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POPULATION ECOLOGY OF COMMON GALLINULES IN SOUTHWESTERN LAKE ERIE MARSHES[1]

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ABSTRACT. Population size, distribution, reproduction, and habitat selection of common gallinules (*Gallinula chloropus*) were studied in 1977-78 in the southwestern Lake Erie marshes in Ohio. Gallinules were censused by playing a tape-recorded call and counting the number of individuals responding within a 40-m radius. Eight to 30 of these 0.5-ha circular plots were placed randomly in each of 16 marsh habitats. The frequency of nonresponse was estimated from the responses of pairs with known locations, and estimates were corrected for nonresponse. Nest-density estimates from strip-transects were not different ($P > 0.05$) from pair-density estimates based on calling males. Pair-density estimates ranged from 0.2 to 4.6 pairs per ha. The population for 1978 was estimated to be 1,197 ± 149 pairs in 5,188 ha of wetland. Clutch size averaged 8.04 ± 0.56 eggs for 55 clutches, and 77% of 61 nests hatched at least 1 egg. Twenty-eight brood counts averaged 3.6 ± 0.6 fledged young. Gallinule densities were highest on semipermanently flooded wetlands with narrow-leaved, persistent emergent vegetation, an abundance of submergent aquatic plants, and a 1:1 ratio of cover to open water.

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INTRODUCTION

Surveys dating back over a century have indicated the common gallinule was the most abundant breeding aquatic bird in the southwestern Lake Erie wetlands (Wheaton 1879, Jones 1910, Christy 1931, Anderson 1960, unpubl. report, summer birds of the Winous Point Shooting Club in 1880, 1930, 1960). However, Andrews (1973) caught only 1 common gallinule while trapping rails in 1971-72 during a study of rail nesting ecology at Winous Point, on Muddy Creek Bay. Gallinule populations apparently declined markedly during the 1960s and early 1970s throughout the southwestern Lake Erie marshes. The evidence for the decline was circumstantial, however, because of the

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lack of data on population levels. The effect of wetland management practices on the population was unknown and few attempts had been made to quantify habitat typically used by nesting common gallinules. In addition, no one had investigated gallinule reproduction in the Lake Erie wetlands.

The objectives of this study were to determine population size and reproductive success, and to characterize habitats selected by nesting common gallinules in the southwestern Lake Erie wetlands.

STUDY SITE

The southwestern Lake Erie marshes are a narrow, discontinuous belt of wetlands bordering the shore and bays of Lake Erie from Point Mouillee, south of Detroit, to the Huron River west of Cleveland. This study was limited to marshes that lay between Maumee Bay, near Toledo, and the outlet of Sandusky Bay near Sandusky, Ohio (fig. 1). Wetlands within 8 km of the lakeshore along the Portage, Toussaint, and Sandusky rivers, and Muddy Creek were also investigated. The wetlands range in size from 14 to 882 ha. More than 5,000 ha of the 7,269 ha of wetlands known to exist in the Ohio Lake region in 1970 (Weeks 1978) were included in the study area.

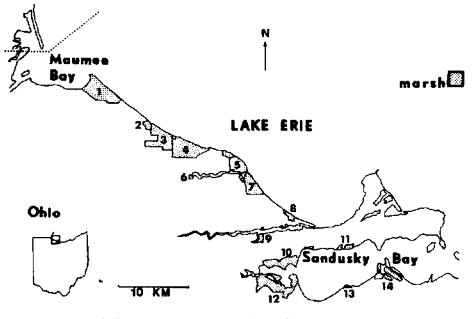

FIGURE 1. The major wetlands along the southwestern Lake Erie shore in Ohio that were studied (1, Cedar Point Marsh, Ottawa National Wildlife Refuge [NWR]; 2, Metzgar Marsh State Wildlife Area [SWA]; 3, Ottawa NWR; 4, Magee Marsh SWA; 5, Navarre Marsh, Ottawa NWR; 6, Toussaint Creek SWA; 7, Toussaint Shooting Club [private]; 8, Darby marsh, Ottawa NWR; 9, Little Portage SWA; 10, Winous Point Shooting Club [private]; 11, Gypsum Plant Marshes [private]; 12, Ottawa Shooting Club [private]; 13, Willow Creek SWA; 14, Bay View Marshes [private]).

