accidental, u = uncommon, r = rare, c = common, a = abundance, o = occasional, # = breeding in area. For habitat, r = rice, f = fallow field, ff = fallow flooded, s = sugarcane, ag = general agricultural habitat, all = all habitats, - means no specific habitat could be assigned.

Name	Abundance EAA	Habitat EAA	Abundance other
Black-bellied Whistling-Duck			1 – no
Dendrocygna autumnalis	r	r, ff	2 – no
Fulvous Whistling-Duck#	c	r, ff	1 – u
D. bicolor			2 – u/c
Snow Goose	*	f	1 - *
Chen caerulescens			2 - *
Gadwall	*	r	1 – r
Anas strepera			2 - o
American Wigeon	*	-	1 – c
A. Americana			2 – u
American Black Duck	*	r, ff	1 - *
A. rubripes			2 – r
Mottled Duck#	a	r, ff	1 – c#
A. fulvigula			2 – a#
Blue-winged Teal	c	-	1 – c
A. discors			2 – a/o
Northern Shoveler	r	-	1 – c
A. clypeata			2 – u
Green-winged Teal	r	-	1 – u
A. crecca			2 - c
Ring-necked Duck	r	ff	1 – c
Aythya collaris			2 – a
Ruddy Duck	r	ff	1 – u
Oxyura jamaicensis			2 – r
Wild Turkey	r	ag	1 – r#
Meleagris gallopavo			2 - *
Northern Bobwhite#	r	ag	1 – c#
Colinus virginianus			2 – u#
Pied-billed Grebe#	r	ff, r	1 – c#
Podilymbus podiceps			2 – c#
American White Pelican	r	ff, r	1 – c
Pelecanus erythrorhynchos			2 – r
Brown Pelican	r	ag	1 – c#
P. occidentalis			2 - *
Double-crested Cormorant	c	all	1 – c#
Phalacrocorax auritus			2 – u#
Anhinga	c	ff, canal	1 – c#
Anhinga anhinga			2 – a#
American Bittern	r	-	1 – u/r/c
Botaurus lentiginosus			2 – u

Least Bittern#	c	r, c	1 – u#
Ixobrychus exilis			2 – u#
Great Blue Heron	c	all	1 – c#
Ardea herodias			2 – a#
Great White Heron	*	ff	1 – c#
A. herodias			2 - no
Great Egret	a	all	1 – c#
A. alba			2 – a#
Snowy Egret	a	all	1 – c#
Egretta thula			2 – c#
Little Blue Heron	a	r, f, ff	1 – c#
E. caerulea			2 – a#
Tricolored Heron	a	r, f, ff	1 – c#
E. tricolor			2 – c#
Reddish Egret	*	-	1 – u#
E. rufescens			2 - no
Cattle Egret	a	all	1 – c#
Bubulcus ibis			2 – a#
Green Heron#	a	all	1 – c#
Butorides virescens			2 – a#
Black-crowned Night-Heron#			1 – c#
Nycticorax nycticorax	c	r, f, ff	2 – c#
Yellow-crowned Night-Heron#			1 – u#
Nyctanassa violacea	c	all	2 – u#
White Ibis	a	r, f, ff	1 – c#
Eudocimus albus			2 – c#
Glossy Ibis	a	r, f, ff	1 – u#
Plegadis falcinellus			2 – c/u#
Roseate Spoonbill	c	r, ff	1 – c#
Platalea ajaja			2 – o
Wood Stork	a	r, ff	1 – u/r#
Mycteria Americana			2 – c/u#
Black Vulture	a	all	1 – c#
Coragyps atratus			2 – a#
Turkey Vulture	a	all	1 – c#
Cathartes aura			2 – a#
Osprey	c	ff	1 – c#
Pandion haliaetus			2 – c#
Swallow-tailed Kite	r	all	1 – c#
Elanoides forficatus			2 – u/r
Bald Eagle	r	all	1 – c#
Haliaeetus leucocephalus			2 – o/r
Northern Harrier	c	all	1 – u/c
Circus cyaneus			2 – c
Sharp-shinned Hawk	r	all	1 – u
Accipiter striatus			2 – c
Cooper's Hawk	r	all	1 – r
A. cooperii			2 – o
Red-shouldered Hawk	c	all	1 – c#

