EFFECTS OF MANAGEMENT PRACTICES ON WETLAND BIRDS:

YELLOW RAIL

Grasslands Ecosystem Initiative
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This report is one in a series of literature syntheses on North American wetland birds. The need for these reports was identified by the Prairie Pothole Joint Venture (PPJV), a part of the North American Waterfowl Management Plan. The PPJV adopted a goal to stabilize or increase populations of declining grassland- and wetland-associated wildlife species in the Prairie Pothole Region. To further that objective, it is essential to understand the habitat needs of birds other than waterfowl, and how management practices affect their habitats. The focus of these reports is on management of breeding habitat, particularly in the northern Great Plains.

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Species for which syntheses are available or are in preparation:

Eared Grebe
American Bittern
Virginia Rail
Sora
Yellow Rail
American Avocet
Willet
Long-billed Curlew
Marbled Godwit
Wilson's Phalarope
Black Tern
Marsh Wren
Sedge Wren
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow

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YELLOW RAIL

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ORGANIZATION AND FEATURES OF THIS SPECIES ACCOUNT

Information on the habitat requirements and effects of habitat management on wetland birds were summarized from information in more than 500 published and unpublished papers. A ***range map*** is provided to indicate the relative densities of the species in North America, based on Breeding Bird Survey (BBS) data. Although the BBS may not capture the presence of elusive waterbird species, the BBS is a standardized survey and the range maps, in many cases, represent the most consistent information available on species' distributions. Although birds frequently are observed outside the breeding range indicated, the maps are intended to show areas where managers might concentrate their attention. It may be ineffectual to manage habitat at a site for a species that rarely occurs in an area. The species account begins with a brief ***capsule statement***, which provides the fundamental components or keys to management for the species. A section on ***breeding range*** outlines the current breeding distribution of the species in North America, including areas that could not be mapped using BBS data. The ***suitable habitat*** section describes the breeding habitat and occasionally microhabitat characteristics of the species, especially those habitats that occur in the Great Plains. Details on habitat and microhabitat requirements often provide clues to how a species will respond to a particular management practice. A ***table*** near the end of the account complements the section on suitable habitat, and lists the specific habitat characteristics for the species by individual studies. The ***area requirements*** section provides details on territory and home range sizes, minimum area requirements, and the effects of patch size, edges, and other landscape and habitat features on abundance and productivity. It may be futile to manage a small block of suitable habitat for a species that has minimum area requirements that are larger than the area being managed. The section on ***brood parasitism*** summarizes information on intra- and interspecific parasitism, host responses to parasitism, and factors that influence parasitism, such as nest concealment and host density. The impact of management depends, in part, upon a species' nesting phenology and biology. The section on ***breeding-season phenology and site fidelity*** includes details on spring arrival and fall departure for migratory populations in the Great Plains, peak breeding periods, the tendency to renest after nest failure or success, and the propensity to return to a previous breeding site. The duration and timing of breeding varies among regions and years. ***Species' response to management*** summarizes the current knowledge and major findings in the literature on the effects of different management practices on the species. The section on ***management recommendations*** complements the previous section and summarizes recommendations for habitat management provided in the literature. The ***literature cited*** contains references to published and unpublished literature on the management effects and habitat requirements of the species. This section is not meant to be a complete bibliography; a searchable, annotated bibliography of published and unpublished papers dealing with habitat needs of wetland birds and their responses to habitat management is posted at the Web site mentioned below.

Yellow Rail
(*Coturnicops noveboracensis*)

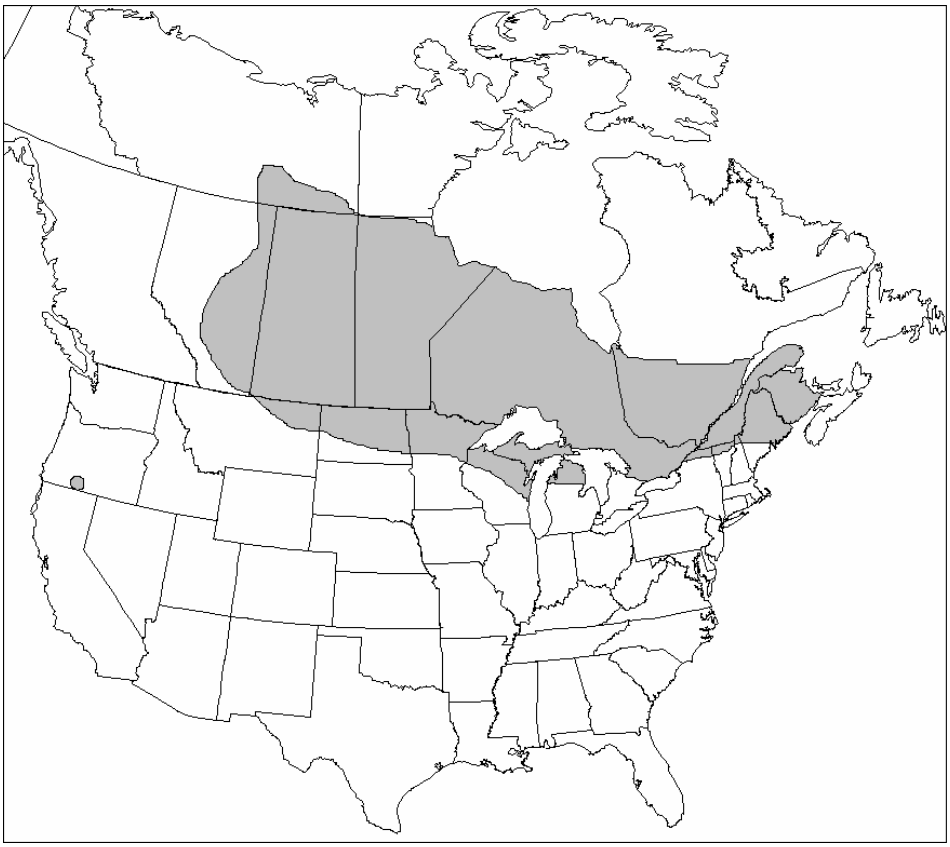

Figure. Breeding distribution of the Yellow Rail in the United States and Canada. Shaded area represents the estimated breeding area. Map adapted from Bookhout 1995.

Keys to management include protecting existing wetlands; controlling encroachment of woody vegetation in wet meadows; maintaining standing water in wet meadows, quaking bogs, and fens; and maintaining a dense layer of residual vegetation.

Breeding range:

Yellow Rails breed from southcentral Northwest Territories through eastern Alberta, Saskatchewan, Manitoba, Ontario, southern Quebec, New Brunswick, and Maine, and south to northern New Hampshire, Vermont, New York, Michigan, Wisconsin, Minnesota, North Dakota, and northeastern Montana (National Geographic Society 1999). A small, separate breeding population is located in southcentral Oregon. (See figure for estimated breeding area in the United States and Canada.)

Suitable habitat:

Yellow Rails prefer wet meadows, fens, boggy swales, floodplains, montane meadows, and emergent vegetation in fresh and brackish wetlands (Swales 1912, Peabody 1922, Roberts

1932, Fryer 1937, Devitt 1939, Walkinshaw 1939, Terrill 1943, Huber 1960, Bent 1963, Houston 1969, Stewart 1975, Salt and Salt 1976, Anderson 1977, Ripley 1977, Stenzel 1982, Niemi and Hanowski 1983, Bart et al. 1984, Janssen 1987, Gibbs et al. 1991, Berkey et al. 1993, Stern et al. 1993, Bookhout 1995, Robert and Laporte 1997, Prescott et al. 2001). Yellow Rails prefer wetlands that are dominated by sedges (*Carex* spp.) or grasses, that contain a canopy of residual vegetation required for nesting, and that contain shallow water or damp ground (Peabody 1905, 1922; Maltby 1915; Devitt 1939; Huber 1960; Lane 1962; Stalheim 1974; Stewart 1975; Ripley 1977; Elliot and Morrison 1979; Stenzel 1982; Stenzel and Bookhout 1982; Bart et al. 1984; Bookhout and Stenzel 1987; Gibbs et al. 1991; Burkman 1993; Stern et al 1993; Robert and Laporte 1997; Popper and Stern 2000, Robert et al. 2000, Prescott et al. 2001). Although sedges often are the dominant plant species in Yellow Rail nesting habitat, Yellow Rails also nest in grasses, rushes (*Juncus* spp.), and bulrushes (*Schoenoplectus* and *Scirpus* spp.) (Arnold 1896, Walkinshaw 1939, Terrill 1943, Houston 1969, Grimm 1991, Nelson 1991, Robert et al. 2000, Lundsten and Popper 2002).

The presence of Yellow Rails in a wetland usually is related to water depth (Bart et al. 1984, Burkman 1993, Robert et al. 2000). Yellow Rails nest in areas with standing water or saturated ground. Water depths at nest sites ranged from 0 to 20 cm (Peabody 1905, 1922; Maltby 1915, Peters 1918; Devitt 1939; Walkinshaw 1939; Elliot and Morrison 1979; Stenzel 1982; Nelson 1991; Popper and Stern 2000; Robert et al. 2000). Water depths in areas occupied by breeding Yellow Rails ranged from 0-46 cm (Peabody 1925, Fryer 1937, Stalheim 1974, Stenzel 1982, Bart et al. 1984, Hanowski and Niemi 1986, Bookhout and Stenzel 1987, Gibbs et al. 1991, Burkman 1993, Stern et al. 1993, Robert et al. 2000, Lundsten and Popper 2002).

