

# **Habitat Suitability of the Yellow Rail in South-Central Manitoba**

by

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A Thesis Submitted to the Faculty of Graduate Studies of  
The University of Manitoba  
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## ABSTRACT

Little is known about the distribution and habitat suitability of yellow rails (*Coturnicops noveboracensis*) throughout their breeding range. Yellow rail and vegetation surveys were conducted at 80 wetlands in south-central Manitoba in 2010-2011 to evaluate the effectiveness of repeat-visit, call-broadcast night surveys for detecting this species and habitat associations of this species at the 3-km landscape, patch, and plot scales. Yellow rails were detected at 44% of the study wetlands. Yellow rail detection was imperfect (0.63 in each year), but call-broadcast increased the number of yellow rails detected. Future yellow rail survey efforts should employ call-broadcast and at least three surveys per survey point. Yellow rail presence was positively influenced by the amount of marsh/fen in the landscape and the proportion of rushes at the study wetlands. These characteristics should be considered when identifying potential yellow rail habitat in south-central Manitoba.

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## CHAPTER 1: INTRODUCTION

### 1.1 CONTEXT

One of the most sought-after birds by birdwatchers in North America is a small, secretive, marsh bird called the yellow rail (*Coturnicops noveboracensis*; Bennett 1981, Robert 1997). The size of a large sparrow, the yellow rail spends most of its time hidden in dense marsh vegetation, and rarely comes out into the open (Figure 1-1; Sibley 2000). Yellow rail presence at a marsh is best detected by hearing its night-time vocalizations, a series of repeated clicks: *tic-tic*, *tic-tic-tic* (Sibley 2000). The yellow rail was listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2001 as a species of Special Concern (COSEWIC 2001), and has since been added to Canada's federal Species at Risk Act under the same category (Species at Risk Act 2002, Schedule 1). In reviewing the status of the yellow rail in 2009, COSEWIC again classified this species as Special Concern (COSEWIC 2009).



Figure 1-1 Yellow rail seen during a night survey, 3 km NE of Lundar, Manitoba. Photo by K. Martin.

Little is known about yellow rail population sizes and trends in most areas throughout their range (Alvo and Robert 1999). This uncertainty results primarily from challenges associated with monitoring yellow rail populations. Due to their primary vocalization period being at night (Bookhout 1995), yellow rail populations are not effectively monitored through standard, long-term monitoring programs such as the North American breeding bird survey (Robbins et al. 1989, Herkert 1995). In addition, while yellow rails are often included in morning or evening surveys for other marsh birds (e.g. Hay 2006, Conway and Nadeau 2010), population estimates garnered from these surveys are not reliable because they do not encompass the yellow rail's primary vocalization period. Currently, no range-wide survey programs for yellow rails exist, although survey protocols specifically targeting yellow rails, using the call-broadcast method, have been developed (e.g. Bazin and Baldwin 2007). However, little is known

about yellow rail detectability and the effectiveness of call-broadcast night surveys for detecting yellow rails. Furthermore, the effects of temporal and environmental variables on yellow rail detectability needs further study.

Despite the uncertainty associated with yellow rail population sizes and trends, it is believed that yellow rail populations have declined significantly throughout their range (Alvo and Robert 1999). The primary cause for these declines is thought to be wetland loss (Alvo and Robert 1999), which has been extensive throughout much of the yellow rail's range (Dahl and Johnson 1991, Natural Resources Canada 2009).

In addition to uncertainty about population sizes and trends, a lack of information exists regarding habitat suitability for yellow rails (Bookhout 1995). On their breeding grounds, yellow rails tend to be associated with shallow marshes (Stenzel 1982, Robert and Laporte 1999, Luterbach 2000) that are typically dominated by sedges (Bookhout and Stenzel 1987, Gibbs et al. 1991, Popper and Stern 2000), and that tend to be flooded in the spring but dry up by the end of the summer (Stenzel 1982, Bookhout and Stenzel 1987, Popper and Stern 2000). However, the influence of other vegetation types, including forbs, rushes, grasses, cattail and woody vegetation on yellow rail habitat suitability is not well understood. Other local wetland characteristics, such as water depth, vegetation structure and wetland size have similarly not been evaluated to determine their importance for yellow rail habitat suitability. Furthermore, the effects of landscape-scale characteristics on yellow rails have not been evaluated. Landscape-level variables such as the amount, fragmentation, composition and configuration of habitat in the landscape have been shown to influence other bird species (Trzcinski et al. 1999, Villard et al. 1999, Vander Haegan et al. 2000), including wetland birds (Naugle et al.

1999, Fairbairn and Dinsmore 2001, Guadagnin and Maltchik 2007, Smith and Chow-Fraser 2010).

Manitoba may represent an extensive and important portion of the breeding range of this species (Alvo and Robert 1999). Yellow rails have been found throughout Manitoba, from Churchill in the north-east portion of the province (Fuller 1938), to the Interlake region (Christian Artuso, pers. comm., Holland and Taylor 2003), to the southern portion of the province (Lane 1962). Many of the known locations at which yellow rails have been found are in the south-central portion of the province, including Oak Hammock Marsh (Holland and Taylor 2003), the Rat River Wildlife Management Area (Ken DeSmet, pers. comm.), areas of the Netley-Libau Marsh (Holland and Taylor 2003), and Grant's Lake, located just northwest of Winnipeg (Fryer 1937). It is believed that south-central Manitoba, the Interlake region in particular, may contain hundreds more breeding sites for yellow rails (Alvo and Robert 1999). However, the majority of wetlands in this area have not been surveyed for yellow rails. In addition, much of our understanding of yellow rail wetland habitat comes from observations and studies that have been done in the northern United States and Québec (e.g. Terrill 1943, Stenzel 1982, Robert and Laporte 1999). Wetlands in south-central Manitoba may have very different vegetation characteristics, and thus influential local habitat conditions might be different from those found in more eastern and southern areas of Canada and in the United States.

## **1.2 PROBLEM STATEMENT**

The yellow rail is listed as a species of Special Concern under SARA (Species at Risk Act 2002, Schedule 1) due to declining populations associated with wetland loss throughout its range (Alvo and Robert 1999). Monitoring efforts for this species are

impeded by a lack of understanding about the effectiveness of call-broadcast night surveys for yellow rails. Similarly, little is known about how local wetland characteristics (e.g. wetland size, vegetation community composition) and landscape-scale characteristics (e.g. landscape composition, landscape configuration) influence habitat suitability for yellow rails. Research on yellow rail detection probability during night surveys is needed to inform future yellow rail survey programs designed to monitor population sizes and trends for this species. Additionally, future yellow rail habitat conservation efforts would benefit from a better understanding of the influence of local and landscape-scale variables on yellow rail habitat suitability.

### **1.3 RESEARCH OBJECTIVES**

The overall objective of this study is two-fold: (1) to evaluate the effectiveness of call-broadcast night surveys for detecting yellow rails, and (2) to evaluate the influence of local and landscape-scale habitat variables on wetland suitability for yellow rails. These goals will be achieved by accomplishing the following objectives:

- To conduct night surveys for yellow rails at wetlands in south-central Manitoba to evaluate how repeat site visits, the use of call-broadcast, and variation in temporal and environment conditions influence the probability of detecting yellow rails.
- To survey known yellow rail locations and previously unsurveyed wetlands to explore the distribution of breeding yellow rails throughout south-central Manitoba.
- To identify factors influencing yellow rail habitat suitability at multiple spatial scales.

- To suggest land and wetland management strategies that would be most compatible with the conservation of yellow rail habitat in south-central Manitoba.

#### **1.4 HYPOTHESES**

I have developed the following hypotheses to accompany the above research objectives:

- If yellow rails are imperfectly detected, then the probability of detecting yellow rails will increase with repeat surveys and with the use of call-broadcast, as has been found for other marsh bird species.
- If yellow rails select habitats with vegetation that provides adequate cover from predators, then sedges, rushes and grasses will be positively influence yellow rail habitat suitability. If yellow rail movement through a wetland is impeded by deep water, and dense woody vegetation or cattails, these variables will negatively influence wetland suitability for yellow rails.
- If individual yellow rails engage in social interactions (e.g. extra-pair copulations) with other individuals, only wetlands large enough to support several pairs of breeding yellow rails will be suitable.
- If yellow rails use multiple wetlands for foraging, the abundance and arrangement of wetland habitat in the landscape will affect wetland suitability for yellow rails.

#### **1.5 GENERAL METHODS**

In 2010-2011, approximately 80 study wetlands will be selected based on 1) prior presence of yellow rails during the breeding season, or 2) containing potentially suitable yellow rail habitat, i.e. sedge, rush, and/or grass vegetation. One to eight survey points will be randomly established within the potentially suitable habitat at each wetland.



Survey points will be a minimum of 400 m apart to avoid double-counting individuals. Two rounds of yellow rail surveys will be conducted at each wetland, following the protocol developed by Bazin and Baldwin (2007), between 20 May and 7 July. All surveys will be conducted between one hour after sunset and one hour before sunrise (Bazin and Baldwin 2007) to capture the primary vocalization period of the yellow rail. Each survey will consist of five minutes of passive listening, three minutes of broadcasted yellow rail vocalizations interspersed with 30 seconds of silence after each 30 seconds of broadcast call, and a final two minutes of passive listening (Bazin and Baldwin 2007).

To evaluate the influence of local wetland characteristics on yellow rail habitat suitability, vegetation and water depth data will be collected at the patch (i.e. overall wetland) and plot (i.e. survey point) scales. To obtain plot-scale data, vegetation transects will be established at each survey point. Transects will begin at the survey point and extend towards the center of the wetland, stopping at 50 m or when open water is reached. At each 2 m along the transect, maximum vegetation height, vegetation density, and water depth will be measured. At each 5 m along the transect, the vegetation within a 1 m x 1 m frame will be classified by percent vegetation type (e.g. percent cattail, percent forbs, etc.), percent live vs. percent dead vegetation, and four canopy closure measurements will be taken (Snell-Rood and Cristol 2003).

To evaluate patch-scale vegetation, three vegetation transects will be randomly established at each wetland. Again, all transects will begin at the random point and extend 50 m towards the center of the wetland or until open water is reached. All

measurements will be conducted the same as for the plot-scale vegetation transects. In addition, each wetland will be classified by type and class (Stewart and Kantrud 1971).

Landscape-scale variables will also be evaluated for each wetland. Using ArcMap 10 (ESRI 2010), 3-km buffers will be created around each wetland, using the land cover and waterbodies layers developed by Manitoba Land Initiative (Manitoba Land Initiative 2001, 2002, unknown year). Metrics representing habitat amount, fragmentation, composition and configuration at the landscape scale will be calculated for each wetland using FRAGSTATS (McGarigal and Marks 1995). Landscapes surrounding each wetland will be ground-truthed to ensure land cover polygons reflect the most current land use.

A generalized linear mixed model will be used to evaluate the influence of temporal (e.g. date, time of survey) and environmental (e.g. cloud cover, temperature) conditions on yellow rail detectability. Occupancy modeling will be used to calculate yellow rail detection probability based on the two surveys at each wetland. Generalized linear mixed models will be used to evaluate the influence of plot-, patch-, and landscape-scale characteristics on the presence of yellow rails. Akaike's Information Criterion will be used to compare model fit and select the best-fitting model at each scale of analysis.

## **1.6 JUSTIFICATION OF RESEARCH**

As a species-at-risk, it is important that yellow rail populations be monitored for further declines. However, effective population monitoring for this species is lacking. Furthermore, much uncertainty exists with regards to the effectiveness of call-broadcast night surveys for the detection of yellow rails, and the influence of temporal and environmental variables on yellow rail detection probability. An evaluation of yellow rail detection probability during call-broadcast, night surveys for yellow rails, and an

investigation of the temporal and environmental conditions affecting this detection probability, would inform future yellow rail monitoring programs by determining the most effective survey methods for this species.

Habitat conservation efforts for yellow rail have been minimal, despite the known declines in breeding habitat that have occurred throughout their range (Alvo and Robert 1999). Before critical habitat can be identified, a better understanding of the habitat variables, at both the local and landscape scales, is needed. The research that I propose here will examine the importance of vegetation structure, vegetation community composition, water depth, wetland area, and landscape habitat amount, fragmentation, composition, and configuration on the suitability of wetland habitat for yellow rails in south-central Manitoba. This information could be used in the future to assess habitat across south-central Manitoba to identify priority areas for breeding yellow rails.

## **1.7 ORGANIZATION OF THESIS**

This thesis is organized into five chapters. In Chapter 2, the literature relevant to yellow rails, specifically in terms of their population trends and habitat use, is reviewed. Chapter 3 is the evaluation of yellow rail detection probability during call-broadcast night surveys, and the influence of repeat survey visits, temporal, and environmental variables on the detection probability of yellow rails. Chapter 4 is the portion of the study evaluating the local- and landscape-scale influences on yellow rail habitat suitability using a multiple spatial scale approach. Finally, Chapter 5 is a summary of the important results from Chapters 3 and 4, and the management implications resulting from those results.

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## CHAPTER 2: LITERATURE REVIEW

### 2.1 LIFE HISTORY OF THE YELLOW RAIL

#### *Physical Description and Behaviour*

The yellow rail is one of six rail species found in North America. Measuring just over 7 inches in length and weighing around 50 g (Sibley 2000), the sparrow-sized yellow rail is one of the smallest North American rails, second only to the black rail (*Laterallus jamaicensis*). Aptly named, the yellow rail is characterized by its tawny, buffy yellow coloring, fine white barring on its wings and body, and distinctive white wing patches that are obvious in flight (Bookhout 1995, Sibley 2000).

Yellow rails are often described as being elusive and secretive (Fuller 1938, Houston 1969, Bart et al. 1984). This characterization is attributed to the yellow rail's habit of staying hidden in thick marsh vegetation, rarely coming out into the open (Robert and Laporte 1997, Sibley 2000). Like other rails, the laterally compressed body shape of the yellow rail allows it to move easily and swiftly through dense wetland vegetation. For this reason, Burt (1994) describes the movement of the yellow rail as "something magical... a bird that threads its way through the grass with the fluency of a snake".

As a result of their secretive habits, yellow rails are notoriously difficult to see (Robert and Laporte 1997), much to the frustration of birdwatchers. Instead, yellow rail presence at a wetland is best determined by detecting the vocalizations of a calling male, which are described as a series of clicking calls in a Morse Code-like pattern of *tic-tic*, *tictictic* (Sibley 2000). This mechanical, unmelodic call has been described as un-bird-like (Holland and Taylor 2003), likened to the tapping of a typewriter (Burt 1994), and can be easily imitated by tapping two stones together (Bookhout 1995). Adding to the



difficulty in detecting yellow rail is the fact that while it occasionally calls during the day (Terrill 1943, Bookhout 1995), the primary vocalization period of this species is nocturnal (Robert 1997). The rhythmic, nocturnal call of the yellow rail has even been mistaken for an insect (Fuller 1938).

