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SURVEY METHODS FOR BREEDING YELLOW RAILS

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Yellow rails (*Coturnicops noveboracensis*) are difficult to survey because they are secretive and uncommon and call primarily at night. They usually breed in damp meadows or marshes (Morris 1905, Peabody 1922, Walkinshaw 1939, Terrill 1943, Lane 1962), but no detailed studies of their habitat requirements or calling behavior have been reported. As a result, "no satisfactory census procedures . . . are known" for the species (Anderson 1977: 68). The objective of this study was to develop a feasible survey method for yellow rails. We describe habitat preferences among a population of more than 50 calling males, compare line and strip transect methods for surveying the species, and calculate the number of surveys required for a nearly complete count of the population. A general method is presented for testing the assumption that all birds that ever call were detected, and the assumption is shown to be reasonable for the population we studied.

STUDY AREA

The study area (175 km²) was near Seney, Michigan, and extended south from C-3 Pool in the Seney National Wildlife Refuge to 5 km south of the Refuge border in the Manistique River State Forest (Fig. 1). A dry, nearly level sandplain covers the entire area and slopes southeasterly at 1.0-1.5 m/km (Heinselman 1965). Sand ridges 3-30 m wide and up to 1,000 m long are found throughout the plain. Most of them are oriented northeast-southwest, perpendicular to the flow of ground water. During the study, temporary ponds with a maximum depth of 20 cm, and covering up to 20 ha, occurred on the northwest side of many of these ridges. Their depth fluctuated in response to snow depth the previous winter and rain during the spring. They disappeared by mid-August in the 2 years of our study.

The ridges, dominated by red and white pine (*Pinus resinosa, P. strobus*), were bordered by shrubs (*Betula pumila, Alnus rugosa, Chamaedaphne calyculata, Salix candida*) that also occurred on drier portions of the plain. *Carex* sp. and *Vaccinium* sp. occurred frequently and formed homogeneous stands (mainly of *C. lasiocarpa*) in the depressions.

METHODS

Fieldwork was conducted during 1981 and 1982. In 1981, a six-person team spent 10–16 June evaluating line and strip transects as possible survey methods for breeding yellow rails. Four 1.6-km transects were surveyed on foot a total of eight times by five observers. Observers took bearings on calling birds during the first 3 hours of darkness and estimated distances to them from predetermined points on the line transects. When possible, data on the same bird were recorded from more than one point on the transect line so that the bird could be located by triangulation. On the final night, exact locations of birds along two of the transects were determined by an observer who approached to within 30 m of each bird. These locations were used in evaluating the results of the surveyors who stayed on the transect. In the strip transect approach, observers searched throughout the plot, going wherever necessary for thorough coverage. The width of the plot was 0.4 km.