Yellow Rails often inhabit areas where water depth fluctuates throughout the breeding season. An area used by Yellow Rails may have 20-30 cm of standing water in the spring and no standing water by July or September (Stenzel 1982, Bookhout and Stenzel 1987, Robert et al. 2000). Water depths at nesting areas also may vary because of tidal changes, winds, and precipitation (Robert et al. 2000, Lundsten and Popper 2002). In estuary marshes in Quebec, Yellow Rails occupied wetlands in which water depths were usually $\leq$12 cm, but in which water could become deeper (as high as 43 cm) depending on high tides and precipitation. Yellow Rails may respond to changes in water levels by building deep (13-16 cm) nests, as measured from the top to the bottom of the nest. However, nests still may occasionally succumb to flooding (Robert et al 2000).

Several authors have described the vegetation characteristics of areas where Yellow Rails have been observed and/or were breeding. In North Dakota, Yellow Rails were observed in a large fen comprised of sedges, rushes, and grasses (Peabody 1922). Small springs supported cattails (*Typha* spp.), and a wet meadow was dotted with small areas of willow (*Salix* spp.), rose (*Rosa* sp.), and aspen (*Populus* spp.) (Peabody 1922). Berkey et al. (1993) stated that Yellow Rails prefer fens (which are a rare habitat in North Dakota) but also will use wet meadows with standing water.

In a northwestern Minnesota wetland, vegetation where Yellow Rails were observed was composed of 90% sedges and 10% softstem bulrush (*Schoenoplectus tabernaemontani*) and hardstem bulrush (*S. acutus*) (Huber 1960). At the same site, several years later, vegetation where Yellow Rails were observed was identified as cattail, reedgrass (*Calamagrostis* sp.), reed (*Phragmites* sp.), bulrush, sedge, and *Lasiocarpes* (author's term that probably referred to

woolyfruit sedge [*Carex lasiocarpa*]) (Stalheim 1974). In northern Minnesota, mean vegetation measurements from 100 sampling points within 10 Yellow Rail territories were 122.4 cm vegetation height, 16% ground cover (coverage of live vegetation with a total height of ≤10 cm), 12.6 cm water depth, 77.3 cm phanerophyte height, 357.5 graminoid stems/m^2, 6.1 forb stems/m^2, and 7.2 phanerophyte stems/m^2 (Hanowski and Niemi 1988). Phanerophytes were defined as shrubs, forbs, or graminoids >40 cm high and present each year. Forb species within Yellow Rail territories were arrowhead (*Sagittaria* spp.), wild calla (*Calla palustris*), marsh marigold (*Caltha palustris*), mints (Lamiaceae), parsley (Apiaceae), tufted loosestrife (*Lysimachia thyrsiflora*), bedstraw (*Galium* spp.), and goldenrod (*Solidago* spp.). Phanerophyte species were willow, and cattails (*Typha latifolia*) (Niemi and Hanowski 1983).

In Michigan, wetlands used by Yellow Rails were dominated by woolyfruit sedge (Bart et al. 1984). Of 52 vocalizing males, all but one were located in nearly monotypic stands of woolyfruit sedge; the remaining Yellow Rail was located in areas of sedges and blueberry (*Vaccinium* sp.). Average vegetation composition measurements from 100 plots within a 30.25-ha area were 87% woolyfruit sedge; 4.3% bluejoint (*Calamagrostis canadensis*); 7.5% sand island; and 1.2% Canadian rush (*Juncus canadensis*), cattail, or bog birch (*Betula pumila*) (Stenzel 1982). Total stem density was 1400 stems/m^2 (Stenzel and Bookhout 1982). Yellow Rails preferred areas with high percentages of woolyfruit sedge and low percentages of shrubs (Burkman 1993).

The general habitat used by Yellow Rails in three separate areas in southern Quebec was dominated by chaffy sedge, alkali bulrush (*Scirpus maritimus*), Mackenzie's sedge (*Carex mackenziei*), saltmarsh spike rush (*Eleocharis halophila*), saltmeadow rush (*Juncus gerardii*), hairy sedge (*Carex lacustris*), bluejoint, water sedge (*Carex aquatilis*), prairie cordgrass, purple loosestrife (*Lythrum salicaria*), baltic rush, and American burnet (*Sanguisorba canadensis*) (Robert et al. 2000). Average vegetation measurements at the three sites ranged from 91.7 to130.5 cm stem height, 782.8 to 3503.9 stems/m^2, and 9.9 to 18.3 cm canopy height; water depth ranged from 1.9 to 2.5 cm. Six nests found at one site were in areas characterized by prairie cordgrass (*Spartina pectinata*), chaffy sedge (*Carex paleacea*), marsh straw sedge (*Carex hormathodes*), and baltic rush (*Juncus balticus*) (Robert et al. 2000). All six nests occurred in areas with a high percentage of live vegetation and a well-developed canopy. In southeastern Quebec, one nest was found beneath a canopy of dead softstem bulrush and surrounded by living softstem bulrush that was 1.2-1.8 m in height (Terrill 1943).

In eastern Ontario, one Yellow Rail nest was discovered in a wetland characterized by moderately heavy cover of grasses, sedges, rushes, and bulrushes (Elliot and Morrison 1979). In another eastern Ontario wetland, one nest was located in the center of a dense grass clump that was 38 cm tall (Devitt 1939). The area was predominantly grasses and sedges, with occasional willows. In Alberta, Yellow Rails were located in seasonal wetlands and wetlands dominated by sedges or a mix of sedges, cattails, and bulrush more often than semipermanent or permanent wetlands or wetlands dominated by cattail or bulrush (Prescott et al. 2001). Yellow Rails used areas with significantly less open water than unused areas (10.6% vs. 24.8%).

In eastern and central Maine, three sites occupied by Yellow Rails were large (>400 ha), sedge- and grass-dominated floodplains adjacent to free-flowing streams (Gibbs et al. 1991). A fourth site was a smaller wetland near a stream. Dominant vegetation at these sites included woolyfruit sedge, beaked sedge (*Carex rostrata*), silvery sedge (*Carex canescens*), Hayden's

sedge (*Carex haydenii*), blister sedge (*Carex vesicaria*), bog rush (*Juncus effusus*), blackgirdle bulrush (*Scirpus atrocinctus*), bluejoint, upright sedge (*Carex stricta*), threeway sedge (*Dulichium arundinaceum*), and bald spikerush (*Eleocharis erythropoda*). Average stem densities ranged from 85.5 stems/m^2 to 150.0 stems/m^2. Height of the tallest stem ranged from 0.6 m to 1.1 m and the dead vegetation mat ranged from 11.3 cm to 21.5 cm in height.

In southcentral Oregon, Yellow Rails occupied wet meadows located near cold water springs, seeps, flowing creeks, or river floodplains (Stern et al 1993). Vegetation was characterized by analogue sedge (*Carex simulata*), blister sedge, and beaked sedge. The average percent cover for live and dead vegetation at 42 nests (active and inactive) was 48.4% and 48.7%, respectively (Lundsten and Popper 2002). Percent cover of bare ground was 2.8%. Of the live vegetation at the nests, 34% was sedges; 10% was common spikerush (*Eleocharis palustris*), rush (*Juncus* spp.), or pondweed (*Potamogeton aquatilis*); 2% was grasses, and 1% was forbs. Vegetation height at 42 nest sites ranged from 15 to 93.3 cm. A table near the end of this account lists the specific habitat characteristics for Yellow Rail by study.

Area requirements:

Size of wetlands used by Yellow Rails can vary. During the breeding season, Yellow Rails have been found in sedge meadows as small as 0.5 ha (Alvo and Robert 1999). In Minnesota, 16 wetlands used by Yellow Rails for nesting ranged from 24 to 1000 ha and averaged 231.9 ha (Hanowski and Niemi 1986). In Maine, wetlands occupied by Yellow Rails ranged from 14 to 840 ha (Gibbs et al. 1991). In Michigan, temporary wetlands used by breeding Yellow Rails were $\leq$20 ha (Bart et al. 1984). Bart et al. (1984) suggested that Yellow Rails can be gregarious. Several pairs of Yellow Rails will nest in a small area (30 ha) (Peabody 1905, Robert 1996).

In Michigan, the average home range of five males was 8.29 ha; home ranges overlapped (Stenzel 1982). In the same study, four mated males had an average home range of 7.8 ha (Bookhout and Stenzel 1987, Bookhout 1995). In a 530-ha wetland in Quebec, three males had home ranges of 8.6, 13.7, and 19.8 ha, respectively, (Robert 1996). In a 30-ha wetland in Quebec, two males had home ranges of 1.6 and 4.6 ha, respectively, and their home ranges overlapped (Robert 1996). In Michigan, four females, on average, used <1 ha per female prior to and during incubation (Stenzel and Bookhout 1982). During the brood-rearing period, a female and her brood used 1 ha (Stenzel 1982). Of three areas used by females, average size ranged from 0.2 to 1.3 ha, depending on stage of nesting (Bookhout 1995).

Brood parasitism:

No records of intra- or interspecific brood parasitism exist. Yellow Rails are not suitable hosts for Brown-headed Cowbirds (*Molothrus ater*) because Yellow Rail young are semiprecocial, whereas cowbird young are altricial.

Breeding-season phenology and site fidelity:

In the southern portion of their breeding range (Michigan, Minnesota, and North Dakota), Yellow Rails may arrive in late March but usually arrive from late April to late May, and depart from mid-August to late October (Roberts 1932, Walkinshaw 1939, Stalheim 1974, Stenzel 1982, Savaloja 1984, Janssen 1987, Bookhout 1995). In the northern portion of their breeding

range (Alberta, Manitoba, and Quebec), Yellow Rails arrive from late April to late May and depart from September to early November (Arnold 1896, Salt and Salt 1976, Robert 1997). The disjunct population in southcentral Oregon arrives in mid-April and departs in mid-September (Popper and Stern 2000).

