Florida Field Naturalist

PUBLISHED BY THE FLORIDA ORNITHOLOGICAL SOCIETY

VOL. 25, NO. 1 FEBRUARY 1997 PAGES 1-32

Fla. Field Nat. 25(1):1-10, 1997.

AVIFAUNA OF AN UNIMPOUNDED SALT MARSH ON MERRITT ISLAND

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Abstract.—Variable circular plots were used to quantify avian composition and abundance in an unimpounded salt marsh. There were 31 avian species of conservation concern observed using the marsh for resting, feeding, or breeding. A high species richness (89 species) and density of birds (15 birds per ha) used the marsh.

Few studies have quantified the avian species composition of the salt marshes that border much of Florida's coastline (Engstrom 1992). Few studies of avian species composition in saline environments have been published in North America (Burger et al. 1992, Weller 1994). The objective of this paper is to quantify avian composition within several remnants of unimpounded salt marsh that occur along the estuarine edges of the Indian River lagoon system on Merritt Island.

Most salt marshes that remain along the Indian River are impounded for mosquito control or are highly fragmented due to human activities (Larson 1995). Impoundment could have benefited most bird species (see Provost 1969), but contributed to the extinction of the Dusky Seaside Sparrow (*Ammodramus maritimus nigrescens*) (Sykes 1980, Kale 1988) and the reduction of Black Rail populations on Merritt Island (Sykes 1978). Impounded salt marshes often have higher bird densities and biomass than do unimpounded marshes because there is more shallow, open water in impoundments (Trost 1968, Provost 1968, Burger et al. 1992, Smith and Breininger 1995). Unimpounded salt marshes on Merritt Island were described as "avian deserts" (Provost 1969).

STUDY AREA AND METHODS

The Indian River Lagoon watershed, an estuary of national significance, occurs between barrier islands and the mainland of central Florida's Atlantic coast (DeFreese

1991). This coastal zone of central Florida is the southern transition between grassy marshes to the north and mangrove swamps to the south (Schmalzer 1995). Merritt Island National Wildlife Refuge includes much of the northern Indian River Lagoon complex. Estuarine water levels on Merritt Island are influenced by wind-driven tides, rainfall, and evapotranspiration, but not ocean tides. The marsh occurred adjacent to Gator Hole, an estuarine water located at the northern extent of the Banana River estuarine lagoon. Seven stations were located in the marsh 100-200 m from the open water estuary and at least 200 m apart from each other.

Scientific nomenclature follows Wunderlin (1982) for plants and American Ornithologists' Union (1983) for birds. Salt pans, that were occasionally flooded, comprised 1/5 of the marsh; mangroves (*Avicennia germinans*) comprised 1/5 of the marsh; short (< 1 m) vegetation (*Distichlis spicata, Salicornia* spp., *Batis maritima, Borrichia frutescens, Spartina alterniflora,* and *Juncus roemerianus*) comprised 3/5 of the marsh. Small, permanently flooded pools (< 0.3 ha) were scattered among the vegetation. All seven stations included pools, salt pans, mangroves and most or all of the short vegetation from above. Remnants of such heterogeneous vegetation are common along the estuary (Larson 1995, Schmalzer 1995).

The variable circular plot (VCP) method (Reynolds et al. 1980) was selected to survey birds because of its advantages in patchy habitat (Breininger 1990, 1992; Breininger and Schmalzer 1990, Breininger and Smith 1992). Each station was surveyed eight times. Survey periods were spring 1985 (26 March, 28 March, 7 May, 15 May), summer 1985 (1 July, 8 July, 28 August), fall 1985 (4 September, 3 October, 16 October, 21 November), and winter 1985/1986 (2 December, 22 January, 27 January, 26 February, 27 February). Birds flushed during arrival to the station were tallied, and distances between their flushing location and the station's center point were recorded. All birds seen or heard within seven-minute sampling intervals were recorded, except for those birds that flew over the area without landing (e.g., swallows). Surveys were conducted between one-half hour before sunrise to three hours after sunrise. No surveys were conducted during rain or windy conditions.

