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WADING BIRDS, SHOREBIRDS, AND WATERFOWL IN RICE FIELDS WITHIN THE EVERGLADES AGRICULTURAL AREA

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Abstract.—Wetland reclamation and development have resulted in wildlife habitat loss and diminished habitat quality in south Florida. In response to these changes, waterbird numbers have declined or individuals have moved into modified or artificial habitats. Rice, a well-known artificial habitat for waterbirds in many rice-growing regions (Kushlan and Hafner 2000), is cultivated in the Everglades Agricultural Area (EAA) and provides habitat for waterbirds. During the 1998 rice-growing season, 300 surveys were conducted in 14 representative rice fields. Objectives included determining the number and relative abundance of waterbird species in rice fields, impacts of temporal and spatial field condition on waterbird richness and abundance, and characterization of waterbird activities in rice fields. Forty-one species of waterbirds were observed in rice fields. Species richness at survey sites ranged from 12-28 and density ranged from 4.6 to 72.6 birds/min/100 ha. Species richness and overall abundance fluctuated in response to rice growth or harvest phase and field water levels. Significantly more wading birds and shorebirds were present in rice fields during water drawdown. Shorebird abundance was negatively correlated to water level and rice height. Waterfowl abundance was negatively correlated with cloud cover. Primary activity of all birds was foraging (63%), followed by resting (33%), walking or running (4%), and nesting (<1%). Rice fields harvested twice (ratooned) provided additional water drawdown phases. Waterbird abundance may increase in the EAA with greater area devoted to rice fields and increased ratooning of existing fields. Effects of rice farming practices on waterbirds, including chemical use and harvesting methods, should be further evaluated.

Numbers of waterbirds in south Florida, including wading birds, shorebirds, and waterfowl, have declined throughout the last century as anthropogenic influences have altered original ecosystems (Kahl 1964, Robertson and Kushlan 1974, Kushlan 1976, Ogden 1994, Frohring et al. 1988, Sklar et al. 2002). The decline in waterbirds has frequently been attributed to habitat loss through wetland conversion

(National Audubon Society 1992, Light and Dineen 1994). Two important consequences of landscape perturbation have been loss of nearly half of the native Everglades habitats and degradation of remaining wetlands (Davis and Ogden 1994). In response to habitat loss and alteration in the Everglades, many waterbird species are now found in modified or artificial habitats (Kushlan and White 1977, Bancroft 1989, Ogden 1991, Frederick 1993, Frederick and McGehee 1994).

As natural wetland area declines, waterbird populations increasingly use rice fields for additional or alternative foraging and nesting habitat worldwide. Artificial wetlands associated with rice farming provide habitat for waterbirds in the Mediterranean region (Fasola et al. 1996, Fasola and Ruiz 1996), Malaysia (Avery 1997), Cuba (Acosta et al. 1996), and Japan (Maeda 2001). In the U.S. over one million hectares of rice are grown annually, primarily in the Mississippi Alluvial Valley, Gulf Coastal Plain, and Central Valley of California (Coats 2004) and receive high use by shorebirds, wading birds, and waterfowl (Twedt and Nelms 1999, Elphick 2000, Maeda 2001, Czech and Parsons 2002, Huner et al. 2002).

Rice culture in the Everglades Agricultural Area (EAA) began in the late 1970s and approximately 7800 ha are currently grown annually (Schueneman and Deren 2000). Summer censuses conducted by Sykes and Hunter (1978) detected 59 waterbird species using temporarily flooded fallow fields in the EAA. Turnbull et al. (1989a) reported the presence of breeding Fulvous Whistling-Ducks (*Dendrocygna bicolor*) centered in the EAA, and Smith (1995) briefly noted the use of EAA irrigation ditches by Snowy Egrets (*Egretta thula*) and Tricolored Herons (*Egretta tricolor*). An undated census reported that all species found in the water conservation areas (WCAs) of the Everglades were also found in EAA rice fields (Lodge 1994).

Recovery of Florida's waterbird species relies on identification of habitats currently in use, whether artificial or natural, and the evaluation of their role as waterbird habitat. Our objectives in this study were to (1) compile a species checklist of waterbirds using EAA rice fields, (2) compare waterbird abundance and richness in selected rice fields to spatial and temporal variables, and (3) evaluate activity and microhabitat preference of all individual birds observed within selected rice fields.