Lowden (1969) listed the important aquatic plant species and associations at Winous Point, a marsh that typifies the wetlands communities of southwestern Lake Erie. Under the classification system of Cowardin et al. (1979), the wetlands are primarily Palustrine with inclusions of Lacustrine wetland. Many of the wetlands have been diked since the early 1900s to protect them from siltation and the destructive lake seiches created by prevailing northeast and southwest winds (Andrews 1952). Several of these wetlands are managed by reducing the water levels in the spring, thereby exposing mudflats and favoring the germination of plants favored by feeding migratory waterfowl. Although the water regimes of these wetlands must be classed as artificially flooded, the management practices on most diked wetlands are consistent enough to be classed under other regimes — permanently flooded, semipermanently flooded, seasonally flooded, and saturated. The wetlands that are not diked are subject to frequent but irregular fluctuations in water levels from seiches, which may leave the substrate temporarily exposed. Although these are not tidal influences, the water regimes are similar to the definition for irregularly exposed tidal areas. The regimes can also be defined as intermittently exposed due to seasonal and long term changes in lake levels. The vegetation of the wetlands includes persistent narrow-leaved emergent; nonpersistent, narrow and broad-leaved emergent; broad-leaved deciduous scrub-shrub; aquatic bed; and unconsolidated bottom. The water is fresh circum-neutral.

METHODS

The secretive behavior of the common gallinule and the extensive study area effectively eliminated nest searching and conventional census techniques for estimating population size. Tape-recorded vocalizations have been used to survey and census rails (Rallidae) (Tomlinson and Todd 1973, Baird 1974, Glahn 1974, Tacha 1975, Greise 1977) and were used in this study for locating and censusing gallinules. A cassette tape recording of common gallinule advertisement calls was transcribed from the collections of the Borror Laboratory of Bioacoustics at The Ohio State University. The recording was delivered in the field at full volume through a 9-V cassette tape-player and a portable outdoor speaker mounted vertically on a pack frame. The advertisement call, described by Brewster (1891), exhibits a distinct vocal-tone difference between sexes (Strohmeyer 1977), the male having the lower-pitched call (E. Greij, pers. comm.).

Isolated gallinule pairs responded to the tape-recorded calls as readily as pairs in high density areas. Gallinules also responded equally well throughout the breeding season. The frequency of nonresponse was estimated from responses of pairs whose nest location was known or who could be visibly observed. Males from pairs with known locations responded to the call in 93% of the trials (26 of 28) and females responded in only 21% (6 of 28). Therefore, only male calls were used to estimate pair-densities. To estimate population size in 1978, we used a method similar to Marion's (1974) and counted the number of male gallinules within a 40-m radius (0.5-ha circle) that responded to the tape-recorded call. A single male call was played once followed by a 1-min listening period. If no males responded the procedure was repeated. Eight to 30 plots were established in each of 16 individually discrete marsh habitats by pacing along randomly chosen azimuths and placing the plot centers at 100-m intervals. Care was taken to avoid placing the plot on previous plots, on dry land, or in large, open water areas. Plot radius distances were estimated with an optical rangefinder where the instrument could be used. Total counts were made on areas with fewer than 12 pairs of gallinules. Habitats were censused once from mid-June to early August on rainless mornings (0630-1030) with wind speeds less than 24.1 km/h.Gallinule densities were calculated by the plot-sampling formula of Seber (1973).

Nest searches were conducted on 9 ha at Winous Point and 10 ha at Bay View marshes in 1977, and on 13 ha at Navarre Marsh in 1978. We also searched for nests on 20-m-wide strip-transects in late May and again in late June 1978 in 5 marshes (table 1). One to 4 transects, totalling 700–1,300 m in length and covering 5 to 8% of the area, were placed randomly in each marsh area. Transects were marked in the center with flagging or string. Located nests were flagged and the eggs were candled (Weller 1956) to determine the stage of incubation. Nest initiation dates were estimated by back-dating from the stage in which the nest was found; we assumed that gallinules laid 1 egg per day, began incubation after the 5th egg, and required 21 days for incubation (Krauth 1972). Nests were checked periodically for clutch size and nesting success, and water depth and distance to open water were measured at each nest site. Counts of broods were taken during late July and August from tree blinds or from a vehicle.

