Breeding habitat use and postbreeding movements
by Soras and Virginia Rails

by

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GENERAL INTRODUCTION

Though volumes of data have been collected on other aquatic gamebirds, Virginia Rails (*Rallus limicola*) and Soras (*Porzana carolina*) have been largely ignored. Relatively little is known of their ecology because of their secretive nature and the dense vegetation they inhabit. Both species are abundant summer residents in northwest Iowa wetlands. Other investigations of these species in the Upper Midwest have dealt primarily with foraging and nesting ecology (Tanner and Hendrickson, 1954, 1956; Horak, 1970). Habitat studies have attempted to relate rail distribution to dominant species of emergent vegetation and water depth (Weller and Spatcher, 1965; Andrews, 1973; Baird, 1974). A major management need for these species is a better understanding of their seasonal distribution and habitat use (Odom, 1977; Zimmerman, 1977). This thesis examines the ecology of Virginia Rails and Soras in northwest Iowa marshes during the breeding and postbreeding phases of their summer residence.

Section I of this thesis focuses on the technique of eliciting primary advertising calls from Virginia Rails and Soras by broadcasting playback recordings of their calls. Glahn (1974) reported that playback broadcasts significantly increased the calling rate of both species. This paper tests the hypothesis that both Virginia Rails and Soras respond equally well to playback recordings of interspecific and conspecific calling. It also demonstrates the value of night broadcasts in determining the distribution and abundance of Virginia Rails.

Section II examines the patterns of habitat use on seasonal and semipermanent wetlands by breeding Virginia Rails and Soras. Playback broadcasts were used to elicit responses from territorial rails. The structure of the habitat on rail territories was examined. Also, the hypothesis that Virginia Rails and Soras exhibit differential use of dominant emergent cover-types was investigated. Considerations for wetland managers are presented

Section III reports the results of the first attempt to monitor Virginia Rail and Sora movements with biotelemetry. The movements of ten Virginia Rails and ten Soras are examined during the brood-rearing phase of the breeding season. The postbreeding dispersal of 15 of these rails is reported, and the pattern of emigration of several is examined.

Explanation of Thesis Format

This thesis adheres to the guidelines specified for the alternate format. It consists of three discrete components, described above, each written for publication, mindful of the requirements and foci of the journals for which they are intended. The contribution of Rex R. Johnson, in each case, has been that of co-originator, field worker, and principal author. James J. Dinsmore's contribution has principally been one of coordinator, advisor, and editor.

SECTION I. COUNTING VIRGINIA RAILS AND SORAS WITH PLAYBACK RECORDINGS

INTRODUCTION

Playback recordings have been used for the last two decades to count breeding birds (Johnson et al., 1981). Because of the elusive nature of rails and the dense vegetation they inhabit, the playback technique has become a principal means of counting these species. Playback of taped calls significantly increased the calling rate of breeding Virginia Rails (*Rallus limicola*) and Soras (*Porzana carolina*) (Glahn, 1974). Both species responded as readily to interspecific and conspecific calls. However, Baird (1974) found that Soras responded less consistently to taped calls than Virginia Rails, and concluded that playback censusing could not be applied accurately to Soras. This paper documents a test of the hypothesis that breeding Virginia Rails and Soras respond equally well to tapes of interspecific and conspecific calls. It also demonstrates the value of night counting as a tool in obtaining indices of breeding rail densities.

MATERIALS AND METHODS

The distribution of territorial Virginia Rails and Soras was studied on Dewey's Pasture and Spring Run Game Management Areas, both state-owned wetland complexes in northwest Iowa. Count routes were established around the periphery of marshes. One hundred and eight stations were located at a mean interval of 100 m (30m-150m) along the routes, achieving 100% coverage of available habitat. Total area surveyed was 65 ha of wetland, including 52 ha of emergent vegetation. One min continuous loop tapes of the primary advertising call of the Virginia Rail and Sora, each broadcasting 7 calls per minute, were used. Tapes were broadcast with a Sharp model RD-664AV cassette recorder. Maximum sound pressure 1 m from the source was 90 db.

Counts were initiated on 1 May 1981 and 15 April 1982, and continued until 16 June 1981 and 1 June 1982. Surveys were made from 1 hr before to 3 hr after sunrise, and were not performed when wind velocities exceeded 24 km/hr, or in heavy rain. Night counting was initiated in early June when morning surveys stimulated few responses to taped calls, and was conducted from 1-4 hr after sunset.

Virginia Rail and Sora calls were each broadcast for 2 min continuously at each station. The call played first was alternated at each station. For all rail vocal responses, the tape played first and the tape responded to were recorded. The locations of responding rails were recorded on cover maps prepared from aerial photos of the study areas. The dis-distance of each responding rail from the count station was measured on these maps.