Methods

Study Area.—The EAA is about 280,000 ha of primarily sugarcane (76%), with smaller areas devoted to vegetables, rice, and sod (Izuno and Bottcher 1994). Approximately 6% of total land area devoted to sugarcane and vegetables is rotated annually to rice production and then returned back to other uses (Izuno and Bottcher 1994). Fields are planted with rice between late February and mid-May and require an average of

120 days for maturation. Fields are harvested without extracting the entire plant, which allows a second or ratoon crop to grow to maturity after an additional 85 days (Schueneman and Deren 2001). Initial harvests generally take place in July and August and ratoon harvests occur between September and October. Fields are laser-leveled prior to planting to assure flooding results in uniform water depth across planted areas. Temporary and permanent irrigation ditches and canals connect rice fields and offer variation in water depth and vegetation communities between rice fields.

We surveyed 14 rice fields between March and November of 1998 (Fig. 1). We identified a representative section of each field, marked each corner with flagging, and counted all waterbirds seen or heard within the identified area. Representative sections included a portion of the larger rice field complex, transitional vegetation to the road

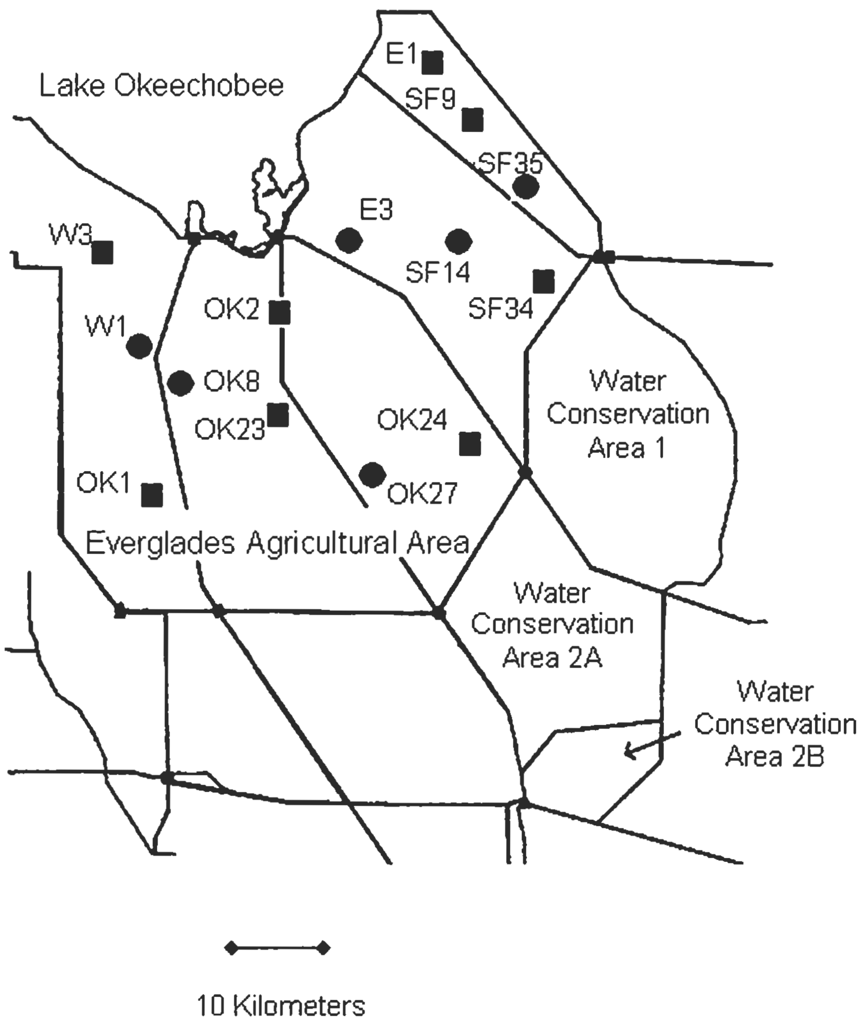

Figure 1. Survey sites within the Everglades Agricultural Area.

edge or adjacent field, and the full width of one irrigation waterway. Each survey consisted of either a 20- or 30-min count and start time varied randomly to eliminate time of day bias. Counts occurred within five hours of sunrise. All birds that touched down in the flagged area were counted unless they were observed leaving and re-entering the field; their activity and microhabitat location were assessed. Activity was divided into four categories: foraging, resting, moving, or nesting. Microhabitats included bare soil, dry vegetation, edge, open water, and emergent vegetation. All birds were grouped according to feeding guilds and identified as wading bird, shorebird, or waterfowl as described by Elphick et al. (2001).