### *Breeding and Wintering Range*

The yellow rail has one of the most northerly breeding ranges of all the North American rails. Yellow rails breed in Canada from Nova Scotia west to Alberta and up into the Northwest Territories (Bookhout 1995, Alvo and Robert 1999). In the United States, yellow rails are known to breed in Montana, North Dakota, Minnesota, Wisconsin, Michigan and Maine, with an isolated breeding population in Oregon (Bookhout 1995). The vast majority of the breeding range of the yellow rail is in Canada (Bookhout 1995). Despite their seemingly widespread breeding range, the distribution of yellow rails throughout their breeding range may actually be very patchy and uneven (Bookhout 1995, Alvo and Robert 1999), with breeding concentrated at certain specific wetlands (Bookhout 1995, Robert et al. 2004). Much of the potentially suitable yellow rail habitat remains unsurveyed (Alvo and Robert 1999), resulting in incomplete knowledge of the distribution of yellow rails throughout their breeding range. The wintering range of the yellow rail extends along the eastern coast of the southern United States, from North Carolina to southern Texas, with some historical records from California (Bookhout 1995). Little is known about migration in this species, although recoveries of numerous yellow rails after fatal collisions with TV transmission and communication towers (Shire et al. 2000) suggest that migration occurs at night, in small groups (Bookhout 1995).

### *Diet*

Yellow rails feed by foraging in shallow water (Bookhout 1995). Their diet consists of snails (Walkinshaw 1939), invertebrates (Walkinshaw 1939, Easterla 1962, Robert 1997) and vegetation and seeds (Averill 1888, Walkinshaw 1939, Easterla 1962, Robert 1997).

### *Male Territorial Behaviour*

Site fidelity of male yellow rails to breeding territories appears to be low. Of 129 male yellow rails banded in 1993-1996, only seven were re-captured at the same site in a subsequent year (Robert and Laporte 1997). Similarly, in fifteen years of yellow rail banding at Seney National Wildlife Refuge in Michigan, with two possible exceptions, no males occupied the same territories in subsequent years (Urbanek, unpublished in Bookhout 1995).

Although male yellow rails establish and defend territories at wetlands on their breeding grounds (Bookhout 1995), male breeding territories within the same wetland often overlap (Bookhout and Stenzel 1987). This behaviour may suggest that yellow rails are actually slightly gregarious (Bart et al. 1984, Bookhout and Stenzel 1987).

### *Breeding and Nesting*

Pairing of individuals is thought to occur on the breeding grounds (Bookhout 1995). Nest-building occurs through the participation of both sexes, with both males and females digging scrapes and the female finishing nests at the chosen sites (Bookhout 1995). Often multiple nests are built, with one used for incubating, and additional nests used for brooding the young (Bookhout 1995). Females usually lay between five and ten buff-colored eggs with a purple-ish/red wreath around the egg towards one end

(Bookhout 1995), and begin incubation after the last egg of the clutch is laid (Elliot and Morrison 1979). Both parents have been viewed with the young (Harris 1945).

## **2.2 CHARACTERISTICS OF YELLOW RAIL HABITAT ON THE BREEDING GROUNDS**

### *Wetland Size*

Breeding yellow rails have been found to use a wide range of wetland sizes. Typically, breeding yellow rails are found at large wetlands, as large as >400 ha (Gibbs et al. 1991) and 650 ha (Popper and Stern 2000) in size. A study by Bookhout and Stenzel (1987) found that within these wetlands, individual male yellow rails tend to defend territories ranging from 5.8 to 10.5 ha in size, but generally spend most of their time within smaller, more concentrated areas. Due to the slightly gregarious behaviour of yellow rails, as suggested by overlapping male breeding territories (Bart et al. 1984, Stenzel and Bookhout 1987), the suitability of breeding wetland habitat may be dependent on wetlands being large enough support several pairs of breeding yellow rails. However, Lane (1962) found yellow rails breeding near Brandon, Manitoba, at wetlands of just 0.6 ha and 0.8 ha in area. Small wetlands might, therefore, also provide suitable habitat for yellow rails. More information is needed on the minimum wetland size required for breeding yellow rails.

### *Wetland Vegetation Community Composition*

Yellow rails are most commonly associated with wetlands dominated by sedges (Fuller 1938, Walkinshaw 1939, Lane 1962, Elliot and Morrison 1979, Gibbs et al. 1991, Grimm 1991, Sherrington 1994). In particular, narrow-leaved woolly sedge (*Carex lasiocarpa*; Stenzel 1982, Bookhout and Stenzel 1987, Gibbs et al. 1991), analogue sedge (*Carex simulata*), common yellow lake sedge (*Carex utriculata*), tufted lake sedge

(*Carex vesicaria*; Stern et al. 1993, Popper and Stern 2000), beaked sedge (*Carex rostrata*; Stern et al. 1993), yellow sedge (*Carex flava*; Devitt 1939), prairie sedge (*Carex prairea*; Walkinshaw 1939), chaffy sedge (*Carex paleacea*; Robert et al. 2004), and creeping spike-rush (*Eleocharis palustris*; Popper and Stern 2000) are often characteristic of sites where yellow rails are detected. Yellow rails are also often found in bulrush beds, namely dominated by *Schoenoplectus* spp. (Walkinshaw 1939, Elliot and Morrison 1979), in particular greater bulrush (*Schoenoplectus validus*; Terrill 1943). Rushes are also commonly found at yellow rail breeding locations, especially *Juncus* spp. (Elliot and Morrison 1979, Stenzel 1982, Robert and Laporte 1997, Robert and Laporte 1999, Popper and Stern 2000). Grasses are also often typical of wetlands occupied by yellow rails during the breeding season (O'Reilly 1937, Fuller 1938, Walkinshaw 1939, Houston 1969, Blicharz 1971, Elliot and Morrison 1979, Gibbs et al. 1991). Specifically, Kentucky bluegrass (*Poa pratensis*), meadow foxtail (*Alopecurus pratensis*), slimstem reedgrass (*Calamagrostis stricta*) and red fescue (*Festuca rubra*; Robert et al. 2004) have been identified at yellow rail breeding sites. Types of forbs that have been identified at yellow rail breeding wetlands are buttercups (*Ranunculus* spp.; Stern et al. 1993), buck-bean (*Menyanthes trifoliata*; Terrill 1943, Stern et al. 1993), pondweed (*Potamogeton* spp.; Stern et al. 1993), elephant heads (*Pedicularis groenlandica*; Stern et al. 1993), and *Montia* species (Stern et al. 1993).

Yellow rails are typically not found in wetlands dominated by cattail (*Typha* spp.; Bookhout 1995). Stenzel (1982) estimated that cattails comprised less than 1% of the vegetation community at a wetland with breeding yellow rails at Seney National Wildlife Refuge in Michigan. Furrer (1974) observed a yellow rail in dense cattail stands at a

wetland near Othello, Washington. However, it was suggested that this was not in the breeding range of the yellow rail and may be just be used as temporary refuge during migration (Furrer 1974). Cattails appear to reduce the suitability of wetland habitats for yellow rails (Hyde 2001), although the principal mechanism for this relationship is not understood. Sedge vegetation can be out-competed by cattail species (Wilcox et al. 1985), a trend that is facilitated by the stabilization of water levels (Wilcox et al. 1985) and nutrient inputs to the wetland (Woo and Zedler 2002). Encroaching cattail might reduce the availability of sedge habitat for breeding yellow rails. However, the extent of the influence of cattail on wetland suitability for yellow rails is unknown.

The influence of woody vegetation at yellow rail breeding sites is also not well understood. It is often thought that encroachment by woody vegetation reduces the suitability of wetland habitat for breeding yellow rails (Bookhout 1995, Hyde 2001). However, in many areas of their breeding range, yellow rails are known to use fen and bog wetlands surrounded by trees, such as quaking aspen (*Populus tremuloides*; Stenzel 1982, Bookhout and Stenzel 1987, Popper and Stern 2000), white pine (*Pinus strobus*; Bart et al. 1984, Bookhout and Stenzel 1987), red pine (*Pinus resinosa*; Bart et al. 1984, Bookhout and Stenzel 1987), speckled alder (*Alnus rugosa*; Bart et al. 1984, Bookhout and Stenzel 1987), swamp birch (*Betula pumila*; Bart et al. 1984, Bookhout and Stenzel 1987), blueberry bushes (*Vaccinium* spp.; Bart et al. 1984, Bookhout and Stenzel 1987), leatherleaf (*Chamaedaphne calyculata*; Bart et al. 1984), lodgepole pine (*Pinus contorta*; Popper and Stern 2000), ponderosa pine (*Pinus ponderosa*; Popper and Stern 2000), white fir (*Abies concolor*; Popper and Stern 2000) and willows (*Salix* spp.; Devitt 1939, Terrill 1943, Stenzel 1982, Bart et al. 1984, Popper and Stern 2000). In particular,

willows are often found at yellow rail nest sites (Lane 1962, Stern et al. 1993). The degree of woody vegetation encroachment that renders wetland habitat unsuitable for breeding yellow rails remains unknown.

#### *Wetland Vegetation Structure*

It is not well understood whether vegetation community composition or wetland vegetation structure is more influential on the suitability of wetland habitat for yellow rail. Vegetation structure has been found to be more important than vegetation community composition for many avian species (Naugle et al. 2000), including other rails (Rundle and Fredrickson 1981, Flores and Eddleman 1995). Yellow rails might select habitat based on vegetation structure that would provide adequate cover for them and their nests (Alvo and Robert 1999). Typically, breeding yellow rails are found at wetlands characterized by a dense vegetation canopy (Stenzel 1982, Bart et al. 1984, Gibbs et al. 1991). Such canopies seem to always be present at nesting locations, and effectively hide yellow rail nests from overhead view (Devitt 1939, Lane 1962).

In addition to a dense canopy, vegetation height likely plays an important role in concealing yellow rails and their nests. However, the height of vegetation at wetlands frequented by breeding yellow rails seems to be quite variable. Studies have found that vegetation height at marshes with breeding yellow rails ranges from 16 to 110 cm (Stenzel 1982, Gibbs et al. 1991, Robert 1997), with measured vegetation heights at the nest site ranging from 38 cm to approximately 182 centimeters (Devitt 1939, Terrill 1943, Stenzel 1982). The minimum height of vegetation that still provides sufficient cover for breeding rails is not yet known.

### *Water Depth*

Yellow rails have been found at wetlands with a wide range of water depths. On their breeding grounds, yellow rails have been found in areas with water levels ranging from moist soil (Robert and Laporte 1999) to shallow waters ranging up to 46 cm (Fryer 1937, Stenzel 1982, Bookhout and Stenzel 1987, Gibbs et al 1991, Robert and Laporte 1999, Luterbach 2000). Often, yellow rails are found at wetlands that are flooded in the spring, but dry up towards the end of the summer (Stenzel 1982, Bookhout and Stenzel 1987, Popper and Stern 2000). Active yellow rail nests have been found surrounded by water ranging from damp substrate, with no standing water (Devitt 1939, Walkinshaw 1939, Houston 1969), to 8 inches in depth (Lane 1962, Elliot and Morrison 1979, Popper and Stern 2000). In wet years, yellow rails have also been found in flooded pasture (Luterbach 2000) and flooded hay fields (Ross Dickson, pers. comm.) on their breeding grounds, although it is not known if breeding actually took place in those locations. This suggests that the presence of adequate water levels may be one of the most important variables contributing to yellow rail habitat suitability.

### **2.3 YELLOW RAIL POPULATION TRENDS AND STATUS**

In Canada, populations of yellow rails are thought to have declined significantly in Alberta, Saskatchewan, Manitoba (excluding Hudson Bay), Ontario (excluding Hudson/James Bay), Quebec (excluding James Bay), and New Brunswick (Alvo and Robert 1999, COSEWIC 2009). Yellow rail populations in these regions may still be declining, although likely at slower rates (Alvo and Robert 1999). Yellow rail population trends remain unknown for Nova Scotia and the Northwest Territories (Alvo and Robert 1999). The only possible stable population is thought to be the Hudson/James Bay

populations of northern Manitoba, Ontario and Quebec, although the extremely rapid increase in the snow goose (*Chen caerulescens*) population may cause future yellow rail habitat destruction and subsequent population declines (Alvo and Robert 1999). These declining yellow rail population trends are mirrored in the United States portion of the breeding range. While insufficient information exists to assess yellow rail population trends in Montana, Wyoming, and North Dakota, populations of yellow rails are facing continued threats to their breeding habitat in Minnesota and Michigan (Alvo and Robert 1999). The Oregon population is the only American population that appears to be somewhat stable (Alvo and Robert 1999).

Manitoba may represent a significant area of breeding habitat for yellow rails. Recent COSEWIC reports identified twenty-six known locations throughout Manitoba where yellow rails have been found during the breeding season, excluding Hudson Bay (Alvo and Robert 1999, COSEWIC 2009). Additional unidentified areas of suitable yellow rail habitat may exist in Manitoba, particularly in the Interlake region (Alvo and Robert 1999). R. Koes (pers. comm. in Alvo and Robert 1999) suggests that there may actually be hundreds of yellow rail breeding sites in Manitoba. As a result, the actual population of yellow rails in Manitoba might therefore be larger than current estimates (Alvo and Robert 1999). This trend has been suggested for other areas of their breeding range as well (Stenzel 1982).

The primary cause for yellow rail population declines is believed to be the loss of wetland habitat (Alvo and Robert 1999, COSEWIC 2009). Throughout North America, the loss of wetland habitat has been extensive and widespread (Dahl and Johnson 1991, Natural Resources Canada 2009). Wetland loss has been especially concentrated in the



prairie pothole region of the United States and Canada (Natural Resources Canada 2009), where significant wetland loss has occurred as a result of wetland drainage to further agricultural production (Dahl 1990). Due to their association with shallower, sedge-dominated portions of wetlands, yellow rails are particularly vulnerable to habitat loss, since these types of wetlands (or portions of wetlands) are often the easiest and first portions of the wetland to be converted for other uses, primarily agriculture (Alvo and Robert 1999). Continued wetland habitat loss throughout the yellow rail's breeding range (COSEWIC 2009) and wintering range in the southern United States threatens the future stability of yellow rail populations (Alvo and Robert 1999).