RESULTS AND DISCUSSION

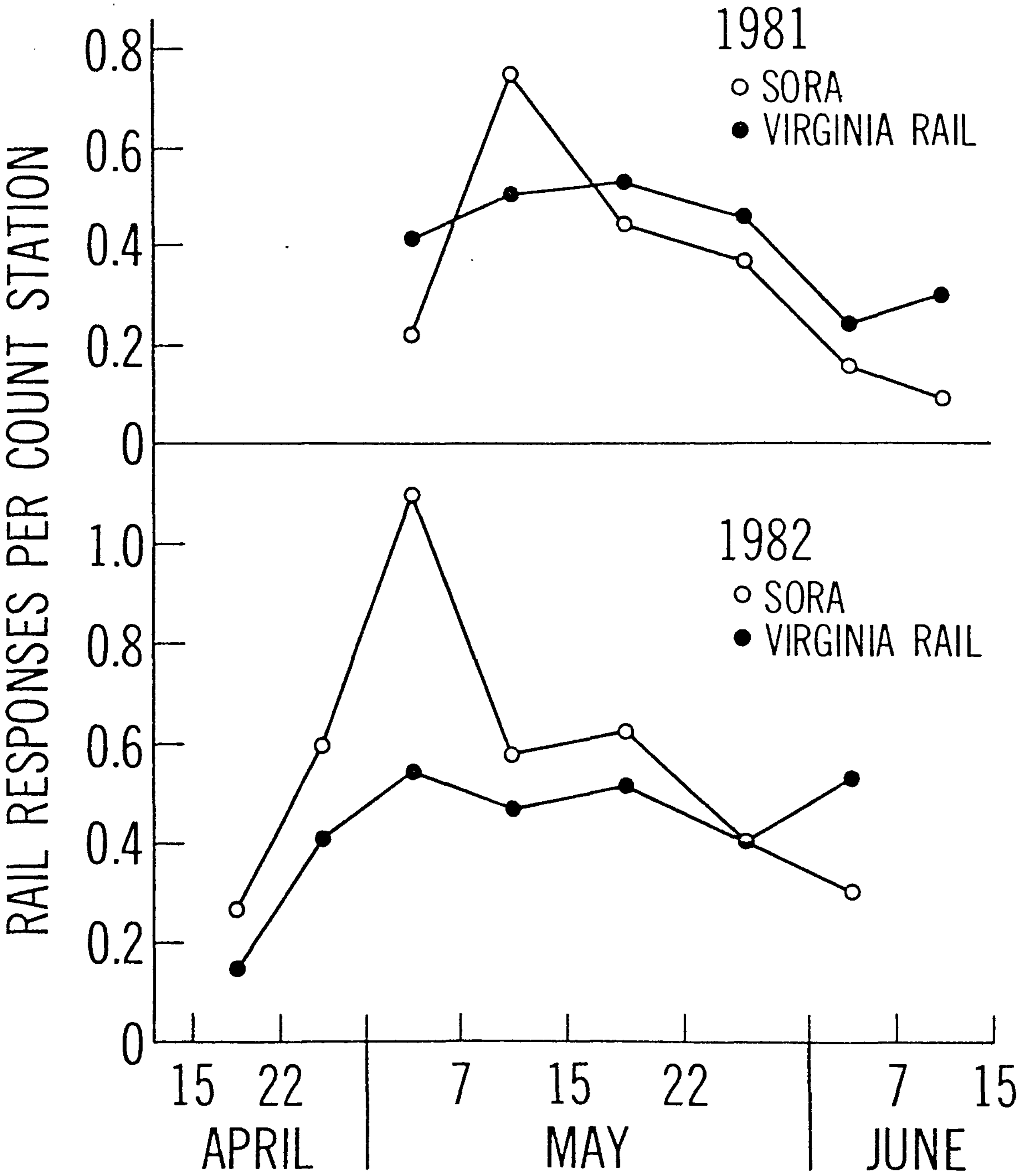
The characteristics of 528 Virginia Rail and 470 Sora responses to playback calls were recorded. Weekly response patterns for 1982 mirror the patterns in 1981 data, but exhibit an earlier peak in the number of rail responses/station, and, consequently, an earlier decline in response frequency (Figure 1). This temporal shift is supported by nest initiation dates, estimated by back-dating nests found, and by the onset of brooding behavior. The peak of egg laying occurred approximately 10 days earlier in 1982 (10 May) for both Virginia Rails and Soras.

Soras responded to morning broadcasts of playback recordings at a significantly greater distance [68 m ± 4.4 m (SE)] than Virginia Rails (51 m ± 2.7 m) ($t = 2.39$, $P < .010$). Virginia Rails responded to night broadcasts (118 m ± 7.1 m) at a significantly greater distance than that found for morning surveys ($t = 6.84$, $P < .001$). Neither morning nor night broadcasts consistently elicited responses from Soras after early June of either 1981 or 1982.

Playback counts conducted at night elicited significantly higher response rates from Virginia Rails in late incubation and brood rearing periods than morning surveys. Identical morning and night surveys, made over a 24 hr period, were run ten times from 8 June to 21 July 1981 and 1982. Morning and night broadcasts elicited 0.4 and 0.9 Virginia Rail responses/station, respectively ($t = 4.2$, $P < .001$).

Chi-square analysis of response data indicates a significant Sora preference for responding to conspecific calls ($\chi^2 = 98.78$, $P < .001$). This preference was consistent for prelaying and postlaying periods over

Figure 1. Weekly rail response rates to playback recordings per count station, morning surveys, 1981 and 1982


1981
○ SORA
● VIRGINIA RAIL
1982
○ SORA
● VIRGINIA RAIL
RAIL RESPONSES PER COUNT STATION
0.8
0.6
0.4
0.2
0
1.0
0.8
0.6
0.4
0.2
0
15
22
7
15
22
7
15
APRIL
MAY
JUNE

both years of the study (Table 1). Virginia Rails exhibit a significant postlaying preference for responding to intraspecific calling ($\chi^2 = 11.70$, $P < .001$). Prelaying Virginia Rails exhibited no preference for the calls of either species (Table 2).

Table 1. Playback recordings responded to by breeding Soras, 1981 and 1982

	1981				1982			
	S[a]	V[b]	χ^2	P	S	V	χ^2	P
Prelaying	49	16	16.8	<.001	130	44	42.5	< .001
Postlaying	64	31	11.5	<.001	92	44	16.9	< .001

[a] Soras responding to Sora playback recordings.

[b] Soras responding to Virginia Rail playback recordings.

Table 2. Playback recordings responsed to by breeding Virginia Rails, 1981 and 1982

	1981				1982			
	S[a]	V[b]	χ^2	P	S	V	χ^2	P
Prelaying	37	29	1.0	>.25	49	52	0.1	>.75
Postlaying	77	118	8.6	<.005	65	89	3.7	≤.05

[a] Virginia Rails responding to Sora playback recordings.

[b] Virginia Rails responding to Virginia Rail playback recordings.

Soras exhibited a significant tendency to respond to the first tape broadcast at a census station ($\chi^2 = 18.2$, $P < .001$), except during the postlaying period of 1982, when no significant pattern existed. However, where a preference was exhibited for the first tape broadcast, tape playing order and the call responded to were not independent. This suggests that, when the Sora tape was broadcast first, it proved an almost irresistable stimulus to respond. When the Virginia Rail tape was broadcast first, less than one half (N = 57) of the responding Soras responded to the Virginia Rail primary advertising call, while more than one half (N = 95) did not respond until the Sora primary advertising call was broadcast ($\chi^2 = 9.5$, $P < .005$). This indicates that the Sora's strong preference for conspecific calls has confounded any analysis of Sora sensitivity to the order of tape presentation, and suggests that no such sensitivity exists. The order of tape presentation was not a significant factor in eliciting responses from Virginia Rails.