Buteo lineatus			2 – a#
Broad-winged Hawk	r	all	1 – u
B. platypterus			2 – o
Short-tailed Hawk	r	all	1 – u/r#
B. brachyurus			2 – o
Red-tailed Hawk	c	all	1 – u#
B. jamaicensis			2 – u
Crested Caracara	r	all	1 - *
Caracara cheriway			2 - *
American Kestrel	c	all	1 – c
Falco sparverius			2 – c
Merlin	r	all	1 – u
F. columbarius			2 – u
Peregrine Falcon	r	all	1 – u
F. peregrinus			2 – r
Clapper Rail	r	r, s	1 – c#
Rallus longirostris			2 - no
King Rail#	c	s, r, ff	1 – c#
R. elegans			2 – c#
Sora	r	-	1 – c
Porzana Carolina			2 – u
Purple Gallinule#	a	r, s, ag	1 – c#
Porphyrio martinica			2 – c#
Common Moorhen#	a	all	1 – c#
Gallinula chloropus			2 – a#
American Coot	c	ff	1 – c#
Fulica Americana			2 – a#
Limpkin	*	r, f	1 – c#
Aramus guarauna			2 – c#
Sandhill Crane#	r	f	1 – r#
Grus Canadensis			2 – c#
Black-bellied Plover	c	ff, ag	1 – c/r
Pluvalis squatarola			2 – u
Wilson's Plover	*	ff	1 – c#
Charadrius wilsonia			2 - no
Semipalmated Plover	r	r, f, ff	1 – c
C. semipalmatus			2 – c
Killdeer#	a	all	1 – c#
C. vociferous			2 – c#
Black-necked Stilt#	a	all	1 – u/r#
Himantopus mexicanus			2 – c#
American Avocet	r		1 – c
Recurvirostra Americana			2 – o
Greater Yellowlegs	c	r, f, ff	1 – c
Tringa melanoleuca			2 – c/u
Lesser Yellowlegs	c	r, ff	1 – c
T. flavipes			2 – c/u
Solitary Sandpiper	c	r, ff	1 – u/r
T. solitaria			2 – u/r

Willet *Catoptrophorus semipalmatus*	*	ff	1 – c 2 – r
Spotted Sandpiper *Actitis macularia*	r	f, ff	1 – c 2 – c/u
Upland Sandpiper *Bartramia longicauda*	*	ff	1 - * 2 - no
Ruddy Turnstone *Arenaria interpres*	*	ff	1 – c 2 - no
Semipalmated Sandpiper *Calidris pusilla*	c	r, f, ff	1 – u/r 2 – c
Western Sandpiper *C. mauri*	r	ff	1 – c 2 – c
Least Sandpiper *C. minutilla*	c	r, ff, f, ag	1 – c 2 – a/c
White-rumped Sandpiper *C. fuscicollis*	r	r, ff	1 – r 2 – u
Pectoral Sandpiper *C. melanotos*	c	ff	1 – c 2 – u
Stilt Sandpiper *C. himantopus*	r	ff	1 – u 2 – u
Ruff *Philomachus pugnax*	*	f	1 - * 2 - no
Short-billed Dowitcher *Limnodromus griseus*	r	ff	1 – c 2 – o/c
Long-billed Dowitcher *L. scolopaceus*	r	ff	1 – u 2 - no
Common Snipe *Gallinago gallinago*	r	-	1 – u 2 – c
Wilson's Phalarope *Phalaropus tricolor*	*	ff	1 - * 2 - no
Laughing Gull *Larus atricilla*	a	s, ff	1 – c# 2 – u
Ring-billed Gull *L. delawarensis*	r	ff	1 – c 2 – u
Herring Gull *L. argentatus*	r	ff	1 – c 2 – o
Gull-billed Tern *Sterna nilotica*	c	ff	1 – u 2 – r/o
Caspian Tern *S. caspia*	r	ff	1 – c 2 – u
Royal Tern *C. maxima*	*	ff	1 – c 2 - no
Sandwich Tern *S. sandvicensis*	r	ff	1 – u 2 - no
Common Tern *S. hirundo*	r	ff	1 – u 2 - no
Forster's Tern *S. forsteri*	*	ff	1 – c 2 – o
Least Tern	c	r, ff	1 – c#