Yellow Rails may renest after an unsuccessful initial nest attempt (Stenzel 1982). Yellow Rails are single-brooded (Bookhout 1995). They may build more than one nest, using the additional nest as a brood nest (Stalheim 1974, Stenzel 1982). Chicks are moved to a brood nest 1-2 d after hatching, and brood nests lack a vegetation canopy (Stenzel 1982, Bookhout 1995). One female and her brood used a brood nest 17 m from the original nest (Stenzel 1982). The brood nest appeared to be one year old and did not have a canopy.

Information concerning site fidelity of Yellow Rails is scant. Of 134 males banded in southern Michigan, two were recaptured the year following banding (Bookhout 1995). Of 130 Yellow Rails banded along the St. Lawrence River in southern Quebec, seven were recaptured at the same site in subsequent years, and one was recaptured at a site within 125 km of the capture site in a subsequent year (Robert and Laporte 1999). The average recapture rate in southcentral Oregon was 11% of 242 captured rails (Lundsten and Popper 2002). The average distance between capture locations from one year to the next for the 27 returning rails was 547 m.

Species' response to management:

Burning aids in preventing the encroachment of woody vegetation into wet meadows and in removing mats of dead vegetation that become too thick for nesting (Stalheim 1974, Savaloja 1981, Stenzel 1982, Burkman 1993, Bookhout 1995). Dead vegetation can fill in a wetland and act like a wick to increase evaporation (Stalheim 1974, Savaloja 1981). The removal of excessive residual vegetation may benefit Yellow Rails during periods of low water by increasing the water level in the wetland (Stalheim 1974). In Michigan, Yellow Rails avoided burned areas immediately postburn, but favored burned areas over unburned areas after one growing season (Burkman 1993).

In Quebec, areas burned and mowed on a regular basis were not used for nesting until at least one full growing season after burning due to the removal of the residual vegetation that may be required for nesting (Robert et al. 2000). Yellow Rails may be attracted to revegetated, recently burned areas late in the breeding season due to increased food quantity and availability, and the removal of thick residual vegetation may facilitate movement (Robert and Laporte 1999). Savaloja (1981) suggested that if burning occurs after spring arrival and territory establishment, Yellow Rails will continue to use burned areas, but if a wetland is burned before spring arrival, Yellow Rails will use available unburned areas. Burkman (1993) stated that prescribed fire encourages favorable habitat conditions for Yellow Rails by causing an increase in woolyfruit sedge and maintaining density of grasses, rushes, and other sedges.

Yellow Rails have been found in wet meadows that were mowed the previous fall (Peabody 1905, 1922; Maltby 1915), but no studies have examined the effects of mowing on Yellow Rails. Mowing of wet meadow areas may encourage the growth of sedges and grasses (Larson 1986). In Wisconsin, a wet meadow that was mowed in July to control woody vegetation had more grasses and sedges than nearby unmowed areas (Larson 1986). In North Dakota, Yellow Rails used areas with 10 cm of standing water and coarse grass that was annually mowed (Peabody 1905, 1922; Maltby 1915). In Saskatchewan, one nest was located on

the remains of a haystack, both of which were trampled by cattle (Symons 1956). In southern Quebec, no nests were found in an area that was burned and mowed on a regular basis, apparently because the area lacked a canopy of residual vegetation (Robert et al. 2000). Yellow Rail mortality due to mowing during the breeding season has been documented in Quebec (Alvo and Robert 1999).

Peabody (1922) believed that the replacement of coarse grass by fine grass in a large wetland area in North Dakota may have caused Yellow Rails to abandon some areas. He believed this replacement may have been caused by intensive grazing or possibly intensive mowing. No studies have been conducted on the effects of grazing on Yellow Rails. Grazing by cattle may reduce vegetation height and percent cover of emergent vegetation and increase disturbance (Robert 1997). Grazing by cattle also may reduce the senescent layer of vegetation that is preferred by breeding Yellow Rails (Lundsten and Popper 2002).

The effect on Yellow Rails of pesticide use in wetland areas is unknown (Ripley 1977). More research on the effects of pesticides and other contaminants is needed (Eddleman et al. 1988).

Efforts to maintain standing water in wetland areas and/or to reverse long-term dry conditions should be beneficial to Yellow Rails (Burkman 1993). Large fluctuations in water levels may cause otherwise suitable breeding habitat to become undesirable to Yellow Rails (Lundsten and Popper 2002). In Oregon, the primary threat to Yellow Rails is the drainage of wetlands for use as cropland (Stern et al. 1993). Yellow Rails may be negatively impacted by the manipulation of water levels in an attempt to create a hemi-marsh (wetland containing approximately 50% open water and 50% emergent vegetation) or deep-water marsh for waterfowl use (Bookhout 1995, Alvo and Robert 1999). Yellow Rails use wetlands that are shallower and have a greater density of emergent cover than those typically used by waterfowl (Alvo and Robert 1999).

Collisions with towers, wires, or other structures may cause injury or death to Yellow Rails. Thompson and Ely (1989) reported that >30 Yellow Rails struck a television tower near Topeka, Kansas over the course of one fall season. Individual Yellow Rails have been found dead under television towers in Iowa (Dinsmore et. al 1987), North Dakota (Avery and Clement 1972), Saskatchewan (Belcher 1962), and Texas (Pulich 1961). In Texas, 10 Yellow Rails were found dead and four were apparently stunned after striking a television tower (Pulich 1961). An injured Yellow Rail that might have struck a wire or building was captured on the University of Michigan campus (Wood 1909).

Management Recommendations:

Loss of wetlands is the most serious factor affecting Yellow Rail populations (Anderson 1977, Bookhout 1995, Alvo and Robert 1999). Freshwater wetlands and estuaries should be protected from drainage, channelization, and other forms of destruction (Anderson 1977, Eddleman et al. 1988, Stern et al. 1993, Bookhout 1995, Popper and Stern 2000). The enforcement of the 1985 “Swampbuster” Farm Act would protect a maximum acreage of wetlands from further drainage for agricultural use (Eddleman et al. 1988). In North Dakota, Yellow Rails were restricted to natural fen areas (Stewart 1975). Wetland manipulation that

destroys natural fens to create deeper, more permanent water would destroy this preferred habitat (Berkey et al. 1993).

It is unknown if Yellow Rails will utilize restored wetlands, but restored wetlands that are very isolated from natural wetlands may not contain the plant seeds necessary for revegetation (Galatowitsch and van der Valk 1996). Active planting may be necessary to establish wet meadow and shallow emergent vegetation (Knutsen and Euliss 2001). Control of unwanted, competitive species may be needed to restore wet-meadow vegetation. Galatowitsch and van der Valk (1994) present a detailed explanation of restoration methods and provide specific recommendations for establishing vegetation in restored wetlands.

In some geographical areas, Yellow Rails seem to prefer specific plant species and wetland types. Management practices that reduce those plant species should be avoided. In Michigan, any management technique that would reduce the abundance of woolyfruit sedge (a plant species that seems to be preferred by Yellow Rails in Michigan) would reduce Yellow Rail habitat (Stenzel 1982). Some sedge species, such as woolyfruit sedge and beaked sedge, can be successfully planted in restored wetlands with appropriate seed storage and adequate control of competitive weeds for at least two growing seasons (Budelsky 1998). Generally, sedge seeds stored in a wet location at 4^{o}C maintain a high viability for up to 2.5 yr. Robert et al. (2000) suggested that habitat selection was based not on particular plant species, but rather on plant physiognomy, species composition, and stem density. Rather than relying on *Carex* species as the only indicator of suitable habitat, attention must be given to maintaining plant structure, maximum water levels, and the presence of a senescent canopy.

Efforts to maintain standing water in wetland areas and attempts to reverse long-term dry conditions would be beneficial to Yellow Rails (Burkman 1993). Manipulation of water levels that would cause a wetland to become too dry or too wet for use by Yellow Rails should be avoided (Stenzel 1982, Lundsten and Popper 2002). One example of these manipulations would be an attempt to create a hemi-marsh or deep-water marsh for use by waterfowl (Bookhout 1995). This practice could have a negative impact on Yellow Rails, but more research on the effects of waterfowl management practices on Yellow Rails is needed (Eddleman et al. 1988). Careful manipulation of wetland/impoundment complexes is necessary to accommodate both waterfowl and rails. Rails apparently prefer to forage at the interface between moist soil and marsh habitats. Optimal interspersion of vegetation and water can be created by the gradual dewatering of topographically diverse wetlands that provide the maximum amount of this type of edge habitat. Land leveling (i.e., reducing the topographic heterogeneity) to facilitate irrigation or water level manipulations reduces opportunities to create this type of edge habitat. Wetland management techniques should maximize the coverage of emergent perennial vegetation that is used as nesting habitat by Yellow Rails (Eddleman et al. 1988).

The use of controlled burns in wetland areas can be a useful management tool for maintaining Yellow Rail habitat by reducing the encroachment of woody vegetation into wetland areas, reducing the percentage and height of shrubs in wet meadows, and removing the excessive residual vegetation that can fill in a wetland and act like a wick to increase evaporation (Vogl 1964, Stalheim 1974, Savaloja 1981, Stenzel 1982, Eddleman et al. 1988, Burkman 1993). Acidic water caused by burning may discourage some shrubs such as alder (*Alnus* sp.), willow, and bog birch, while encouraging sedge species (Burkman 1993). Burned areas should be monitored for the encroachment of woody vegetation as well as changes in the overall

composition of the herbaceous layer. Regeneration and spread of shrubs in an area can be used as an indicator of how often an area should be burned (Burkman 1993). Dense vegetation in a wet meadow that is not burned periodically may cause a fire to burn too hot (Eddleman et al 1988). A hot fire will remove the root layer, thus requiring a longer time period for regrowth. A large wetland should be burned in rotations so that unburned portions will be available for Yellow Rails that arrive at the start of the breeding season (Burkman 1993). During periods of low water, removal of excessive residual vegetation may increase water levels and improve nesting habitat (Stalheim 1974). Education of the general public on the importance of fire as a habitat management tool also would be beneficial in gaining acceptance of burning wetlands (Burkman 1993).