My data do not support the hypothesis that Virginia Rails and Soras respond equally well to conspecific and interspecific calls during the breeding season (Glahn, 1974). Tacha (1975) found that a large percentage of Virginia Rail responses were elicited by conspecific calls (78%), while Soras responded best to interspecific broadcasts (71%); however, he had a very small sample of Sora responses (N = 17). My data indicate that, where Virginia Rails and Soras are sympatric, both species may be successfully counted during the prelaying period by broadcasting playback recordings of the Sora primary advertising call. However, during the postlaying phase of the breeding season, optimum results are achieved by alternately broadcasting the recorded calls of both species.

Night counting appears to be a viable tool for obtaining indices to breeding rail densities. Night surveys stimulated greater Virginia Rail response rates, over a significantly greater radius than morning surveys, and may prove of use to researchers and managers monitoring annual fluctuations in rail populations.

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SECTION II. HABITAT UTILIZATION BY BREEDING SORAS AND VIRGINIA RAILS IN IOWA

INTRODUCTION

Research on Virginia Rails (*Rallus limicola*) and Soras (*Porzana carolina*) has been retarded by their secretive nature and lack of importance as game birds. A major research need for the effective management of both species is knowledge of their seasonal distribution and habitat use (Odom, 1977; Zimmerman, 1977). Previous habitat studies have attempted to relate rail distribution to dominant species of emergent vegetation and water depth (Tanner and Hendrickson, 1954, 1956; Andrews, 1973). Soras are thought to favor fine vegetation, on moist soils or in shallow water, while Virginia Rails occupy deepwater sites dominated by robust emergents (Weller and Spatcher, 1965; Baird, 1974). The objective of this paper is to identify patterns of habitat use by Virginia Rails and Soras.

STUDY AREA

The study was conducted on the Dewey's Pasture and Spring Run Game Management Areas in northwest Iowa. Dewey's Pasture is a 136-ha wetland-upland complex in Clay and Palo Alto counties (Bennett, 1938; Hayden, 1943; Low, 1945; Weller, 1979), and is subdivided into three drainages, including 45 ha of wetlands. Drainage B wetlands and uplands were burned in both 1981 and 1982, and data from them were not included in this analysis. Marshes are dominated by monospecific stands of cattail (*Typha glauca*), sedges (*Carex* spp., and bulrushes, *Scirpus acutus*, and *Scirpus fluviatilis*) and bur reed (*Sparganium eurycarpum*).

Spring Run in Dickinson County covers roughly 200 ha, of which 28 ha were surveyed for breeding rails. Krapu et al. (1970) describe the upland vegetation. Marshes are dominated by cattail, sedges, bur reed, and willows (*Salix* spp.). All marshes were seasonally or semipermanently flooded.

METHODS

The distribution of breeding rails was determined by broadcasting one-minute continuous loop recordings of the primary advertising calls of the Virginia Rail and Sora, and eliciting responses from territorial males or pairs (Baird, 1974; Glahn, 1974; Tacha, 1975; Todd, 1976; Griese et al., 1980; Marion et al., 1981). Tapes were broadcast at a maximum sound pressure of 90 db, at a rate of 7 calls/minute. Census stations were located at 30-150-m intervals around the periphery of all wetlands, achieving 100% coverage of available habitat.

Breeding rail surveys were initiated on 1 May 1981 and 16 April 1982, and continued until 16 June 1981 and 1 June 1982. Surveys were conducted from 1 hr before to 3 hrs after sunrise, when wind velocities did not exceed 24 kph. Virginia Rail and Sora tapes each were broadcast for 2 minutes continuously at all census stations. Simultaneous pair responses on individual surveys and clusters of responses from repeated surveys were used to define territory locations (Kendeigh, 1944). In this paper, I define a territory as the defended use area of a pair or of a responding male. Other researchers have referred to this use area as a territory, and have interpreted the primary advertising call as a means of territory defense (Kaufmann, 1971; Glahn, 1974). Rail territories correspond to Nice's (1941) type A territory.

Availability of cover types on surveyed wetlands was determined from cover maps prepared from 35-mm aerial photos taken on 1 June 1981 and 1 May 1982, when the visual contrast in the emergent vegetation was the greatest. Simultaneous ground truthing was necessary. Cover type was defined by the structurally dominant species of emergent vegetation in the stand. Poorly represented species were pooled for analysis under a miscellaneous category.

The habitat structure on 92 Virginia Rail and 71 Sora territories was examined along 20-25 m transects, centrally located on territories and aligned to cut across any vegetation interfaces present. Along the transect, 1 m^2 quadrants were placed at 2 m intervals. Within each quadrant, stems were counted by species, and water depth, effective height of the stand (Robel et al., 1970), total stem density, and the amount of floating residual vegetation were recorded. In 1982, 50 similar transects were run at randomly selected sites.

Preference ranks for dominant species of emergent vegetation were developed with Johnson's (1980) nonparametric technique using habitat use data obtained from rail censuses, and habitat availability data measured from aerial photos. Nested and one-way analyses of variance and chi-square goodness-of-fit tests were used for analysis (Snedecor and Cochran, 1967).

RESULTS

Broadcasts of playback recordings elicited 734 Virginia Rail and 600 Sora responses. Spot-mapping these responses identified 147 Virginia Rail and 143 Sora territories. The mean breeding densities calculated on pooled 1981 and 1982 data were 1.3 (±.43) Sora pairs/ha and 1.4 (±.33) Virginia Rail pairs/ha. These estimates are similar to those reported by Griese et al. (1980).

Habitat Use

The ratio of Virginia Rail to Sora territories was greatest in monospecific stands of cattail (1.25:1), and was smallest at high diversity sites (0.59:1), or at sites where emergent cover types were highly interspersed, where Soras reached their greatest breeding density. Using Baxter and Wolfe's (1972) Interspersion Index, I calculated a mean index to interspersion on Virginia Rail and Sora territories and found the difference to be highly significant ($t = 2.54$, $P \leq .01$).

The mean distance from the center of rail territories to a vegetative interface, where two dominant cover types meet, was significantly less for Sora territories than for Virginia Rail territories ($P < .005$) or for a random distribution of 100 locations ($P < .005$, Table 1). These interfaces were most frequently with *Carex* spp.-dominated stands (38%), though *Carex* spp. composed only 12.7% of the emergent vegetation on my study areas. Its distribution was typically peripheral in narrow blocks or bands.