The mean number of birds per visit was calculated for every species by summing the total number of detections and dividing by the number of visits (56). Densities were calculated for common species (see below) using an effective detection distance (x) that was determined for each taxon. The x was estimated as the inflection point of a graph of the number of birds per area per band using 10-m concentric bands according to criteria of Reynolds et al. (1980). All ducks, shorebirds, and herons were grouped to determine the x for species within these taxa. The x for all other species was determined separately for each species if the number of observations was greater than 25.

The number of detections were calculated by multiplying the number of singing males by two, unless the total count of all sightings was greater, in which case the total number of sightings was used. Estimates of birds per ha were calculated by summing the number of detections within x, dividing by the number of visits and $\prod x^2$, and multiplying by 10,000 (Reynolds et al. 1980).

RESULTS

Patches of *Spartina alterniflora* were flooded throughout the survey, but *Distichlis spicata* and *Avicennia germinans* were flooded from August to March. The salt pans were flooded in October and November. Thirty-eight species of wintering birds and 51 local breeders used the marsh (Table 1). Wintering species included individuals that were winter residents and individuals present on Merritt Island only during migration (Cruickshank 1980). Most of the local breeders did not nest

Table 1. Bird abundances (mean sightings/visit) of birds sighted within an unimpounded salt marsh on Merritt Island, 1985-1986.

Common name	Status[a]	Scientific name	Birds/visit[b]
Red-winged Blackbird	B	*Agelaius phoeniceus*	2.96
Willet	B	*Catoptrophorus semipalmatus*	1.32
Yellow-rumped Warbler	W	*Dendroica coronata*	1.29
Blue-winged Teal	W	*Anas discors*	1.21
Rufous-sided Towhee	B	*Pipilo erythrophthalmus*	1.07
Least Sandpiper	W	*Calidris minutilla*	0.86
Western Sandpiper[c]	W	*Calidris mauri*	0.80
Tricolored Heron[c]	B	*Egretta tricolor*	0.66
White Ibis[c]	B	*Eudocimus albus*	0.63
Common Yellowthroat	W	*Geothlypis trichas*	0.61
Boat-tailed Grackle	B	*Quiscalus major*	0.54
Royal Tern[c]	B	*Sterna maxima*	0.52
Dunlin[c]	W	*Calidris alpina*	0.41
Mottled Duck[c]	B	*Anas platyrhynchos*	0.39
Unknown *Calidris*	W	*Calidris* spp.	0.38
Semipalmated Plover	W	*Charadrius semipalmatus*	0.36
Short-billed Dowitcher[c]	W	*Limnodromus griseus*	0.32
Palm Warbler	W	*Dendroica palmarum*	0.32
Unknown *Anas*	W	*Anas* spp.	0.21
Northern Cardinal	W	*Cardinalis cardinalis*	0.20
American Robin	W	*Turdus migratorius*	0.18
Tringa spp.	W	*T. melanoleuca* and *T. flavipes*	0.16
Killdeer	B	*Charadrius vociferus*	0.16
Carolina Wren	B	*Thryothorus ludovicianus*	0.16
White-eyed Vireo	B	*Vireo griseus*	0.14
Unknown Sparrow	W		0.13
Ruby-crowned Kinglet	W	*Regulus calendula*	0.11
Reddish Egret[c]	B	*Egretta rufescens*	0.11
Northern Mockingbird	B	*Mimus polyglottos*	0.11
Little Blue Heron[c]	B	*Egretta caerulea*	0.11
Great Egret[c]	B	*Casmerodius albus*	0.09
Common Moorhen	B	*Gallinula chloropus*	0.09
Eastern Kingbird	B	*Tyrannus tyrannus*	0.09
Snowy Egret[c]	B	*Egretta thula*	0.07
Savannah Sparrow	W	*Passerculus sandwichensis*	0.07
Northern Bobwhite	B	*Colinus virginianus*	0.07
Least Bittern[c]	B	*Ixobrychus exilis*	0.07
House Wren	W	*Troglodytes aedon*	0.07
Common Ground-Dove	B	*Columbina passerina*	0.07
Northern Flicker	B	*Colaptes auratus*	0.07
American Black Duck[c]	W	*Anas rubribes*	0.07

[a]B = breeds on Merritt Island, W = species includes individuals that winter on Merritt Island; many individuals may only use Merritt Island during migration.

[b]p = species sighted within the marsh while the investigator was transiting among stations, but not sighted while at a station.