Mowing is a possible management technique for controlling the growth of willow and cottonwood (*Populus* spp.) in wet meadows. The dense regrowth of sedges and grasses that is caused by mowing may prevent shrub seedlings from becoming established (Larson 1986). However, accidental death to Yellow Rails caused by the mowing of wet meadows during the breeding season has been reported (Alvo and Robert 1999).

The effects of grazing on Yellow Rails requires further research (Eddleman et al. 1988). Grazing by cattle may reduce vegetation height and percent cover of emergent vegetation, reduce the amount of senescent vegetation, and increase disturbance (Robert 1997, Lundsten and Popper 2002). Grazing also may cause the replacement of coarse grass by fine grass, thereby reducing habitat suitability (Peabody 1922).

Excessive human disturbance (e.g., by overzealous birdwatchers) can trample vegetation in the nesting area and cause a major disturbance to breeding activity (Stenzel 1982). To avoid this inadvertent disturbance and possible destruction of well-hidden nests, people should be discouraged from entering a wetland where Yellow Rails are breeding (Grimm 1991).

Mortality due to fences can be prevented by reviewing fence construction plans and modifying plans for proposed management projects (Allen and Ramirez 1990). Fences placed through wetlands should be replaced or marked to make them conspicuous and to decrease likelihood of bird/fence collisions. Power lines should not be constructed through flight corridors used heavily during bird migrations or within 1 km of known historical high-water marks of wetlands or dry basins known to hold water intermittently (Malcolm 1982).

Table. Yellow Rail habitat characteristics.

Author(s)	**Location**	**Habitat(s) Studied***	**Species-specific Habitat Characteristics**
Arnold 1896	Manitoba	Wetland	Nested in long grass in the dry area of a wetland
Bart et al. 1984	Michigan	Wet meadow, wetland	Occupied wetlands contained sedges (*Carex* spp.), mostly woolyfruit sedge (*C. lasiocarpa*), and blueberry (*Vaccinium* sp.); wetlands were $\leq$ 20 ha in size and 20 cm deep; 51 of 52 vocalizing males were located in nearly monotypic stands of woolyfruit sedge, and one male was in a mixed stand of sedge and blueberry; of the 52 vocalizing males, 48 were located in wetlands containing standing water and four were in areas of saturated ground
Bookhout 1995	Rangewide	Wet meadow, wet meadow hayland, wetland	Used fresh and brackish wetlands, unmowed wet meadows, and wet meadows that had been cut for hay the previous year
Burkman 1993	Michigan	Burned wetland, wetland	Preferred areas with higher percentages of woolyfruit sedge and lower percentages of shrubs than found in adjacent areas; used areas with standing water; dominant vegetation in the study area was woolyfruit sedge
Devitt 1939	Ontario	Wetland	Nested in a dense clump of grass located near the edge of a wetland; grass was 38 cm tall, the rim of the nest was 7.6 cm above ground, and the bottom of the nest rested on the ground; surrounding dead vegetation was bent over, forming a canopy over the nest; there was no standing water under the nest but the soil was saturated; area surrounding the nest was covered with grasses, sedges, and an occasional willow (*Salix* spp.)

Elliot and Morrison 1979	Ontario	Wetland	Nested in a wetland with moderately heavy cover of rushes (*Juncus* spp.) and sedges; nest was concealed by residual vegetation and was 5 cm above water that was 5-10 cm deep
Fryer 1937	Manitoba	Wetland	Used two areas, one was a mixture of fine and coarse marsh grass that was approximately 46-61 cm tall in 5-10 cm of water, and the second area was heavy, coarse grass in 13-15 cm of water
Gibbs et al. 1991	Maine	Floodplain, wetland	Occupied three large (>400 ha), sedge- and grass-dominated floodplains adjacent to free-flowing streams and a smaller wetland near a stream; specific habitat used consisted of damp, low-lying areas in otherwise dry portions of floodplains; dominant vegetation at sites were: woolyfruit sedge, beaked sedge (*Carex rostrata*), silvery sedge (*C. canescens*), Hayden's sedge (*C. haydenii*), blister sedge (*C. vesicaria*), bog rush (*Juncus effusus*), blackgirdle bulrush (*Scirpus atrocinctus*), bluejoint (*Calamagrostis canadensis*), upright sedge (*Carex stricta*), threeway sedge (*Dulichium arundinaceum*), and bald spikerush (*Eleocharis erythropoda*); stem density ranged from 85.5 to 150.0 stems/m^2; height of tallest stem ranged from 0.6 to 1.1 m; height of dead vegetation mat ranged from 11.3 to 21.5 cm; water depth ranged from 0.8 to 10.2 cm
Grimm 1991	Wisconsin	Wet meadow, wetland	Occupied a site dominated by reed canary grass (*Phalaris arundinacea*) with small patches of common threesquare (*Schoenoplectus pungens*), and sedge, and which contained a significant amount of residual vegetation
Hanowski and Niemi 1986, 1988	Minnesota	Wetland	Occurred in wetlands; average vegetation measurements from 100 sampling points within 10 territories were 122.4 cm

			vegetation height, 16% ground cover, 12.6 cm water depth, 77.3 cm phanerophyte height (shrubs, forbs, or graminoids >40 cm tall and present each year); average stem density measurements were 357.5/m^2 graminoids, 6.1/m^2 forbs, 7.2/m^2 phanerophytes; average wetland size was 231.9 ha; most common forb species was tufted loosestrife (*Lysimachia thyrsiflora*), and most common phanerophytes were broad-leaved cattail (*Typha latifolia*) and willow; sixteen wetlands used for nesting ranged from 24 to 1000 ha and averaged 231.9 ha
Houston 1969	Saskatchewan	Wetland	Nested in long grass on damp ground at the edge of water
Huber 1960	Minnesota	Wetland	Occupied a wetland characterized by 90% sedge and 10% hardstem bulrush (*Schoenoplectus acutus*)
Janssen 1987	Minnesota	Wetland	Found in large, grassy wetlands
Lane 1962	Manitoba	Bog, wetland	Nested on the top of a low hummock in an area dominated by sedges; nest was concealed by a canopy of dead and living grass, and water depth under the nest was 20 cm; a second nest was in a quaking bog that contained willows up to 3 m tall; nest was 15 cm above water that was 5 cm deep; bog was surrounded by willows, and young shoots of hoary willow (*Salix candida*) grew near the nest; used another area dominated by sedges with a few scattered willows
Lundsten and Popper 2002	Oregon	Wet meadow	Average percent cover for live and dead vegetation at 42 nests (active and inactive) was 48.4% and 48.7%, respectively, and percent cover of bare ground was 2.8%; live vegetation at nests was 34% sedges, 10% pondweed (*Potamogeton aquatilis*) or rushes (common spikerush [*Eleocharis palustris*], rush [*Juncus* spp.]), 2% grasses, and 1% forbs; vegetation

			height ranged from 15 to 93 cm; average water depth from 660 calling locations was 7.3 cm, ranging from 0 to 24 cm
Maltby 1915	North Dakota	Wet meadow, wet meadow hayland, wetland	Nested in a wetland over water 3-5 cm deep; one of 12 nests was found in an area that had been mowed the previous year; most nests were covered by a canopy of dead vegetation
Nelson 1991	Minnesota	Wetland	Nested in wetland; nest was 19 cm above the water in a tussock of grass; water was 10 cm deep under the nest, and the nest was concealed by a canopy of dead grass
Niemi and Hanowski 1983	Minnesota	Wetland	Occurred in wet areas; common forb species within territories were mints (Lamiaceae), parsley family (Apiaceae), wild calla (*Calla palustris*), arrowhead (*Sagittaria* spp.), and tufted loosestrife; common phanerophyte species within territories were broad-leaved cattail and willow; mean habitat variables were as follows: 130 cm vegetation height, 15% ground cover, 7.5 cm water depth, 95 cm phanerophyte height
Peabody 1905	North Dakota	Wet meadow, wet meadow hayland, wetland	Occupied areas of soft, tall meadow grass; nested in previously mowed, green, growing grass with water <10 cm deep; nest was covered by a thick canopy
Peabody 1922	North Dakota	Wet meadow, wet meadow hayland, wetland	Used grassy areas that were annually mowed; average water depth was 10 cm; entire area contained sedge, rushes, and grasses with small open areas containing cattails (*Typha* spp.) and scattered areas of willow, rose (*Rosa* sp.), and aspen (*Populus* sp.)
Peabody 1925	North Dakota	Wet meadow, wetland	Occupied a 6-m wide margin of coarse grasses that contained dead, matted vegetation; water depth was 36 cm
Peters 1918	Minnesota	Wetland	Nested in a wetland; water under nest was approximately 20