Sora breeding density (territories/ha emergent vegetation) was sigificantly positively correlated with a ratio of shoreline length (km) to wetland area (ha) ($R = .62$, $P \leq .001$). The correlation was improved by eliminating variation due to cover type, and considering only cattail-dominated marshes ($R = 0.78$, $P \leq .0025$).

Table 1. Distance (in meters) to physiographic features of wetlands from geometric centers of Sora and Virginia Rail territories, and from random points, 1981 and 1982

	Sora		Virginia Rail		Random	
	$N^a = 143$		$N = 147$		$N = 100$	
Distance to	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Open water	30.0A[b]	(2.6)	29.5A	(3.1)	32.2A	(3.8)
Upland	19.6B	(1.1)	17.1B	(0.9)	16.9B	(1.4)
Vegetation Interface	23.5D	(2.7)	38.4C	(4.3)	38.2C	(4.8)
Cattail	18.3E	(2.3)	12.9E	(1.8)	14.0E	(2.5)

[a] Number of rail territories.

[b] Values sharing a letter are not significantly different, one-way analysis of variance, $P < .005$.

Cover Type Use

All cover types were used by Virginia Rails and Soras, and in all cover types, both species' territories commonly overlapped. Species of emergent vegetation were used roughly in proportion to availability. All cover types I examined, therefore, provide usable breeding habitat on typical midwestern seasonal and semipermanent wetlands.

Sora cover type use and emergent availability were highly correlated in 1981 and 1982 (R = 0.95, Table 2). Cattail-dominated sites received the greatest percentage of use, though availability exceeded use in both years. In 1982, this difference approached significance ($\chi^2 = 3.54$, $P < .10$). However, cattail is an important cover type for breeding Soras in northwest Iowa by virtue of its great availability.

Table 2. Percentage emergent vegetation use and availability and preference rank for Soras, 1981 and 1982

	1981		1982		
Cover type	% Use[a]	% Available	% Use[b]	% Available	Preference Rank[c]
Typha sp.	48.9	53.3	52.4	67.9	4A[d]
Sparganium sp.	30.0	17.3	13.2	10.5	5A
Carex sp.	9.0	13.7	18.0	11.7	6A
Scirpus fluviatilis	4.0	1.6	4.8	3.1	1A
Scirpus acutus	0.9	1.8	5.0	2.7	3A
Miscellaneous	7.6	12.4	6.6	4.0	2A

[a] N = 223.

[b] N = 361.

[c] Johnson, 1980. Ranked from most preferred to least preferred.

[d] Ranks sharing a letter are not significantly different.

In 1981, use of bur reed stands significantly exceeded availability ($\chi^2 = 9.30$, $P < .01$). In the second year of the study, use still exceeded availability, but the two parameters were roughly equivalent. Heavy snow and ice cover had produced poor quality residual cover in most bur reed stands. *Carex* spp.-dominated sites were used in proportion to availability in 1981. However, in 1982, use exceeded availability (the difference approached significance, ($\chi^2 = 3.69$, $P < .10$). Hard-stemmed bulrush (*Scripus fluviatilis*) use also increased in 1982, though these cover types were poorly represented on my study areas. I used Johnson (1980) to identify relative cover type preference by breeding Soras. Johnson's ranking procedure failed to identify any significant preference for emergent cover types, supporting the observation that, year to year, emergent availability and Sora habitat use are nearly synonymous.

Virginia Rail cover type use, like Sora, corresponds to availability ($R = 0.98$, Table 3). Use of no single cover type deviated significantly from its availability. However, combining 1981 and 1982 data, Johnson's (1980) preference analysis indicates that Virginia Rails have a significant preference for inhabiting fine to moderately robust emergent vegetation, such as *Carex* spp., hard-stemmed bulrush, and bur reed over cattail, river bulrush, and the miscellaneous emergents. River bulrush was little used, but occurred chiefly in small isolated stands.

I combined Sora and Virginia Rail observations and developed a preference index, ranking emergents from most to least preferred (Table 4). Breeding rails preferred fine vegetation (i.e., *Carex* spp. (bur reed) significantly more than cattail-dominated sites (robust emergents). Moderately robust emergents like hard-stemmed and river bulrush were intermediately preferred, but were not significantly more attractive than cattail.

Table 3. Percentage emergent vegetation use and availability, and preference rank for Virginia Rails, 1981 and 1982

Cover type	1981		1982		
	% Use[a]	% Available	% Use[b]	% Available	Preference Rank[c]
Typha sp.	49.6	53.3	65.9	67.9	4B[d]
Sparganium sp.	22.4	17.3	5.0	10.5	3A
Carex spp.	18.6	13.7	17.2	11.7	1A
Scirpus fluviatilis	0.5	1.6	2.9	3.1	5B
Scirpus acutus	4.0	1.8	2.3	2.7	2A
Miscellaneous	4.9	12.4	6.7	4.0	6B

[a] N = 371.

[b] N = 320.

[c] Johnson, 1980. Ranked from most preferred to least preferred.

[d] Ranks sharing a letter are not significantly different.

Table 4. Percentage emergent vegetation use and availability and preference rank for Virginia Rails and Soras, 1981 and 1982

Cover type	1981		1982		
	% Use[a]	% Available	% Use[b]	% Available	Preference Rank[c]
Typha sp.	49.3	53.3	57.6	63.0	5C[d]
Sparganium sp.	25.1	17.3	9.8	12.7	2AB
Carex spp.	15.0	13.7	17.9	13.4	1A
Scirpus fluviatilis	1.9	1.6	4.1	3.7	4BC
Scirpus acutus	2.9	1.8	3.7	3.1	3ABC
Miscellaneous	5.9	12.4	6.9	4.2	

[a] N = 594.

[b] N = 681.

[c] Johnson, 1980. Ranked from most preferred to least preferred.

[d] Ranks sharing a letter are not significantly different.

Habitat Structure

Walkinshaw (1940) and Chapman (1952) reported that Soras nest over water 15-20 cm deep. Billard (1947) noted that the mean water depth at Virginia Rail nests was 6.6 cm. Tanner and Hendrickson (1954, 1956) found both species nesting over water 13-58 cm deep. It appears that Virginia Rails and Soras nest over a wide range of suitable water depth, wherever the characteristics of the emergent vegetation are suitable for territories. The mean depth on Sora territories in 1981 and 1982 was 38.4 cm (0-92 cm) and 40.3 cm (0-93 cm) on Virginia Rail territories. These results are consistent with the observation of Rundle and Fredrickson (1981) who found no significant difference in water depth at sites used by migrant Virginia Rails and Soras. The mean water depth along 50 transects at random sites was significantly deeper than at Sora territories (Table 5).