#### **2.4 SURVEYS TO MONITOR YELLOW RAIL POPULATIONS**

While wetland habitat loss is believed to be the primary reason for the declines in yellow rail populations (Alvo and Robert 1999, COSEWIC 2009), our understanding of yellow rail population trends is complicated by challenges in surveying for this secretive species. Yellow rails are not effectively detected and monitored by standardized techniques such as the North American Breeding Bird Survey (Robbins et al. 1989, Herkert 1995), due to their tendency to remain hidden and vocalize primarily at night. Yellow rail surveys are usually conducted in conjunction with surveys for other marsh birds (e.g. Hay 2006, Conway 2009, Conway and Nadeau 2010). However, these surveys typically take place in the early morning or evening (Conway 2009, Conway and Nadeau 2010), and thus fail to capture the primary vocalization period of the yellow rail. In Canada, a protocol specifically aimed at targeting yellow rails has been developed (Bazin and Baldwin 2007). Although night surveys for yellow rails have been conducted in several regions of Canada as part of research projects (Prescott et al. 2002, Robert and

Laporte 1999, Robert et al. 2004), no range-wide, annual yellow rail monitoring program exists in Canada.

## **2.5 YELLOW RAIL STATUS UNDER CANADA'S SPECIES AT RISK ACT**

In 2002, Canada's Species at Risk Act (SARA) was implemented to provide legal protection for species of wildlife that are at risk of becoming endangered, extirpated or extinct, and to promote and allow for the recovery of populations of at-risk species (Species at Risk Act 2002 s. 6). The process of a species (or specific population of a species) being listed begins with the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This committee of experts evaluates and assesses the status of the species in Canada, and classifies it as Extinct (no longer in existence), Extirpated (no longer found in Canada), Endangered (extinction or extirpation is impending), Threatened (at risk of becoming Endangered), Special Concern (at risk of becoming Threatened or Endangered), not at risk (not currently at risk of extinction), or states that there is not enough information to classify the species appropriately (COSEWIC 2010). COSEWIC assessments and recommendations are then used by the federal Minister of Environment in deciding if the species should be added under SARA (Species at Risk Act 2002 s. 27(3)). In 2001, the yellow rail was assessed by COSEWIC as a species of Special Concern (COSEWIC 2001) as a result of extensive population declines and continued threats to wetland habitats (Alvo and Robert 1999). The yellow rail was then added to the list of at-risk species under SARA, as a species of Special Concern (Species at Risk Act 2002, schedule 1).

One of the goals identified in SARA is to manage species of Special Concern so that they do not become Threatened or Endangered (Species at Risk Act 2002, s. 6). Once

a species has been classified under SARA as a species of Special Concern, a management plan must be developed for that species and its habitat within three years of it being listed (Species at Risk Act 2002, s.65, 68). This management plan must outline appropriate measures for the conservation of the species (Species at Risk Act 2002, s.65). The management plan for the yellow rail is currently being prepared, but has not yet been completed (Species at Risk Public Registry 2010).

As federal legislation, Canada's SARA applies only to at-risk species found on lands under federal jurisdiction. Provincial species at risk legislation also exists in some provinces to afford some degree of protection to at-risk species, although the implications of being provincially listed vary from province to province. In Manitoba, at-risk wildlife species can be listed under Manitoba's Endangered Species Act as Extinct, Extirpated, Endangered or Threatened (*Manitoba Endangered Species Act 1990 s.2(1)*), and subsequently receive legal protection on all lands in Manitoba, including those that are privately owned (*Manitoba Endangered Species Act 1990 s. 3(1)*). The yellow rail is not currently listed under Manitoba's Endangered Species Act.

## **2.6 LANDSCAPE ECOLOGY AND MULTIPLE SPATIAL SCALE HABITAT ANALYSIS**

It has long been understood that local habitat characteristics, such as vegetation height (Koper and Schmiegelow 2006) or the percentage of emergent wetland vegetation (Fairbairn and Dinsmore 2001), can be important determinants of habitat suitability for avian species. More recently, the influence of broader, landscape-scale characteristics on habitat suitability has also been documented (Naugle et al. 2000, Bakker et al. 2002, Radford and Bennett 2007, Platteeuw et al. 2010). In particular, four characteristics of the surrounding researcher-defined landscape are known to influence species: landscape

habitat amount (Trzcinski et al. 1999, Naugle et al. 1999, Fairbairn and Dinsmore 2001), landscape fragmentation (Fahrig 1998, 2003), landscape composition (Vander Haegan et al. 2000, Naugle et al. 2001, Smith and Chow-Fraser 2010), and landscape configuration (Paracuellos and Telleria 2004, Guadagnin and Maltchik 2007, Platteeuw et al. 2010).

In recent decades, the focus of ecological studies has broadened from the evaluation of local, patch-scale habitat characteristics only to multiple spatial scale analyses that evaluate the influence of both local and landscape-scale characteristics on the target species (e.g. Naugle et al. 2000, Naugle et al. 2001, Koper and Schmiegelow 2006). This type of habitat analysis is crucial not only for identifying which variables influence habitat suitability, but also for determining at which scale the effects are occurring. Variables can affect habitat selection at some scales but not others (Wiens 1989), and in many cases avian species appear to respond to habitat variables at several different scales (Fairbairn and Dinsmore 2001, Koper and Schmiegelow 2006, Taft and Haig 2006).

Studies using the multiple spatial scale approach to evaluate habitat suitability for marsh birds are limited. A recent study evaluated the role of local habitat and landscape variables in determining habitat suitability for the California black rail (*Laterallus jamaicensis coturniculus*; Spautz et al. 2005). This study found that the presence of black rails was correlated with several local- and landscape-level variables, although local characteristics were better predictors of black rail presence. At the local scale, black rail presence at a wetland was negatively associated with average vegetation height, but positively associated with the proportion of cattails (*Typha* spp.) and pickleweed (*Salicornia virginica*; Spautz et al. 2005). At the landscape scale, black rail presence at a

wetland was negatively associated with distance to water and distance to the nearest large (100 ha) marsh, but positively associated with the total amount of marsh within 250 m of the wetland (Spautz et al. 2005). Hay (2006) investigated habitat suitability requirements of secretive marsh birds in southern Manitoba. Overall, the characteristics of the wetlands themselves, rather than the type of surrounding land use (e.g. agriculture), were the most important predictors for American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), sora rail (*Porzana carolina*), Virginia rail (*Rallus limicola*), and pied-billed grebe (*Podilymbus podiceps*; Hay 2006). However, American bittern and pied-billed grebe tended to be associated with wetlands with a high proportion of marsh at the 5 km (i.e. landscape) scale (Hay 2006).

To my knowledge, no multiple spatial scale habitat suitability studies have been conducted for yellow rails on either their breeding or wintering grounds. It is not known if yellow rails make use of multiple wetlands during the breeding season. If they do, the amount of wetland habitat in the landscape, and the configuration of the habitat patches, might influence habitat suitability for yellow rails. Additionally, in the agriculture-dominated prairie region of south-central Manitoba, most wetlands exist in a matrix of cropland and grassland (Natural Resources Canada 1995). If yellow rails avoid landscapes with high proportions of cropland, as other avian species have been shown to do (Saab 1999, Naugle et al. 2000), landscapes with low proportions of cropland could be identified as priorities for yellow rail habitat conservation efforts. In addition to the possible influence of these landscape characteristics, local wetland habitat characteristics are likely also important determinants of habitat suitability for yellow rails.

## **2.7 MANAGEMENT AND CONSERVATION OF YELLOW RAIL HABITAT**

At the current time, no wetlands in south-central Manitoba are managed or conserved specifically for yellow rail. Outside of the study area, Douglas Marsh in south-western Manitoba has been designated as a Protected Area by Manitoba Conservation (Manitoba Conservation 2011) due to the high concentrations of breeding yellow rails at this location. However, the development of a yellow rail management plan is currently underway, as per the regulations outlined in SARA, so management or conservation initiatives will likely be instituted in the near future.

Potential management options to conserve yellow rail habitat might include burning, grazing, or water level management. Burning can be used to control the invasion of cattails at prairie wetlands (Furniss 1938). Therefore, if the invasion of cattails reduces habitat quality for yellow rails, burning might be used as a management tool to maintain wetland suitability for yellow rails. If increases in the proportion of woody vegetation decrease the suitability of wetland habitat for yellow rails (Bookhout 1995), preventing the encroachment of woody vegetation may be an important strategy for conserving yellow rail habitat (Stenzel 1982). This could be achieved through periodic burning of the wetland area (Stenzel 1982, Eddleman et al. 1988, Grace et al. 2005). The timing of burns may be important, however, as Robert and Laporte (1999) found that wetlands burned in May were not used by yellow rails until July or August of the same year, after the vegetation had grown back sufficiently. Similarly, cattle grazing can reduce the encroachment of woody vegetation (Bailey et al. 1990), and therefore might be used as a tool to maintain yellow rail habitat. However, this would have to be closely watched, as Eddleman et al. (1988) suggest that cattle grazing of wetland vegetation can destroy

vegetation cover or interfere with rail breeding success through the disruption of breeding pairs or trampling of nests, and grazing can adversely affect sedge vegetation (Stewart and Kantrud 1972, Millar 1973).

The conservation of yellow rail habitat might also be possible in conjunction with current wetland conservation efforts in south-central Manitoba that target other species of waterfowl. At some large wetland complexes, such as Delta Marsh and Oak Hammock Marsh, water levels are controlled to maintain suitable habitat for waterfowl. However, these managed wetlands can often be beneficial for other species of wetland birds (Naugle et al. 2000), including rails (Johnson and Dinsmore 1986). Yellow rail habitat might be created and maintained if the margins surrounding the wetland complex support adequate sedge vegetation (Alvo and Robert 1999). A better understanding of the local- and landscape-scale variables influencing habitat suitability for yellow rails will aid the identification of management strategies that would be most beneficial for the yellow rail.

## **2.8 OCCUPANCY MODELING**

One of the issues associated with developing habitat suitability models using presence-absence data is that the detection probability of most species is less than one (MacKenzie et al. 2002, MacKenzie et al. 2006). As a result, sites that are classified as ‘absences’ due to non-detection of the target species may actually be the result of one of two situations: 1) the species is not present at the site, or 2) the species is actually present at the site, but due to an imperfect detection probability it is not detected by the observer (MacKenzie et al. 2006). The second case results in what is known as a ‘false absence’ (MacKenzie et al. 2006). This could bias an assessment of the importance or use of different habitat types: sites that are improperly classified as ‘absences’ might actually

represent suitable habitat for the species, leading to errors in defining habitat suitability for that species (Tyre et al. 2003, Gu and Swihart 2004, MacKenzie et al. 2006). For an at-risk species such as the yellow rail, ignoring suitable habitat as a result of false absences could have deleterious effects in terms of failing to recognize and devote protection efforts to areas of important habitat for that species (Gu and Swihart 2004). To address this issue, a technique called occupancy modeling has been developed, which incorporates a species' detection probability to determine the probability that a given site is actually occupied by the species (MacKenzie et al. 2002, MacKenzie et al. 2006). While the detection probability for other secretive marsh birds has been estimated (e.g. Conway et al. 2004), no published information could be found on the detection probability for the yellow rail.

## **2.9 SUMMARY OF LITERATURE REVIEW**

The elusive behaviour of the yellow rail and the challenges associated with surveying for this species have resulted in a lack of knowledge about basic life history characteristics and uncertainty about actual population sizes and trends throughout the breeding and wintering range. The detectability of yellow rails during night surveys is not well understood, particularly due to an imperfect understanding of yellow rail detection probability. Furthermore, knowledge about habitat suitability requirements is lacking for this species. At the local scale, yellow rails are known to associate with shallow, sedge-dominated wetlands. However, observations of yellow rails in wetlands dominated by grasses, rushes, and forbs suggest that suitable habitat for yellow rails might encompass a wider variety of wetland types. In contrast, cattails and woody vegetation are thought to decrease wetland suitability for yellow rails. The extent of the influence of these other



vegetation types on yellow rail habitat suitability needs further study. In addition, the relative importance of vegetation community composition compared to structural vegetation characteristics is poorly understood. Water depth is thought to be an important influence on habitat suitability for yellow rails, but the variation in suitable water levels is not known. Finally, yellow rails are commonly thought to associate with large wetlands. However, small wetlands may provide appropriate habitat; this needs to be further investigated. In addition to the uncertainty of the influence of local wetland characteristics, yellow rail habitat has not been evaluated from a landscape scale; this prevents us from being able to predict which unsurveyed wetlands might provide suitable habitat for yellow rails.

Due to population declines believed to be associated with habitat loss, the yellow rail has been federally listed as a species of Special Concern in Canada. Within the Canadian portion of their breeding range, a large amount of suitable habitat might exist in Manitoba. Currently, there are twenty-six known breeding sites of yellow rails in Manitoba (excluding Hudson Bay), although it is believed that there are likely dozens or hundreds more.

A yellow rail management plan is currently being developed. A better understanding of the detection probability of yellow rails during night surveys and the local and landscape-scale variables that influence habitat suitability for this species is needed to inform decisions relating to the management and conservation of yellow rail habitat.

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## **CHAPTER 3: DETECTABILITY OF YELLOW RAILS USING REPEAT-VISIT, CALL-BROADCAST NIGHT SURVEYS**

### **3.1 INTRODUCTION**

The yellow rail has been listed as a species of Special Concern in Canada (COSEWIC 2001, 2009) and as a species of Special Management Concern in the United States (United States Fish and Wildlife Service 2002). In Canada, population sizes and trends for this species are based on crude estimates for most provinces (Alvo and Robert 1999). Most populations are believed to have declined and may still be declining (Alvo and Robert 1999, COSEWIC 2009). Much of the uncertainty associated with population sizes and trends is due to challenges and uncertainties associated with surveying for yellow rails. Common, long-term avian census programs, such as the North American Breeding Bird Survey, do not effectively sample wetland habitats (Herkert 1995, Ribic et al. 1999, COSEWIC 2009). Additionally, yellow rails vocalize primarily at night (Bookhout 1995, Robert 1997), a period that is not encompassed by the morning or evening surveys that are typically conducted for other marsh birds (Conway 2009, Conway and Nadeau 2010). Thus, a special survey effort is required for yellow rails. Survey protocols targeting yellow rails (e.g. Bazin and Baldwin 2007) recommend that multiple-visit, call-broadcast night surveys be used to survey for yellow rails. However, little is known about the effectiveness of these night surveys in detecting yellow rails, and on the environmental and temporal conditions affecting yellow rail detectability.