			cm deep
Popper and Stern 2000	Oregon	Montane meadow	Average percent cover at 25 nests (active and inactive) were 48.7% live vegetation, 49.7% dead vegetation, and 1.6% bare ground; of the live vegetation, 26.1% was analogue sedge *(Carex simulata*), 5.6% common spikerush, 5.5% Northwest Territory sedge (*C. utriculata*), and about 2-3% cover each of blister sedge, baltic rush, and Sierra rush; water depths at active nests were 0.5-5.0 cm
Prescott et al. 2001	Alberta	Wetland	Used wetlands dominated by sedge and a mix of cattail, bulrush and sedge more often than wetlands dominated by cattail or bulrush; used seasonal wetlands more often than semipermanent or permanent wetlands; used areas with significantly less open water than unused areas (10.6% vs. 24.8%)
Ripley 1977	Rangewide	Hayland, wetland	Occupied wet meadows or hayland; nests were above flooded ground or on damp soil
Robert et al. 2000	Quebec	Wetland	Used areas with chaffy sedge (*Carex apleacea*), alkali bulrush (*Scirpus maritimus*), Mackenzie's sedge (*Carex mackenziei*), saltmarsh spike rush (*Eleocharis halophila*), saltmeadow rush (*Juncus gerardii*), hairy sedge (*Carex lacustris*), bluejoint, water sedge (*Carex aquatilis*), prairie cordgrass (*Spartina pectinata*), purple loosestrife (*Lythrum salicaria*), baltic rush, and American burnet (*Sanguisorba canadensis*); average vegetation measurements at three sites ranged from 91.7 to130.5 cm stem height, 782.8 to 3503.9 stems/m^2, and 9.9 to 18.3 cm canopy height; water depth ranged from 1.9 to 2.5 cm
Roberts 1932	Minnesota	Wet meadow	Occupied wet meadows in which grass or sedges grew in about 5 cm of water and residual vegetation formed a dense

			layer
Salt and Salt 1976	Alberta	Wetland	Used grassy wetlands with little or no standing water during the breeding season
Savaloja 1981	Minnesota	Wet meadow, wetland	Used burned areas if burning was conducted after territories were established, used unburned areas is burning was conducted before arrival
Stalheim 1974	Minnesota	Wetland	Used areas with cattail, reedgrass (*Calamagrostis* sp.), reed (*Phragmites* sp.), bulrush (*Scirpus* sp.), sedges, and *Lasiocarpes* [author's term that could be referring to woolyfruit sedge]; water depths ranged from about 36 cm in early May to about 10 cm in September
Stenzel 1982, Stenzel and Bookhout 1982, Bookhout and Stenzel 1987	Michigan	Wet meadow, wetland	Four calling males occupied areas averaging 6.5 cm water depth (based on 10 measurements/calling location); greatest water depth recorded at a calling site was 46 cm; water depths at seven nest sites ranged from 2 to 4 cm; vegetation measured at 100 sample points within the study area was characterized by average values of >90% woolyfruit sedge and 1398 stems/m^2
Stern et al. 1993	Oregon	Floodplain, montane meadow	Occupied montane meadows that were located near cold water springs, seeps, flowing creeks or river floodplains; vegetation was characterized by analogue sedge, blister sedge, and beaked sedge; water depths ranged from 2 to 30 cm
Stewart 1975	North Dakota	Fen, wetland	Used fens or boggy swales fed by spring water; vegetation consisted of cattail and softstem bulrush (*Schoenoplectus tabernaemontani*) with intervening expanses of northern reedgrass (*Calamagrostis stricta inexpansa*), water sedge, beaked sedge, cottongrass (*Eriophorum* sp.) and water

			hemlock (*Cicuta* sp.)
Swales 1912	Michigan	Wet meadow, wetland	Used wetland and wet, low field characterized by coarse grasses, forbs, and sedges
Symons 1956	Saskatchewan	Wet meadow hayland, wetland	Used an area dominated by wire grass (no scientific name given) with willow on the dry edges; one nest that had been trampled by cattle was found on the remains of a haystack
Terrill 1943	Quebec	Wetland	Nested in a dense patch of softstem bulrush; nest was covered with a canopy of dead rushes and was lightly resting on the ground; area was almost a monotypic stand of bulrush except for the margins that contained a few shrubs and forbs
Walkinshaw 1939	Michigan	Wetland	Nested in a dense mass of fallen softstem bulrush; the ground beneath the nest was damp and covered with moss; prairie sedge (*Carex prairea*) was also within 5 cm of the nest; preferred the drier parts of large wet meadows

*In an effort to standardize terminology among studies, various descriptors were used to denote the management or type of habitat. "Idle" used as a modifier (e.g., idle tallgrass) denotes undisturbed or unmanaged (e.g., not burned, mowed, or grazed) areas. "Idle" by itself denotes unmanaged areas in which the plant species were not mentioned. Examples of "idle" habitats include weedy or fallow areas (e.g., oldfields), fencerows, grassed waterways, terraces, ditches, and road rights-of-way. "Tame" denotes introduced plant species (e.g., smooth brome [*Bromus inermis*]) that are not native to North American prairies. "Hayland" refers to any habitat that was mowed, regardless of whether the resulting cut vegetation was removed. "Burned" includes habitats that were burned intentionally or accidentally or those burned by natural forces (e.g., lightning). In situations where there are two or more descriptors (e.g., idle tame hayland), the first descriptor modifies the following descriptors. For example, idle tame hayland is habitat that is usually mowed annually but happened to be undisturbed during the year of the study.

LITERATURE CITED

Allen, G. T., and P. Ramirez. 1990. A review of bird deaths on barbed-wire fences. Wilson Bulletin 102:553-558.

Alvo, R., and M. Robert. 1999. COSEWIC status report on Yellow Rail (*Coturnicops noveboracensis*). Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 72 pages.

Anderson, J. M. 1977. Yellow Rail (*Coturnicops noveboracensis*). Pages 66-70 *in* G. C. Sanderson, editor. Management of migratory shore and upland game birds in North America. International Association of Fish and Wildlife Agencies, Washington, D.C.

Arnold, E. 1896. My 1895 outing in Assiniboia. Oologist 13:19-21.

Avery, M., and T. Clement. 1972. Bird mortality at four towers in eastern North Dakota--fall 1972. Prairie Naturalist 4:87-95.

Bart, J., R. A. Stehn, J. A. Herrick, N. A. Heaslip, T. A. Bookhout, and J. R. Stenzel. 1984. Survey methods for breeding Yellow Rails. Journal of Wildlife Management 48:1382-1386.

Belcher, M. 1962. First Yellow Rail record for Regina. Blue Jay 20:153.

Bent, A. C. 1963. Life histories of North American marsh birds. Dover Publications, Inc., New York, New York. 392 pages.

Berkey, G., R. Crawford, S. Galipeau, D. Johnson, D. Lambeth, and R. Kreil. 1993. A review of wildlife management practices in North Dakota: effects on nongame bird populations and habitats. Report submitted to Region 6. U.S. Fish and Wildlife Service, Denver, Colorado. 51 pages.

Bookhout, T. A. 1995. Yellow Rail (*Coturnicops noveboracensis*). A. Poole and F. Gill, editors. The birds of North America, No. 139. The Academy of Natural Sciences, Philadelphia, Pennsylvania; The American Ornithologists' Union, Washington, D.C.

Bookhout, T. A., and J. R. Stenzel. 1987. Habitat and movements of breeding Yellow Rails. Wilson Bulletin 99:441-447.

Budelsky, R. A. 1998. Establishment of native sedges in restored and created wetlands. Ph.D. dissertation. University of Minnesota, Minneapolis, Minnesota. 111 pages.

Burkman, M. A. 1993. The use of fire to manage breeding habitat for Yellow Rails. M.S. thesis. Northern Michigan University, Marquette, Michigan. 67 pages.

Devitt, O. E. 1939. The Yellow Rail breeding in Ontario. Auk 56:238-243.

Dinsmore, S., E. Munson, J. J. Dinsmore, and G. M. Nelson. 1987. Two television tower kills in Iowa. Iowa Bird Life 57:5-8.

Eddleman, W. R., F. L. Knopf, B. Meanley, F. A. Reid, and R. Zembal. 1988. Conservation of North American rallids. Wilson Bulletin 100:458-475.

Elliot, R. D., and R. I. G. Morrison. 1979. The incubation period of the Yellow Rail. Auk 96:422-423.

Fryer, R. 1937. The Yellow Rail in southern Manitoba. Canadian Field-Naturalist 51:41-42.

Galatowitsch, S. M., and A. G. van der Valk. 1994. Restoring prairie wetlands: an ecological approach. Iowa State University Press, Ames, Iowa. 246 pages.

Galatowitsch, S. M., and A. G. van der Valk. 1996. Characteristics of recently restored wetlands in the Prairie Pothole Region. Wetlands 16:75-83.

Gibbs, J. P., W. G. Shriver, and S. M. Melvin. 1991. Spring and summer records of the Yellow Rail in Maine. Journal of Field Ornithology 62:509-516.

Grimm, M. 1991. Northeast Wisconsin Yellow Rail survey. Passenger Pigeon 53:115-121.

Hanowski, J. M., and G. J. Niemi. 1986. Habitat characteristics for bird species of special concern. Unpublished report to Minnesota Department of Natural Resources, St. Paul, Minnesota. 50 pages.

Hanowski, J. M., and G. J. Niemi. 1988. An approach for quantifying habitat characteristics for rare wetland birds. Pages 51-56 *in* Ecosystem management: rare and endangered species and significant habitats. Proceedings of the 15th Annual Natural Areas Conference.

Houston, C. S. 1969. Nesting records of the Yellow Rail in Saskatchewan. Blue Jay 27:81-82.

Huber, R. 1960. Yellow Rails again found in Becker County, Minnesota. Flicker 32:102.

Janssen, R. B. 1987. Birds in Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 352 pages.

Knutsen, G. A., and N. H. Euliss, Jr. 2001. Wetland restoration in the Prairie Pothole Region of North America: A literature review. U.S. Geological Survey, Biological Resources Division, Biological Science Report, USGS/BRD/BSR-2001-0006. 54 pages.

Lane, J. 1962. Nesting of the Yellow Rail in south-western Manitoba. Canadian Field-Naturalist 76:189-191.

Larson, J. L. 1986. Restoration of a woolgrass-dominated sedge meadow. Restoration and Management Notes 4:77.