Table 5. Comparisons of structural habitat characteristics on Sora and Virginia Rail territories, and at random sites, 1981 and 1982

Structural variable	Sora $N^a = 732$		Virginia Rail $N^b = 957$		Random $N^c = 420$	
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Effective height	128.0 cm	(42.5)	131.3 cm	(45.6)	137.6 cm	(46.5)
Total stems	121.9	(80.9)	116.0	(75.5)	134.4	(86.8)
Water depth	38.4 cm*	(16.1)	40.3 cm	(29.1)	44.1 cm*	(16.4)
Residual[d]	2.6	(1.1)	2.4	(1.1)	2.4	(1.2)

[a] Number of 1 m^2 quadrats on 71 territories.

[b] Number of 1 m^2 quadrats on 92 territories.

[c] Number of 1 m^2 quadrats at 50 random sites.

[d] Amount of floating or submersed residual vegetation measured by a 5-level class variable, 0 being the lowest and 4 the highest.

*Nested analysis of variance; $F = 7.74$, 1, 119 d.f., $P < 0.025$.

Though such wetlands were poorly represented on my study areas in 1981 and 1982, neither species responded to playback broadcasts from sites without standing water. One such site was twice occupied by a Virginia Rail during the summer of 1981 following periods of heavy rain, until the area was again dry. No rails occupied this temporary wetland during periods without standing water. Gochfeld (1972) flushed wintering Soras from a Trinidad impoundment wherever standing water was present. As the dry season progressed, Soras moved into the remaining wet areas, with taller emergents that they had previously avoided.

Mean stem densities on Virginia Rail and Sora territories were not significantly different from those found at random locations (Table 5). However, rails may avoid emergent stands with very high stem densities, or stands heavily lodged with residual vegetation, which could impede movement. The low mean stem density on Virginia Rail territories reflects their extensive use of cattails (Table 3).

Similarly, the effective height (Robel et al., 1970) of the emergent vegetation on Virginia Rail and Sora territories, and that at random locations were statistically equivalent (Table 5). Like stem density, this variable does not appear to have significantly influenced rail distribution on Dewey's Pasture or Spring Run. However, in 1982, heavy snow, ice, and high water combined to level the emergent vegetation at several sites on these study areas. Rails did not exploit these sites until the growth of new stems provided some horizontal and aerial coverage. In early May, 1982, when new growth *Carex* spp. reached a height of 20-30 cm above the water surface at an estimated density of 80-100 stems/m^2, Soras were visible in great numbers in *Carex* spp. stands previously unused. These birds were feeding extensively on *Carex* spp. seeds and invertebrates inhabiting the extensive mat of residual stems. Rundle and Fredrickson (1981) observed a similar phenomenon.

I attempted to quantify the amount of floating and submersed residual vegetation and the density of the mat it formed on rail territories and at random sites with a 5-level variable (0-4) (Table 5). The differences were insignificant. This mat, as noted, provides a substrate both for invertebrate prey and a place for rails to walk. Only once did I observe a rail swim more than 1 m. Several times, I saw rails walking on mats of *Spirodella polyrhiza* winrowed in cattail adjacent to open water. Movement was difficult, and the birds repeatedly broke through and were forced to swim short distances.

Emergent Composition of Rail Territories

The species composition of emergent cover on Virginia Rail and Sora territories mirror the composition of the cover at 50 random sites (Table 6). Only arrowhead (*Sagittaria latifola*), which was most abundant at shallow, peripheral sites, occurred significantly more often on Sora territories than it did at random locations ($F = 5.37$, $P < 0.01$).

Table 6. Frequency of occurrence and stem densities of emergents on Sora and Virginia Rail territories, and at random sites, 1981 and 1982

	Sora		Virginia Rail		Random		Density[a]	
	N[b] = 732		N = 957		N = 420		N[b] = 1689	
Emergent	$\bar{X}$[c]	(S.E.)	$\bar{X}$[d]	(S.E.)	$\bar{X}$[e]	(S.E.)	$\bar{X}$	(S.E.)
Typha sp.	63.8	(1.8)	72.5	(1.4)	69.1	(2.3)	35.0	(0.2)
Sparganium sp.	52.5	(1.8)	44.7	(1.6)	44.1	(2.4)	36.1	(0.4)
Carex spp.	58.3	(1.8)	53.0	(1.6)	58.6	(2.4)	31.7	(0.4)
Scirpus fluviatilis	16.3	(1.4)	14.4	(1.1)	18.1	(1.9)	2.7	(0.1)
Scirpus acutus	12.3	(1.2)	11.9	(1.0)	15.5	(1.8)	7.9	(0.2)
Phragmites sp.	1.8	(0.4)	0.1	(0.1)	0.0	(0.0)	0.5	(0.1)
Polygonum spp.	44.8	(1.8)	41.1	(1.6)	43.3	(2.4)	3.2	(0.1)
Sagittaria sp.	15.6	(1.3)*	11.7	(1.0)	6.0	(1.2)*	1.4	(0.1)
Miscellaneous	3.8	(1.0)	3.2	(0.9)	2.6	(1.2)	0.1	(0.1)

[a] Density of emergents on Virginia Rail and Sora territories.

[b] N = number of 1 m^2 quadrats at 71 territories.

[c] Mean frequency of occurrence in 732 1 m^2 quadrats at 71 territories.

[d] Mean frequency of occurrence in 957 1 m^2 quadrats at 92 territories.

[d] Mean frequency of occurrence in 420 1 m^2 quadrats at 50 sites.

*Nested analysis of variance; F = 5.37, 1, 119 d.f., $P < 0.01$.