Environmental variables recorded included height of rice, height of plants, depth of water, minutes after sunrise, wind speed measured in five mile per hour increments, cloud cover estimated in 10% increments between 0 and 100, air temperature in degrees Celsius, and cultivation phase. Cultivation phases included a pre-planting period when fields were cleared of vegetation, periods of rice growing without flooding, flooded rice fields, the drawdown period, and the initial and final harvests which were characterized by rice stubble standing in non-flooded fields.

Abundance variables, including total number of birds per minute per 100 ha (min/100 ha), wading birds/min/100 ha, shorebirds/min/100 ha, and waterfowl/min/100 ha, were compared with independent environmental conditions using ANOVA. Total bird abundance in a selected representative rice field was also graphed over time. Variables related to species richness included total number of species and number of species within each guild, but these values were too low for statistical analysis.

No changes in bird activity or microhabitat location were recorded after initial count and assessment. Birds entering a field during a count were recorded as moving. Moving birds also included those walking, swimming, or running, unless these activities were necessary for foraging or nesting. Nesting behaviors included nest building, nest inhabitation, incubation of eggs, copulation, or interaction with young remaining in nests.

Results

Forty-one waterbird species were observed using rice fields of the EAA. Breeding evidence was positively identified for 8 of these species (Table 1). Half the total individuals observed were wading birds (50%), followed by waterfowl (39%), and shorebirds (11%). Twenty-two species were observed on more than 50 days and were observed using six or more survey sites (Fig. 2). Species richness ranged from 12-28 species and average number of wading bird species observed each day was higher than waterfowl or shorebirds. Total bird abundance, and abundance for each guild, peaked twice throughout the growing season (Fig. 3).

The primary activity for all waterbirds was foraging (63%), followed by resting (33%), moving (4%), and nesting (<1%). Shorebirds and wading birds spent the majority of their time foraging, while waterfowl foraged and lounged nearly equally. Only waterfowl and shorebirds were observed engaged in breeding activities. The number of all birds foraging and moving decreased continually from sunrise to five hours after sunrise. Resting peaked in the third hour for all birds, and reproductive activities differed little among hours.

Wading birds and waterfowl were observed most frequently in open water, whereas shorebirds were seen most frequently in non-

Table 1. Waterbird species observed in rice fields of the Everglades Agricultural Area, total number of individuals observed throughout the survey period[1], guild designations, and status in Florida according to Rodgers et al. (1992).

Common name	Species	Total number	Guild	Status
American Coot[7]	*Fulica americana*	22	D[2]	—
Anhinga	*Anhinga anhinga*	30	D	—
Black-crowned Night-Heron	*Nycticorax nycticorax*	10	W[3]	—
Black-necked Stilt[7]	*Himantopus mexicanus*	298	S[4]	—
Blue-winged Teal	*Anas discors*	22	D	—
Cattle Egret	*Bubulcus ibis*	630	W	—
Common Moorhen[7]	*Gallinula chloropus*	755	D	—
Fulvous Whistling-Duck[7]	*Dendrocygna bicolor*	101	D	—
Glossy Ibis	*Plegadis falcinellus*	474	W	—
Great Blue Heron	*Ardea herodias*	55	W	—
Great Egret	*Ardea alba*	459	W	—
Greater Yellowlegs	*Tringa melanoleuca*	20	S	—
Green Heron	*Butorides virescens*	115	W	—
Killdeer[7]	*Charadrius vociferus*	150	S	—
King Rail[7]	*Rallus elegans*	33	S	—
Least Bittern	*Ixobrychus exilis*	40	W	SSC[5]
Least Sandpiper	*Calidris minutilla*	12	S	—
Lesser Yellowlegs	*Tringa flavipes*	105	S	—
Little Blue Heron	*Egretta caerulea*	158	W	SSC
Mottled Duck[7]	*Anas fulvigula*	1035	D	—
Pied-billed Grebe	*Podilymbus podiceps*	54	D	—
Purple Gallinule[7]	*Porphyrula martinica*	197	D	—
Semipalmated Sandpiper	*Calidris pusilla*	46	S	—
Snowy Egret	*Egretta thula*	212	W	SSC
Sora	*Porzana carolina*	53	S	—
Tri-colored Heron	*Egretta tricolor*	182	W	SSC
White Ibis	*Eudocimus albus*	299	W	SSC
Wood Stork	*Mycteria americana*	435	W	E[6]
Yellow-crowned Night-Heron	*Nyctanassa violacea*	56	W	—