Call-broadcast has become standard in marsh bird survey methods (Conway 2009). This survey method, which involves playing tape-recorded calls of the target species to elicit vocal responses, has been used to survey marsh birds for several decades (Glahn 1974, Johnson and Dinsmore 1986). Compared to passive listening surveys, the

use of conspecific call-broadcast has been shown to increase the number of rails and bitterns detected (Gibbs and Melvin 1993, Lor and Malecki 2002, Allen et al. 2004, Conway and Gibbs 2005), thus providing more accurate abundance estimates. Yet, the effectiveness of call-broadcast for detecting yellow rails during night surveys is not well understood (Nadeau et al. 2008).

The effectiveness of surveys for secretive marsh birds is partly influenced by the focal species' detection probability. Most species exhibit imperfect detection: individuals that are present at a site may not always be detected during surveys (MacKenzie et al. 2002). Knowledge of a species' detection probability is necessary for determining the number of surveys required to detect the species at sites that it occupies (MacKenzie et al. 2002, MacKenzie and Royle 2005). If too few survey visits are used, sites may be falsely classified as unoccupied by the species (Tyre et al. 2003, MacKenzie 2005, MacKenzie and Royle 2005, MacKenzie et al. 2006). Conversely, if a single survey visit is sufficient, repeat site visits needlessly consume financial and personnel resources that could be better devoted to increasing the study sample size by surveying additional sites. The detection probability of yellow rails needs to be quantified to determine if single survey visits adequately capture the majority of yellow rails present, or if repeat surveys at each site are required.

Finally, temporal and environmental factors and observer effects can influence a species' detectability and, therefore, survey effectiveness. To obtain accurate data on population sizes and trends, surveys should coincide with the peak vocalization period of the target species (Rehm and Baldassarre 2007). Studies have shown that the detection probability for other marsh bird species is not constant throughout the breeding season

(Legare et al. 1999, Rehm and Baldassarre 2007), and that peak detection periods throughout the breeding season vary for each species (Rehm and Baldassarre 2007). Furthermore, the detection probability of marsh birds is often not constant throughout a daily survey period. This has been shown for California black rails (Spear et al. 1999), and least and American bitterns (Gibbs and Melvin 1993). Variation in the detectability of yellow rails throughout the breeding season and throughout the night is not well understood. Environmental factors such as temperature and wind can also influence the detection probability of marsh bird species (Gibbs and Melvin 1993, Legare et al. 1999, Spear et al. 1999). In addition, because yellow rails vocalize at night, their detectability may be influenced by factors that affect ambient light levels, such as cloud cover, moon phase and moon visibility (Spear et al. 1999, Mougeot and Bretagnolle 2000). Finally, the detection probability of a species may be influenced by observer behaviour or ability (Conway et al. 2004, Nadeau et al. 2008).

In this study, I evaluated the effectiveness of repeat-visit, call-broadcast night surveys for detecting yellow rails. I also quantified yellow rail detection probability, and evaluated the influence of temporal and environmental variables on yellow rail detectability to help inform future survey methods and monitoring programs for this species of Special Concern.

## **3.2 STUDY AREA AND METHODS**

### **3.2.1 Study Area**

The study area consisted of 82 wetlands in south-central Manitoba (Figure 3-1). The study area was bound to the north by Ashern (UTM 14U 5670386 N, 546618 E), to the east by Menisino (UTM 14U 709154 N, 5441370 E), to the south by Sirko (UTM

14U 5432839 N, 701311 E) and to the west by Portage la Prairie (UTM 14U 5535846 N, 550726 E). The study area included two different ecoregions: the Interlake Plain and the Lake Manitoba Plain (Ecological Stratification Working Group 1995). Upland vegetation in the Interlake Plain ecoregion was dominated by shrubs, trembling aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*), while common upland vegetation types of the Lake Manitoba Plain ecoregion included oak (*Quercus* spp.) and trembling aspen (*Populus tremuloides*) intermixed with fescue (*Festuca* spp.) grasslands (Ecological Stratification Working Group 1995). In both ecoregions, wetlands were characterized by sedge and willow vegetation (Ecological Stratification Working Group 1995). Agricultural production was a common land use in both ecoregions (Ecological Stratification Working Group 1995).

### 3.2.2 Selection of Study Wetlands

Of the 82 wetlands, 44 were surveyed in 2010, and 38 were surveyed in 2011. Although random wetland selection would better represent the variation in wetland types found in the study area (Gibbs and Melvin 1997), random selection of study sites can be problematic if the target species is uncommon, as the species may not be detected at any of the randomly selected sites (Gibbs and Melvin 1997). To increase the probability of sampling an adequate number of wetlands occupied by yellow rails, study wetlands were selected opportunistically in two ways.

All wetlands ( $n = 10$ ) within the study area at which yellow rail presence had been confirmed in previous breeding seasons were selected (Table 3-1). These site locations were obtained from local birdwatchers, researchers, published literature, and Manitoba Conservation Data Centre records, and were all surveyed in 2010. The remaining 72

wetlands surveyed in 2010 or 2011 were selected based on the presence of vegetation types that yellow rails have been associated with: sedge, rush and/or grass (Elliot and Morrison 1979, Stenzel 1982, Popper and Stern 2000).



Figure 3-1 Study area consisting of 82 wetlands in south-central Manitoba. Wetlands surveyed in 2010 are denoted by circles, those surveyed in 2011 are denoted by stars. Base layer map from ESRI (2010).

Table 3-1 Locations of ten wetlands in south-central Manitoba, all surveyed in 2010, at which yellow rail presence had been detected in previous breeding seasons.

Site Name	UTM Zone	UTM Easting	UTM Northing	Information Source
Tall Grass Prairie Preserve	14 U	663158	5455070	Local Birdwatcher
Sundown Bog	14 U	691817	5442395	Local Birdwatchers/Biologists
Richer	14 U	685187	5503706	Manitoba Conservation Data Centre
PR 501, Ste. Genevieve	14 U	679067	5513996	Local Birdwatchers
Brokenhead Swamp	14 U	686469	5513955	Local Birdwatchers
Grant's Lake WMA	14 U	604331	5546737	Fryer 1937
Oak Hammock WMA	14 U	631283	5562129	Local Birdwatchers, Holland and Taylor 2003
Little Birch WMA	14 U	552117	5662486	Local Birdwatcher/Biologist
Marshy Point	14 U	568001	5597041	Local Birdwatcher/Biologist
3 km NE of Lundar	14 U	569281	5620326	Manitoba Conservation Data Centre

### 3.2.3 Selection of Survey Points

A map of each wetland was created in ArcMap 10.0 (ESRI 2010) using land cover type layers (Manitoba Land Initiative 2001, 2002) and a waterbodies inventory layer (Manitoba Land Initiative, year unknown). At each study wetland, an initial survey point was chosen by extrapolating a randomly selected angle (0° to 359°) from the center of the wetland to the edge. Additional survey points within a wetland were selected in the same manner. Survey points were separated by a minimum of 400 m to reduce the probability of double-counting individual yellow rails (Conway 2009). If an additional survey point corresponding to a randomly selected angle was not at least 400 m from all other survey points, a new angle was randomly selected until this condition was met.

Survey points were added until each wetland was saturated with survey points, or until a

maximum of eight survey points was established. As surveys were conducted at night, survey points were situated within 900 m of road access for safety reasons. For large wetlands that could not be completely surveyed due to these constraints, only a portion of the wetland was surveyed.

Locations of all survey points (in UTM) were obtained from ArcMap 10.0 (ESRI 2010), and transferred to a handheld GPS unit. Upon the first wetland visit, survey points located in unsuitable or inaccessible habitat (e.g. in deep water or a thick cattail patch) were re-located to the nearest suitable habitat if possible, or eliminated if relocation to suitable habitat that was at least 400 m away from other survey points was not possible. In total, 178 survey points were established within the 82 study wetlands (range = 1 to 8 points/wetland, mean = 2.2 points/wetland, mode = 1 point/wetland). Seven of these points were interior wetland points in large, shallow wetlands where access (on foot) to the wetland interior was possible; all other points were located along the wetland edge.

#### 3.2.4 Call-Broadcast Surveys for Yellow Rails

The call-broadcast method was used to survey for yellow rails, as is standard for secretive wetland birds (Johnson and Dinsmore 1986, Gibbs and Melvin 1993, Gibbs and Melvin 1997, Lor and Malecki 2002, Prescott et al. 2002, Allen et al. 2004, Conway 2009). The Canadian Wildlife Service Standardized Protocol for the Survey of Yellow Rails in Prairie and Northern Region (Bazin and Baldwin 2007) was followed as its scope includes south-central Manitoba, and it employs survey methods that are consistent with wider-ranging marsh bird survey protocols, such as the USGS Standardized North American Marsh Bird Monitoring Protocols (Conway 2009).

Each survey was ten minutes in length, and consisted of a five-minute passive-listening period, followed by a three-minute conspecific call-broadcast period, and a final two-minute passive-listening period (Bazin and Baldwin 2007). Each minute of the call-broadcast period consisted of 30 seconds of broadcasted yellow rail clicking vocalizations (courtesy of Monty Brigham, Bird Sounds of Canada CD) followed by 30 seconds of silence (Bazin and Baldwin 2007). The same yellow rail vocalization sequence was used for all surveys. The vocalizations were broadcast from a game caller (Western Rivers, Tennessee, USA), facing the wetland center, at approximately 70 dB (measured 1 m in front of the speaker). As suggested by Conway (2009), surveys were initiated upon arrival at the survey point, with no initial settlement period. Each ten-minute survey period was sub-divided into one-minute counting blocks (see sample survey form in Appendix I; Bazin and Baldwin 2007). To keep track of individual yellow rails, the distance (0-25m, 25-50m, 50-75m, 75-125m, 125-200m, or >200m) and direction of each vocalizing yellow rail from the survey point were estimated (Bazin and Baldwin 2007). The vocalizing activity (i.e. vocalizing or not vocalizing) was noted for each yellow rail during each minute, as well as immediately prior to and after the survey.

In each year, two rounds of yellow rail surveys were conducted at each wetland, between 23 May and 5 July, which corresponds with the most active vocalization period for yellow rails in the study region (Holland and Taylor 2003, Bazin and Baldwin 2007). In 2010, wetlands were surveyed once between 23 May and 15 June 2010 and again between 16 June and 5 July 2010. In 2011, wetlands were surveyed once between 24 May and 14 June 2011 and again between 15 June and 1 July 2011. In 2011, two complete wetlands ( $n = 10$  survey points) and one of the points from another wetland



were only surveyed on the first survey round, as flooding of Lake Manitoba and the Shoal Lakes prevented site access on the second survey round. This reduced the total number of survey points that were surveyed twice to 167 points within 80 wetlands. In 2010, the length of time between the first and second surveys ranged from 14 to 40 days, with a mean of 22 days. In 2011, the length of time between the two surveys ranged from 10 to 33 days, with a mean of 20 days. Surveys were restricted to between one hour after sunset and one hour before sunrise, to correspond with highest yellow rail vocal activity (Bazin and Baldwin 2007). Prior to initiating each survey, ambient temperature (in °C) was measured using a Kestrel 2000 Pocket Wind Meter (Nielson-Kellerman, Pennsylvania, USA) in 2010 and from the field vehicle's temperature sensor in 2011. The moon phase (e.g. new, full), moon visibility (e.g. visible, obscured), percent of the sky covered by clouds (0%, 0-25%, 25-50%, 50-75%, 75-100% or 100%), and Beaufort wind speed were also noted at the start of each survey. Surveys were not conducted during heavy rain or wind speeds of Beaufort 4 or greater (Bazin and Baldwin 2007).

All surveys in 2010 and all first round surveys in 2011 were conducted jointly by K. Martin and one other individual (D. Furutani), with both observers contributing yellow rail detections to the survey. In 2011, the double-observer method (Nichols et al. 2000) was used for all second-round surveys to determine if observer identity affects the probability of detecting yellow rails during night surveys. For these surveys, one observer was randomly designated as the primary observer, and the other as the secondary observer, at the beginning of the first survey each night (Nichols et al. 2000). During the survey, the primary observer would announce all of the birds that they heard and the birds' initial distances and directions from the survey point (Nichols et al. 2000). Both

observers recorded this information on separate data sheets. In addition to all of the primary observer's observations, the secondary observer recorded all of the birds they detected that were missed by the primary observer (Nichols et al. 2000). The secondary observer always stood behind the primary observer during surveys to avoid indirectly informing the primary observer about additional birds that were missed (Nichols et al. 2000). The observers alternated between primary and secondary roles for the remainder of the surveys each night (Nichols et al. 2000). While only those surveys conducted using the double-observer method (i.e. second-round surveys in 2011) were used to quantify observer effects, all four survey rounds in 2010-2011 were used in all other analyses, as in all cases both observers contributed yellow rail detections to the surveys.

### 3.2.5 Data Analysis

For each survey round, the percent increase in yellow rails detected as a result of the call-broadcast segment was calculated as:

$$\frac{(\text{total \# of yellow rails detected} - \text{\# of yellow rails detected during passive period})}{(\text{\# of yellow rails detected during passive period})} \times 100$$

The percent increase in the number of survey points at which yellow rails were detected as a result of the second survey round was calculated as:

$$\frac{(\text{\# of survey points where yellow rails were only detected on round 2})}{(\text{\# of survey points where yellow rails were detected on round 1})} \times 100$$

Similarly, the percent increase in the number of wetlands at which yellow rails were detected as a result of the second survey round was calculated as:

$$\frac{(\text{\# of wetlands where yellow rails were only detected on round 2})}{(\text{\# of wetlands where yellow rails were detected on round 1})} \times 100$$

Yellow rail detection probability and the estimated true wetland occupancy were calculated in the software program PRESENCE (version 2.3, available at

<http://www.mbr-pwrc.usgs.gov/software/presence.html>). Detection probability and the resulting true wetland occupancy were estimated for 2010 ( $n = 44$  wetlands) and 2011 ( $n = 36$  wetlands) separately, as two different sets of wetlands were surveyed in each year. For each dataset, two candidate models were tested in PRESENCE: one holding detection probability constant over the two survey rounds, and the other allowing detection probability to vary between the two survey rounds. For each year, the model that best explained yellow rail detection probability was selected using Akaike's Information Criterion, corrected for small sample size ( $AIC_c$ ; Burnham and Anderson 2002).