Vegetation was sampled in 8 wetlands with line-transects placed systematically from random starts. One to 3 transects, each 500–750 m long, were sampled per marsh. Plant stem density and species composition were sampled at 5-m intervals on 1-m^2 plots, and the width of open water greater than 1.5 m was recorded. The amount and proportion of different wetland habitats in the study area were estimated by cover-mapping all accessible wetlands.

Normal and nonparametric statistical procedures (Snedecor and Cochran 1967, Hollander and Wolfe 1973) were used. All intervals of means are 95% confidence intervals.

RESULTS AND DISCUSSION

REPRODUCTION. Dates of nest initiation for 67 nests ranged from 2 May to 10 July and peaked during the period 17-31 May. Thirteen nests (19%) were started between 2 and 16 May, 37 (55%) between 17 and 31 May, 12 (18%) between 1 and 15 June, and 5 (8%) between 16 June and 10 July (Brackney 1979). In contrast, most nests located by Krauth (1972) in Wisconsin and by Fredrickson (1971) in Iowa were initiated in June. In our study, only 17 nests (26%) were initiated after 1 June, and 3 of 5 nests initiated after 15 June were either depredated or abandoned.

Forty-seven (77%) of the 61 nests that could be followed to termination were successful in that at least 1 egg hatched: 6 of 10 (60%) in 1977, and 41 of 51 (80%) in 1978. Nine of the 14 unsuccessful nests were depredated, 4 were abandoned, and 1 was flooded. Common gallinule nesting success reported in other studies included 79% of 38 nests and 60% of 123 nests from southern Texas (Cottam and Glazener 1959), and 61% of 18 nests in Wisconsin (Krauth 1972).

Some nests were in the middle or late stages of incubation when found. This could have significantly increased the probability of those nests hatching successfully and thus biased the estimate of successful nests upward (Mayfield 1961). To alleviate this problem, we used Mayfield's method, in which the number of exposure-days of a nest under observation is used for the calculation of a corrected success rate.

A 26-day nesting cycle was used to calculate a corrected nesting success value of 66%.

Clutch size averaged 6.63 ±1.72 eggs (8 nests) in 1977, 8.28 ±0.54 eggs (47 nests) in 1978, and 8.04 ±0.53 eggs (range 3-15, 55 nests) for both years. Mean clutch sizes reported for the northern portion of the breeding range included 10.0 in Pennsylvania (Harlow 1918), 8.1 in Wisconsin (Krauth 1972), and 7.1 in Iowa (Fredrickson 1971). Because nests were visited only periodically, hatching success could not be determined precisely. The possibility of the adults ejecting unhatched eggs from the nest when incubation was terminated (Krauth 1972) compounded the problem.

Broods in which young had juvenal plumage (6 weeks old) averaged 3.4 ±0.7 young for 12 broods in 1977, 3.7 ±0.9 for 16 broods in 1978, and 3.6 ±0.6 (range 1-8) for 28 broods in both years. Twenty-five broods (89%) had between 2 and 5 young. The percentage of pairs that failed to fledge young could not be determined. Bell (1976) reported an average of 2.6 young per brood in 15 common gallinule broods, 4-6 weeks old, in Louisiana.

POPULATION ESTIMATES. No evidence of nonbreeding or polygamous gallinules was found during the censusing or the nesting study. To determine the accuracy of the census, we compared nest-density estimates to the pair-density estimates based on calling males (table 1) after pair-density estimates were divided by 0.93 to correct for nonresponding individuals. Nest-density estimates were corrected by dividing the number of successful nests by the corrected nesting success figure (0.66) calculated by Mayfield's (1961) method. Miller and Johnson (1978) suggested this procedure to account for nests that were destroyed prior to, or between, nest searches. A nonparametric regression of nest densities (X) on pair densities (Y) was Y = 0.15 ±0.92X. The slope was not different from 1 (P = 0.98) and the Y-intercept was not different from zero (P = 0.50). Clearly, the pair-density estimates from the auditory census were as precise as estimates based on nest searching.

Pair-density estimates, based on densities of calling males, ranged from 0.2 pair/ha at Winous Point-south to 4.6 pairs/ha at Navarre Marsh (table 2). Beecher (1942) found 19 gallinule nests in a Lake Michigan marsh at a density of 1.19 acres/nest (2.1 nests/ha). The population estimate in 1978 was 1,197 ±149 pairs (table 2) on 5,188 ha of wetlands that were surveyed or censused. Gallinules inhabitated only 795 ha (15%) of the available wetlands although seasonally and semipermanently flooded habitat amounted to 25% of the total wetland area. We could not determine whether the population was increasing or decreasing.