[1]Species with fewer than 10 sightings included: American Bittern (*Botaurus lentiginosus*), Double-crested Cormorant (*Phalacrocorax auritus*), Herring Gull (*Larus argentatus*), Limpkin[5] (*Aramus guarauna*), Reddish Egret[5] (*Egretta rufescens*), Short-billed Dowitcher (*Limnodromus griseus*), Solitary Sandpiper (*Tringa solitaria*), Semipalmated Plover (*Charadrius semipalmatus*), Stilt Sandpiper (*Calidris himantopus*), Upland Sandpiper (*Bartramia longicauda*), Western Sandpiper (*Calidris mauri*), and Wilson's Plover[5] (*Charadrius wilsonia*), [2]Waterfowl, [3]Wading bird, [4]Shorebird, [5]State species of concern, [6]Federally endangered, [7]Breeding evidence observed.

flooded vegetation. All wading birds and waterfowl used each microhabitat at least once. Shorebirds used all except levees without vegetation and did not perch above water. Foraging waterbirds were observed in open water most often, followed by vegetated water and cleared soil, and used all habitats. All microhabitats were used for lounging, but ditch edges and vegetated water were used for this activity most often.

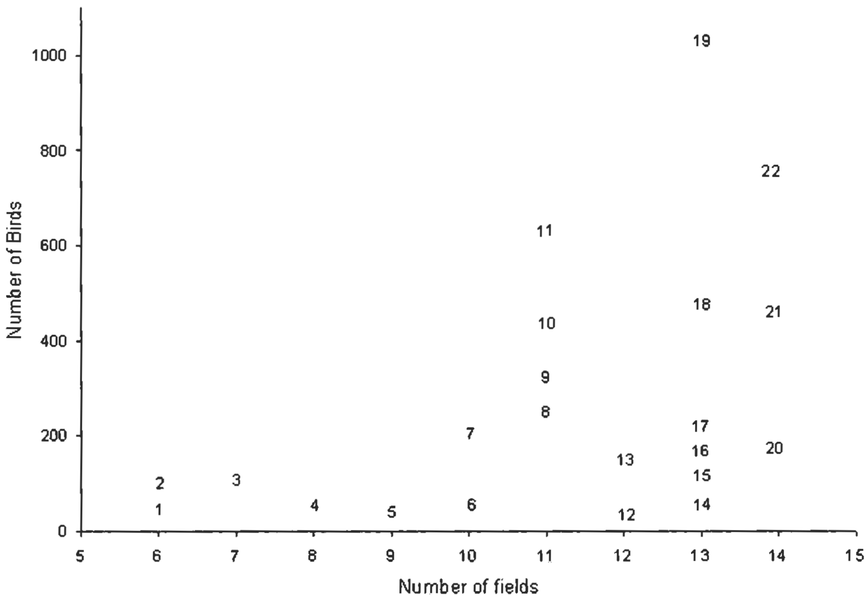

Figure 2. Number of individuals of each species seen in 6 or more fields (>50 observations). 1 = Sora, 2 = Fulvous Whistling-Duck, 3 = Lesser Yellowlegs, 4 = Pied-billed Grebe, 5 = Least Bittern, 6 = Yellow-crowned Night-Heron, 7 = Snowy Egret, 8 = White Ibis, 9 = Black-necked Stilt, 10 = Wood Stork, 11 = Cattle Egret, 12 = King Rail, 13 = Killdeer, 14 = Great Blue Heron, 15 = Green Heron, 16 = Little Blue Heron, 17 = Purple Gallinule, 18 = Glossy Ibis, 19 = Mottled Duck, 20 = Tri-colored Heron, 21 = Great Egret, 22 = Common Moorhen.

Moving birds were typically on cleared soil, dry vegetation, in open water, or in vegetated water. Nesting took place primarily in emergent or dry vegetation, but also occurred on bare soil.

