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WATERBIRD USE OF COASTAL IMPOUNDMENTS AND MANAGEMENT IMPLICATIONS IN EAST-CENTRAL FLORIDA

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Abstract: Monthly surveys were conducted on Kennedy Space Center for one year to determine densities of waterbirds within impounded salt marshes that were predominantly open water with little emergent vegetation. The objective was to assess the importance of these impoundments to waterbirds, particularly wading birds, which are species of special conservation concern. Water-level management for mosquito control and waterfowl provided habitat for an abundance of ducks, shorebirds, coots, and wading birds. Average densities throughout the year for these groups were 5.26, 4.12, 2.80, and 2.20 birds/ha, respectively. The majority of waterfowl were present during the winter. Shorebirds were most common during spring migration. Wading bird densities increased with declining water level. Due to the extensive alteration and development of coastal wetlands in central Florida, properly managed impoundments may provide important feeding areas for maintaining certain waterbird populations.

Key Words: Anseriformes, Charadriiformes, Ciconiiformes, Florida, habitat use, impoundments, mosquito control, shorebirds, wading birds, waterfowl, wetlands.

INTRODUCTION

The creation of open water impoundments has proven to be an economic, simple, non-toxic approach to mosquito control (Provost 1967, 1969). Along the east-central Florida coast, these impoundments were originally high salt marshes that were diked to flood the exposed mud on which salt-marsh mosquitoes (i.e., *Aedes taeniorhyncus*) oviposit (Provost 1967). Unbroken expanses of high salt marsh or scrub mangrove were reported to have low bird densities; impoundments are used by numerous waterbirds, particularly waders (Ciconiiformes) and waterfowl (Trost 1968, Provost 1969). Most wildlife studies concerning impoundment management have focused on waterfowl and their food items, but a need exists to document the importance of impoundments to other birds (Rundle and Fredrickson 1981, Epstein and Joyner 1986).

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Florida wetlands are vital habitat for migrating waterfowl using the Atlantic Flyway, and Merritt Island National Wildlife Refuge (MINWR) on the John F. Kennedy Space Center (KSC, Figure 1) supports a large wintering population. Since much of the nearby waterbird habitat has been converted to agriculture, silviculture, pasture, or housing, and is not being managed for wildlife (Lowe *et al.* 1984), impoundments at MINWR and along the Indian River lagoon are probably important for maintaining the existing regional wading bird populations (H.W. Kale, II, pers. comm.).

Some effects of impounding marshes have been negative, particularly for the dusky seaside sparrow, clapper rail, and certain fish-eating waterbirds (Trost 1968). Since marsh impoundment has been implicated in the decline of fisheries in nearby estuaries, managers have been pressured to reduce or eliminate such negative influences (Montague *et al.* 1985).

The objective of this study was to quantify waterbird use of open water impoundments on MINWR near operational areas of KSC. Wading birds were emphasized because they are abundant on MINWR and are species of special conservation concern in Florida (Wood 1987).

STUDY AREA

The impoundments studied (T-29A, T-27D, T-33A, T-33B; Leenhouts 1983) were created in the early 1960s and are comprised principally of open water with little emergent vegetation. Areas of open water for each impoundment were 37.2 ha, 259.9 ha, 43.3 ha, and 46.6 ha, respectively. Surrounding the open water areas are dikes, or the original uplands or marshes. The landscape is characterized by slight topographic relief in a series of ridges and troughs where uplands occupy the ridges, open water areas occupy the troughs, and marshes are intermediate. Because of natural features and dikes, the impoundments are comprised of areas where surface waters are connected during high water but are often isolated during low water. The coastal zone of central Florida is the southern transition between grassy marshes to the north and mangrove swamps to the south, due to climatic differences and the intolerance of mangroves to freezes (Trost 1968, Bidlingmayer 1982). Salt marshes on MINWR are comprised of saltwort, glasswort, graminoids such as sand cordgrass, salt grass, or needle rush, with patches of mangroves, especially black mangrove and white mangrove, and occasionally *Spartina alterniflora* (Provost 1967). Before impoundment, these marshes were nontidal and usually dry except for creeks and pools (Trost 1968). The prolonged flooding associated with impoundment resulted in the loss of salt marsh vegetation, which was replaced by open water. Salinity level in the impoundments is dependent on rainfall and water level and can range from near fresh water to 35 ppt (Snelson 1976).