DISCUSSION

Hilden (1965) states that, when the distribution of species with similar ecological preferences overlap, they are each more strictly confined to their ecologically optimal environment. In 1981 and 1982 in northwest Iowa, Virginia Rails and Soras exploited the available habitat on seasonal and semipermanent marshes similarly; i.e., no strong segregating mechanisms were manifest. Both breeding seasons were characterized by abundant spring runoff and above-average spring and early-summer rainfall. While the relative availability of other resources is unknown, cover and water must have approached their optimum. Under these conditions, strategies for partitioning the available habitat, based on variables I considered, were not exhibited. Under a less desirable cover-moisture regime, where the availability of quality habitat is restricted, these strategies may be more evident. My observations demonstrate subtle differences in Virginia Rail and Sora habitat use, which may indicate the direction of such a partitioning strategy.

For neither Virginia Rails nor Soras were use and availability of any species of emergent vegetation different enough to suggest strong cover type preference. The high positive correlations of emergent use and availability support this. The significant differences in preference ranks for Virginia Rails and combined Sora and Virginia Rail observations result from annual patterns of use and availability; i.e., when use exceeded availability in both study years, a high preference rank was assigned. Where such subtle deviations from availability exist, long-term studies will be required to adequately define cover type preferences. Rundle and

Fredrickson (1981) suggest that rails select habitat because of water conditions and vegetation structure, not species composition.

Like cover type preference, morphological features of wetlands and emergent vegetation and habitat structure did not generally influence the distribution of breeding rails. In all aspects of their habitat use, Virginia Rails and Soras exploited available habitat similarly. No strong pattern of habitat use was exhibited by rails, and habitat was used as it was available. Though undoubtedly at the extremes of the spectrum of emergent habitat structure unsuitable habitat exists, it was not evident on my study areas. The avoidance of dry emergent stands by both species was an exception to this observation.

Soras did exhibit some deviation from a random use of habitats. Soras reach their greatest breeding densities at relatively shallow, shoreward sites where water level instability produces a mosaic of fine, moderately robust, and robust emergent vegetation. This tendency may be related to their extensive use of seeds of wetland and aquatic plants (most notably *Carex* spp.) as food during the breeding season (Horak, 1970; Johnson, unpubl. data, Dept. Animal Ecology, Iowa State University, Ames, IA). A high density of floating and submersed residual vegetation may make emergent stands more attractive to Soras. Kaufmann (1971) reported that Soras typically feed by picking at the water's surface. High floating residual cover, most commonly found in stands of fine or moderately robust emergents, provides a good substrate for invertebrates and, simultaneously, may keep them near the surface where they are available to the short-billed Sora. Such a mat of residual vegetation obviously also provides rails with a convenient substrate to walk on.

Management Recommendations

Current management practices aimed at maximizing use by breeding and migrant waterfowl are compatible with rail habitat management. I believe the following recommendations are pertinent for rails:

1. On marshes with a water level control structure where a drawdown is planned, dewatering, when practiced, should occur before 15 April in Iowa. Fall, or over-winter drawdowns maintained through the following growing season may be more practical. Reflooding in late August should provide attractive habitat for fall migrants (Griese, 1977). Partial drawdowns leaving some flooded emergent breeding cover may be preferable. Where these guidelines are impractical, dewatering schedules coordinated with other management objectives are acceptable (Weller and Fredrickson, 1973; Weller and Spathcer, 1965).
2. Management practices which encourage diversity in dominant cover types or strong horizontal zonation are valuable.
3. Measures should be taken to prevent extensive lodging of emergent stands with residual stems which can impede movement of adult and juvenile rails, and may make habitat less attractive. The potential for this problem is most acute in stands of fine or moderately robust emergents (e.g., sedges). Burning, grazing, or, in some cases, mowing may be effective controls.
4. Development of cover:water interspersion similar to Stewart and Kantrud's (1971) cover types 3 and 4 should be discouraged. The former effectively isolates potential breeding habitat from upland

and peripheral wetland seed-producing plants, while the latter obviously provides little suitable emergent habitat.

5. Future research efforts should be directed at:
   a. Broad scale studies assessing the value of temporary, seasonal, and semipermanent wetlands to migrant and breeding rails, and the impact of wetland size and cover regimes on breeding density;
   b. Wetland complexes as biogeographic islands and their relative value to breeding rails;
   c. A synthesis of habitat and population dynamics studies; and
   d. Wintering rail ecology.

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SECTION III. BROOD-REARING AND POSTBREEDING HABITAT USE AND MOVEMENTS OF VIRGINIA RAILS AND SORAS

INTRODUCTION

Virginia Rails (*Rallus limicola*) and Soras (*Porzana carolina*) are abundant summer residents in upper Midwestern marshes. Relatively little is known of their ecology because of their secretive nature and the dense vegetation they inhabit. Recent research has focused on their breeding habitat use (Weller and Spatcher, 1965; Andrews, 1973; Baird, 1974; Tacha, 1975; Griese et al., 1980; see Section II, herein). Virginia Rail and Sora brood-rearing and postbreeding habitat use and movements, however, are virtually unknown. In 1982, a biotelemetry study was conducted to identify these features of their ecology. This represents the first attempt to apply biotelemetry in the study of these species.

STUDY AREA

The study was conducted on Dewey's Pasture and Spring Run Game Management Areas in northwest Iowa. Dewey's Pasture is a 136 ha wetland complex in Clay and Palo Alto counties (Bennett, 1938; Hayden, 1943; Low, 1945; Weller, 1979), including 45 ha of seasonal and semipermanent marshes. Dewey's Pasture wetlands are dominated by emergent stands of cattail (*Typha glauca*), sedges (*Carex* spp., and bulrushes, *Scirpus acutus* and *S. fluviatilis*), and bur reed (*Sparganium eurycarpum*).

Spring Run in Dickinson County covers roughly 200 ha. Krapu et al. (1970) describe the upland vegetation. Marshes are dominated by cattail, sedges, bur reed, and willows (*Salix* spp.), and are seasonally or semipermanently flooded.

MATERIALS AND METHODS

Incubating and brood-rearing Virginia Rails and Soras were located by walking through marshes near known rail territories (see Section II, herein) and listening for the adult alarm calls (Kaufmann, 1983). A trap consisting of a catch box (Baird, 1974) placed at the apex of a V formed by two 15.5-23.1 m leads of 96 cm tall, 2.6 cm mesh poultry netting was constructed near the calling adult. Rails were driven into the trap by dragging a rope, with rock-filled cans and jugs attached, through the emergent vegetation toward the trap. Adults ran up the ramp of the catch box and dropped into the holding pen.