Phase of cultivation significantly affected overall abundance of birds, wading birds, and shorebirds (ANOVA, $p < 0.0001$), but not waterfowl (ANOVA, $p > 0.05$). In addition, shorebird abundance was inversely related to water depth and rice height (ANOVA, $p = 0.02$, $p < 0.0001$ respectively), and waterfowl abundance was inversely related to cloud cover (ANOVA, $p = 0.03$). The time of the count in minutes after sunrise had no detected influence on total bird abundance (ANOVA, $p > 0.05$). Total abundance, shorebird abundance, and waterfowl abundance were significantly different among fields (ANOVA, $p = 0.02$, $p = 0.02$ and $p < 0.0001$ respectively).

Discussion

Waterbird abundance in EAA rice fields appears to represent interplay between seasonal migration patterns and rice field conditions. For

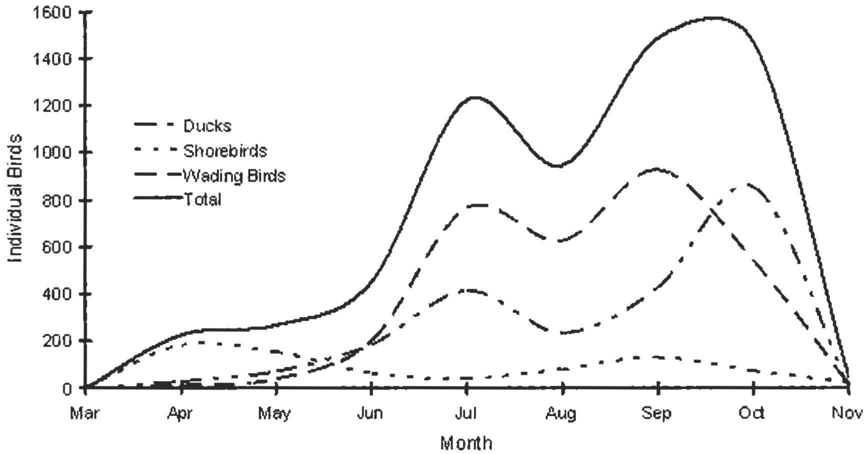

Figure 3. Number of individual birds present in EAA rice fields by guild during the 1998 rice-growing season.

shorebirds and waterfowl, it is unclear which of these most influenced abundance. While abundance peaks for shorebirds and waterfowl may have occurred as a result of natural spring and fall migration periods, it is also possible that field conditions were best suited for shorebirds during spring migration when shallow water and recently cleared soils attracted shorter-legged, substrate foragers. Similarly, ducks were most abundant during their fall migrations, which also coincided with availability of large expanses of open water in rice fields, a preferred habitat for foraging. Wading birds exhibited peak abundance beginning in June that may have resulted from northward movement from the Everglades at the close of the nesting season and the beginning of the rainy season, when prey are less concentrated in natural wetlands. However, wading birds were present in rice fields throughout the summer, with fluctuations in abundance corresponding more closely to rice field conditions.

Examination of abundance in a selected representative rice field (SF9), illustrates the interplay of migration and field conditions more clearly (Fig. 4). During the pre-planting stage when fields were cleared and not yet flooded, little bird activity took place. An initial increase in bird abundance coincided with flooding (Fig. 4, Point A). Shorebirds were the first guild to arrive following this initial flooding, suggesting that flooded fields with little vegetation were more attractive to shorebirds than cleared and dry fields, since both conditions were available during spring migrations. As rice matured and flood level was unchanged, total bird abundance fluctuated little (remaining around 20 birds/min/100 ha).