S. antillarum			2 – u
Black Tern	c	ff	1 – u
Chlidonias niger			2 – u
Black Skimmer	r	ff	1 – c
Rynchops niger			2 - no
Ringed Turtle-Dove	*	r	1 - no
Streptopelia risoria			2 - no
Eurasian Collared-Dove	r	ag	1 - no
S. decaocto			2 - no
Mourning Dove	c	all	1 – c#
Zenaida macroura			2 – a#
Common Ground-dove	c	all	1 – u#
Columbina passerina			2 – c#
Barn Owl#	c	f, s	1 – u#
Tyto alba			2 – u#
Burrowing Owl	r	s	1 – r
Athene cunicularia			2 - *
Barred Owl	r	ag	1 – c#
Strix varia			2 – o#
Common Nighthawk	c	all	1 – c#
Chordeiles minor			2 – c#
Belted Kingfisher	c	r, ag	1 – c
Ceryle alcyon			2 – a/c
Red-bellied Woodpecker	r	ag	1 – c#
Melanerpes carolinus			2 – a#
Pileated Woodpecker	r	ag	1 – c#
Dryocopus pileatus			2 – c#
Eastern Phoebe	r	s	1 – c
Sayornis phoebe			2 – a/c
Great Crested Flycatcher	r	ff	1 – c#
Myiarchus crinitus			2 – c/r#
Eastern Kingbird	r	s	1 – c#
Tyrannus tyrannus			2 – a/u#
Gray Kingbird	*	ag	1 – c#
T. dominicensis			2 – r/u
Loggerhead Shrike	r	f, s	1 – u#
Lanius ludovicianus			2 – c#
Blue Jay	c	all	1 – c#
Cyanocitta cristata			2 – c#
American Crow	r	ag	1 – c#
Corvus brachyrhynchos			2 - no
Tree Swallow	c	f	1 – c
Tachycineta bicolor			2 – a
Northern Rough-winged Swallow			1 – u
Stelgidopteryx serripennis	c	f, ff	2 – c
Bank Swallow	r	f, ff, s	1 – u
Riparia riparia			2 – u
Barn Swallow	a	all	1 – c/u#
Hirundo rustica			2 – a

Carolina Wren *Thryothorus ludovicianus*	r	ag	1 – c# 2 – c#
Sedge Wren *Cistothorus platensis*	r		1 – u 2 – r
Blue-gray Gnatcatcher *Polioptila caerulea*	r	ag	1 – c 2 – a
American Robin *Turdus migratorius*	r	ag	1 – r/c 2 – a/u
Gray Catbird *Dumetella carolinensis*	c	ag	1 – c 2 – a
Northern Mockingbird *Mimus polyglottos*	c	s, ag	1 – c# 2 – a
Yellow-rumped Warbler *Dendroica coronata*	r	s	1 – c/r 2 – a
Prairie Warbler *D. discolor*	*	ag	1 – c# 2 – a/u
Palm Warbler *D. palmarum*	c	all	1 – c 2 – a
Swainson's Warbler *Limnothlypis swainsonii*	r	s	1 – r 2 – r
Common Yellowthroat# *Geothlypis trichas*	a	all	1 – c# 2 – a#
Eastern Towhee *Pipilo erythrophthalmus*	r	s	1 – c# 2 – c
Savannah Sparrow *Passerculus sandwichensis*	c	all	1 – c 2 – a/c
Grasshopper Sparrow *Ammodramus savannarum*	*	-	1 – u 2 – u
Lincoln's Sparrow *Melospiza lincolnii*	*	-	1 – r/u 2 - *
Northern Cardinal *Cardinalis cardinalis*	c	f	1 – c# 2 – a#
Red-winged Blackbird *Agelaius phoeniceus*	a	all	1 – c# 2 – a#
Eastern Meadowlark *Sturnella magna*	c	all	1 – c# 2 – u#
Rusty Blackbird *Euphagus carolinus*	r	s	1 - * 2 – r
Boat-tailed Grackle *Quiscalus major*	a	all	1 – c# 2 – a#

Appendix 3. Photos of methods and wildlife observed during the study.