Fieldwork in 1982 (26 Jun–3 Jul) was devoted to further developing and evalu-

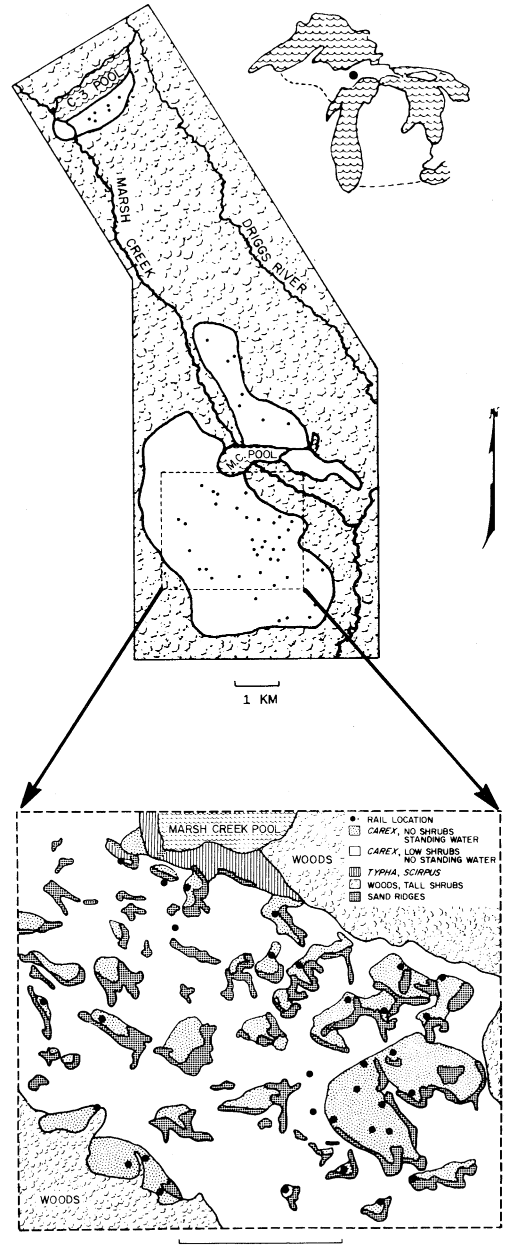

Fig. 1. Habitat use by yellow rails showing their tendency to occur in *Carex* beds with standing water. Note the clumped distribution suggesting a gregarious tendency. Seney, Michigan, 1981–82.

Table 1. Habitat use by breeding yellow rails at Seney, Michigan, in 1982.

Vegetation	Standing water?	Proportion of area[a]	*N* birds
Carex, Vaccinium	no	0.48	1
<95% *Carex*	no	0.31	4
>95% *Carex*	2–10 cm	0.22	47

[a] Proportions estimated from photo interpretation at 1,000 randomly selected points throughout the study area.

ating the strip transect method and to determining habitat requirements of the species. We also studied calling behavior by observing birds from a distance of 1–2 m. We began fieldwork shortly after dark between 2230 and 2330 and ceased data collection by 0430. By 0500 many yellow rails had stopped calling.

To study calling rates and the factors that influence them, we surveyed a 6-km^2 area (Fig. 1) 4–10 times during 5 nights. Coverage of this area varied according to the difficulty of estimating the total number of birds present. We avoided overcounting (due to movements by birds) by ensuring that the neighbors within 0.5 km of every bird were all recorded on at least 1 night. On 1 of the nights, surveyors found all but two of the birds ever found in the entire repeatedly surveyed area.

Habitat was studied with the aid of color infrared photos, taken in the autumn of 1978 at a scale of 1/20,000. Interpretation of the photos was aided by plant community descriptions and approximate water depths that we recorded at more than 150 sites throughout the study area. When birds were not heard in apparently suitable habitat, surveyors imitated their song—a monotonous series of clicks given at the rate of three to five per second—by tapping two stones together. During the fieldwork in 1982, a team of up to 10 people/night searched all suitable habitat (ca. 45 km^2) in the study area and traversed more than 400 km on foot during 52 person-nights.

Fieldwork in 1979–81 (Stenzel 1982) showed that calling activity of yellow rails on our study area began in mid-May and ended by mid-July. Thus our surveys were conducted during the middle two-thirds of the calling season.

RESULTS AND DISCUSSION

Habitat Requirements

During 1982 we recorded 52 calling yellow rails; 32 of them were located in the repeatedly surveyed area (Fig. 1). With a single exception, the yellow rails were found in monotypic stands of *C. lasiocarpa* in the depressions northwest of the sand ridges (Table 1). All but four occurred in depressions with standing water although dry depressions covered more area than depressions with standing water. Several *Carex* beds without rails were encoun-

Table 2. Number of yellow rails surveyed at night during their 1982 breeding season at Seney, Michigan. Entries are the number of new birds recorded on each survey.

	Survey						
N times area surveyed	1	2	3	4	5	6	7+
4	7	0	1	2	—	—	—
5	8	0	1	1	0	—	—
6	3	1	0	0	1	0	—
7+	5	2	0	0	0	0	0
Total	23	3	2	3	1	0	0
Cumulative proportion	0.72	0.81	0.88	0.97	1.0	1.0	1.0

Table 3. Evidence that breeding yellow rails vary their song intensity among nights, Seney, Michigan, 1981–82.

A. Record of singing rates per night.[a]

Periods per night		Periods in which bird sang 0	1	2	3	6	Total
2	observed	6.0	7.0	24.0	—	—	37.0
	expected	3.3	15.5	18.1	—	—	36.9
3	observed	1.0	0.0	2.0	4.0	—	7.0
	expected	0.2	1.3	3.1	2.4	—	7.0
6	observed	1.0		0.0		1.0	2.0
	expected	0.0		1.8		0.2	2.0

B. Nights with song heard during all or none of periods.[b]

	N	Frequency	Sample size
Observed	37	0.804	46
Expected	24	0.522	46

[a] Example: in 6 of 37 bird-nights during which the bird was surveyed twice, it was not heard during either survey. Under the null hypothesis that P (singing) is constant, the expected number is 3.3.
[b] Statistical analysis: observed frequency = 0.80 ± 0.06, significantly ($P < 0.001$) larger than the expected value. Observed/expected = 1.54.