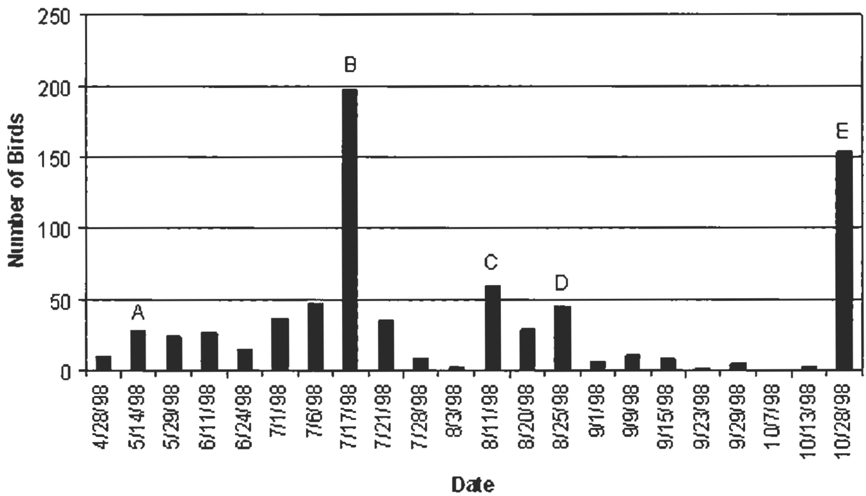

Figure 4. Total number of individuals of all guilds in a representative rice field (SF9) throughout the 1998 growing season. Each date represents a single sampling event. A = initial flood, B = drawdown, C = initial harvest, D = ratoon reflood, E = final drawdown.

Bird abundance rose rapidly in mid-July during the initial drawdown period, when water is drained from fields in preparation for harvest (Fig. 4, Point B). Drawdown reduces water level in rice fields rapidly, generally taking less than a day to completely drain a field and reduce water levels in adjacent irrigation ditches. Aquatic organisms become highly concentrated in ditches and easy prey for foraging waterbirds. Hundreds of wading birds were frequently observed using irrigation ditches for foraging during drawdown. It is this great surge in abundance, long observed by EAA farmers, that initiated this study.

Soon after drawdown, bird abundance decreased rapidly. Unharvested fields of dry vegetation attracted few birds. Again, this indicates wading bird preferences for certain field conditions, since all field conditions were available for selection during the period of the study.

The next peak in bird abundance occurred during initial harvests after rice is extracted and while machinery is working the soil (Fig. 4, Point C). Prey items exposed during tilling result in a parade of foraging birds following behind machinery. In particular, Great Egrets and Cattle Egrets were most abundant in fields as tilling occurred.

After the initial harvest, this field was ratooned, resulting in a repeat of the entire cultivation cycle, although abbreviated to 2-3 months. The second flood (Fig. 4, Point D) and drawdown (Fig. 4, Point E) attracted a similar large number of birds.

While aquatic prey assemblages in the rice fields of the U.S. are poorly studied, rice fields in other areas provide indications of potential aquatic communities. Once Mediterranean fields are flooded, complex mature communities of aquatic prey become established through ecological succession, despite human induced alterations (Fores and Comin 1992). In some cases, rice fields have been assessed as preferable habitat for some species of herons in the Mediterranean, since they offer superior prey availability to natural areas and allow greater food intake rates (Fasola and Ruiz 1996).

Microhabitat availability was an important factor in waterbird use of rice fields, particularly edge habitat, which was used often by all guilds. The importance of edge habitat for birds in agriculture has been recognized in rice as well as other crops (Best et al. 1990, Maeda 2001, Perkins et al. 2000). Dry vegetation, such as that found on levees and at the edges of fields, was used by wading birds and primarily for resting and moving between other microhabitats. Open water, often associated with irrigation or field management in conjunction with the rice itself, was one of the microhabitats most frequently used by ducks. Fallow fields or bare soil can also be important habitat for many of the birds found in agriculture in this study (Best et al. 1990, Fujioka et al. 2001, Perkins et al. 2000). Variation in microhabitat availability between fields may be a result of varying management practices at separate fields. Peripheral vegetation, canal placement, and size and shape of irrigation ditches all vary between fields.

In Australian rice fields, cultivation schedules conflicted with breeding season of waterbirds (Richardson et al. 2001). As a result, increasing food needs of reproducing birds of each year do not correspond to the highest availability of prey items in rice fields. However, in the EAA, rice field cultivation schedules are currently beneficial to migrating, breeding, and foraging waterbirds of south Florida. Furthermore, it may be possible to increase benefits to waterbirds by making adjustments to EAA rice cultivation timing and practices. For example, because only a portion of the existing rice fields in any year are ratooned, hundreds of hectares of land are left fallow (Schueneman and Deren 2000). Increasing the number of ratooned fields would offer additional acreage of waterbird habitat and a greater number of overall drawdown events. In addition, although some sugarcane is left fallow after three crop rotations, it may not be rotated into rice until after six rotations (Lodge 1994). Rotating sugarcane fields into rice every three rotations would also increase acreage of rice field availability.