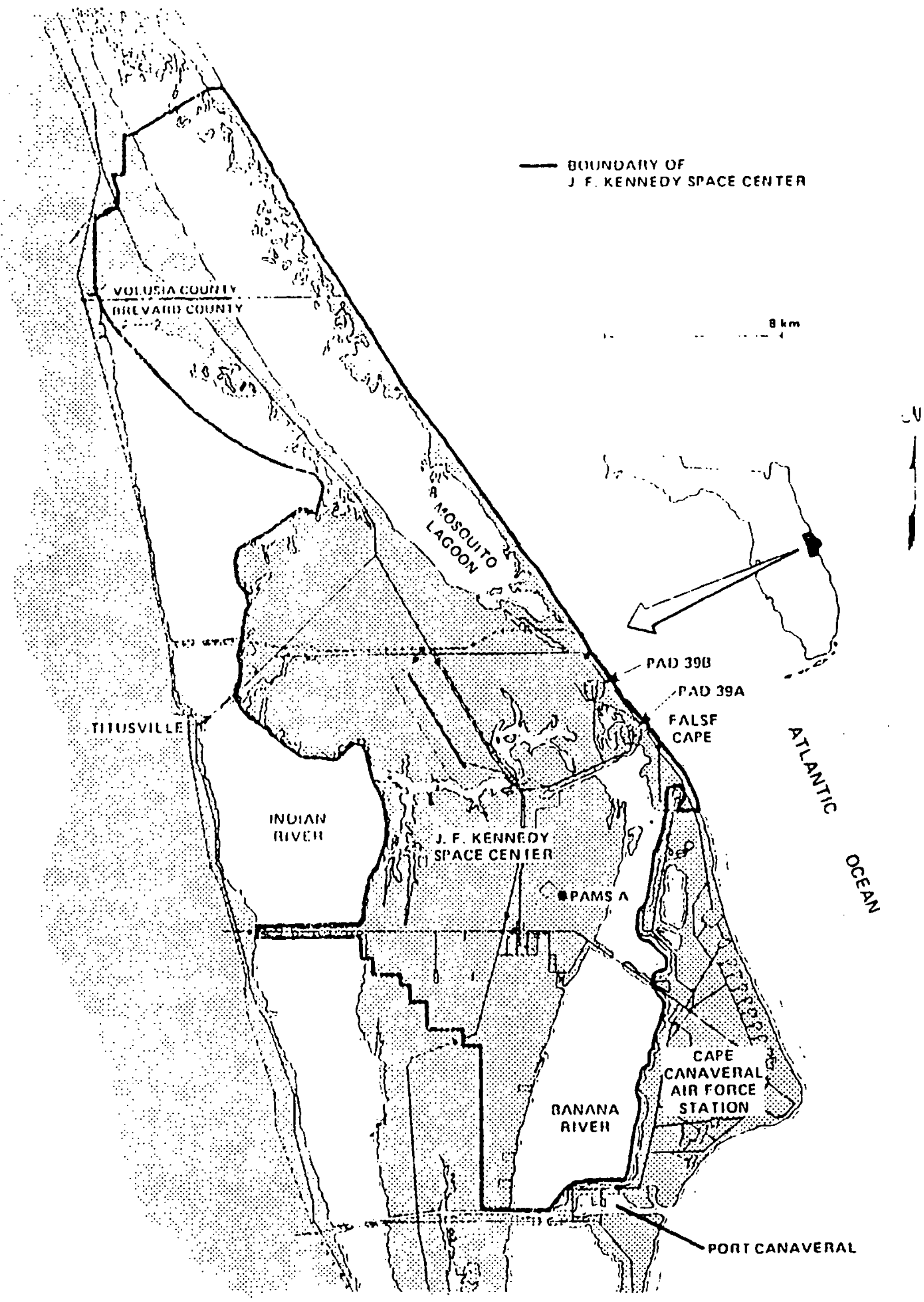

Figure 1. Boundary of Kennedy Space Center, which includes areas managed as Merritt Island National Wildlife Refuge.

Rainfall at MINWR is seasonal, with 70% of the yearly precipitation falling between June and September (NASA 1979). The management strategy for the study impoundments was as follows: when summer rains began to induce the production of mosquitoes, the Brevard County Mosquito Control District attempted to maintain flooded conditions using water from estuarine inflow, rainfall, and pumping. After October, high water levels were maintained by the United States Fish and Wildlife Service (USFWS) to provide habitat for wintering waterfowl until March. Without such management for waterfowl, these impoundments usually would be dry by late winter. After March, the impoundments were allowed to fluctuate with the estuary until summer when mosquito control once again became necessary.

METHODS

Because of the large area to be surveyed, each of the impoundments was divided into subunits based on natural features and dikes. There was a total of 17 subunits from all four impoundments combined, ranging in size from 1.0 to 75.3 ha. Each subunit was surveyed by direct counts performed 13 times from March 1984 to March 1985. The first survey of all subunits was conducted in the early morning, the second in the early afternoon, the third in the late morning, and the fourth in the early evening. This sequence was repeated twice; the thirteenth survey was conducted in the early morning. Average densities were similar during all time periods, so time of day was not treated as a variable. Surveys were not performed during rain or high winds. Birds were identified to the species level whenever possible, except for peeps (*Calidris* spp.). Water level was measured each survey from staff guages in all four impoundments.