Captured rails were removed immediately from the catch box, weighed, and banded with U.S. Fish and Wildlife Service bands. Rails were sexed using characteristics described by Horak (1964). Captured rails were equipped with AVM single stage transmitters powered by a single Hg575 or Hg41 battery. The transmitting antenna consisted of a 15-cm, 0.26-mm diameter stainless steel guitar string. The entire package was encapsulated in a coating of HySol epoxy, and weighed 3.6-4.0 g. The package had a theoretical transmitting life of 65-90 days.

The transmitter was held in place by clipping the mantle feathers and gluing the package to the skin with commercial eyelash cement. As a security measure, the package was also attached by a harness which was tied around the birds.

Transmittered rails were relocated at two-day intervals with an AVM receiver and hand-held Yagi antenna. Locations were plotted on cover maps of the study area prepared from aerial photos (see Section II, herein). On 1 August 1982, the Spring Run area was searched aerially.

RESULTS

From 25 May to 6 July 1982, 17 Virginia Rails and 16 Soras were captured and banded. Ten birds of each species (5 males and 5 females) were equipped with transmitters. Transmitter weight equalled 3.9-4.4% of rail body weight. The mean duration of contact with transmittered birds was 27±16 (SD) days. Contact was lost due to transmitter failure or emigration from the study area.

Two brood-rearing female Soras dispersed within 4 days of capture, apparently in response to investigator disturbance. Both were relocated once away from the nest vicinity before contact was permanently lost. Additionally, a female Virginia Rail died when her transmitter antenna became tangled in vegetation.

Brood-rearing Habitat Use and Movements

Both Virginia Rails and Soras raise their broods to independence as a family group on the breeding territory. The size of this brood-rearing home range compares favorably with estimates of the size of the breeding territory (Glahn, 1974). Estimates of the home range size were obtained by connecting the outermost locations for transmittered birds (N=9 and 8 for Virginia Rails and Soras, respectively). Soras and Virginia Rails occupy small brood-rearing home ranges of similar size [0.18±0.02 (SE) ha and 0.19±0.02 ha, respectively]. Home ranges were similar for both sexes. Sora males maintained home ranges of 0.17±0.03 ha, and females 0.22±0.01 ha. Virginia Rail male home ranges included 0.16±0.03 ha of wetland, and females 0.22±0.07 ha.

Home ranges of paired males and females typically overlapped extensively. The only exception was Virginia Rail pair 203-205 (identified by the last three digits of the U.S.F.W.S. band), whose combined home range followed the contours of a band of emergent vegetation, bounded by upland and open water. The two home ranges formed two equally long arms of a V. Each sex occupied one arm, and the home ranges overlapped only at the apex. Locations for both pair members were uniformly distributed throughout their home ranges, and no preponderance of locations occurred at the apex. This pair earlier occupied a large breeding territory, which may have allowed a great degree of pair member segregation.

Brood-rearing home ranges typically were bounded by open water and upland. As with breeding rails, no significant preference was exhibited for any species of emergent vegetation on the home range. Cover was used as available. Breeding Soras occupied sites significantly more diverse in emergent vegetation than Virginia Rails, and their territories were located significantly closer to an interface of two dominant species of emergents than were Virginia Rails' (see Section II, herein). Brood-rearing home range size was not correlated with cover-type diversity for either species ($P > 0.10$).

Territories and home ranges were seldom located over water shallow enough for rails to wade; rather rails apparently moved about on floating residual vegetation. Because brood-rearing and breeding rails occupied the same sites, other habitat use variables are also synonymous (see Section II, herein).

The distances moved by Virginia Rails and Soras on their home ranges in the intervals between locations were similar [43±7 (SD) m and 44±11 m, respectively]. The distances moved by males and females were also similar.

Dispersal

The postbreeding movements of Virginia Rails and Soras prior to migration have been poorly documented. Hon et al. (1977) found that coastal Georgia Clapper Rails (*Rallus longirostris*) undergo a postbreeding dispersal. The average dispersal distance of 6 rails banded in the prehunting season and shot away from the banding site was 51 km. It is not clear how the postbreeding movements of that presumably nonmigratory population compare with those of migratory Virginia Rail and Sora populations in Iowa.

I maintained contact with 16 transmittered birds (8 Virginia Rails and 8 Soras) until late July, 1982, when emigration from my study areas occurred. However, of these 16 birds, one transmitter failed (female Sora), and a female Virginia Rail, already discussed, died after dispersing from the nest vicinity and her mate.

The emigration of transmittered birds from the brood-rearing home range was fairly synchronous from both Dewey's Pasture and Spring Run, 19 km apart. Between 19 July and 1 August, 1982, 7 Virginia Rails (5 males, 2 females) and 7 Soras (5 males, 2 females) dispersed from the nest vicinity.

The first dispersal-like movements were recorded on 12 July, when 2 Virginia Rails (1 male, 1 female) left the nest vicinity. Male 221 was located moving along a sparsely vegetated road ditch 150 m north of previous locations. On 14 July, he was located 100 m east of the nest vicinity, across a gravel road, apparently previously a physical boundary of his home range. He remained there until contact was lost on 19 July.

Female Virginia Rail 214 left her mate (215) on 12 July and moved her 17-day-old brood to a weedy cornfield (*Zea maize*) 200 m southwest of the former brood-rearing home range. She and the brood apparently remained in the cornfield until 14 July, then moved 250 m south-southwest to a temporary wetland where she remained on the upland-wetland interface for 4 days until she died on 18 July. Her mate remained on the family group's home range until 26 July.

Because of the short effective transmitting range of the packages (typically 250 m), it was difficult to maintain contact with dispersing rails. After dispersal, contact was reestablished with only 2 Virginia Rails and 1 Sora. Female Virginia Rail 214 is discussed above. Male Virginia Rail 233 was repeatedly relocated as he moved through study area wetlands. Contact was initially lost on 19 July, and was reestablished on 20 July on a semipermanent wetland 600 m north of the brood-rearing home range. On 26 July, he was relocated 550 m southwest of the above location. Within 2 days, he had moved 175 m north-northwest of that location. He was located last on 1 August 1982, 2.3 km north of the 28 July location, and 2.6 km north of the brood-rearing home range.