Before management recommendations can be made, however, further studies are necessary. Farming practices and timing, including use of chemicals and fertilizers and cultivation and tillage may adversely affect waterbirds in rice (Wyss 1996, O'Connor and Shrubb

1986). A study of pesticide residues found sublethal levels of organochlorine and organophosphate pesticides within Fulvous Whistling-Ducks of the EAA (Turnbull et al. 1989b). Local traffic, harvest, and crop rotation also pose threats to birds in crops (O'Connor and Shrubb 1986). Wyss (1996) found that Fulvous Whistling-Duck nests frequently failed since initiation occurred too close to harvests.

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LITERATURE CITED

ACOSTA, M., L. MUGICA, C. MANCINA, AND X. RUIZ. 1996. Resource partitioning between Glossy and White Ibises in a rice field system in southcentral Cuba. Colonial Waterbirds 19: 65-72.

AVERY, M. L. 1997. Occurrence of migrant shorebirds in Malaysian ricefields. Abstract *in* Colonial Waterbird Society Twenty-first Annual Meeting, Symposia, and Workshops, Program and Abstracts, The Waterbird Society, Lafayette, LA.

BANCROFT, G. T. 1989. Status and conservation of wading birds in the Everglades. American Birds 43:1258-1265.

BEST, L. B., R. C. WHITMORE, AND G. M. BOOTH. 1990. Use of cornfields by birds during the breeding season: The importance of edge habitat. American Midlands Naturalist 123:84-99.

COATS, B. 2004. Numbers: what the 2002 and 2003 marketing years teach us about seizing the opportunity in 2004. Rice Journal 107:2-4.

CZECH, H. A., AND K. C. PARSONS. 2002. Agricultural wetlands and waterbirds: A review. Waterbirds 25:56-65.

DAVIS, S. M., AND J. C. OGDEN. 1994. Introduction. Pages 3-8 *in* S. M. Davis and J. C. Ogden (eds.). Everglades: The Ecosystem and Its Restoration. St. Lucie Press, Delray Beach, FL.

ELPHICK, C. S. 2000. Functional equivalency between rice fields and seminatural wetland habitats. Conservation Biology 14:181-191.

ELPHICK, C. S., J. B. DUNNING, JR., AND D. A. SIBLEY. 2001. The Sibley guide to bird life and behavior. Alfred A. Knopf, New York.

FASOLA, M., L. CANOVA, AND N. SAINO. 1996. Rice fields support a large portion of herons breeding in the Mediterranean Region. Colonial Waterbirds 19:129-134.

FASOLA, M., AND X. RUIZ. 1996. The value of rice fields as substitutes for natural wetlands for waterbirds in the Mediterranean region. Colonial Waterbirds 19:122-128.

FORES, E., AND F. A. COMIN. 1992. Ricefields, a limnological perspective. Limnetica 8:105-109.

FREDERICK, P. C. 1993. Wading bird nesting success studies in the WCAs of the Everglades. Final Report to the South Florida Water Management District, West Palm Beach, FL.

FREDERICK, P. C., AND S. M. MCGEHEE. 1994. Wading bird use of wastewater treatment wetlands in central Florida, USA. Colonial Waterbirds 17:50-59.

FROHRING, P. C., D. P. VOORHEES, AND J. A. KUSHLAN. 1988. History of wading bird populations in the Florida Everglades: A lesson in the use of historical information. Colonial Waterbirds 11:328-335.

FUJIOKA, M., J. W. ARMACOST JR., H. YOSHIDA, AND T. MAEDA. 2001. Value of fallow farmlands as summer habitats for waterbirds in a Japanese rural area. Ecological Research 16:555-567.

HUNER, J. V., C. W. JESKE, AND W. NORLING. 2002. Managing agricultural wetlands for waterbirds in the coastal regions of Louisiana, U.S.A. Waterbirds 25:66-78.

IZUNO, F. T., AND A. B. BOTTCHER. 1994. Introduction. Pages 1-12 *in* A. B. Bottcher and F. T. Izuno (eds) Everglades Agricultural Area (EAA): Water, Soil, Crop, and Environmental Management. University Press of Florida, Gainesville.

KAHL, M. P., JR. 1964. Food ecology of the Wood Stork (*Mycteria Americana*) in Florida. Ecological Monographs 34:97-117.

KUSHLAN, J. A. 1976. Feeding behavior of North American herons. Auk 93:86-94.

KUSHLAN, J. A. AND H. HAFNER (EDS.). 2000. Heron Conservation. Academic Press, San Diego, CA.