A generalized linear mixed model (GLMM; PROC GLIMMIX, SAS 9.2, SAS Institute Inc. 2008) was used to determine if the number of yellow rails detected per survey point varied linearly with ambient temperature, moon phase, moon visibility, cloud cover, Beaufort wind speed, Julian date, year and time since sunset. A two-way interaction term of moon phase and moon visibility was included to evaluate the effect of ambient light on yellow rail detectability. Quadratic effects of date and time since sunset were also evaluated. Site occupancy was assumed to be constant for each breeding season, so the dataset for this analysis was limited to only surveys at points where yellow rails were detected at least once over the two survey rounds ( $n = 150$  surveys at 75 survey points; Conway et al. 2004, Conway and Gibbs 2005, Rehm and Baldassarre 2007). Including survey points at which yellow rails were never detected would have biased the results, as those survey points would have been interpreted as points where yellow rails were present, but not detected. Instead, it was assumed that yellow rails were not present at those survey points (i.e. there were no yellow rails there to detect), and, therefore, they

were not included in the analysis. Yellow rails that were detected while walking between survey points but not during surveys were not included in the analysis.

A Poisson distribution was used to describe the distribution of the response variable, the number of yellow rails detected per survey point, as the model did not converge when a negative binomial distribution was specified. Wetland was included as a random effects variable. I initially also included survey point as a random variable but the estimate of its effect size was very small, suggesting that it did not explain a significant amount of additional variation in the data. Including survey point as an additional random variable also led to the model's failure to converge, presumably because the model was over-parameterized. Survey point was, therefore, excluded from the final model. An alpha level of 0.1 was used to reduce the probability of Type II error.

To evaluate whether variables were collinear, prior to the final analyses I calculated correlations between the independent variables, using Spearman's rank correlation coefficient ( $r_s$ ) because the distributions of the independent variables were not normal. As expected, temperature and Julian date were correlated ( $r_s = 0.73$ ,  $p = <0.0001$ ). However, because this correlation was less than  $r_s = 0.75$ , and because excluding influential variables can result in misleading conclusions about the effect and significance of variables with which they are correlated (Smith et al. 2009), both variables were still included in the model. No other variables were highly correlated. All survey condition variables were treated as continuous. Moon phase was classified on a scale from 0 (new moon) to 4 (full moon), and moon visibility was classified on a scale from 0 (moon absent) to 2 (moon visible). Time since sunset was the number of minutes between sunset (for Winnipeg, Lat. 49.9, Long. -97.22) and the survey start time.

The software program DOBSERV (Hines 2000, available at <http://137.227.242.23/software/dobserv.shtml>) was used to calculate observer detection probability. First, two standard candidate models were tested in DOBSERV (Table 3-2) on the survey data collected while using the double-observer approach (i.e. all second-round surveys in 2011): one model holding observer detection probability the same for both observers, and the other allowing observer detection probability to vary with observer (Table 3-2).  $AIC_c$  was used to select the best-fitting model, which was then used to calculate observer detection probability for both observers.

Table 3-2 The two candidate models tested in program DOBSERV to see which best explains observer detection probability and species detection probability (Hines 2000) for the detection of yellow rails during night surveys conducted at wetlands in south-central Manitoba in 2011.

Model	Observer Detection Probability	Species Detection Probability
P(.,.)	Same for both observers	Same for all species
P(.,I)	Different for each observer	Same for all species

### 3.3 RESULTS

#### 3.3.1 Night Surveys for Yellow Rails in South-Central Manitoba

In 2010-2011, 334 night surveys for yellow rails were conducted (218 in 2010, 116 in 2011) at 167 survey points within 80 wetlands. More yellow rails were detected in 2010 than in 2011 (Table 3-3). In both years, the number of yellow rails detected per survey point ranged from 0 to 4. In 2010, an additional twenty yellow rails were detected while walking between survey points, but not during the yellow rail surveys. In 2011, two additional yellow rails were detected while walking between survey points. Yellow rail presence was detected at a higher proportion of survey points and wetlands in 2010 than in 2011 (Table 3-3). Over the two years of the study, yellow rail presence was confirmed at 35 of the 80 wetlands (43.8%).

Table 3-3 Results of 334 night surveys for yellow rail conducted at 167 survey points within 80 wetlands in south-central Manitoba in 2010-2011.

Year	# Yellow Rails Detected on Round 1	# Yellow Rails Detected on Round 2	% of Survey Points Where Yellow Rails Detected	% of Wetlands Where Yellow Rails Detected
2010	88	69	50.5	54.5
2011	31	16	36.2	30.6

### 3.3.2 Use of Call-Broadcast during Night Surveys for Yellow Rail

In 2010, the call-broadcast segment increased the number of yellow rails detected by 17.3% and 6.2% during the first and second survey rounds, respectively (Figure 3-2). In 2011, no new individuals were detected as a result of the call-broadcast segment on the first round of surveys, but 14.3% more yellow rails were detected as a result of call-broadcast on the second survey round (Figure 3-2). On average, call-broadcast increased the number of yellow rails detected by 9.5% per survey round.

Of the 204 yellow rails detected during night surveys in 2010-2011, the majority of individuals were detected within the first survey minute (Figure 3-3). Yellow rails did not respond immediately to the conspecific call-broadcast segment; the entire three-minute call-broadcast segment and the first minute of the final passive listening period were important for detecting new yellow rails (Figure 3-3). Only 3.9% of the yellow rails detected prior to the call-broadcast segment stopped vocalizing after initiation of the call-broadcast sequence.

The call-broadcast segment increased the number of survey points at which yellow rail presence was confirmed by 1.4% in 2010 and 0.8% in 2011. Use of the call-broadcast segment did not increase the number of wetlands at which yellow rail presence was confirmed in either year of the study.

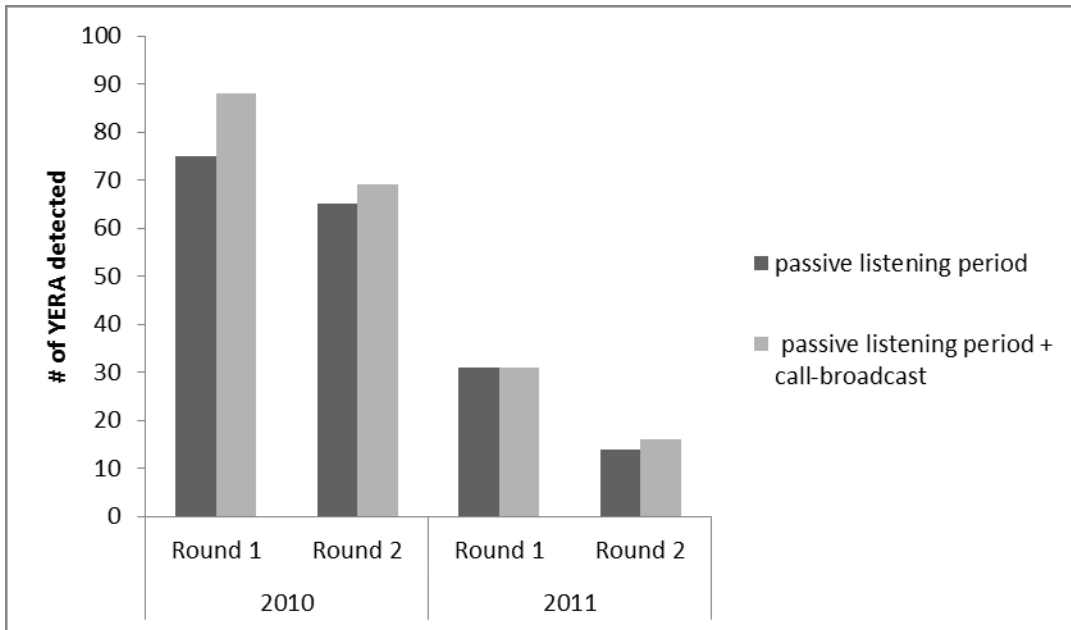


Figure 3-2 Number of yellow rails (YERA) detected during the five-minute initial passive listening period compared to the number detected during the five-minute passive listening period and the five-minute call-broadcast period combined for each yellow rail survey round conducted in south-central Manitoba in 2010 and 2011.



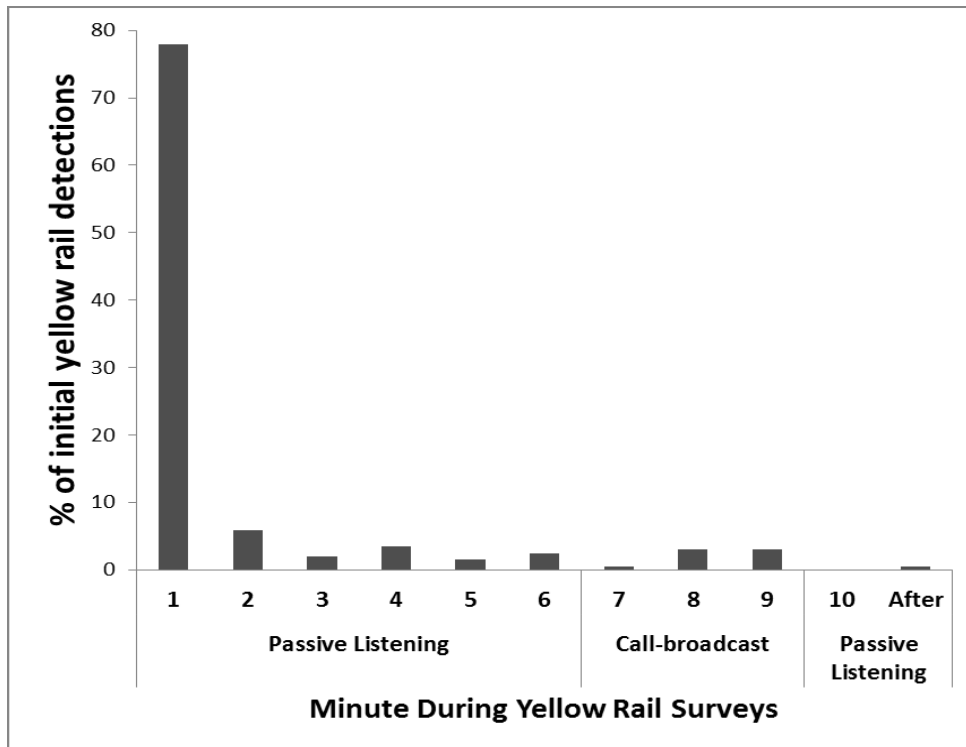


Figure 3-3 Survey minute in which individual yellow rails were initially detected during night surveys conducted in south-central Manitoba in 2010-2011.

### 3.3.3 Repeat Site Visits, Yellow Rail Detection Probability, and Occupancy Estimation

In both years, yellow rails were detected at more survey points and more wetlands on the first round of surveys as compared to the second round of surveys. However, the second survey round increased the overall number of survey points and wetlands at which yellow rails were detected by 22% and 26%, respectively, in 2010, and by 3.4% and 5.6%, respectively, in 2011. Of the 35 wetlands at which yellow rail presence was detected in the two-year study, yellow rails were heard at only 16 (45.7%) of the wetlands in both survey rounds.

Detection probability and estimated wetland occupancy were similar in both years. In each year, the best-supported model was the model holding detection probability

constant over both survey rounds (Tables 3-4, 3-5). For both datasets, the  $\Delta AIC_c$  of the model allowing detection to vary with survey round was less than 2. However, because the model holding detection probability constant had fewer parameters, and had double the  $AIC_c$  weight, the model holding detection probability constant was assumed to best explain the data. In 2010, the detection probability for yellow rail was estimated at 0.63 (SE = 0.096). The true wetland occupancy rate was estimated at 0.63 (SE = 0.10). This estimated true wetland occupancy rate was 16% higher than the naïve occupancy rate of 0.545. For the 2011 dataset, the probability of detection for yellow rail was estimated at 0.63 (SE = 0.14). The true wetland occupancy rate was estimated at 0.36 (SE = 0.0996), which was 17.8% higher than the naïve occupancy rate of 0.306. In both years, the 95% confidence intervals of the estimated true wetland occupancy encompassed the naïve occupancy rate (95% CI = 0.434 – 0.826 in 2010, 95% CI = 0.165 – 0.555 in 2011).

Table 3-4  $AIC_c$  values and weights for the two candidate models tested in PRESENCE to estimate yellow rail detection probability and estimated true wetland occupancy at 44 wetlands, located in south-central Manitoba, surveyed in 2010.

Model	# of Parameters	-2*Log-Likelihood	AIC	$AIC_c$	$\Delta AIC_c$	$AIC_c$ weight
Constant detection probability	2	111.760	115.760	116.050	0	0.691
Survey-specific detection probability	3	111.060	117.060	117.660	1.610	0.309

Table 3-5 AIC<sub>c</sub> values and weights for the two candidate models tested in PRESENCE to estimate yellow rail detection probability and estimated true wetland occupancy at 36 wetlands, located in south-central Manitoba, surveyed in 2011.

Model	# of Para- meters	-2*Log- Likelihood	AIC	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	AIC <sub>c</sub> weight
Constant detection probability	2	67.790	71.790	72.150	0	0.702
Survey-specific detection probability	3	67.110	73.110	73.860	1.710	0.298

### 3.3.4 Effects of Survey Conditions on the Detection Probability of Yellow Rails

The number of yellow rail detections was not significantly affected by any of the temporal or environmental covariates tested (Table 3-6). In addition, no significant quadratic relationships existed between the number of yellow rails detected and date ( $\beta$  estimate =  $-1.5 \times 10^{-6}$ ,  $p = 0.998$ ) or time since sunset ( $\beta$  estimate =  $-1.0 \times 10^{-5}$ ,  $p = 0.355$ ).

Table 3-6 Results of a generalized linear mixed model evaluating the effects of survey conditions on the number of yellow rails detected during 150 night surveys at 75 survey points at wetlands in south-central Manitoba where yellow rails were detected at least once throughout the breeding season in 2010 or 2011.

Survey Covariate	$\beta$ Estimate	Standard Error	Degrees of Freedom	$p$
Intercept	1.708	1.315	33	0.203
Year	0.084	0.276	33	0.764
Time since sunset	-0.001	0.001	107	0.185
Temperature	-0.003	0.031	107	0.922
Julian date	-0.005	0.009	107	0.562
Beaufort windspeed	-0.104	0.098	107	0.289
Cloud cover	-0.085	0.069	107	0.218
Moon phase	-0.088	0.136	107	0.519
Moon visibility	-0.036	0.313	107	0.908
Moon phase*moon visibility	0.024	0.138	107	0.862

### 3.3.5 Observer Detection Probability

The double-observer approach was used for 58 surveys in 2011. Yellow rails ( $n = 16$ ) were detected in 10 surveys. Of the two candidate models tested in program DOBSERV (Table 3-2; Hines 2000), the P(.,.) model, in which detection probability was the same for both observers, was the simplest applicable model that best explained the data (Table 3-7). Observer detection probability ( $\pm$  standard error) for both observers was high:  $0.98 \pm 0.03$ . Thus, as the primary observer, Observer 1 detected 98.3% of the yellow rails that were detected by the secondary observer. As the primary observer, Observer 2 detected 98.3% of the yellow rails that were detected by the secondary observer.