TABLE 1

A comparison of nest-density estimates and pair-density estimates based on calling male gallinules, southwestern Lake Erie wetlands, 1978.

Wetland	Area searched (ha)	No. nests (corrected)*	Gallinule density	
			nests/ha	pairs/ha
Navarre-central	2.98	15	5.0	4.6 ±0.8
Cedar Point-central	2.47	6	2.4	2.6 ±1.0
Navarre-west	13.33	24	1.8	2.2 ±1.3
Metzgar-south	1.76	3	1.7	2.0 ±0.5
Metzgar-north	1.45	2	1.4	1.3 ±0.7
Darby-west	1.68	2	1.2	1.3 ±0.6

*Value for Navarre-west is a total count; all other values are derived from counts on strip transects.

TABLE 2

Population estimates for common gallinules in 19 discrete wetland habitats along southwestern Lake Erie, 1978. Estimates were derived from counts on circular plots for the first 16 wetlands, and from total counts on the remaining 4 wetlands.

Wetland	Area	No. plots	Area censused (ha)	Pairs/ha	No. pairs on marsh
Navarre	east	22	42.2	4.1 ±0.7	302 ±36
	central	13	21.7	4.6 ±0.8	
	west	9	13.3	2.2 ±1.3	
Cedar Point	east	15	45.2	2.3 ±0.7	478 ±122
	central	9	29.7	2.6 ±1.0	
	west	14	32.5	2.9 ±0.7	
	south	30	281.7	0.7 ±0.4	
Darby	central	14	40.0	1.1 ±0.7	58 ±29
	west	10	11.3	1.3 ±0.6	
Metzgar	north	12	18.9	1.3 ±0.7	45 ±14
	south	12	11.1	2.0 ±0.5	
Bay View	east	10	6.8	3.7 ±0.6	58 ±15
	bayside	12	14.0	2.3 ±1.1	
Ottawa NWR	main	14	35.9	2.0 ±0.9	72 ±32
Toussaint SC		10	69.4	1.3 ±1.0	90 ±69
Magee	Perry	12	22.2	2.9 ±1.0	64 ±21
	main		56.2	0.2	12
Toussaint Creek SWA			14.4	0.6	9
Ottawa SC			9.0	0.5	5
Winous Point	south		20.4	0.2	4
				Total	1197 ±149

HABITAT SELECTION. Habitat selection by common gallinules is probably influenced by vegetation structure and interspersion, food, water depth, and water quality among other factors. To analyze gallinule response to vegetation interspersion, we sampled wetlands of 2 types: diked, semipermanently flooded marshes, with persistent emergent vegetation, that are protected from the extreme Lake Erie water fluctuations, and undiked, intermittently exposed marshes, also with persistent emergent vegetation, that are open to the free flow of water between the Lake and the wetland. Gallinule densities and the vegetation characteristics of 5 diked wetlands were compared by Spearman's rank correlation tests (table 3). Densities showed a positive association ($P < 0.05$) with the percentage of open water, relative frequency of submerged plants, and amount of edge measured along the line-transects. Edge, percentage of open water, and relative frequency of submerged plants were also correlated ($P < 0.05$) with one another. Because only Darby-west marsh had a stem density different from stem densities of the other 4 diked marshes, no relationship ($P > 0.05$, Fisher's least significant different test) between pair density and stem density could be demonstrated. Although the number of undiked wetlands we sampled were too few for statistical analysis, gallinule densities in the undiked wetlands increased with decreasing plant stem-density and increasing percentage of open water and edge (table 3). The relative frequency of submergent aquatic plants on the undiked wetlands was low due to high turbidity and extreme water level fluctuations (Brackney 1979).

Densities of common gallinules in both marsh types were highest on wetlands with about 50% open water interspersed with

TABLE 3

Gallinule densities, percentage of open water, edge, relative frequencies of floating and submerged plants, and plant stem density in 5 diked and 3 undiked wetlands along southwestern Lake Erie, 1977-78.