KUSHLAN, J. A., AND D. A. WHITE. 1977. Nesting wading bird populations in southern Florida. Florida Scientist 40:65-72.

LIGHT, S. S., AND J. W. DINEEN. 1994. Water control in the Everglades: A historical perspective. Pages 47-84 *in* S. M. Davis and J. C. Ogden (eds.). Everglades: The Ecosystem and Its Restoration. St. Lucie Press, Delray Beach, FL.

LODGE, T. E. 1994. The Everglades handbook: understanding the ecosystem. St. Lucie Press, Delray Beach, FL.

MAEDA, T. 2001. Patterns of bird abundance and habitat use in rice fields of the Kanto Plain, central Japan. Ecological Research 16:569-585.

NATIONAL AUDUBON SOCIETY. 1992. Report of the Advisory Panel on the Everglades and Endangered Species, Audubon Conservation Report No. 8, National Audubon Society, New York.

O'CONNOR, R. J., AND M. SHRUBB. 1986. Farming and Birds. Cambridge University Press, New York.

OGDEN, J. C. 1991. Nesting by Wood Storks in natural, altered, and artificial wetlands in central and northern Florida. Colonial Waterbirds 14:39-45.

OGDEN, J. C. 1994. A comparison of wading bird nesting colony dynamics (1931-46 and 1974-89) as an indication of ecosystem conditions in the Southern Everglades. Pages 533-570 *in* S. M. Davis and J. C. Ogden (eds). Everglades: The Ecosystem and Its Restoration. St. Lucie Press, Delray Beach, FL.

PERKINS, A. J., M. J. WHITTINGHAM, R. B. BRADBURY, J. D. WILSON, A. J. MORRIS, AND P. R. BARNETT. 2000. Habitat characteristics affecting use of lowland agricultural grassland by birds in winter. Biological Conservation 95: 279-294.

RICHARDSON, A. J., I. R. TAYLOR, AND J. E. GROWNS. 2001. The foraging ecology of egrets in rice fields in southern New South Wales, Australia. Waterbirds 24:255-264.

ROBERTSON, W. R., JR., AND J. A. KUSHLAN. 1974. The southern Florida avifauna. Miami Geological Society Memoir 2:414-452.

RODGERS, J. A., JR., H. W. KALE II, AND H. T. SMITH (EDS.). 1992. Rare and endangered biota of Florida. Volume V. Birds. University Press of Florida, Gainesville.

SCHUENEMAN, T. J., AND C. W. DEREN. 2000. Florida's 2000 rice variety census. Fact Sheet SS-AGR-76. Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

SCHUENEMAN, T. J., AND C. W. DEREN. 2001. Rice in the crop rotation. Fact Sheet SS-AGR-23. Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

SKLAR, F., C. MCVOY, R. VAN ZEE, D. GAWLIK, K. TARBOTON, D. RUDNICK, AND S. MIAO. 2002. The effects of altered hydrology on the ecology of the Everglades. Pages XX *in* J. W. Porter and K. G. Porter (eds.). The Everglades, Florida Bay, and Coral Reefs of the Florida Keys, An Ecosystem Sourcebook. CRC Press LLC, FL.

SMITH, J. P. 1995. Foraging flights and habitat use of nesting wading birds (Ciconiiformes) at Lake Okeechobee, Florida. Ph.D. dissertation, University of Florida, Gainesville.

SYKES, P. W., JR., AND G. S. HUNTER. 1978. Bird use of flooded agricultural field during summer and early fall and some recommendations for management. Florida Field Naturalist 6:37-43.

TURNBULL, R. E., F. A. JOHNSON, AND D. H. BRAKHAGE. 1989a. Status, distribution, and food of Fulvous Whistling-Ducks in south Florida. Journal of Wildlife Management 53:1046-1051.

TURNBULL, R. E., F. A. JOHNSON, M.A. HERNANDEZ, W. B. WHEELER, AND J. P. TOTH. 1989b. Pesticide residues in Fulvous Whistling-Ducks from south Florida. Journal of Wildlife Management.53:1052-1057.

TWEDT, D. J., AND C. O. NELMS. 1999. Waterfowl density on agricultural fields managed to retain water in winter. Wildlife Society Bulletin 27:924-930.

WYSS, A. J. 1996. Nesting Ecology of Fulvous Whistling-Ducks in the Everglades Agricultural Area of southern Florida. M.S. thesis, Auburn University, Auburn, AL.