Table 3-7 AIC<sub>c</sub> values for two candidate models tested in program DOBSERV (Hines 2000) to explain observer detection probability for yellow rail surveys conducted in south-central Manitoba in 2010-2011.

Model	Likelihood	DF	AIC	QAIC	AIC <sub>c</sub>	QAIC <sub>c</sub>	G-O-F
P(.,.)	-1.885	3	5.770	5.770	6.056	6.056	0.998
P(.,I)	-1.867	2	7.734	7.734	8.657	8.657	1.000

### 3.4 DISCUSSION

#### 3.4.1 Night Surveys for Yellow Rails in South-Central Manitoba

Although fewer yellow rails were detected in 2011, this should not be interpreted as a population decline from 2010. Fewer surveys were conducted in 2011 (116 as compared to 218 in 2010), at a smaller number of wetlands (36 as compared to 44 in 2010). In addition, ten wetlands that were surveyed in 2010 were locations where yellow rails had been detected in previous year(s), while none of the 2011 wetlands had been surveyed before. In particular, two large, well-known yellow rail locations, Oak Hammock Marsh (UTM 14U 631283 5562129) and Sundown Bog (UTM 14U 691817 5442395), collectively accounted for 43.2% and 40.6% of all yellow rails detected on the first and second survey rounds, respectively, in 2010. Increased knowledge about the potential for yellow rails at the ten sites where yellow rails had been detected in previous years may have contributed to the higher number of yellow rails detected in 2010 as compared to 2011. Overall, however, the relatively high number of occupied sites supports the belief that yellow rails are more abundant and widespread than the few documented sites where they have been known to occur (Alvo and Robert 1999).

### 3.4.2 Call-Broadcast Surveys for Yellow Rail

The use of a yellow rail call-broadcast segment increased the number of yellow rails detected in three of the four rounds of night surveys. The magnitudes of the increases (<20% for each survey round) were similar to the 19.6% increase in yellow rails detected as a result of call-broadcast used in night surveys in a study in Alberta (Prescott et al. 2002). In contrast, Conway and Nadeau (2010) found that call-broadcast increased the number of yellow rail detections by 112% during morning and evening surveys. Night surveys encompass the primary vocalization period of yellow rail (Bookhout 1995, Robert 1997). The relatively low response by yellow rail to the conspecific call-broadcast suggests that the majority of yellow rails were already vocalizing prior to the initiation of the call-broadcast segment. Other species of secretive marsh birds have shown much higher responses to call-broadcast during their primary vocalization periods. For example, call-broadcast (using multiple species' calls) has been shown to increase the number of American bitterns detected by >50% (Lor and Malecki 2002), soras by >100% (Lor and Malecki 2002, Allen et al. 2004), Virginia rails by >400% (Lor and Malecki 2002, Allen et al. 2004), and king rails (*Rallus elegans*) by >1000% (Allen et al. 2004). Therefore, despite the yellow rail being considered a very secretive species (Robert 1997, Sibley 2000), yellow rails vocalize quite readily during their primary vocalization period, as compared to other marsh bird species. Conspecific call-broadcast should nonetheless continue to be used in night surveys for yellow rail to maximize the number of yellow rails detected, to achieve more accurate abundance estimates, and to reduce the probability of falsely classifying wetland sites as unoccupied by yellow rails.

Both the three-minute call-broadcast sequence and the final listening period were beneficial for detecting new yellow rails. Prescott et al. (2002) found similar results, with approximately one-third of the yellow rails detected as a result of call-broadcast being detected in the passive listening period following the call-broadcast segment. Protocols for multi-species surveys often require only 30 seconds of vocalization playback, followed by 30 seconds of silence, for each species (Conway 2009). If night surveys for yellow rail are altered to include call-broadcast for other nocturnally-vocalizing marsh bird species, such as Virginia rails or soras, the effectiveness of call-broadcast may be reduced if the length of the yellow rail call-broadcast segment is reduced. Future night surveys for yellow rail should maintain a three-minute conspecific call-broadcast segment and a final passive listening period.

#### 3.4.3 Repeat Site Visits, Yellow Rail Detection Probability and Occupancy Estimation

Differences in the number of yellow rails detected from one survey round to the next in both years indicate that yellow rail detection probability is imperfect (i.e.  $<1$ ). The estimated yellow rail detection probability of 0.63 that was calculated in both years means that if two rounds of night surveys are conducted at each study wetland, the probability of detecting yellow rail presence at wetlands where they are present is 0.63. This detection probability is relatively high for secretive marsh birds. Valente et al. (2011) estimated detection probabilities for common moorhen (*Gallinula chloropus*), least bittern and purple gallinule (*Porphyrio martinica*) at between 0.11 and 0.75, depending on observer and environmental conditions. Budd and Krementz (2010) estimated least bittern detection probability at 0.16 and 0.58 in the two years of their study. Although relatively high, a detection probability of 0.63 is still imperfect, leaving

substantial room for erroneously classifying wetlands as not occupied by yellow rails when in fact this species is actually present.

If survey points and sites were closed populations, yellow rails were always present at sites where they were detected at least once. This suggests that even if present, they were not always detected. Gibbs et al. (1991) failed to detect yellow rails in mid-June to early July at four wetlands at which yellow rails had previously been detected. Similarly, Bart et al. (1984) concluded that not all individual yellow rails vocalized every night, although no survey covariates were able to explain this trend.

The difference between survey rounds highlights the importance of conducting repeat surveys at each site. Using the estimates of detection probability ( $p$ ) and true site occupancy ( $\Psi$ ) that were calculated here, the number of site visits required to obtain a high probability of detecting yellow rails at least once at a given wetland can be calculated (MacKenzie and Royle 2005). Over the two years of the study, the mean detection probability was 0.6, and the mean true site occupancy was 0.5. Using the table developed by MacKenzie and Royle (2005), the optimal number of visits at each site for a detection probability of 0.6 and a site occupancy rate of 0.5 is 3. The probability of detecting yellow rails at least once ( $p^*$ ) using 3 site visits ( $K = 3$ ) can be calculated as follows:  $p^* = 1 - (1-p)^K = 1 - (1-0.6)^3 = 0.936$ . If four survey visits are used, the probability of detecting yellow rails if they are in fact present increases to 0.974. As these numbers give much more confidence that yellow rail presence will be detected, future night surveys for yellow rail should employ a minimum of 3, but preferably 4, survey visits to more accurately classify wetlands as being occupied by yellow rails or not.



#### 3.4.4 Effects of Survey Conditions on the Detection Probability of Yellow Rails

Yellow rail detection probability did not vary significantly with Julian date, but in both years the total number of yellow rails detected on the second round of surveys was lower than on the first. Most studies have found that yellow rail vocalization activity does not cease until mid-to-late July (Devitt 1939, Stenzel 1982) or August (Bookhout and Stenzel 1987, Robert and Laporte 1999). However, Gibbs et al. (1991) failed to detect yellow rails during surveys conducted in mid-June to early July, at locations where they had detected yellow rails on earlier surveys. Lane (1962) observed that yellow rail vocalization is high during incubation, but ceases upon hatching of the young. The decreased number of yellow rail detections on the second round of surveys in both years of this study may be the result of some individuals no longer vocalizing because their young have hatched.

A major concern with using aural surveys to inform species monitoring programs is ensuring that the survey period coincides with the species' peak vocalization period (Rehm and Baldassarre 2007). Guidelines for yellow rail surveys in Manitoba suggest that surveys be conducted no later than mid-July (Bazin and Baldwin 2007). Although not significant, the decline in yellow rail abundance throughout the season, and the lower number of detections on the second survey rounds observed in this study suggest that surveys conducted at wetlands within the same latitude as the study area should be concentrated towards the first half of the breeding season (i.e. until approximately mid-June) to maximize the number of yellow rails detected. The primary vocalization period for yellow rails might differ at different latitudes; studies conducted in other areas of the

yellow rail breeding range may need to evaluate temporal patterns in yellow rail vocalization behaviour to determine the most appropriate survey period for those areas.

Yellow rail detections decreased throughout the night, but this effect was not significant. Similarly, most studies and observations have noted that yellow rail vocal activity begins after total darkness and continues throughout the night (Devitt 1939, Gibbs et al. 1991, Bookhout 1995). Prescott et al. (2002) found that peak nightly vocalization of yellow rails was during 00:00h to 01:59h, which they describe as “the darkest part of the night”. Our study reinforces these observations, and agrees with Bazin and Baldwin’s (2007) guidelines that yellow rail surveys should be restricted to between one hour after sunset and one hour prior to sunrise.

There were no significant effects of wind, temperature, cloud cover, moon phase, moon visibility, or the interaction of moon phase and moon visibility on the detection probability of yellow rails. Bart et al. (1984) and Prescott et al. (2002) also found that yellow rail vocalization rates were not significantly influenced by weather variables. Weather variables often have little effect on the detection probabilities of marsh birds (Gibbs and Melvin 1993, Legare et al. 1999, Conway and Gibbs 2005, Conway and Nadeau 2010). Night surveys for yellow rail can, therefore, be effectively conducted during light to moderate wind speeds (Beaufort < 4). Nadeau et al. (2008) suggested that the effect of temperature on avian vocal activity has been unclear in many studies due to high correlations between temperature and time of day and temperature and time of season. In this study, temperature was not significantly correlated with time since sunset ( $r_s = -0.021, p < 0.7962$ ), but was somewhat correlated with Julian date ( $r_s = 0.73, p < 0.0001$ ). However, as Julian date did not significantly influence the detection probability

of yellow rail, it can be assumed that temperature was also not an important factor affecting the detection probability of yellow rail. Prescott et al. (2002), who also evaluated the effects of weather variables on yellow rail detectability, found that lunar phase was significant, with fewer yellow rail detections during higher moon phases. This trend was in the same direction, but not significant, in this study. In addition, the number of yellow rail detections decreased with increasing moon visibility. The positive association, between the number of yellow rails detected and the two-way interaction between moon phase and moon visibility, although not significant, suggests that the effect of moon phase increases as moon visibility increases. Studies using instruments designed to measure ambient light levels should be conducted to clarify the relationship between yellow rail detectability and light levels during the night, as ambient light has been shown to influence nightly vocalization behaviour of other avian species. For example, Mougeot and Bretagnolle (2000) found that nocturnal vocalizations of petrels decreased with increasing moon phase on nights when the moon was visible; this was suggested as a behavioural predator-avoidance strategy (Mougeot and Bretagnolle 2000).

#### 3.4.5 Observer Detection Probability

Observer detection probability for the detection of yellow rails during night surveys using call-broadcast was high compared to estimates for the detection of other species of marsh birds. For example, mean observer detection probability of California black rails was found to be 75.5% in a study by Conway et al. (2004). Similarly, Nadeau et al. (2008) found that the observer detection probability for several secretive marsh bird species was 75%. Observer detection probability does not seem to be an influential factor in the number of yellow rails detected.

### **3.5 CONCLUSIONS AND RECOMMENDATIONS**

Yellow rails appear to call fairly readily at night. The use of a call-broadcast segment resulted in an average increase of approximately 10% in the number of yellow rails detected on each round of surveys. As a result, call-broadcast is an important tool for surveying yellow rails, and should continue to be used in night surveys for this species. However, surveys where this is not feasible, such as volunteer surveys and breeding bird atlases, would still be likely to obtain reasonably good estimates of yellow rail abundances, as long as surveys were conducted at night.

Yellow rail detection was imperfect, but fairly high at 0.63 in both years. I recommend that future yellow rail studies should employ at least three, but preferably four, survey visits to each point and wetland to maximize the number of yellow rails detected and to correctly classify sites as occupied or unoccupied by yellow rails.

Yellow rails were detected in lower numbers and at fewer survey points and sites on the second survey round in both years of the study. Because of this, I recommend that in future studies at wetlands located at the same latitude as the study area, if four rounds of surveys are conducted, that two or perhaps even three of the survey rounds are conducted by mid-June. This will also help to capture the most vocal period for yellow rails.

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## **CHAPTER 4: HABITAT SUITABILITY FOR YELLOW RAILS IN SOUTH-CENTRAL MANITOBA: AN EVALUATION AT MULTIPLE SPATIAL SCALES**

### **4.1 INTRODUCTION**

In Canada, legislation concerning species-at-risk conservation specifies that management plans, action plans, and/or recovery strategies be developed for each species designated as at-risk (Species at Risk Act 2002). These action plans and recovery strategies are based on scientific and traditional knowledge about the species' natural history and habitat requirements (Species at Risk Act 2002). In the case of species that have experienced population declines associated with habitat loss, these plans and strategies often require that the species' critical habitat, defined as "the habitat that is necessary for the survival or recovery of a listed wildlife species" (Species at Risk Act 2002, s.2, page 4), be identified and protected from future loss or degradation (Species at Risk Act 2002). The identification of critical habitat can only be achieved if the habitat requirements for the focal species are well-understood.

To fully understand habitat requirements for any species, habitat suitability needs to be evaluated at multiple spatial scales (Wiens 1989, Naugle et al. 1999, Naugle et al. 2000, Koper and Schmiegelow 2006). In this type of analysis, the influence of variables from several different habitat scales (e.g. plot scale, patch scale, 1-km landscape scale, etc.) on the focal species is investigated. Some habitat variables can be influential at one scale and not another (Turner 1989, Wiens 1989). This may be related to the extent of the environment that is perceived by the focal species (Wiens and Milne 1989). Failing to conduct a habitat suitability analysis at multiple spatial scales could result in falsely concluding that habitat variables do not affect the suitability of the habitat patch for the focal species (Wiens 1989). If management plans and recovery strategies are based on

this inaccurate information, their success in conserving habitats and promoting the recovery of at-risk species may be limited.

Local habitat characteristics are often important influences on habitat suitability for avian species. Among wetland birds, habitat characteristics such as the amount of emergent vegetation within a wetland (Fairbairn and Dinsmore 2001, Riffell et al. 2003), vegetation structure (Sayre and Rundle 1984, Riffell et al. 2001, Riffell et al. 2003), the composition of the wetland vegetation community (Riffell et al. 2001), water depth (Sayre and Rundle 1984, Riffell et al. 2003), and wetland size (Brown and Dinsmore 1986, Guadagnin and Maltchik 2007) are known to influence habitat suitability.