Breder trap used for fish censusing

Minnow trap used for fish censusing

Blue tilapia *(Oreochromis aureus)*

Young Banded Watersnake (*Nerodia fasciata*)

Snapping Turtle (*Chelydra serpentina*)

American White Pelicans (*Pelecanus erythrorhynchos*) resting in a field with wading birds

Purple Gallinule (*Porphyrio martinica*) in mature rice

King Rail (*Rallus elegans*) near rice field

Cattle egret (*Eudocimus albus*) foraging near sugarcane fire

Appendix 4. Abstracts from manuscripts submitted to peer-reviewed journals for publication.

A Checklist of Birds of the Everglades Agricultural Area by: Elise V. Pearlstine, Michelle L. Casler and Frank J. Mazzotti, University of Florida, IFAS

Abstract: We studied bird habitat affinity and abundance in the Everglades Agricultural Area (EAA). The EAA is comprised of approximately 280,000 ha of agriculture that is dominated by sugarcane. Rice is grown on less than 10% of the area. We completed four years of study in rice fields and one year of surveys throughout sugarcane fields in the area. Birds were surveyed on transects along rice field edges and all birds within each field were counted. We used point counts along a road transect through sugarcane fields and established three to five points per field including any field ditches. Point counts lasted five minutes. We observed 139 species of birds in all habitats of the EAA with birds being most abundant in rice fields. Sixteen species were observed breeding in the area and 18 other species are potential breeders. We saw all species of wading birds that occur regularly in south Florida, nearly all species of raptors and many bird species that prefer open country. Waterbirds in general were the best represented group and these included three species of breeding ducks. Sugarcane fields and associated edge habitat supported a number of upland and other birds. Forest and woodland birds were poorly represented in the EAA due to the sparse distribution of trees in the area. Because of its size and the nature of agriculture in the EAA, a large number and diversity of birds use this habitat for dispersal, migratory and breeding habitat.

Relative distribution and abundance of wintering raptors in agricultural and wetland landscapes of south Florida by: Elise V. Pearlstine, Frank J. Mazzotti and Mary Hudson Kelly, University of Florida, IFAS

Abstract: We investigated the relative distribution and abundance of raptors (vultures, hawks and falcons) between agricultural and natural habitats along Route 27, a four line highway in south Florida using roadside surveys during the winters of 1998 through 2003, excluding winter 2001/2002. We recorded occurrence in roadside habitat, perch type selection, and density of raptors along the roadside as well as species richness and diversity in each habitat type. Turkey vultures (*Cathartes aura*), Northern harriers (*Circus cyaneus*), Red-tailed hawks (*Buteo jamaicensis*), and American kestrels (*Falco sparverius*) were more abundant in agricultural than natural habitat. Black vultures (*Coragyps atratus*), Ospreys (*Pandion haliaetus*) and Red-shouldered hawks (*Buteo lineatus*) were found more often in natural habitat. Choice of perch type was significant with powerlines or poles utilized more frequently than natural perches. Each species was observed more often than expected on one or more of five types of perch or in flight. All seven species were found in both habitats making species richness equal in agriculture and natural. Each species seemed to exhibit unique patterns of habitat occurrence and perch use. This study outlines the importance of the agricultural landscape of south Florida in supporting wintering and migrating populations of raptors.

Bird Observations in Five Agricultural Field Types of the Everglades Agricultural Area in the Summer and Fall by: Elise V. Pearlstine, Frank J. Mazzotti, and Anna E. Liner, University of Florida, IFAS

Abstract: The Everglades Agricultural Area is a 283,000 ha segment of the former Everglades that was drained and dedicated to agricultural cultivation. It is an integral part of the greater Everglades system, however, tthe wildlife of this area remains relatively unstudied. In this study five prominent cover types of the EAA were sampled for birds from mid-June to December of 1999 at 18 sites throughout the region. Comparisons between these EAA sites and four sites at the adjacent Arthur R. Marshall Loxahatchee National Wildlife Refuge were made. A total of 20,573 bird observations including 80 species were recorded within the EAA. Flooded habitats, such as rice and fallow flooded fields, were found to exhibit greater bird activity and species richness than terrestrial habitats (cane, sod, fallow fields) within the EAA. It is recommended here that flooded habitats be expanded within the EAA, especially on idle lands. The need for further study and the inclusion of wildlife in agricultural and restoration planning for the area is emphasized.