				Relative frequency		
Wetland	Pairs/ha	% open water	Edge pts/ 100 m transect	floating plants	submerged plants	Mean no. stems/m^2
Diked[*]						
Navarre-central	4.6 ±0.8	47	19.8	0.93	0.89	20.4 ±3.2 (83)[**]
Navarre-east	4.1 ±0.7	45	19.2	0.77	0.80	21.1 ±2.8 (88)
Magee-Perry	2.9 ±1.0	40	14.0	0.93	0.65	24.0 ±4.2 (68)
Bay View-central[†]	2.9 ±0.7	38	19.1	0.16	0.66	20.9 ±3.0 (124)
Darby-west	1.3 ±0.6	22	6.6	0.85	0.38	51.4 ±5.2[††] (109)
Undiked						
Winous Point-south[†]	2.5 ±0.5	55	19.3	0.0	0.0	32.5 ±5.7[††] (83)
Metzgar-south	2.0 ±0.5	44	14.6	0.06	0.10	44.9 ±6.7[††] (71)
Metzgar-north	1.3 ±0.7	33	12.6	0.11	0.05	50.6 ±6.5[††] (74)

[*] Spearman's rank correlation test, positive association ($P < 0.05$) between pairs/ha and % open water, edge points/100 m transect, and relative frequency of submerged plants, and between % open water and edge points/100 m transect and relative frequency of submerged plants.

[**] Sample size in parentheses.

[†] Sampled in 1977.

[††] Analysis of variance, Fisher's least significant difference test, significant ($P < 0.01$). Diked and undiked marshes were analyzed separately.

the vegetation. Bay View east marsh, which was not sampled, had approximately 65–75% open water interspersed with vegetation and a lower than maximum gallinule density (3.7 ±0.7 pairs/ha). A continued decrease in the amount of emergent vegetation at the Winous Point-south marsh from 45% in 1977 (table 3) to an estimated 10% in 1978 caused a nearly complete abandonment of that wetland by gallinules. The selection of nest sites also showed gallinule preference for maximum interspersion and edge. The mean distance between the nest and the vegetation-open water interface was 5.5 ±0.9 m (range 0–15). Other studies have reported mean distances to open water of 4.7 m (range 2-28) for 19 nests in Iowa (Fredrickson 1971) and 0.8 m for 10 nests in Louisiana (Bell 1976).

A comparison of gallinule densities on 20 wetlands with the water regime and vegetation life-form classification of Cowardin et al. (1979) showed that the highest densities occurred on semipermanently flooded wetlands with persistent emergent vegetation (table 4). Medium gallinule densities were found on seasonally flooded and undiked, intermittently exposed wetlands with persistent emergent vegetation. Lowest densities were on wetlands with nonpersistent emergent vegetation, mixtures of scrub-shrub and persistent emergent vegetation, and seasonally flooded or undiked, intermittently exposed wetlands with a high ratio of open water to persistent emergent vegetation.

Gallinules seemed to prefer persistent emergent vegetation in which the dead stems remain to the following spring. Sixty-two of 67 nests (93%) were located in cattail (*Typha* sp.) or giant burreed (*Sparganium eurycarpum*), both of which are narrow leaved persistent emergent plants. The remaining 5 nests were found in broad-leaved nonpersistent emergent vegetation (2 nests), woody vegetation (2 nests), and softstem bulrush (*Scirpus validus*), a narrow-leaved nonpersistent emergent (1 nest). Because only 80% of

TABLE 4

The water regimes and vegetation life-form of 20 discrete wetlands in relation to gallinule densities, Lake Erie marshes, 1978.

Wetland	Area	Pairs/ha	Water Regime*	Life-form*
Navarre	central	4.6	SpF**	PE**
Navarre	east	4.1	SpF	PE
Bay View	east	3.7	SpF	PE
Magee	Perry	2.9	SpF	PE
Cedar Point	west	2.9	SF	PE
Cedar Point	central	2.6	SF	PE
Bay View	bayside	2.3	SF	PE
Cedar Point	east	2.3	SF	PE
Navarre	west	2.2	SpF/SF†	NPE/PE
Ottawa NWR		2.0	SF	PE
Metzgar	south	2.0	IE	PE
Toussaint SC		1.3	SF/S	PE
Metzgar	north	1.3	IE	PE
Darby	west	1.3	SpF	NPE
Darby	central	1.1	SpF	NPE
Cedar Point	south	0.7	SF/S	NPE
Toussaint Creek		0.6	SpF/SF	PE/SS
Ottawa SC		0.5	IE	PE/UB
Winous Point SC		0.2	IE	UB/PE
Magee	main	0.2	SF	UB/PE

*Terms and definitions follow Cowardin et al. (1979).