Density data from all impoundments were pooled because their water-level fluctuations were similar. Also, we believed that differences between impoundments would largely be due to chance because of a few rare aggregation events that often accounted for most of the total sightings for some species. Mean monthly densities (birds/ha) were calculated for each species by adding the number of birds sighted in all subunits and dividing by the total area of the subunits. Mean densities for the entire study were calculated by adding the total number sighted and dividing by 13 times the total area of all subunits. Monthly densities for orders were calculated by adding densities of all component species, except for Order Charadriiformes (shorebirds), where monthly densities were calculated for subfamilies. A frequency for each species for the entire study was calculated by adding the number of months a species was seen in at least one subunit and dividing by 13. Densities for orders and subfamilies were similar in March 1984 and March 1985, so an average March density was used in the presentation of seasonal trends.

The area and perimeter of each subunit, based on surrounding vegetation and not water level, were determined from aerial imagery (1:12,000). Pearson product-moment correlation analysis was performed between mean wading-bird density and the area, perimeter, and perimeter/area ratio of each of the 17 subunits.

Aggregation size of wading birds was calculated for each subunit in each of the 13 sampling periods by summing the total number of individuals sighted in an aggregation. This was done separately for each species and for all wading birds combined for each of the 121 samples (the number of sample periods times the number of subunits). Aggregation size was classified as small (≤10 birds), medium (11-50 birds), or large (>50 birds). The relative frequency with which a size class occurred was determined for single species and mixed species aggregations by adding the number of times the size class occurred, dividing by 121, and multiplying by 100. For each species, the percent of total individuals represented by the largest aggregation was calculated by dividing the number of birds in the largest aggregation by the number sighted for the entire year.

From 1961-1964, Trost (1968) conducted wildlife surveys of mosquito control impoundments and unimpounded marshes along the east-central Florida coast, focusing on wading birds, ducks, and rails. Provost wrote an undated, unpublished appendix to Trost's report (Bureau of Sports Fisheries and Wildlife, USFWS Contract # 14-16-0008-623) analyzing Trost's data in greater detail. Based on those descriptions, we chose five of Trost's nearby impoundments that were most similar to ours to compare densities from both studies.

RESULTS

Except for ditches, most impoundments were less than 1-m deep. Mean monthly water levels during this study varied by 35 cm, with high levels in fall and low levels in spring. During high water periods, two submergents, musk-grass and widgeon grass, were abundant. Seasonally receding water provided large areas of exposed mudflats.

Wading birds

Mean monthly densities of dominant wading birds (Table 1) fluctuated greatly during the year. Higher densities were recorded when water levels declined in February, March, April, and August (Figure 2). Many impoundments were partially dry from late April through August and wading bird densities were low from May through July.

Large feeding aggregations (>50 birds) were common among the waders. Wading birds were present in any given subunit 77% of the time; small aggregations of <10 birds occurred during 42% of the visits; medium aggregations of 11 to 50 birds for 21% of the visits; and large aggregations of >50 birds for the remaining 13% of the visits. All but one of the large aggregations were mixed-species flocks.

Table 1. Density (#/ha), frequency, and aggregation data of dominant wading birds in impoundments surveyed at Kennedy Space Center, Florida, 1984 - 1985.

Species	Mean Density (#/ha)	Frequency	Size of Largest Aggregation	Percent Total[a]	Aggregations >10 Birds	
					Frequency	Percent Total for Species
Snowy Egret	0.56	1.0	205	13	0.10	85
Glossy Ibis	0.48	1.0	207	15	0.11	86
White Ibis	0.41	1.0	85	7	0.10	80
Tricolored Heron	0.37	1.0	115	11	0.08	55
Great Egret	0.23	0.92	115	20	0.04	62
Little Blue Heron	0.07	0.85	33	17	0.02	69
Roseate Spoonbill	0.03	0.54	45	54	<0.01	54
Wood Stork	0.02	0.46	18	37	<0.01	37

[a]Percent of total represented by the largest aggregation of a given species sighted for the entire year.