[c]Species of conservation concern (vulnerable to local, regional, or global extinction [Breininger et al. 1994]).

Table 1. (Continued) Bird abundances (mean sightings/visit) of birds sighted within an unimpounded salt marsh on Merritt Island, 1985-1986.

Common name	Status[a]	Scientific name	Birds/visit[b]
Prairie Warbler[c]	B	*Dendroica discolor*	0.05
Northern Harrier[c]	W	*Circus cyaneus*	0.05
Mourning Dove	B	*Zenaida macroura*	0.05
Gray Catbird	W	*Dumetella carolinensis*	0.05
Black-bellied Plover[c]	W	*Pluvialis squatarola*	0.05
Sharp-tailed Sparrow	W	*Ammodramus caudacutus*	0.04
Song Sparrow	W	*Melospiza melodia*	0.04
Eastern Phoebe	W	*Sayornis phoebe*	0.04
Mallard	W	*Anas platyrhynchos*	0.04
Gray Kingbird	B	*Tyrannus dominicensis*	0.04
Green Heron	B	*Butorides striatus*	0.04
Great Blue Heron	B	*Ardea herodias*	0.04
Black-wiskered Vireo[c]	B	*Vireo altiloquus*	0.04
Belted Kingfisher	W	*Ceryle alcyon*	0.04
Unknown *Seiurus*	W	*S. noveboracensis* or *S. motacilla*	0.02
Tree Swallow	W	*Tachycineta bicolor*	0.02
Unkown swallow	W		0.02
Roseate Spoonbill[c]	B	*Ajaia ajaja*	0.02
Common Snipe	W	*Gallinago gallinago*	0.02
Pied-billed Grebe	B	*Podilymbus podiceps*	0.02
Osprey[c]	B	*Pandion haliaetus*	0.02
Common Nighthawk	B	*Chordeiles minor*	0.02
Eastern Meadowlark	B	*Sturnella magna*	0.02
Laughing Gull	B	*Larus atricilla*	0.02
Clapper Rail	B	*Rallus longirostris*	0.02
Black Vulture	B	*Coragyps atratus*	0.02
Black-crowned Night-Heron[c]	B	*Nycticorax nycticorax*	0.02
American Bittern[c]	W	*Botaurus lentiginosus*	0.02
Cattle Egret	B	*Bubulcus ibis*	P
Glossy Ibis[c]	B	*Plegadis falcinellus*	P
Wood Stork[c]	B	*Mycteria americana*	P
Turkey Vulture	B	*Cathartes aura*	P
Bald Eagle[c]	B	*Haliaeetus leucocephalus*	P
Red-tailed Hawk	B	*Buteo jamaicensis*	P
American Kestrel	W	*Falco sparvarius*	P
Merlin[c]	W	*Falco columbarius*	P
Peregrine Falcon[c]	W	*Falco peregrinus*	P
Black Rail[c]	B	*Laterallus jamaicensis*	P
Virginia Rail	W	*Rallus limicola*	P
Sora	W	*Poranza carolina*	P
American Coot	B	*Fulica americana*	P

[a]B = breeds on Merritt Island, W = species includes individuals that winter on Merritt Island; many individuals may only use Merritt Island during migration.

[b]p = species sighted within the marsh while the investigator was transiting among stations, but not sighted while at a station.

[c]Species of conservation concern (vulnerable to local, regional, or global extinction [Breininger et al. 1994]).

Table 1. (Continued) Bird abundances (mean sightings/visit) of birds sighted within an unimpounded salt marsh on Merritt Island, 1985-1986.

Common name	Status[a]	Scientific name	Birds/visit[b]
Wilson's Plover[c]	B	*Charadrius wilsonia*	P
Black-necked Stilt[c]	B	*Himantopus mexicanus*	P
Spotted Sandpiper	W	*Actitis macularia*	P
Ring-billed Gull	W	*Larus delawarensis*	P
Gull-billed Tern[c]	B	*Sterna nilotica*	P
Black Skimmer[c]	B	*Rynchops niger*	P
Fish Crow	B	*Corvus ossifragus*	P
Sedge Wren[w]	W	*Cistothorus platensis*	P
Marsh Wren[w]	W	*Cistothorus palustris*	P
Common Grackle	B	*Quiscalus quiscula*	P