**Abbreviations: SpF-semipermanently flooded, SF-seasonally flooded, S-saturated, IE-irregularly exposed/intermittently exposed, PE-persistent emergent vegetation, NPE-nonpersistent emergent, SS-scrub shrub, UB-unconsolidated bottom.

†Slash lines indicate substantial amounts of each type.

the nest searching took place in persistent emergent vegetation, gallinules showed a significant preference ($X^2 = 6.34$, $P < 0.05$) for this vegetation as nesting cover. Krauth (1972) found 18 nests distributed proportionally in various types of emergent cover, 15 of which were located in cattail or burreed. Most nests located in this study were initiated prior to the time the new vegetation provided sufficient cover for concealment. The dead stems of the persistent vegetation were used for cover and nesting material before new emergent shoots were available. Gallinules typically utilize dead material for nest construction (Krauth 1972). Additionally, cattail and burreed provided higher cover at maturity (1.5–2 m) than broad-leaved nonpersistent emergents (0.3–1.0 m) such as arrowhead (*Sagittaria* sp.) and swamp smartweed (*Polygonum coccineum*).

The semipermanently flooded wetlands typically had better interspersion of open water to emergent cover and a greater abundance of submergent plants due to the increased depth and consistency of water levels. Seasonally flooded wetlands were generally more dense with less interspersion of cover to open water. An exception to this was a semipermanently flooded wetland, Darby marsh, which was reflooded in 1978 after being drawn down the previous year. Stem densities were higher and interspersion was less (table 3) than on other semipermanently flooded wetlands. Dead vegetation was not present from the previous year, although the new vegetation was cattail and burreed. Thus gallinules nested in lower densities at Darby marsh than at most seasonally flooded marshes. The undiked, intermittently exposed wetlands had lower gallinule densities due to the large water level fluctuations and lack of submergent aquatic plants as a food source.

Although common gallinules probably attain highest breeding densities in semipermanently flooded wetlands with submergent and persistent narrow-leaved emergent vegetation, the species will nest in a broad range of wetland habitats. The water depth under 62 nests examined in this study averaged 40.5 ±3.5 cm but ranged from 0 to 60 cm. In Iowa, depth at 19 gallinule nests measured by Fredrickson (1971) averaged 53 cm and ranged from 20 to 91 cm. Water depth might be important in its effect on egg and brood predation. At Navarre Marsh in 1978, 6 gallinule nests were depredated within 1 week of a 30-cm drop in water levels, which left the nests over dry substrate. While censusing seasonally flooded wetlands, we often surprised adults and broods feeding on mudflats adjacent to cattail stands. The adults abandoned the young much more readily when on the mudflats than when on the water, and the chicks seemed more confused and vulnerable when on mudflats. In the wetland areas, raccoons (*Procyon lotor*) den extensively on muskrat (*Ondatra zibethicus*) houses and spend 50% of their time in emergent vegetation (Urban 1970). Severe reductions in water levels from drawdown management could leave gallinule nests and young vulnerable to predation. Increased emphasis on drawdown management in the southwestern Lake Erie wetlands in the 1960s might have increased predation and reduced the amount and quality of habitat available to common gallinules.

Within a wetland complex, a variety of water depths and vegetation life-forms favors the highest diversity of avian species (Beecher 1942, Weller and Spatcher 1965). Complete drawdowns during the growing season, a prevalent management practice along southwestern Lake Erie, can be extremely detrimental to nesting marsh birds. Meeks (1969) demonstrated that this type of management, over a period of years, results in a succession towards terrestrial annual weeds, and he recommended partial drawdowns as a solution. This is best accomplished by managing in a cycle of partial drawdowns in which summer water levels are varied over a period of years, depending upon the condition of the vegetation (R. L. Meeks, pers. comm.). Because marsh birds are adapted to fluctuating environmental conditions (Weller and Spatcher 1965), these management practices could provide suitable habitat for marsh birds and also be compatible with management for migratory waterfowl.

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EDITOR'S NOTE

In an effort to reduce the backlog of manuscripts and thereby shorten the time between acceptance and publication, we have increased the size of this issue by 40 pages.