On 1 August, an aerial search for dispersing rails was conducted around Sring Run. A total of 522 km^2 surrounding the study area, including concentrations of nearby wetlands, were searched. Sora male 222, originally lost on 19 July, was relocated 4.8 km east-southeast of the study area, in a soybean (*Glycine max*) field approximately 300 m from a large seasonal wetland. A subsequent ground check of this bird indicated that he was moving. No other transmittered rails lost in the late July dispersal were relocated in this search, and financial constraints prohibited expanding the search area.

For those transmittered rails monitored until dispersal for which the age of the brood could be estimated, it appeared that the adults remained on the brood-rearing home range until Virginia Rail young were 15-42 days old ($\bar{x}$ = 25, N = 7), and Sora chicks were 16-32 ($\bar{x}$ = 23, N = 5) days old. Most adults emigrated from the brood-rearing home range when their broods were 15-21 days old. The movement of the young at the time of adult emigration is unknown. The single young-of-the-year transmittered, a fledgling Sora male, was captured near a Sora breeding territory on 6 July, and remained there until 23 July.

The movements of 1 Virginia Rail and 1 Sora pair suggest that a breakdown of the pair bond may occur before an extensive dispersal takes place. Virginia Rail pair 214-215 are discussed above. Sora pair 229-230 raised their brood to 17-20 days (21 July), at which time the male (229) moved across a gravel road, previously a physical boundary of the home range, to a 3 ha semipermanent wetland, and established a home range 150 m from the female. He remained there until 5 August when contact was lost. His mate (230) remained on the brood-rearing home range until 26 July, when she apparently emigrated.

DISCUSSION

Monitoring brood-rearing Virginia Rail and Sora movements indicates that both species raise their broods on a highly localized brood-rearing home range, previously the breeding territory (see Section II, herein). Kaufmann (1971) noted that 3 Virginia Rail family groups remained on their breeding territories up to 20 days after hatching, and abandoned the sites only when the marsh was nearly dry. He also noted that chicks older than 1 week spread out in the home range, apparently recognize its boundaries, and seek an adult only for brooding or feeding. Irish (1974) interpreted Virginia Rail and Sora responses to tape recorded calls in July and August as defense of a postbreeding territory, though little evidence is presented to support this hypothesis. By contrast, I observed that chasing and posturing in response to taped calls, the primary means of territory defense (Kaufmann, 1983), were rare within several weeks after territory establishment. The frequency of responses to taped calls declined as hatching approached (see Section I, herein). Irish's observations may correspond to the second peak in calling activity observed by Pospichal and Marshall (1954), Glahn (1974), and Kaufmann (1971). No clearly defined second peak was observed in this study.

Adult Virginia Rails and Soras made a heretofore unreported dispersal from the vicinity of the brood-rearing home range. The stimulus for this emigration, I believe, is the maturation, and increasing independence of the brood. The adult male may stimulate the breakdown of the family group with increasing aggressiveness toward the chicks and female. However, females appear to molt before males, and may be the sex which undergoes a hormonal change first (Kaufmann, 1971). I was unable to determine which sex emigrated from the home range first.

Kaufmann (1971) noted that adults feed the chicks until 2-3 weeks of age. Begging by older chicks frequently resulted in attacks by the male. Pospichal and Marshall (1954) observed 1-2 week old Virginia Rail chicks with adults, but older chicks were never seen with adults. They also noted that Sora chicks at 25 days wore almost full juvenal plumage and were independent.

When emigration or dispersal does occur, it is apparently a fairly long-distance movement between wetlands. Pospichal and Marshall (1954) noted that in late summer rails leave wetlands for short periods to feed on the upland, and support these observations with food habits data. Therefore, uplands, including row crops, may serve as suitable dispersal habitat. Virginia Rail 214 and her brood used a weedy cornfield for 2 days before returning to wetland habitat. Sora 222, located after dispersal near an isolated seasonal wetland 5 km from his brood-rearing home range, must have made extensive use of row crops as cover in the 12 days after dispersal, and, indeed, was relocated in a soybean field.

The significance of this dispersal is unclear. It may simply serve to segregate family members because of increasing adult aggressiveness toward the chicks, it may be a limited molt migration, or a shift to a fall migration staging area. The extent and pattern of this emigration deserves further investigation if we are to diagnose the impact of the loss of small private wetlands.

Summer drawdowns may retard rail productivity. Ideally, on marshes where control is possible, water level stability should be maintained between 15 April and 1 August to provide migrant, breeding, and brood-rearing habitat. Where this is not practical, dewatering or flooding should be avoided between 15 May and 1 August to avoid disrupting the breeding cycle. Dewatering selected marshes of wetland complexes after dispersal should have little impact on rails. The impact of manipulating isolated wetlands on breeding rail populations requires further study.

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GENERAL SUMMARY AND DISCUSSION

Virginia Rails and Soras are among the most abundant nonpasserines nesting in Iowa wetlands. The mean breeding densities of Sora and Virginia Rail pairs on my study areas were 1.3±0.43 (SD) pairs/ha and 1.4±0.33 pairs/ha, respectively (see Section II, herein). These estimates compare favorably with those reported by Griese et al. (1980).

Playback broadcasts of taped primary advertising calls is an effective technique for counting both Virginia Rails and Soras. However, both species do not respond equally well to conspecific and interspecific calling as reported by Glahn (1974). Soras respond significantly more often to tapes of conspecific calls, as do postlaying Virginia Rails. Prelaying Virginia Rails, however, exhibited no such tendency. Postlaying Virginia Rails may be most effectively counted with night broadcasts of playback recordings (see Section II, herein).

In all respects of their summering ecology, from breeding territory establishment to postbreeding dispersal, Virginia Rails and Soras are similar. Both species used wetland emergent cover as it was available on my study areas, i.e., no differential habitat use was detected, and no significant preference for inhabiting any species of emergents was exhibited. Soras do exhibit some deviation from a random use of wetland habitat, being most abundant at relatively shallow sites with a diverse mosaic of emergent stands (see Section II).

Both Soras and Virginia Rails remain on the breeding territory while raising their broods to independence. Adults remain on the brood-rearing home range until the chicks are 23-25 days old, though adults may leave the family group when chicks are younger (15-21 days) (see Section III, herein).

The stimuli of brood maturation and adult hormonal changes appear to result in a long-distance emigration, i.e., in excess of 8 km, from the brood-rearing home range. This dispersal may simply be a random wandering between wetlands, or a more direct movement toward an unknown destination. The significance of this dispersal is unknown, but deserves further reresearch (see Section III, herein).

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