Broader, landscape-scale characteristics have also been shown to influence habitat suitability for many bird species. In general, four characteristics have been of particular interest: the amount of habitat in the landscape, the degree of habitat fragmentation within the landscape, landscape composition, and landscape configuration.

Landscape habitat amount represents the total amount of suitable habitat for the target species that is present in the landscape. Avian species' presence is often positively related to the amount of suitable habitat in the landscape (Trzcinski et al. 1999, Villard et al. 1999, Bakker et al. 2002, Radford and Bennett 2007). The amount of suitable habitat in the landscape might influence habitat patch suitability if birds use multiple wetlands to satisfy their resource requirements (Naugle et al. 1999), or if birds are initially attracted to landscapes with large amounts of habitat because it expedites finding a suitable patch of breeding habitat (Kristan 2006).

At the landscape scale, fragmentation occurs when habitat patches are further divided into separate, smaller, segments of habitat (Fahrig 1998). Although this process is

often accompanied by a decrease in the total amount of habitat in the landscape (Fahrig 2003), fragmentation addresses only the effects resulting from the division of a patch of habitat into two or more pieces (Fahrig 1998, 2003). Landscape fragmentation increases the amount of edge habitat relative to interior habitat in the landscape (Broadbent et al. 2008), which can increase the abundance of predators and nest parasites (Gibbs 1991, Thompson et al. 2002, Carfagno et al. 2006) and facilitate the spread of invasive species (Laurance 2000). Furthermore, increased edge can alter the microclimate of the habitat patch (Esseen and Renhorn 1998) and decrease habitat quality (Briant et al. 2010).

A third important characteristic is landscape composition. Landscape composition addresses how the presence or amount of other habitat types in the landscape influences habitat suitability for the target species (Guerry and Hunter 2002). Often, landscape heterogeneity increases species richness (Böhning-Gaese 1997, Aauri and de Lucio 2001). However, the presence or amount of certain habitat types can negatively influence the presence of a given species (Vander Haegan et al. 2000, Naugle et al. 2001, Ribic and Sample 2001, Rodewald and Yahner 2001, Bakker et al. 2002). For example, Naugle et al. (2001) found that landscapes consisting of >50% tilled land negatively influenced the presence of several species of wetland birds. Trends such as this may be related to increased predation rates and changes to the predator community in the landscape resulting from the presence or amount of agricultural land (Rodewald and Yahner 2001).

Finally, the arrangement of habitat and non-habitat patches in the surrounding landscape, known as landscape configuration, can also affect habitat patch suitability. The arrangement and proximity of additional patches of habitat in the landscape might be important for species that make use of multiple habitat patches (Villard et al. 1999,

Naugle et al. 2000). Similarly, the presence of functional connections or corridors between habitat patches can also influence habitat suitability by facilitating or impeding movement between patches of habitat (Guadagnin and Maltchik 2007).

In general, the majority of habitat-based research on wetland birds has focused on local-scale habitat variables, with little evaluation of how landscape-scale variables might influence habitat suitability (Valente et al. 2011). However, recent research has suggested that some landscape-scale characteristics might be important determinants of habitat suitability for some wetland birds. In particular, the amount of wetland habitat in the landscape (Naugle et al. 1999, Spautz et al. 2005) and the configuration and connectivity of that wetland habitat (Paracuellos and Telleria 2004, Guadagnin and Maltchik 2007, Platteeuw et al. 2010) have been shown to influence habitat suitability for some wetland bird species. In addition, the amount of urbanization in the surrounding landscape may also affect wetland habitat suitability for some avian species (Smith and Chow-Fraser 2010). Little is known, however, about the impacts of habitat fragmentation on wetland birds.

The yellow rail has been designated as a species of Special Concern in Canada (COSEWIC 2001, 2009). This designation is primarily due to suspected population declines associated with historic and on-going wetland habitat loss in the species' breeding and wintering ranges (Alvo and Robert 1999). The habitat requirements for yellow rails on their breeding grounds are not well understood. Local-scale wetland characteristics with which breeding yellow rails are frequently associated include fine-stemmed wetland vegetation such as sedges (Lane 1962, Elliot and Morrison 1979, Gibbs et al. 1991, Grimm 1991, Sherrington 1994), rushes (Stenzel 1982, Robert and Laporte

1997, Robert and Laporte 1999, Popper and Stern 2000), grasses (Houston 1969, Blicharz 1971, Elliot and Morrison 1979, Gibbs et al. 1991) and forbs (Terrill 1943, Stern et al. 1993), and shallow water depths (Stenzel 1982, Bookhout and Stenzel 1987, Popper and Stern 2000). However, the range of suitable wetland vegetation structures, the influence of cattails and woody vegetation, and the required size of suitable wetland habitat patches for breeding yellow rails are poorly understood (Bookhout 1995). Furthermore, the influence of landscape-level variables on the suitability of wetland habitat patches for breeding yellow rails has not yet been evaluated. As a species of Special Concern on Canada's Species at Risk list, a management plan is required to be developed for yellow rail (Species at Risk Act 2002, s.65, 68). A more comprehensive understanding of the habitat requirements of yellow rails at multiple spatial scales would benefit the development and effectiveness of the management plan for this species.

Approximately 90% of the yellow rail breeding range is concentrated in Canada (Alvo and Robert 1999). Within this range, the prairie provinces of Alberta, Saskatchewan and Manitoba are believed to harbour much potential habitat (Alvo and Robert 1999). In Manitoba, yellow rails have been found in the southern part of the province (Lane 1962, Holland and Taylor 2003, Christian Artuso, pers. comm.), and as far north as Churchill (Fuller 1938) in the north-east corner of the province. However, the distribution of yellow rails throughout much of the province, especially the central portion, remains virtually unknown (Alvo and Robert 1999, COSEWIC 2009). At the time of the first COSEWIC yellow rail status assessment in 1999, there were 26 known yellow rail breeding locations in Manitoba, excluding Hudson Bay (Alvo and Robert 1999). However, it is generally believed that Manitoba may contain a significant amount

of wetland habitat for breeding yellow rails, with hundreds of potential yellow rail breeding locations throughout the province (P. Taylor and R. Koes, in Alvo and Robert 1999).

In this study, the habitat requirements of yellow rails on their breeding grounds in Manitoba were evaluated using a multiple spatial scale approach. The objectives of the study were (1) to develop a better understanding of which local-scale and landscape-scale variables influence yellow rail habitat suitability in south-central Manitoba, and (2) to evaluate the distribution of yellow rails in south-central Manitoba.

## **4.2 STUDY AREA AND METHODS**

### **4.2.1 Study Area**

The study area consisted of 82 wetlands in the area extending from Sirko (UTM 14U 5432839 N, 701311 E) near the Manitoba/U.S. border north to Ashern (UTM 14U 5670386 N, 546618 E) in the Interlake region, and from Portage la Prairie (UTM 14U 5535846 N, 550726 E) east to Menisino (UTM 14U 709154 N, 5441370 E). Two ecoregions were found in the study area: the Interlake Plain and the Lake Manitoba Plain. The Interlake Plain ecoregion was characterized mainly by shrubs, trembling aspen, and balsam poplar, with wetlands that were primarily dominated by sedge, willow, tamarack, and black spruce (Ecological Stratification Working Group 1995). The Lake Manitoba Plain ecoregion was dominated by oak and trembling aspen, intermixed with fescue grasslands; wetlands were characterized by sedge and willow vegetation (Ecological Stratification Working Group 1995). Both ecoregions contained significant amounts of farmland (Ecological Stratification Working Group 1995).



Figure 4-1 Study area consisting of 82 wetlands in south-central Manitoba. Wetlands surveyed in 2010 are denoted by circles, those surveyed in 2011 by stars. Base layer map from ESRI (2010).

#### 4.2.2 Selection of Study Wetlands and Survey Points

A different set of wetlands was surveyed in each year ( $n = 44$  in 2010,  $n = 38$  in 2011). In 2010, wetlands were selected opportunistically in two ways. First, all wetlands at which yellow rails had been detected in previous years were identified (from local birdwatchers, researchers and published studies;  $n = 10$ , see Table 4-1). The remaining 34



wetlands in 2010 and all wetlands in 2011 were located while scouting the study area, and selected because they contained vegetation types that yellow rails are known to associate with: sedges, rushes, and/or grasses (Elliot and Morrison 1979, Stenzel 1982, Popper and Stern 2000). Wetland selection was opportunistic, rather than random, to reduce the probability of failing to select any wetlands with yellow rails present, as often occurs when the target species is uncommon (Gibbs and Melvin 1997). Extreme flooding of Lake Manitoba and the Shoal Lakes in 2011 reduced the 2011 sample size to 34, as four wetlands became inaccessible.

Table 4-1 Locations of ten wetlands in south-central Manitoba, all surveyed in 2010, at which yellow rail presence had been detected in previous breeding seasons (WMA = Wildlife Management Area).

Site Name	UTM Zone	UTM Easting	UTM Northing	Information Source
Tall Grass Prairie Preserve	14 U	663158	5455070	Local Birdwatcher
Sundown Bog	14 U	691817	5442395	Local Birdwatchers/Biologists
Richer	14 U	685187	5503706	Manitoba Conservation Data Centre
PR 501, Ste. Genevieve	14 U	679067	5513996	Local Birdwatchers
Brokenhead Swamp	14 U	686469	5513955	Local Birdwatchers
Grant's Lake WMA	14 U	604331	5546737	Fryer 1937
Oak Hammock WMA	14 U	631283	5562129	Local Birdwatchers, Holland and Taylor 2003
Little Birch WMA	14 U	552117	5662486	Local Birdwatcher/Biologist
Marshy Point	14 U	568001	5597041	Local Birdwatcher/Biologist
3 km NE of Lundar	14 U	569281	5620326	Manitoba Conservation Data Centre

To select survey points within study wetlands, each wetland was mapped in ArcMap 10.0 (ESRI 2010) using Manitoba land cover layers (Manitoba Land Initiative 2001, 2002) and a waterbodies layer (Manitoba Land Initiative year unknown). A

randomly-selected angle ( $0^{\circ}$  to  $359^{\circ}$ ) was extrapolated from the wetland center to the edge to establish the first survey point. Subsequent survey points were similarly established, but were required to be  $>400$  m from other survey points to reduce the likelihood of detecting the same individual yellow rails at multiple points during surveys (Conway 2009). If this requirement was not met, a new angle was randomly selected. Wetlands were saturated with survey points when no additional points could be added, or when a maximum of eight survey points was established. Large wetlands could not be completely surveyed. Survey points were required to be within 900 m of road access, due to safety concerns associated with night surveys. In total, 178 survey points were established, but 17 points became inaccessible as a result of flooding of Lake Manitoba and the Shoal Lakes in 2011, reducing the sample size of survey points to 161: 109 in 2010 and 52 in 2011.

Survey points were located, using a handheld GPS unit, prior to the start of night surveys. Any points not situated in potentially suitable habitat were moved to the nearest area of suitable habitat or removed if this could not be done while maintaining a distance of  $>400$  m from all other points. The number of survey points per wetland ranged from 1 to 8, with a mean of 2.2 and a mode of 1. The majority of points were edge points, although several wetlands were large and shallow enough to permit the establishment of survey points within the wetland interior ( $n = 7$  points).

#### 4.2.3 Call-Broadcast Surveys for Yellow Rails

Surveys were conducted according to the Canadian Wildlife Service Standardized Protocol for the Survey of Yellow Rails in Prairie and Northern Region (Bazin and Baldwin 2007). This protocol was appropriate because it is applicable to Manitoba, in

addition to other areas in Canada, and it employs the call-broadcast survey method, which is beneficial for surveying secretive wetland birds (Johnson and Dinsmore 1986, Gibbs and Melvin 1993, Gibbs and Melvin 1997, Lor and Malecki 2002, Prescott et al. 2002, Allen et al. 2004, Conway 2009).

Each survey began with a five-minute passive-listening period, followed by a three-minute conspecific call-broadcast period, and ended with a two-minute passive-listening period (Bazin and Baldwin 2007). During the call-broadcast period, a sequence of yellow rail vocalizations (courtesy of Monty Brigham, Bird Sounds of Canada CD) was played at approximately 70 dB (measured 1 m in front of the speaker) from a game caller (Western Rivers, Tennessee, USA) directed towards the wetland center, for 30 seconds, followed by 30 seconds of silence; this was repeated twice (Bazin and Baldwin 2007). Each yellow rail that was detected was recorded as vocalizing or not before the survey, during each minute of the survey, and immediately after the survey (see sample survey form in Appendix I; Bazin and Baldwin 2007).

A distance (0-25m, 25-50m, 50-75m, 75-125m, 125-200m, or >200m) and direction from the observers was assigned to each yellow rail (Bazin and Baldwin 2007).

To capture the peak yellow rail vocalization period, all surveys were conducted between 23 May and 5 July (Holland and Taylor 2003, Bazin and Baldwin 2007). Two rounds of surveys were conducted at each wetland, with the second round beginning on 16 June in 2010 and 15 June in 2011. The mean length of time between the first and second surveys was 22 days in 2010 (range = 14 to 40 days) and 20 days in 2011 (range = 10 to 33 days). All surveys were conducted at night, between one hour after sunset and one hour before sunrise, to encompass the nightly peak in yellow rail vocal activity

(Bazin and Baldwin 2007). Two observers (K. Martin and D. Furutani) jointly conducted all yellow rail surveys.

#### 4.2.4 Habitat Variables: Landscape Scale

In ArcMap version 10.0 (ESRI 2010), Manitoba land cover GIS layers (Manitoba Land Initiative 2001, 2002) and a Manitoba waterbodies inventory GIS layer (Manitoba Land Initiative year unknown) were combined into a single layer using the Union tool in ArcToolbox (ESRI 2010). A 3-km radius landscape was centered on each study wetland, as other wetland-associated birds have been found to respond to characteristics of landscapes ranging up to several kilometers surrounding focal wetlands (Naugle et al. 2001, Hay 2006). Approximately 25% of the study wetlands were not originally found on either the land cover or waterbodies layers. These GIS layers were digitized from aerial photographs (F. Wahl, Manitoba Land Initiative, pers. comm.), and in cases where the photographs were taken in a dry year or late in the summer, ephemeral wetlands may have been dry, and indistinguishable from the surrounding grassland vegetation (F. Wahl, Manitoba Land Initiative, pers. comm.). Study wetlands that were not originally found on the GIS layers were digitized (by K. Martin) onto the combined GIS layer. The sizes and shapes of these study wetlands were based on wetland edge boundaries that were estimated in the field during ground-truthing. I took UTM coordinates of the yellow rail survey points and vegetation transect start points in the field and used them to ensure the newly-digitized wetlands were drawn in the appropriate location on the GIS map.