Lundsten, S., and K. J. Popper. 2002. Breeding ecology of Yellow Rails at Fourmile Creek, Wood River Wetland, Mares Egg Spring, and additional areas in southern Oregon, 2001. Unpublished report submitted to the Bureau of Land Management, Klamath Falls, Oregon. 33 pages.

Malcolm, J. M. 1982. Bird collisions with a power transmission line and their relation to botulism at a Montana wetland. Wildlife Society Bulletin 10:297-304.

Maltby, F. 1915. Nesting of the Yellow Rail in North Dakota. Oologist 32:122-124.

Nelson, W. 1991. The Yellow Rails of McGregor Marsh. Loon 63:92-97.

Niemi, G. J., and J. M. Hanowski. 1983. Habitat characteristics of Yellow Rail, Upland Sandpiper, and Sharp-tailed Sparrow territories. Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota. 15 pages.

Peabody, P. B. 1905. The nesting of the Yellow Rail. Warbler 1:49-51.

Peabody, P. B. 1922. Haunts and breeding habits of the Yellow Rail. Journal of the Museum of Comparative Oology 2:33-44.

Peabody, P. B. 1925. Mysteries of the Yellow Rail. Oologist 42:104-106.

Peters, A. S. 1918. First Minnesota Yellow Rail eggs. Oologist 35:28.

Popper, K. J., and M. A. Stern. 2000. Nesting ecology of Yellow Rails in southcentral Oregon. Journal of Field Ornithology 71:460-466.

Prescott, D. R. C., M. R. Norton, and I. M. G. Michaud. 2001. A survey of Yellow and Virginia Rails in Alberta using nocturnal call playbacks. Unpublished report by the Alberta Conservation Association, Edmonton, Alberta. 20 pages.

Pulich, W. M. 1961. A record of the Yellow Rail from Dallas County, Texas. Auk 78:639-640.

Ripley, S. D. 1977. Rails of the world. M. H. Feheley, Inc., Toronto, Ontario. 406 pages.

Robert, M. 1996. Yellow Rail (*Coturnicops noveboracensis*). Pages 438-441 *in* J. Gauthier and Y. Aubry, editors. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. The province of Quebec Society for the Protection of Birds and Canadian Wildlife Service, Montreal, Quebec.

Robert, M. 1997. A closer look: Yellow Rail. Birding 29:283-290.

Robert, M., and P. Laporte. 1997. Field techniques for studying breeding Yellow Rails. Journal of Field Ornithology 68:56-63.

Robert, M., and P. Laporte. 1999. Numbers and movements of Yellow Rails along the St. Lawrence River. Condor 101:667-671.

Robert, M., P. Laporte, and R. Benoit. 2000. Summer habitat of Yellow Rails, *Coturnicops noveboracensis*, along the St. Lawrence River, Quebec. Canadian Field-Naturalist 114:628-635.

Roberts, T. S. 1932. The birds of Minnesota, Volume 1. University of Minnesota Press, Minneapolis, Minnesota. 691 pages.

Salt, W. R., and J. R. Salt. 1976. The birds of Alberta. Hurtig Publishers, Edmonton, Alberta. 498 pages.

Savaloja, T. 1981. Yellow Rail. Birding 13:80-85.

Savaloja, T. 1984. Yellow Rails of Aitkin County. Loon 56:68.

Stalheim, P. S. 1974. Behavior and ecology of the Yellow Rail (*Coturnicops noveboracensis*). M.S. thesis. University of Minnesota, Minneapolis, Minnesota. 83 pages.

Stenzel, J. R. 1982. Ecology of breeding Yellow Rails at Seney National Wildlife Refuge. M.S. thesis. Ohio State University, Columbus, Ohio. 106 pages.

Stenzel, J. R., and T. A. Bookhout. 1982. Habitat and movements of breeding Yellow Rails. Ohio Journal of Science 82:94.

Stern, M. A., J. F. Morawski, and G. A. Rosenberg. 1993. Rediscovery and status of a disjunct population of breeding Yellow Rails in southern Oregon. Condor 95:1024-1027.

Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, North Dakota. 295 pages.

Swales, B. H. 1912. Yellow Rail (*Coturnicops noveboracensis*). Auk 29:100-101.

Symons, R. D. 1956. Random notes on the Yellow Rail. Blue Jay 14:8-9.

Terrill, L. M. 1943. Nesting habits of the Yellow Rail in Gaspe County, Quebec. Auk 60:171-180.

Thompson, M. C., and C. Ely. 1989. Birds in Kansas, Volume 1. University of Kansas Museum of Natural History Public Education Series 11. Lawrence, Kansas. 404 pages.

Vogl, R. J. 1964. The effects of fire on a muskeg in northern Wisconsin. Journal of Wildlife Management 28:317-329.

Walkinshaw, L. H. 1939. The Yellow Rail in Michigan. Auk 56:227-237.

Wood, N. A. 1909. Notes on the occurrence of the Yellow Rail in Michigan. Auk 26:1-5.

Effects of Management Practices on Wetland Birds:
Bibliography on Survey Methods for Yellow Rail

Note: Most surveys of breeding Yellow Rails have been conducted at night (Devitt 1939; Stalheim 1974; Stenzel 1982; Bart et al. 1984; Savaloja 1984; Bookhout and Stenzel 1987; Gibbs et al. 1991; Grimm 1991; Burkman 1993; Stern et al. 1993; Robert and Laporte 1997; Prescott et al. 2001, 2002; Lundsten and Popper 2002). One popular method of locating Yellow Rails is mimicking the call by using two stones, pieces of metal, or bone and waiting for a response (Devitt 1939, Stenzel 1982, Savaloja 1984, Bookhout and Stenzel 1987, Grimm 1991, Stern et al. 1993, Robert and Laporte 1997, Lundsten and Popper 2002). Tape-recorded calls can be used in the same manner (Gibbs et al. 1991; Grimm 1991; Daub 1993; Prescott et al. 2001, 2002). Another technique used in locating Yellow Rails is the use of trained dogs (Walkinshaw 1939, Stalheim 1974, Stenzel 1982, Bookhout and Stenzel 1987, Robert and Laporte 1997). Dogs can be used to locate Yellow Rail nests and to flush adult birds. Some sources of methods were not reviewed. They are listed at the end of the annotated bibliography.

Annotated articles

Bart, J., R. A. Stehn, J. A. Herrick, N. A. Heaslip, T. A. Bookhout, and J. R. Stenzel. 1984. Survey methods for breeding Yellow Rails. Journal of Wildlife Management 48:1382-1386.

Line and strip survey methods for use in censusing Yellow Rails were described. Fieldwork was conducted in Michigan at the Seney National Wildlife Refuge and Manitisque River State Forest in 1981 and 1982. Four transects that were 1.6 km long were used for the line survey method. Observers took bearings on calling birds and estimated distances to the calling birds from predetermined points. When possible, data on the same bird were collected from more than one point along the line and the bird was located using triangulation. Using the strip method, observers walked four transects and searched throughout the entire 0.4 km wide and 1.6 km long plot. Surveys were conducted in mid-June between 2230 and 2330 hr. When Yellow Rails were not calling, the surveyors would imitate the call by clicking two stones together. Habitat was studied with the aid of color infrared photos. Interpretation of the photos was aided by plant community and water depth data that were collected at more than 150 sites throughout the study area.

In 1982, 52 calling rails were recorded (number of Yellow Rails observed using each type of survey method was not given).

The strip transect proved to be a more feasible survey method than the line method. Major advantages of the strip transect were that the length and width of transects could be adjusted to the terrain. The major disadvantage 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. The author stated that estimating distances and bearings to calling Yellow Rails was difficult while using the line method. Several factors such as movement of the rail, environmental features, and weather affected the ability to determine the exact location of the calling bird.

Bookhout, T. A., and J. R. Stenzel. 1987. Habitat and movements of breeding Yellow Rails. Wilson Bulletin 99:441-447.

The habitat, movements, and breeding biology of the Yellow Rail were studied at Seney National Wildlife Refuge in Michigan, 1979-1980. The study area was a seasonally flooded wet sedge meadow with water depths 30 cm or more in the spring that receded to only moist soil by mid-summer.

Two stones were clicked together to imitate calling males. Hand nets and spotlights were used to capture Yellow Rails that were lured by the call imitations. Capture attempts were conducted between 2200 and 0400 h. A pointing dog was used to locate females and males that did not respond to the call. Radio transmitters were attached to ten captured Yellow Rails.

A grid composed of 121 50 x 50-m plots was placed on the 30-ha study area and 100 0.05-m^2 plots (10 x 50 cm each) were randomly selected. Stem density, vegetation height, height of senescent sedge (*Carex* spp.) layer, and plant species were recorded within each plot. Plant species categories were woolyfruit sedge (*C. lasiocarpa*), other sedge species, rushes (*Juncus* spp.), bluejoint (*Calamagrostis canadensis*), other Gramineae (other than bluejoint), herbaceous species, willow (*Salix* spp.), and other woody species. Four 50-m^2 stem-density plots were centered around locations of calling males outside of the study area. Within the stem-density plots, 10 random locations were chosen and at each location all stems within 0.5-m^2 (2 plots) or 0.25-m^2 (two plots) plots were counted and categorized according to the vegetation species listed above.

Burkman, M. A. 1993. The use of fire to manage breeding habitat for Yellow Rails. M.S. thesis. Northern Michigan University, Marquette, Michigan. 67 pages.