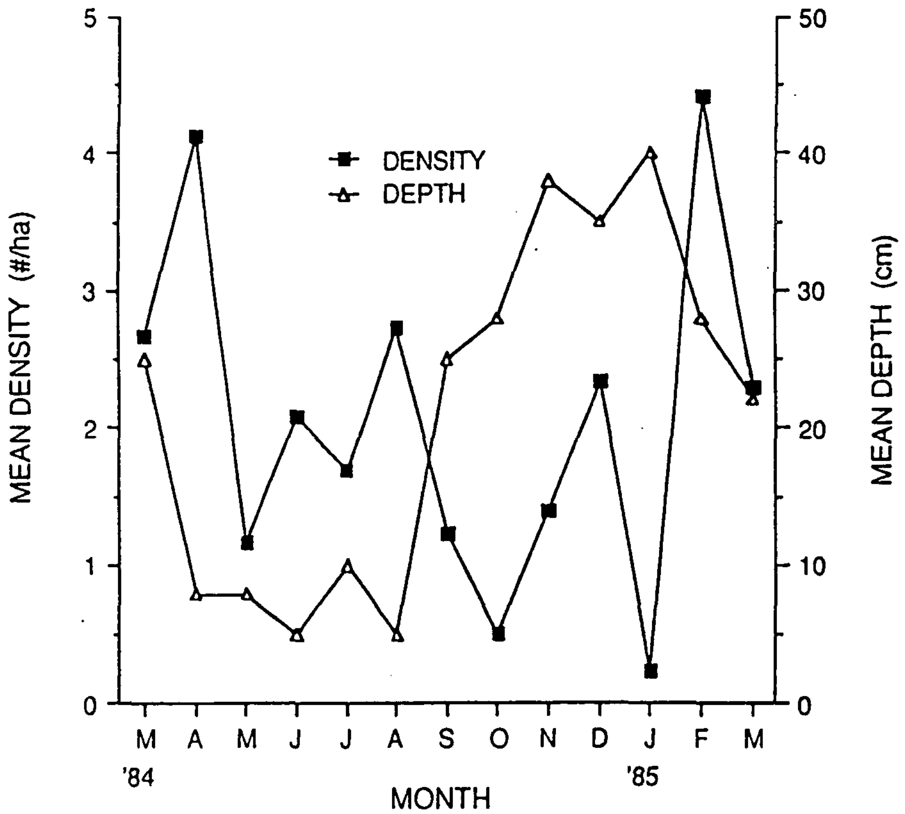

Figure 2. Mean density (#/ha) of wading birds and mean water depth (cm) by month in impoundments surveyed at Kennedy Space Center, Florida, 1984 - 1985.

The largest aggregation (427 birds) occurred in February. Eight dominant species (Table 1) were most common in small single-species aggregations of <10, but all occurred in aggregations >10. Of the 15 wading bird species observed, 7 (great blue herons, black-crowned night-herons, green-backed herons, reddish egrets, American bitterns, cattle egrets, and least bitterns) never occurred in single-species groups larger than four.

Area and perimeter of the impounded areas were positively correlated with wading bird usage. Area accounted for 81% of the variance in density ($p<0.001$), perimeter accounted for 83% ($p<0.001$), but the perimeter/area ratio was negatively correlated with density ($p=0.057$) and only explained 22% of the variance.

Ducks and Rails

Ducks, particularly dabbling ducks, were abundant during November and peaked in February (Figure 3). All ducks except mottled ducks, which nest on

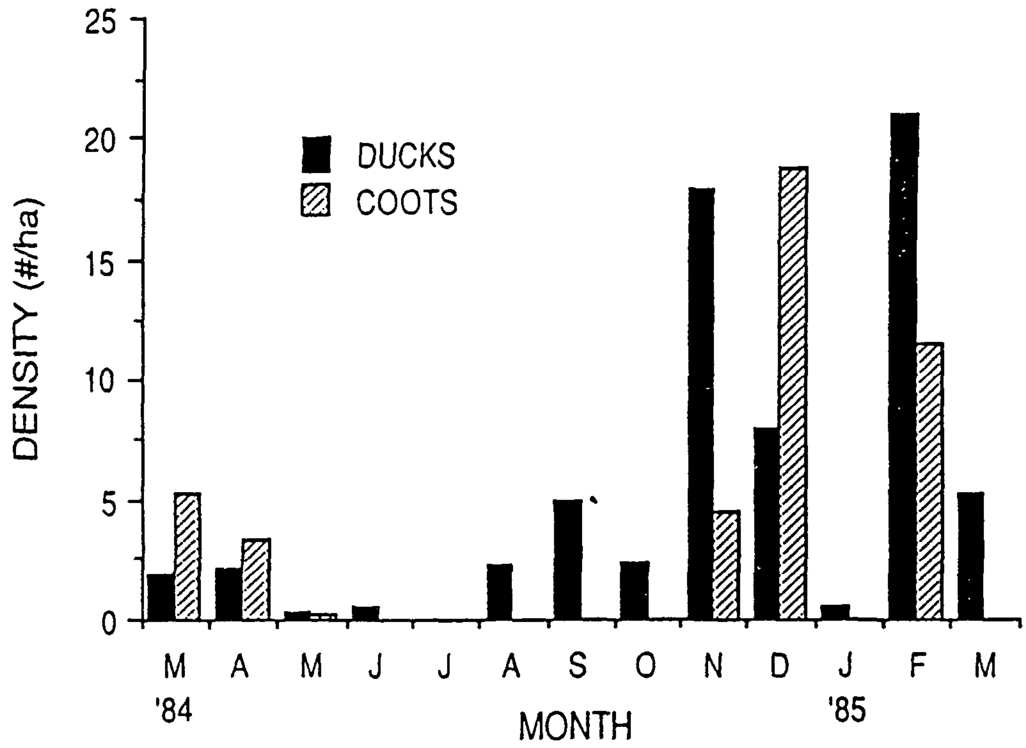

Figure 3. Mean density (#/ha) of ducks and coots by month in impoundments surveyed at Kennedy Space Center, Florida, 1984 - 1985.