[a]B = breeds on Merritt Island, W = species includes individuals that winter on Merritt Island; many individuals may only use Merritt Island during migration.
[b]p = species sighted within the marsh while the investigator was transiting among stations, but not sighted while at a station.
[c]Species of conservation concern (vulnerable to local, regional, or global extinction [Breininger et al. 1994]).

within these marshes (Table 2). All species were observed feeding within the marsh except Royal Terns that occasionally used the marsh for loafing. Nearly all of the Common Yellowthroat sightings involved wintering birds that did not nest on Merritt Island (Breininger and Schmalzer 1990, Breininger and Smith 1992, Breininger 1992).

The effective detection distances ranged from 40 m to 60 m. The mean density of all birds combined for the entire year was 15 birds per ha. Densities of most birds were highest during the fall months and lowest during spring (Table 2). Fall had the highest total bird densities because of the seasonal abundance of ducks and shorebirds. Densities of Red-winged Blackbirds, Rufous-sided Towhees, and Boat-tailed Grackles were highest during summer. Red-winged Backbirds had three times higher densities than did any other species. Only Red-winged Blackbirds, Rufous-sided Towhees, and Tricolored Herons were common throughout the year. Yellow-rumped Warblers had high densities in the winter.

DISCUSSION

Salt marshes are essential habitat for several species such as Clapper Rails, Sharp-tailed Sparrows, and Seaside Sparrows (Burger et al. 1992, Weller 1994). Although Merritt Island marshes no longer have Dusky Seaside Sparrows, they provided essential habitat for species of conservation concern including Black Rails, Black-wiskered Vireos, and Florida Prairie Warblers. Twenty-five other birds in Merritt Island

Table 2. Bird densities (birds/ha) of the most common birds counted within an unimpounded salt marsh on Merritt Island, 1985-1986.

Status	Species	Spring	Summer	Fall	Winter
Breeders within habitat	Red-winged Blackbird	2.4	5.3	4.8	2.1
	Willet	0.2	0.2	4.3	0
	Rufous-sided Towhee	1.4	2.2	0.3	0.6
	Boat-tailed Grackle	0.2	1.4	0	0.1
	Totals	4.2	9.1	9.4	2.8
Other local breeders	Tricolored Heron	0.1	1.0	1.0	0.3
	Royal Tern	0	0	2.2	0
	White Ibis	0	1.6	0.5	0.1
	Mottled Duck	0	0.5	1.0	0
	Totals	0.1	3.1	4.7	0.4
Winter residents	Yellow-rumped Warbler	0	0	0.4	5.0
	Blue-winged Teal	0	0	4.6	0.1
	Common Yellowthroat	0.8	0	1.5	1.9
	Western Sandpiper	0	0	2.6	0
	Palm Warbler	0	0	0.6	1.0
	Unknown Calidris	0	0	1.5	0
	Short-billed Dowitcher	0	0	1.3	0
	Least Sandpiper	0	0	1.1	0
	Dunlin	0	0	1.0	0
	Semipalmated Plover	0	0	0.6	0
	Totals	0.8	0.0	15.2	8.0
All birds		5.1	12.2	29.3	11.2

salt marshes are species of conservation concern not restricted to salt marshes (Breininger et al. 1994).

Eighty-nine avian species were sighted in Merritt Island salt marsh in comparison to 78 species seen in New Jersey (Burger et al. 1992) and 121 species in Texas (Weller 1994). Most birds sighted in salt marshes were the same in all three states. The higher diversity in Texas might be explained by a longer study period and the sampling of a greater diversity of wetland types (Weller 1994). For example, another 26 species not recorded in the Merritt Island salt marsh, were recorded in adjacent open water impoundments on Merritt Island (Breininger and Smith 1990). Many local breeders that did not nest in the marsh do nest in salt marsh vegetation on nearby islands (Breininger et al. 1994, Smith and Breininger 1995). The close proximity of open water, mudflats, grasses, shrubs, and trees was responsible for the high avian diversity found in this marsh. The high diversity of breeding birds using this marsh differs from low diversity associated with structurally simple marshes (Engstrom 1992).