Table 4. Test of the null hypothesis that calling rates of yellow rails did not differ. "Observed" entries are the numbers of birds recorded ≤25%, 26–50%, 51–75%, or ≥76% of the times (N = 4–13) they were surveyed, Seney, Michigan, 1981–82.[a]

	Proportion of surveys during which bird sang 0.01–0.25	0.26–0.50	0.51–0.75	0.76–1.0
Observed	1.0	9.0	8.0	14.0
Expected	1.2	5.9	12.3	12.6

[a] $\chi^2_3 = 3.32$; $0.25 < P < 0.75$. None of the individual deviations is significant.

tered that had the monotypic vegetation, standing water, and procumbent, matlike canopy of dead vegetation that characterized areas with rails. Such areas without rails might have been unsuitable, but it seems more likely that the rails show slight gregariousness as suggested by Morris (1905), Terrill (1943), and Lane (1962).

The combination of standing water and sparse *Carex* vegetation produced a distinctive color on aerial infrared photographs. The color was most similar to parrot green (Color 60; Smithe 1975), though it was usually darker (i.e., lower value) on our photographs. The texture was fine, unlike that representing shrubs and trees, which also occasionally appeared green when growing over standing water. The same color on aerial infrared photos might indicate breeding yellow rail habitat in other areas.

Survey Methodology

Estimating distances and bearings to calling rails proved difficult. The birds often turn slowly while calling, which causes the apparent volume of their calls to change. Under optimal conditions, a calling rail can be heard for more than 1.0 km. Thus observers could frequently hear several individuals calling simultaneously, and their clicks were often so nearly coincident that it was difficult to distinguish the birds. Various features of the environment also reduced our ability to locate birds from line transects. The birds sing from both below the canopy of prostrate dead sedges and from the top of it, causing great differences in the distance at which their calls could be heard. The sand ridges obstructed songs and caused echos, and even a light breeze (Beaufort 2) usually reduced the maximum distance at which birds were detectable by a factor of two or more. As a result of these problems, the data were unsuitable for use either in line transect methods (i.e., Burnham et al. 1979) or in index methods (i.e., Dawson 1981).

The strip transect proved to be a feasible survey method. Its major advantages were that the length and width of transects could be adjusted to the terrain, weather, and bird density and that all calling birds could be found. The major disadvantage, as with most plot survey methods, was that only those birds within the strip could be counted for statistical analysis, even though considerable time might have to be spent in locating birds just outside the plot. We found that one observer could cover a transect 1.6 km long and 0.4 km wide in about 1 hour.

Analysis of the results from the intensively surveyed area, where we believe we found all of the calling birds (see below), indicated that the average probability of recording a bird was 0.72 and that four surveys were required to detect virtually all of the calling birds (Table 2). There was no variation among nights in the proportion of birds detected ($\chi^2_6 = 5.0$, $P > 0.5$). This suggests that environmental conditions, over the ranges we studied, did not drastically affect calling rates. Wind speed during our surveys varied from calm to Beaufort 2; 1 night had steady, light rain. Temperature varied considerably for the area and time of year from overnight lows of 2–15 C.

The birds were detected on all or none of the visits during a single night about 1.5 times as often as expected if their detection probabilities were always 0.72. The highly significant difference (Table 3) indicates that repeat visits to a site are more likely to reveal new birds if they are made on a different night, rather than on the same night as the first visit.

Although individual birds tended to be silent on some nights and vocal on others, there was no detectable tendency for all individuals to select the same night for remaining silent. The probability of missing all birds is therefore $1 - 0.3^N$, where N is the number of birds. With $N = 4$, the probability of not hearing any individuals is less than 1%. Thus, one, or at most two, surveys will probably reveal the species if it is present.

If the probability of recording each bird on a single survey is constant, say p, then the proportion of birds that are never recorded is easily estimated as $(1 - p)^N$, where N is the number of surveys. In contrast, if individuals vary in the frequency with which they call, then the distribution of calling frequencies must be estimated before the proportion of birds recorded by any given number of surveys can be calculated. It therefore is of interest to test the null hypothesis that all birds had the same detection probability. We were unable to reject this null hypothesis (Table 4). The predicted fraction of the birds detected after four surveys was thus $1 - 0.3^4 = 0.99$.

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