MINWR, were wintering birds. Fourteen species were sighted in the impoundments. In addition to the dominant species (Table 2), hooded mergansers, redheads, green-winged teals, ring-necked ducks, gadwalls, American black ducks, and fulvous whistling-ducks also used the impoundments at lower densities and frequencies.

Four species of rails (mean density = 2.82 birds/ha) used the impoundments; nearly all were American coots (Table 2). The highest density of coots occurred in December (Figure 3). Common moorhens were frequently seen and nested in the impoundments. Clapper rails, black rails, and Virginia rails also were infrequently sighted within emergent vegetation along the edges of open water. Clapper and Virginia rails were often flushed from within marsh vegetation that may have prevented more frequent sightings and was not part of the study area.

Shorebirds

At least 27 shorebird species used impoundments (Figure 4). Four were plovers, having a mean density of 0.81 birds/ha. Semipalmated plovers had the

Table 2. Density (#/ha) and frequency of ducks, coots and shorebirds in impoundments at Kennedy Space Center, Florida 1984 - 1985.

Species or Genus	Mean Density (#/ha)	Frequency
Blue-winged Teal	1.15	0.7
American Wigeon	1.14	0.5
Northern Pintail	0.86	0.2
Northern Shoveler	0.51	0.5
Aythya spp.[a]	0.18	0.3
Mottled Duck	0.15	0.8
American Coot	2.80	0.7
Semipalmated Plover	0.31	0.3
Killdeer	0.22	1.0
Calidris spp.	0.82	0.7
Tringa spp.	0.76	0.9
Black-necked Stilt	0.26	0.6
American Avocet	0.12	0.5
Laughing Gull	0.15	0.9
Royal Tern	0.22	0.5
Sandwich Tern	0.14	0.3

[a]Refers primarily to Lesser Scaup, *A. affinis*, with the possibility of a few Greater Scaup, *A. marila*.

highest density (Table 2); most were seen in May when they had an average density of 5.04 birds/ha. The killdeer, a local breeder, was sighted during all sample periods but was most abundant during spring migration. Black-bellied plovers were common but not abundant. Wilson's plovers were sighted on a few occasions in one of the subunits. The most abundant group of sandpipers was *Calidris* spp. (Table 2), which occurred in the impoundments from April through November. Greater yellowlegs and lesser yellowlegs occurred during all months except June and January. Resident willets were observed only during the nesting season. Dowitchers, ruddy turnstones, common snipes, spotted sandpipers, and marbled godwits were occasional visitors during migration and had densities <0.09 for the year. Black-necked stilts (Table 2) also nested in impoundments and had a mean density of 0.51/ha during April through September. American avocets occurred in 6 of 13 months with the highest density (0.82/ha) in March 1985.

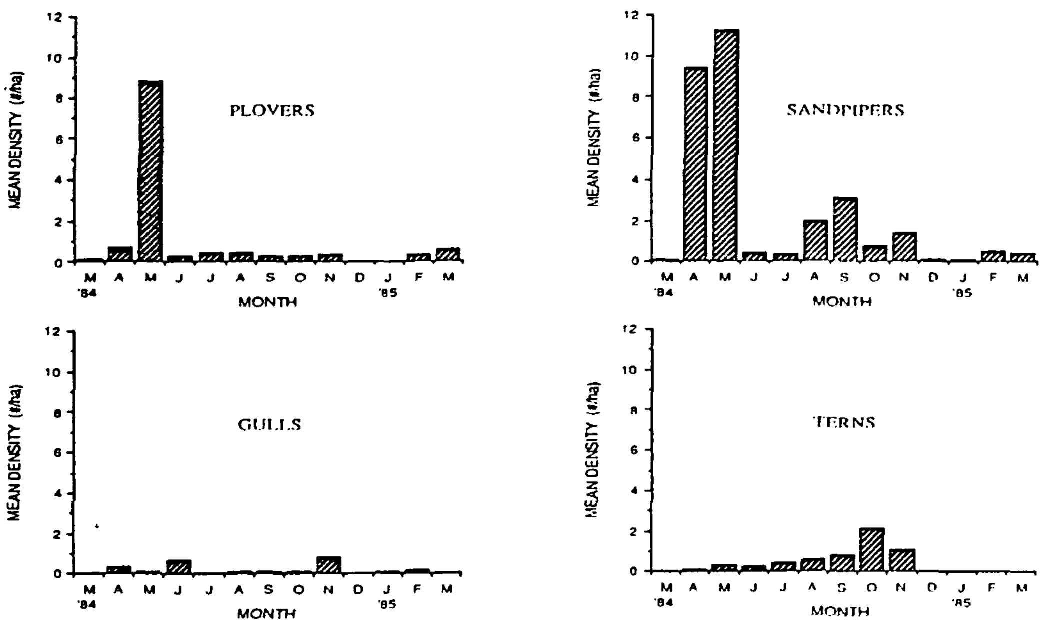

Figure 4. Mean density (#/ha) of shorebirds by month in impoundments surveyed at Kennedy Space Center, Florida, 1984 - 1985.