Red-winged Blackbirds were dominant breeding birds in salt marshes at Merritt Island, New Jersey (Burger et al. 1992), and Texas (Weller 1994). Boat-tailed Grackles were also abundant breeding birds

at Merritt Island and Texas (Weller 1994). Rufous-sided Towhees were also abundant at Merritt Island because mangroves added a shrub and tree component to salt marshes.

Breeding bird counts have been performed near Merritt Island in the cordgrass (*Spartina bakeri*) marshes of the St. Johns National Wildlife Refuge (Leenhouts 1982a, Leenhouts 1992b). Spring and summer bird composition included Red-winged Blackbirds, Eastern Meadowlarks, King Rails (*Rallus elegans*), Black Rails, Common Yellowthroats, Rufous-sided Towhees, and Common Nighthawks. Black Rails were more common in the cordgrass marshes (Leenhouts 1982a, Leenhouts 1982b) compared to the salt marsh examined in this study.

Although no King Rails were sighted in the Merritt Island salt marsh, they occur in Merritt Island swale marshes (Breininger 1992). Swale marshes are narrow freshwater marshes within scrub-dominated landscapes. Green Herons were the only other species that occurred in higher densities in swale marshes than in salt marshes.

The densities of Tricolored Heron, White Ibis, Blue-winged Teal, Mottled Duck, Short-billed Dowitcher, and peeps (*Calidris* spp.) were similar in salt marsh and open water impoundments on Merritt Island (Breininger and Smith 1990). Willets were more abundant in salt marshes than in open water impoundments. Open water impoundments on Merritt Island lacked many species adapted to emergent salt marsh vegetation, but open water had greater waterbird densities than did the Merritt Island salt marsh. Compared to salt marshes, impoundments had higher densities of American Widgeon (*Anas americana*), Northern Pintail (*A. acuta*), Northern Shoveler (*A. clypeata*), Lesser Scaup (*Aytha affnis*) American Coot, Greater Yellowleg, Lesser Yellowleg, Killdeer, Semipalmated Plover, American Avocet (*Recurvirostra americana*), Black-necked Stilt, Snowy Egret, Great Egret, and Glossy Ibis (Trost 1968, Provost 1968, Breininger and Smith 1990, Smith and Breininger 1995).

Temporal variation in waterbird use is influenced by rainfall, water level management practices, movements of local and migratory populations, and changes in overall population size (Clark 1979, Girard and Taylor 1979, Paul et al. 1979, Smith and Breininger 1988, Breininger and Smith 1990, Schikorr and Swain 1995). For Merritt Island salt marshes, shorebird densities were highest in fall when most impoundments were flooded for wintering waterfowl and too deep for shorebirds. For Merritt Island salt marshes, wading bird densities peaked in summer, similar to peak times that wading birds used the adjacent estuary (Smith and Breininger 1990, Schikorr and Swain 1995).

Total bird densities in Merritt Island salt marshes were comparable to habitats with high avian densities (Breininger and Smith 1990, 1992; Breininger and Schmalzer 1990, Burger et al. 1992). Perhaps

only large stands of homogeneous, emergent salt tolerant grasses (e.g., cordgrass) have low avian densities (Trost 1968, Provost 1968, Leenhouts 1982a, Leenhouts 1982b).

This study was too limited in duration and geographical extent to make broad conclusions regarding avian seasonal patterns in salt marshes. Densities from avian survey techniques should be interpreted cautiously owing to potential errors (Verner 1985). Secretive species such as rails, bitterns, and sparrows should be surveyed using additional methods, such as playback recordings (Manci and Rusch 1988). Despite study limitations, I conclude that natural Merritt Island salt marshes are important for the conservation of biological diversity, and they can provide habitat for large numbers of resident and migratory birds. Avian composition and abundance are likely to vary spatially because water levels, habitat structure, vegetative composition, and landscape patterns vary greatly in salt marshes (Brown and Dinsmore 1986, Craig and Beal 1992, Larson 1995, Schmalzer 1995). These sources of variation are relevant to conservation but they have received little study. Management activities in salt marshes are occurring across decades with little quantification of the effects on avian populations.

Acknowledgments

This study was funded by NASA, administered by the Biomedical Operations Office at KSC. Thanks to B. Summerfield, D. Britt, C. Hall, H. Hill, R. Hinkle, W. Knott III, E. Stolen, P. Schmalzer, R. Smith, and T. Engstrom.

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