The response of Yellow Rails to habitat created by fire and the efficacy of using prescribed fire to enhance and maintain habitat for breeding Yellow Rails were examined. The study was conducted during 1991-1993 at Seney National Wildlife Refuge in the Upper Peninsula of Michigan. Passive audio surveys were conducted during the breeding season to determine Yellow Rail use of the plot pairs. Strip transects were walked the length of the plot (plot size was approximately 16.2 ha) and bearings were taken on calling rails. The author stated that the call of the Yellow Rail could be heard at a distance of 1 km; therefore the sample area of the strip transects was a 2-km wide area along the length of the plot and a 1-km semicircle at the end of the plot. Surveys were conducted from late May to mid-June and began at 2330 hr.

Vegetation measurements taken on each plot at 12 random sites each year were mean percent cover, mean percent cover of woody vegetation, height of woody vegetation, total horizontal cover, height of herbaceous vegetation, herbaceous vegetation biomass, herbaceous species composition, and stem density. Water depth and pH also were recorded at each plot.

Daub, B. C. 1993. Effects of marsh area and characteristics on avian diversity and nesting success. M.S. thesis. University of Michigan, Ann Arbor, Michigan. 37 pages.

Daub examined the relationship between marsh area, species richness, and nesting

success in 20 marshes located near Minnedosa, Manitoba, from 1991-1992. Parasitism by Brown-headed Cowbirds also was examined. All marshes were semipermanent or permanent, and ranged in size from 0.1-19.3 ha. Avian censuses were conducted along the perimeter of marshes by placing a randomly chosen, 100 m x 15 m transect, along which nest-searching also occurred. The 15 m portion of the transect included 5 m of emergent vegetation and 10 m of open water. Each transect was walked for 45 min. Each marsh was surveyed three times during the breeding season, about every two weeks. Playback calls were used to elicit responses from American Bittern, Virginia Rail, Yellow Rail, and Sora at the beginning, middle, and end of each transect during every survey. Nesting success was determined using the Mayfield method. Measured marsh characteristics were water depth, vegetative composition (line-intercept technique), and width of vegetation growing in standing water.

Devitt, O. E. 1939. The Yellow Rail breeding in Ontario. Auk 56:238-243.

The author described several observations of Yellow Rails and the finding of a single nest in Ontario. Most of the observations occurred at the Holland River Marsh, approximately 40 km (25 mi) north of Toronto from mid-June to July.

Yellow Rails were located by clicking two stones or pieces of metal together and waiting for a response. If a response was heard, the author would approach the area from which the sound came and imitate the call again. Observations were made with the aid of a high-powered flashlight.

The Yellow Rail was occasionally heard during the daytime, and became much more active just after sunset. The calling period extended at least from 25 May to 27 July.

Gibbs, J. P., Shriver, W. G., and S. M. Melvin. 1991. Spring and summer records of the Yellow Rail in Maine. Journal of Field Ornithology 62:509-516.

New and historical observations of Yellow Rail in Maine were reported, suitable habitat was described, and history of the species in eastern North America was given. Although the Yellow Rail is a regular fall migrant in Maine, only one publication (Knight 1908) described the species' occurrence in the state. The authors located calling Yellow Rails at four sites in eastern and central Maine in May and June 1990. A total of six singing males were detected. Of the four sites, two sites had two calling males each and two sites had one calling male each. Although the range of dates within which the Yellow Rails were heard falls within the egg-laying period of Yellow Rails in the Upper Peninsula of Michigan, nesting was not confirmed at the four wetlands.

Vegetation height, stem density (sedge, rush, and grass stems/m^2), height of dead vegetation mat, and water depth were measured at the wetlands within 25, 0.1-m^2 circular plots located randomly in the wetlands. Yellow Rails were located using tape-recorded calls. Surveys were conducted from 30 min after dark until dawn, May-July. The prime calling time in June did not start until 2130-2200 hr.

Grimm, M. 1991. Northeast Wisconsin Yellow Rail survey. Passenger Pigeon 53:115

Possible breeding sites of the Yellow Rail in northeastern Wisconsin were located by listening for calling adults. Survey methods included using tape-recorded calls and mimicking the call using two stones. Using historic sites and other areas within the type of habitat preferred by Yellow Rails, surveys were conducted between 20 May and 16 June in 1989, and 26 May and 25 June in 1990. Surveys were conducted between 2200 and 0200 hr. Some sites were surveyed with the observer walking and stopping at intervals to listen, some were approached using a canoe, and others were surveyed from the adjacent road.

Popper, K. J., and M. A. Stern. 2000. Nesting ecology of Yellow Rails in Southcentral Oregon. Journal of Field Ornithology 71:460-466.

Nesting success by Yellow Rails was examined in the Wood River Valley, Klamath Co., Oregon, and habitat at nest sites was described. The study occurred from 1995 to 1998. The breeding season began as early as 13 April and extended as late as 13 September. Nests were located using a 1.5 m stick and pulling back the vegetation wherever the possibility of a nest existed. Nest searches were conducted from May through July.

The authors found 34 Yellow Rail nests of which eight were active when found and 26 were inactive when found. Plant species occurrence within a 1-m^2 plot surrounding the nest was recorded. Ocular estimates of percent cover of live and senescent or dead vegetation as well as bare ground were recorded.

Prescott, D. R. C., M. R. Norton, and I. M. G. Michaud. 2001. A survey of Yellow and Virginia rails in Alberta using nocturnal call playbacks. Unpublished report by the Alberta Conservation Association, Edmonton, Alberta. 20 pages. AND

Prescott, D. R. C., M. R. Norton, and I. M. G. Michaud. 2002. Night surveys of Yellow Rails, *Coturnicops noveboracensis*, and Virginia Rails, *Rallus limicola*, in Alberta using Call Playbacks. Canadian Field-Naturalist 116:408-415.

Current distributions of Yellow Rails and Virginia Rails were determined by conducting nocturnal field surveys using call playbacks at 404 sites in Alberta from 17 May to 6 July 2000. This included 17 sites that were visited twice and five sites that were visited three times. Current distribution was compared to historical records. Objectives of the study were to identify sites where the species historically occurred, conduct surveys of those sites to determine whether the species still was present, identify suitable habitat and new potential breeding sites, and gain a better understanding of the habitat requirements and calling behavior of the species to improve the effectiveness of field surveys.

Historical locations for Yellow Rail and Virginia Rail were obtained from the Biodiversity/Species Observation Database, the Alberta Bird Checklist Program, Alberta Bird Atlas database, known published reports, museum collections, the Breeding Bird Survey database, provincial publications, and internet news group publications.

Nocturnal surveys were conducted between 20 May and 25 July and began at sites in the southern portion of the province to reflect earlier arrival of birds there. Past studies indicated

that the probability of detection for these species during a single visit was 75%. When logistically possible, second visits were occasionally made to some sites. In the cases of older sites that were not well described, 2-5 areas of suitable habitat within 5 km of the expected location were surveyed. Alberta Bird Atlas database records were compiled by 10 x 10 km^2 blocks; 2-5 areas of suitable habitat were surveyed within these blocks. All surveyed sites were visited during the daytime to identify access points, identify new areas of potential habitat, record dominant vegetation (percentage of cover types [standing emergents, open water, bare ground, shrubs, or trees]), record wetland permanency (permanent, semipermanent, or seasonal), and georeference the site using a global positioning system. Dominant vegetation categories were cattail (*Typha* spp.), bulrush (*Schoenoplectus* spp.), sedge (*Carex* spp.), or mixed (cattail/bulrush/sedge).

Surveys were conducted between sunset and sunrise, using calls of conspecifics to increase the probability of detection. Call playbacks were obtained from commercial sources and played from a height of about 1.5 m and a volume between 80 and 95 db. Although surveys were conducted under a range of conditions, periods of >20 km/hr winds or heavy rainfall were avoided. Steps in conducting surveys were as follows: 1) three-minute listening period, 2) three, 20-second playbacks of Yellow Rail calls ("clicks") separated by 20 seconds of silence, and three 20-second playbacks of Virginia Rail calls (two sets of descending "grunts" and one set of combined "kadic-kadic" and "kicker" calls [vocalizations most often used in territorial calling and mate attraction]), and 3) a final three-minute listening period. Data recorded included number of birds calling during each of the pre-playback, playback, and post-playback periods, air temperature, wind speed, precipitation or fog, percent cloud cover, moon phase (new, <half full, >half full, or full), moon visibility (visible, obscured, or absent), and time of night (early = 1000 to 1159 h; middle = 2400 to 0159 h, and late = 0200 to 0530 h).

Yellow Rails were found in seasonal wetlands containing sedges. They were most likely to be detected when there was little or no moon, and during the darkest part of the night. Virginia Rails were found in a wide variety of semipermanent and permanent wetlands. They were detected more often when the moon was more than half full and relatively unobscured by clouds. Playbacks were more effective at detecting Virginia Rails, as the number of spontaneously calling individuals was lower (55%) than for Yellow Rails (80.4%).

Reid, F. A. 1989. Differential habitat use by waterbirds in a managed wetland complex. Ph.D. dissertation. University of Missouri, Columbia, Missouri. 240 pages.

Avian use of seasonally flooded wetlands on the Ted Shanks Wildlife Area in northeastern Missouri was examined from 1981 through 1985. Habitat partitioning of six waterbirds (Sora, King Rail, Yellow Rail, Virginia Rail, Least Bittern, and American Bittern) were studied during spring and fall migration. Breeding and foraging ecology of King Rails, and the response of wading birds to controlled drawdowns of a managed wetland, also were examined. Observations of birds were made at specific flush sites in the spring and fall of the year. Birds were flushed by walking the entire wetland area or using strip transects. Surveys were conducted from April to late May and mid-August to mid-October between 0700-1000 hr and 1700-2000 hr.

Robert, M., and P. Laporte. 1997. Field techniques for studying breeding Yellow Rails. Journal of Field Ornithology 68:56-63.