Four species of gulls had a combined average density of 0.22 birds/ha. Laughing gulls were most abundant (Table 2), primarily loafing and occasionally feeding, and ring-billed gulls were seen loafing in impoundments. Herring gulls and Bonaparte's gulls were rare, with densities <0.01/ha. Six species of terns were common as a group in April through November (Figure 4), with an average density of 0.48 birds/ha (Table 2). Royal terns and sandwich terns (Table 2) were abundant loafers in the impoundments in the fall, whereas least terns were common nesting, loafing, or feeding in the spring and summer. Caspian terns, Forster's terns, and gull-billed terns infrequently used the impoundments. Black skimmers were regularly observed loafing and feeding in the impoundments but in low numbers throughout the year (0.03 birds/ha).

Miscellaneous Species

Pied-billed grebes were present from November through March, with an average density of 0.04 birds/ha. Pelicaniforms averaged 0.02 birds/ha. Double-crested cormorants were the most abundant, brown pelicans were common, and American white pelicans and anhingas were rare.

Ospreys were the only falconiforms regularly using the impoundments. Other falconiforms (American kestrels, northern harriers, red-tailed hawks, black vultures, sharp-shinned hawks, peregrine falcons, bald eagles, merlins, red-shouldered hawks) were seen once or twice during the year, always as single birds. Belted kingfishers infrequently used impoundments for feeding from October through March. No attempt was made to estimate densities of birds of other orders, although some, especially icterids, such as red-winged blackbirds, boat-tailed grackles, and common grackles, were often observed using mud flats and salt marsh vegetation within impoundments.

DISCUSSION

Wading Birds

The timing of wading bird reproduction and proximity of nesting colonies probably influenced the use of MINWR impoundments. Nesting coincides with increased food abundance and availability (Kushlan 1978). Nearby colonies have been reported to be most active from February through April (Girard and Taylor 1979), matching peak times of impoundment use.

Fewer waders were in the impoundments in October, November, and January when water levels were too deep for efficient feeding, except along the edges. The comparatively high density in December resulted from one large group of birds in an unusually shallow area and was not typical of the other areas surveyed. In Indian River County, seventy miles south of KSC, wading bird use was highest in fall and winter in impoundments not managed for wintering waterfowl (Gilmore 1987). Water levels declined earlier in these impoundments, concentrating prey for wading bird consumption months before the spring drawdown that occurred in our study.

Wading bird use of impoundments can partially be explained by habitat selection. Our results support previous findings that larger wetlands may attract and support more birds and species than smaller wetlands, which in part might be a function of food supply (Epstein and Joyner 1986, 1988). In our study, larger subunits had higher densities.

Little quantitative information is available on the relationship between wading birds and vegetative cover. Few wading birds were observed feeding under a dense red mangrove canopy (Gilmore 1987). Many species are associated with pools or open water (Burger *et al.* 1982, Brush *et al.* 1986) where aggregations can occur (Fasola 1986). In this study, dominant species (snowy egret, glossy ibis, white ibis, tricolored heron, and great egret) were found in open water where little or no cover was present. These are species that actively search for prey and are generalists in diet (Jenni 1969, Kushlan 1978). Densities of several less abundant species were probably due to the lack of cover (e.g., green-backed herons, American bitterns, and least bitterns). Black-crowned night-herons may have been more abundant at night, which is their typical feeding time.

Most wading birds had densities comparable to data in Trost (1968), with mean densities for total use in both studies being practically identical. However, glossy ibises, the second most numerous wading bird in our study, were uncommon in Trost's study. Glossy ibises were considered to be very rare in the early 1900s (Bent 1926) but since have become common breeders (Osborn and Custer 1978, Nesbitt *et al.* 1982). Reddish egrets also were rare at the beginning of this century (Bent 1926) and were sighted only five times by Trost (1968). They were more frequently observed in our study. Reddish egrets are believed to be reoccupying their former range, and there are currently more than 300 breeding pairs in Florida (Paul *et al.* 1979, R. T. Paul, pers. comm.). Roseate spoonbills were rare in this area during Trost's study (1968), but now frequent the impoundments and estuaries and have extended their breeding range north to include MINWR (Smith and Breininger 1988). Wood storks were more abundant in impoundments than in open marshes in Trost's surveys, with an average density of 0.13 birds/ha in impoundments. Wood storks were often seen in our study but in low abundance (0.02 birds/ha). Although wood storks eat small fish species (Ogden *et al.* 1976) that are abundant in the brackish impoundments (Gilmore *et al.* 1982), they prefer larger fish characteristic of fresh water (Ogden *et al.* 1976). This difference in food supply, an overall declining statewide population, or yearly variation in the local breeding population may have accounted for low densities.

Ducks and Rails

Mangroves and many of the common emergents on MINWR (e.g., needle rush and cordgrass) are not primary food for ducks (Chamberlain 1960). Emergent vegetation that once accounted for the majority of the primary production in impoundments has been replaced by important waterfowl food plants such as widgeon grass and musk-grass (Chamberlain 1960). Few waterfowl were observed in the Indian River impoundments where much of the original marsh vegetation was retained and drawdown occurred in winter (Gilmore 1987). Overall densities of ducks at MINWR were more than twice the 2.0 birds/ha reported for brackish water marshes in Louisiana (Chabreck *et al.* 1975) and 2.4 birds/ha reported by Trost (1968) in east-central Florida. Blue-winged teals, northern pintails, and mottled ducks had densities comparable to North Merritt Island impoundments (Trost 1968). However, Trost reported higher densities of several diving duck species.

Habitat destruction and hunting have greatly influenced mottled duck populations (Montalbano 1980, Johnson *et al.* 1984). In this study, young and adult mottled ducks were common only in the few subunits that had islands of salt marsh vegetation within them.

Seasonal use by the more common ducks was similar to that reported by Trost (1968). Peak use by ducks in south Florida is in January (Kushlan *et al.* 1982), while January densities in this study were low. Our results indicate that blue-winged teal have a bimodal distribution with peaks in November and February; they migrate further south during winter (Bellrose 1976). American wigeons were most abundant at MINWR in November, but they winter in south Florida from December through February (Kushlan *et al.* 1982). Northern pintails also had a bimodal distribution with highest densities in December and February but are abundant in south Florida in January (Kushlan *et al.* 1982).

There was a high density of American coots,.especially compared to other rails, in the impoundments. Trost (1968) found that impoundment increased usage by coots eight times but had a detrimental effect on most other rails due to their preference for dense emergent vegetation.

Shorebirds

The highest densities of shorebirds occurred during spring migration, coinciding with drawdown, lower water levels, and exposed mudflats. Similar observations were reported by Epstein and Joyner (1986) where feeding shorebirds were highly associated with drawdown and concentrated along shallow water edges 1-2 cm deep. Fall migration is more protracted and involves larger flocks than occur in spring migration (Burger 1984), but water levels in fall were too high for feeding, except along edges. Loafing shorebirds were most commonly seen in the few subunits that had islands of spoil material that became exposed when water levels were low. In more southern Indian River impoundments, shorebirds were not as abundant or observed as frequently as other waterbirds (Gilmore *et al.* 1985). Shallow water and mudflats within MINWR impoundments may be particularly important for American avocets. Only about 500 American avocets winter in Florida in four locations, one being MINWR (DeGange 1978).

MANAGEMENT CONSIDERATIONS

This study and others (Trost 1968, Rundle and Fredrickson 1981, Burger *et al.* 1982, Burger 1984, Epstein and Joyner 1986, Fasola 1986, Morales and Pacheco 1986) have demonstrated that impounded wetlands are used by numerous avian species and are important for maintaining regional waterbird populations. Additional studies are needed to quantify the significance of different wetland types to waterbirds. Study designs must consider the high variability among samples; infrequent aggregations can account for most of the total individuals of a species seen during the year (Table 1).

The management strategy of maintaining flooded conditions in summer and fall for mosquito control on MINWR provided suitable conditions for the growth of submergent duck food (Joanen and Glasgow 1965) and a large amount of habitat for fish production (Snelson 1976). The maintenance of water levels through the winter to benefit waterfowl can also benefit wading birds by allowing prey populations of fish to remain in the impoundments until spring drawdown, a time when young wading birds are on the nest and energy demands are highest (Kushlan 1978). Drawdown provides mudflats and shallow water areas that are used by shorebirds during spring migration. An alternative strategy of continuous flooding encourages cattail growth in low salinity impoundments, resulting in decreased waterbird use (Trost 1968). Permanent flooding for mosquito control provides habitat for wading birds and shorebirds only when the water is very shallow (Chabreck 1980). Some permanently flooded impoundments support relatively few ducks as a result of decreased food production (Morgan *et al.* 1976).

Early impoundment management practices first resulted in an abundance of standing water with little emergent cover, characteristic of the impoundments in this study. It was found, however, that much of the original vegetation could be retained through strategic water management (Provost 1967, 1969), but the bird use of these marshes has not been fully researched. The number, density, and biomass of avian species has been positively associated with the amount of open standing water, but natural salt marsh vegetation is necessary habitat for some specialized species (Burger *et al.* 1982).

Flooded conditions >2.4 cm are necessary only during the mosquito breeding season from May to October (Provost 1967, 1969), so water levels could be allowed to fluctuate naturally for the remainder of the year. Under this strategy, high marshes on MINWR would be dry by January and virtually useless to wintering waterfowl, as is the case in the Indian River impoundments (Gilmore 1987), and the increased use by wading birds during the spring drawdown also would not occur. Seasonal releases of impounded water might allow production and export of resources important to the estuary (Montague *et al.* 1986). Isolating impoundments from the estuary for mosquito control normally occurs when use by transient fish species is minimal (Gilmore 1987, Rey *et al.* 1990).