Techniques for capturing Yellow Rails and locating nests were discussed and the effectiveness of methods was compared. From 1993 to 1995, Yellow Rails were captured and banded in southern Quebec in marshes along the St. Lawrence River, the Saguenay River, and Lake St. John.

Yellow Rails were captured at night (generally between 2230 and 0330 hr) using two techniques: waiting and approaching. In both techniques, the males were slowly approached until the observer was within 15 m. If the male stopped calling during the approach, the observer stopped and did not proceed until the male began calling again. In the waiting technique, a 2-m^2 area of vegetation was flattened in front of the observer and two stones were clicked together to imitate the call of the Yellow Rail. When the rail entered the flattened area, a headlamp was shone on it and an attempt was made to capture it with a hand net. In the approaching technique, the rail was located and a large spotlight was shone on it (in hopes of immobilizing the bird). The bird was then approached without making any sudden movements. While keeping the light on it and continuing to imitate the call, an attempt was made to capture the rail using a hand net. Initially, a 30-cm diameter net was used, but capture rate was low. The authors switched to a 47-cm diameter net and a 65-cm net, and determined that the latter size was too large. The 47-cm diameter net appeared to be the most effective size in capturing rails.

Yellow Rails were captured 183 out of 330 attempts (55.5%). Only one female was captured. Robert and Laporte captured 66.7% of the birds with the waiting attempt, 9.3% by approaching, and 24% by approaching after waiting had been unsuccessful. In 1994-1995, the capture rate was 24% higher with the combination of approaching and waiting than with either of the techniques individually. Powerful lamps were needed only when implementing the approaching technique. Two people were more effective at capturing Yellow Rails than one person operating alone.

In 1994 and 1995, pointing dogs were used to locate Yellow Rail nests. In 1994, a German short-haired pointer and a French pointer were used for 18.5 and 7.8 h, respectively. In 1995, the German short-haired pointer was used for 8.8 h. Only the German short-haired pointer found nests--five in 27.3 hours of searching. The effectiveness of using a dog for Yellow Rail nest searching depends on the dog's abilities and training, the dog's handler, and probably the weather conditions. A pointer may be extremely effective at finding Yellow Rail nests, especially in humid conditions.

Robert, M., and P. Laporte. 1999. Numbers and movements of Yellow Rails along the St. Lawrence River, Quebec. Condor 101:667-671.

The authors surveyed Yellow Rails from late May or early June to late August 1993-1996 by systematically counting calling individuals. Counts were conducted when winds were <15 km/hr from a 16-km gravel road at points spaced 400 m apart between 2230 and 0330 hr. Observers listened for 2 min at each point and occasionally imitated the species' call by striking two stones together. The authors commented that, although the species' calls sometimes could be heard as far away as 1000 m, interference from flying insects, calling insects, and calling amphibians reduced the maximum audible range to approximately 500 m.

Savaloja, T. 1984. Yellow Rails of Aitkin County. Loon 56:68.

Savaloja described the general procedure by which people attempted to observe Yellow Rails in Aitkin County, Minnesota. Observations usually were conducted in June at approximately 2400 hr. People stood around in a circle with flashlights and with coins or stones, and clicked the coins or stones until they attracted a Yellow Rail. When the rail responded, the participants aimed their flashlights at the area from which the call came.

Stalheim, P. S. 1974. Behavior and ecology of the Yellow Rail (*Coturnicops noveboracensis*). M.S. thesis, University of Minnesota.

The adaptation of rail behavior to different types of habitat, especially in relation to vegetation density, was examined at a marsh southwest of Waubun, Minnesota, in Mahnomen and Becker counties during 1971 - 1973. Yellow Rails tended to avoid flying during the day, and were more easily flushed at night. Yellow Rails were captured using drift traps and at night with nets (by aid of dogs and spotlights). Captured rails were marked with colored leg bands and transferred to a study pen at the University of Minnesota's Cedar Creek Natural History Area near Minneapolis where behavior could be studied. Behavior of captive Yellow Rails was observed in a study pen located at the capture site during 1972. Stalheim discussed the ecology, behavior patterns, breeding cycle, and breeding patterns of the Yellow Rail.

Stenzel, J. R. 1982. Ecology of breeding Yellow Rails at Seney National Wildlife Refuge. M.S. thesis. Ohio State University, Columbus, Ohio. 106 pages.

The habitat use, movements, and breeding biology of the Yellow Rail were studied at the Seney National Wildlife Refuge in Michigan, 1979-1980. The study area was a seasonally flooded wet sedge meadow with water depths 30 cm or more in the spring that receded to only moist soil by mid-summer.

Yellow Rails were detected using audio surveys. Dogs were used to locate rails that did not respond to calls. Individual rails were lured close enough to be captured by hand or with a hand net by imitating their call. The Yellow Rail call was imitated by tapping a pocket knife against the femur bone of a young deer or by tapping two stones together. Captured Yellow Rails were banded and equipped with radio transmitters. Surveys were conducted at night from late April to mid-July. The author stated that a dog was essential to the location and capture of Yellow Rails that did not respond to the imitation call. The author also stated that Yellow Rails flushed more readily at night, and that night seemed to be the best time to pursue Yellow Rails with the aid of a dog.

In 1980, the 30.25-ha study area was divided into 121 sections and vegetation was measured using 100 randomly located 0.05-m^2 plots. The total vegetation height, the height of the senescent layer from the ground, and stem density were recorded.

Stern, M. A., Morawski, J. F., and G. A. Rosenberg. 1993. Rediscovery and status of a disjunct population of breeding Yellow Rails in southern Oregon. Condor 95:1024-1027.

The distribution, abundance, and breeding status of Yellow Rails in southcentral Oregon were determined. Roadside surveys of Yellow Rails were conducted every 0.5 km using an electronic call or by mimicking the Yellow Rail call using two rocks. Surveys were conducted in areas where rails had previously been heard. Fieldwork coincided with the peak breeding season for Yellow Rails (April-July). Surveys were conducted between 2200 and 0400 hr. Yellow Rails were located at 26 sites in Klamath County and at two sites in Lake County.

Walkinshaw, L. H. 1939. The Yellow Rail in Michigan. Auk 56:227

The history, migration, nesting, weights and measurements, voice, behavior and distribution of the Yellow Rail in Michigan were discussed. A springer spaniel dog was used to flush Yellow Rails during the study. Because of the cryptic behavior of rails, the author believed that a dog would be necessary to study Yellow Rails. Birds were flushed in daylight hours. During June 1934, June 1935, and May 1937, the author observed or heard 64 Yellow Rails.

Lundsten, S., and K. J. Popper. 2002. Breeding ecology of Yellow Rails at Fourmile Creek, Wood River Wetland, Mares Egg Spring, and additional areas in southern Oregon, 2001. Unpublished report submitted to the Bureau of Land Management, Klamath Falls, Oregon. 33 pages.

The status, site fidelity and return rates, and nest site characteristics of Yellow Rail were studied in the Klamath Basin, Oregon, from 1995 to 2001. Research was conducted on three main study areas: Fourmile Creek (640 ha), Mares Egg Spring (30 ha), and Wood River Wetland (12 ha). Various other locations were surveyed for Yellow Rails.

Surveys were conducted from 12 April through 28 July in 2001 following the same methods used in past years (Popper et al. 2000). At the three main study sites, surveys were conducted approximately once every 10 days, between the hours of 2200 and 0500 from 30 April to 28 July. Surveys at additional sites in the Wood River Valley were completed once a month, and more often if rails were detected. Areas outside the Wood River Valley were surveyed once or twice during the 2001 breeding season. Male Yellow Rails were counted by systematically walking through the site, within about 500 m of potential rail habitat. If no rails were heard calling, two stones were used to imitate the call of the male and to elicit a response (duration of listening/imitation calling not specified). Surveys were not conducted on windy or rainy nights. Any rails heard were approached and their locations were recorded using a Global Positioning System. Some sites were surveys from the road only. When conducting road surveys, the observers would stop once every 0.5 km to listen and imitate the call if males weren't calling. If approaching the position of an individual bird was not possible, two compass bearings were recorded to get an approximate location.

Yellow Rails were captured by approaching calling males and imitating their calls by tapping two stones together. A headlamp was used to illuminate the area in front of the observer while imitating the Yellow Rail call. When a rail moved within 1.5 m of the observer, an

oversized butterfly net (0.7 m x 0.5 m with a 1.5 m handle) was brought down on the bird. Captured birds were banded and weighed (method not given). If the rail did not approach the observer, the observer would approach the calling rail and attempt to see or capture the rail.

Areas of suitable habitat (identified by prior experience, calling males, or evidence of a nest) were searched for nests using 1-3 people walking systematically through the area lifting dead vegetation. Nests were marked with flagging. Timing of hatching was estimated by floating eggs. After a nest became inactive, eggs were measured. Width, height, and depth of the nest cup and nest canopy were recorded, as well as percent coverages and maximum height of vegetation within a 1 m^2 plot around the nest. Average water depths at Yellow Rail locations were recorded; water depth was measured in each of four cardinal directions 0.5 m from the location of a calling male or from the location where one was seen. Water levels also were recorded every 10 d at seven permanent gauges located at Fourmile Creek, one gauge at Wood River Wetland, and one at Mares Egg Spring.

The following sources may provide more information on methods.

Conway, C. J. 2002. Standardized North American marsh bird monitoring protocols. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, Arizona. 17 pages.

Marion, W. R., T. E. O'Meara, and D. S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. Studies in Avian Biology 6:81-85.

Slack, R. D., and K. L. Mizell. 1999. Monitoring King and Yellow rails in Texas. Page 47 *in* Proceedings of the marsh bird monitoring workshop. U.S. Fish and Wildlife Service, Denver, Colorado.