It is a concern that impoundment of the open marshes was detrimental to the estuary (Montague *et al.* 1985). The dikes could be removed to allow the water to fluctuate naturally year-round, but the benefits of this management strategy to estuarine health are unproven for the nontidal high marshes on KSC. Perimeter ditches within impoundments provide open water habitat for marsh organisms that normally suffer high mortality during dry periods in high salt marsh (Gilmore 1987). Impoundments can be restored to conditions described as former dusky seaside sparrow habitat (Leenhouts and Baker 1982). However, our study identified many species that heavily use impounded open water habitats for feeding. Pre-impoundment marshes were less productive for many waterbirds (Trost 1968, Provost 1969). Without the impoundments, areas near human habitation would require alternative methods of mosquito control, such as pesticides, grid ditching, and related techniques, all of which have been reported to decrease marsh use by birds or have not been studied (Erwin 1986, Brush *et al.* 1986).

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APPENDIX

Scientific names for plants and birds discussed in text.

Plants:

- musk-grass *Chara* spp.
- widgeon grass *Ruppia maritima*
- saltwort *Batis maritima*
- glasswort *Salicornia* spp.
- sand cordgrass *Spartina bakeri*
- salt grass *Distichlis spicata*
- needle rush *Juncus roemerianus*
- black mangrove *Avicennia germinans*
- white mangrove *Laguncularia racemosa*

Wading Birds:

- wood stork *Mycteria americana*
- glossy ibis *Plegadis falcinellus*
- white ibis *Eudocimus albus*
- roseate spoonbill *Ajaia ajaja*
- great blue heron *Ardea herodias*
- little blue heron *Egretta caerulea*
- tricolored heron *Egretta tricolor*
- green-backed heron *Butorides striatus*
- great egret *Casmerodius albus*
- snowy egret *Egretta thula*
- reddish egret *Egretta rufescens*
- cattle egret *Bubulcus ibis*
- black-crowned night-heron *Nycticorax nycticorax*
- American bittern *Botaurus lentiginosus*
- least bittern *Ixobrychus exilis*

Ducks and Rails:

green-winged teal *Anas crecca*
American black duck *Anas rubripes*
mottled duck *Anas fulvigula*
northern pintail *Anas acuta*
gadwall *Anas strepera*
American wigeon *Anas americana*
blue-winged teal *Anas discors*
fulvous whistling-duck *Dendrocygna bicolor*
redhead *Aythya americana*
ring-necked duck *Aythya collaris*
hooded merganser *Lophodytes cucullatus*
black rail *Laterallus jamaicensis*
clapper rail *Rallus longirostris*
Virginia rail *Rallus limicola*
common moorhen *Gallinula chloropus*
American coot *Fulica americana*

Shorebirds:

black-bellied plover *Pluvialis squatarola*
Wilson's plover *Charadrius wilsonia*
semipalmated plover *Charadrius semipalmatus*
killdeer *Charadrius vociferus*
black-necked stilt *Himantopus mexicanus*
American avocet *Recurvirostra americana*
greater yellowlegs *Tringa melanoleuca*
lesser yellowlegs *Tringa flavipes*
willet *Catoptrophorus semipalmatus*
spotted sandpiper *Actitis macularia*
marbled godwit *Limosa fedoa*
ruddy turnstone *Arenaria interpres*
dowitcher *Limnodromus* spp.
common snipe *Gallinago gallinago*
laughing gull *Larus atricilla*
Bonaparte's gull *Larus philadelphia*
ring-billed gull *Larus delawarensis*
herring gull *Larus argentatus*
gull-billed tern *Sterna nilotica*
Caspian tern *Sterna caspia*
royal tern *Sterna maxima*
sandwich tern *Sterna sandvicensis*
Forster's tern *Sterna forsteri*
least tern *Sterna antillarum*
black skimmer *Rynchops niger*

Miscellaneous Species:

pied-billed grebe *Podilymbus podiceps*
brown pelican *Pelecanus occidentalis*
American white pelican *Pelecanus erythrorhynchos*
double-crested cormorant *Phalacrocorax auritus*
anhinga *Anhinga anhinga*
black vulture *Coragyps atratus*
osprey *Pandion haliaetus*
bald eagle *Haliaeetus leucocephalus*
northern harrier *Circus cyaneus*
sharp-shinned hawk *Accipter straitus*
red-shouldered hawk *Buteo lineatus*
red-tailed hawk *Buteo jamaicensis*

American kestrel *Falco sparverius*
merlin *Falco columbarius*
peregrine falcon *Falco peregrinus*
belted kingfisher *Ceryle alcyon*
dusky seaside sparrow *Ammodramus maritimus nigrescens*
red-winged blackbird *Agelaius phoeniceus*
boat-tailed grackle *Quiscalus major*
common grackle *Quiscalus quiscula*

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