Some wetlands that were intersected by roads (gravel or paved) were classified in the GIS as two or more separate wetlands. However, in this study they were considered to be segments belonging to the same wetland, and in several cases survey points were

located on one or more segments. When evaluating potential habitat from the air, yellow rails might identify roads as unsuitable habitat within the larger wetland patch, like they would open water, and continue to search for habitat within that wetland.

Buffer Wizard (ESRI 2010) was used to create the 3-km radius buffer around each focal wetland. For large wetlands, buffers were centered on the portion of the wetland that was surveyed. Land cover and study wetland polygons within each landscape were updated to reflect current land cover types and focal wetland shapes, as determined by ground-truthing the 3-km landscape surrounding each study wetland. In four cases, pairs of wetlands were not far enough apart to maintain independence at the landscape scale, i.e. the buffers around the wetlands overlapped. One wetland from each pair was randomly selected for use in the landscape analysis. This reduced the sample size of independent landscapes to 74: 43 in 2010, 31 in 2011.

The resulting 3-km radius layers were converted from vector to raster data (output cell size = 30 m) using the Spatial Analyst extension (ESRI 2010). Raster data were then input into program FRAGSTATS (McGarigal and Marks 1995) to calculate all landscape-level variables. Landscape-scale metrics were selected to represent each of the following four landscape-level characteristics of interest: habitat amount, fragmentation, composition and configuration. Percent marsh/fen was used as the measure of landscape habitat amount. Habitat composition was indexed using two metrics: percent of other habitat types (forest, grassland/hayland and cropland) in the landscape, and habitat richness, which is the number of different land cover types in the landscape (McGarigal and Marks 1995). Percent grassland and hayland (tame and native) were combined, as they both represent perennial grass cover (Johnson and Igl 2001). Habitat configuration

was measured using the proximity index for marsh/fen habitat in the landscape (McGarigal and Marks 1995). To calculate this index for a single wetland patch, the sum of the area of each marsh/fen patch (in m<sup>2</sup>) is divided by the distance between the patch and the focal patch, squared (McGarigal and Marks 1995). To obtain an index value for each landscape, this calculation is performed for each wetland in the landscape, and the mean is taken (McGarigal and Marks 1995). Finally, mean shape index (McGarigal and Marks 1995) was used as an index of landscape fragmentation. For each marsh/fen polygon in the landscape, the shape index was calculated by dividing the length of the polygon perimeter by the perimeter length of the most compact polygon possible of the same size (McGarigal and Marks 1995). Mean shape is the average shape value of all marsh/fen polygons in the landscape (McGarigal and Marks 1995).

#### 4.2.5 Habitat Variables: Patch Scale

Three vegetation survey transects were randomly established at each wetland to evaluate the overall wetland characteristics ( $n = 44$  wetlands in 2010, 34 in 2011). These transects were not associated with survey points or areas of suitable habitat; rather they were situated randomly at each wetland to characterize the wetland as a whole. Transect start points were determined by randomly selecting an angle, between 0° and 359°, and extrapolating this angle from the wetland center to the edge of the wetland. Transects extended towards the wetland center, ending at 50 m or when open water was reached. At every 2 m along the transect, a meter stick was used to measure maximum vegetation height (cm), water depth (cm) and vegetation density, measured as the number of pieces of vegetation touching the upright meter stick. At every 5 m along the transect, a 1 m x 1 m quadrat was placed over the vegetation, and the vegetation community composition

was evaluated in terms of percent cover of each vegetation type: percent *Cyperaceae*, percent *Poaceae*, percent cattail, percent rushes, percent forbs, and percent shrub. The forbs class consisted of any non-woody vegetation that did not fall into the other vegetation categories (e.g. wildflowers). Percent live vegetation and percent dead vegetation within the quadrat were also estimated at each 5-m interval. Four canopy closure measurements were also taken, one in each Cardinal direction, at every 5 m along each transect. Canopy closure was measured as the percent of the opening of a PVC pipe (2 ft long, 1.5" diameter), held at a 45° angle between the observer's eye and the ground, that was obscured by vegetation (Snell-Rood and Cristol 2003).

All measurements were first averaged within transects, and then over the three random transects to obtain patch-scale habitat variables (e.g. patch percent cattail, patch canopy closure, patch vegetation density, etc.). Wetlands were categorized by cover type and wetland class, according to the classification system developed by Stewart and Kantrud (1971). Finally, the area (in hectares) of each focal wetland was calculated in the software program FRAGSTATS, using the metric "patch area" (McGarigal and Marks 1995). All vegetation and water depth measurements were conducted between 11 July and 20 August in both years.

#### 4.2.6 Habitat Variables: Plot Scale

To characterize the habitat in the immediate vicinity of the survey point (i.e. the plot scale), one vegetation transect was established at each yellow rail survey point ( $n = 109$  in 2010, 52 in 2011). Transects began at the survey point and extended towards the wetland center, ending at 50 m or upon reaching open water, whichever came first. Using the same methods as for habitat variables at the patch scale, maximum vegetation height,

vegetation density, water depth, canopy closure and vegetation community composition variables were measured along each transect. All measurements were averaged over the entire transect to get plot-scale variables (e.g. plot water depth, plot percent cattail, plot overall canopy closure, etc.) for each survey point. In both years, all vegetation and water depth measurements were conducted between 11 July and 20 August.

#### 4.2.7 Data Analysis

The dataset consisted of all data from both years of the study. At the landscape scale and the patch scale, the response variable was the presence of yellow rails at each study wetland. At the plot scale, the response variable was the presence of yellow rails at each survey point. For each of the three spatial scales, models were created and tested using PROC GLIMMIX in SAS (Version 9.2, SAS Institute, Cary, North Carolina, USA), to evaluate the degree to which they explained the variation in the presence of yellow rails at survey points or within study wetlands. Landscape variables were not combined with local variables in any models because of the smaller sample size of independent landscapes. Patch- and plot-scale habitat variables were not combined as the classification of patch-scale characteristics as suitable or unsuitable would be confusing if yellow rails were present at some survey points within a wetland and not others. Not every possible combination of variables was used; only meaningful, ecologically-relevant models were tested (see Anderson and Burnham 2002). A binomial distribution was specified for the response variable in all models. Initially, all models included two-way interaction terms between each habitat variable and year (e.g. vegetation density x year), to evaluate if the relationships between the habitat variables and yellow rail presence were consistent between years. Any non-significant interaction terms, based on  $p$ -values



and using an alpha value of 0.1, were dropped from the final models. Welch's *t*-tests were used to determine if the means of the habitat variables, at all three spatial scales, differed significantly between years. The Laplace approximation was used so that Akaike's Information Criterion could be used to select the best model (Raudenbush et al. 2000, SAS Institute, Inc. 2011). Odds ratios were calculated for each parameter estimate and the 95% confidence intervals in the top model and all competing models to facilitate the interpretation of the strength and importance of the effects of the habitat variables from an ecological perspective. In cases where models containing variable x year interaction terms were well-supported, the data were reanalyzed by year to compare the strength and direction of the variable effects between the two years.

At the landscape scale, PROC GLIMMIX in SAS (Version 9.2, SAS Institute, Cary, North Carolina, USA) was used to compare the fit of seven models (Table 4-2). Spearman's rank correlation coefficients were used to determine if any variables were highly correlated, as Q-Q plots and Shapiro-Wilk's test for normality indicated that some of the landscape-scale independent variables followed non-normal distributions. Only mean marsh/fen proximity and percent marsh/fen in the landscape were highly correlated ( $r_s = 0.828, p < 0.0001$ ). This was expected, as the calculation for the proximity metric accounts for patch size (McGarigal and Marks 1995). However, percent marsh/fen and mean marsh/fen proximity measure distinct landscape characteristics. While percent marsh/fen only evaluates the amount of habitat in the landscape, mean marsh/fen proximity characterizes the configuration of that habitat, in terms of how it is distributed and arranged within the landscape (McGarigal and Marks 1995). Furthermore, arbitrarily dropping one of two highly positively correlated variables can lead to overestimation of

the effect strength of the variable that is kept in the model (Smith et al. 2009). Therefore, both percent marsh/fen and mean marsh/fen proximity were kept in the final global model. No random effects variables were included in the landscape-scale models.

Table 4-2 Models tested using PROC GLIMMIX in SAS (Version 9.2, SAS Institute, Cary, North Carolina, USA) to evaluate the effects of landscape scale habitat variables on the presence of yellow rails in 74 landscapes (43 in 2010, 31 in 2011) in south-central Manitoba, Canada in 2010-2011.

Model	Independent Landscape-Scale Variables (Fixed Effects)
Null	intercept
Habitat Amount	% marsh/fen habitat + year + % marsh/fen habitat x year
Landscape Composition: Other Habitats	% grassland/hayland + % cropland + % forest
Landscape Composition: Habitat Richness	habitat richness + year + habitat richness x year
Landscape Configuration	mean proximity index for all marsh/fen patches
Landscape Fragmentation	mean marsh/fen patch shape
Global	% marsh/fen habitat + year + % marsh/fen habitat x year + % grassland/hayland + % cropland + % forest + habitat richness + habitat richness x year + mean marsh/fen proximity index + mean marsh/fen shape

At the patch scale, the fit of six models was compared (Table 4-3). Spearman's rank correlation coefficients were used to evaluate correlations between all patch-scale variables. No high correlations were found between any of the patch-scale variables ( $r_s < 0.53$ ). Wetland class and cover type (Stewart and Kantrud 1971) were not used in any models due to insufficient range of variation. No random effects variables were included in the patch-scale models. Due to the small sample size of wetlands, no structural

vegetation characteristics or forbs were included in any patch scale models, to avoid over-parameterization.

Table 4-3 Models tested using PROC GLIMMIX in SAS (Version 9.2, SAS Institute, Cary, North Carolina, USA) to evaluate the effects of patch scale habitat variables on the presence of yellow rails at 78 wetlands in south-central Manitoba, Canada in 2010-2011.

Model	Independent Patch-Scale Variables (Fixed Effects)
Null	none
Wetland Area	focal wetland area
Water Depth	water depth
Vegetation Community: Fine-stemmed Vegetation	% <i>Cyperaceae</i> + % <i>Poaceae</i> + % rush
Vegetation Community: Cattail and Shrubs	year + % cattail + % cattail x year + % shrub + % shrub x year
Global	focal wetland area + water depth + % <i>Cyperaceae</i> + % <i>Poaceae</i> + % rush + % cattail + year + % cattail x year + % shrub + % shrub x year

At the plot scale, nine models were tested (Table 4-4). Spearman's rank correlation coefficients were used to check for correlations between all plot-scale variables. None of the plot-scale variables were highly correlated ( $r_s < 0.55$ ). Wetland was included as a random effects variable in all plot-scale models to account for clustering of survey points within wetlands.

Table 4-4 Models tested using PROC GLIMMIX in SAS (Version 9.2, SAS Institute, Cary, North Carolina, USA) to evaluate the effects of plot scale habitat variables on the presence of yellow rails at 161 survey points (109 in 2010, 55 in 2011) in south-central Manitoba, Canada, in 2010-2011.

Model	Independent Plot-Scale Variables (Fixed Effects)
Null	none
Water Depth	water depth
Vegetation Structure	vegetation height + vegetation density + % dead vegetation + canopy closure
Vegetation Structure + Water Depth	vegetation height + vegetation density + % dead vegetation + canopy closure + water depth
Vegetation Community: Forbs + Fine-stemmed Vegetation	% forbs + % <i>Cyperaceae</i> + % <i>Poaceae</i> + % rush
Vegetation Community: Forbs + Fine-stemmed Vegetation + Water Depth	% forbs + % <i>Cyperaceae</i> + % <i>Poaceae</i> + % rush + water depth
Vegetation Community: Cattail and Shrubs	% cattail + % shrubs
Vegetation Community: Cattail and Shrubs + Water Depth	% cattail + % shrubs + water depth
Global	water depth + vegetation height + vegetation density + % dead vegetation + canopy closure + % forbs + % <i>Cyperaceae</i> + % <i>Poaceae</i> + % rush + % cattail + % shrubs

#### 4.2.8 Model Selection

Akaike's Information Criterion corrected for small sample sizes ( $AIC_c$ ) was used to select the most parsimonious model because at all levels of analysis, the ratio between sample size and the number of parameters being estimated for the most complex model was  $<40$  (Burnham and Anderson 2002). The model with the lowest  $\Delta AIC_c$  score was considered to be the most parsimonious model, but all models with  $\Delta AIC_c$  scores up to 2 were considered to have a high level of support (Burnham and Anderson 2002). Within

the top and competing models, any variables for which the 95% confidence intervals surrounding the parameter estimates included zero were considered to be unimportant.

## 4.3 RESULTS

### 4.3.1 Landscape Scale

Yellow rail presence was confirmed at 34 focal wetlands within the 74 landscapes (46%) that were included in the analysis: 24 in 2010 (56%), and 10 in 2011 (32%). Only the interactions between habitat richness and year and percent marsh/fen and year were significant; all other interaction terms were removed from the final models. The best-supported landscape-scale model was the habitat composition model containing habitat richness, year, and the interaction term between habitat richness and year (Table 4-5). A close competing model was the model containing percent marsh/fen, year, and the interaction term between percent marsh/fen and year (Table 4-5). In both models, there was a strong effect of year on the probability of detecting yellow rails (Table 4-5). When the data were analyzed separately by year, habitat richness did not influence yellow rail presence in 2010:  $\beta$  (Lower 95% CI, Upper 95% CI) = 0.149 (-0.092, 0.391),  $p = 0.213$ , but had a negative influence on yellow rail presence in 2011:  $\beta$  (Lower 95% CI, Upper 95% CI) = -0.496 (-1.029, 0.036),  $p = 0.067$ . However, as the 95% confidence interval for this variable included zero in both years, the importance of habitat richness in 2011 was considered to be negligible (Table 4-5). Mean habitat richness was significantly lower at the 2010 study sites than the 2011 study sites (Table 4-6), although this was not driven by a difference between the ten sites at which yellow rail presence had been detected in prior years and the remaining sites (Table 4-7). When the data were analyzed separately by year, the amount of marsh/fen in the landscape did not influence yellow rail

presence in 2010:  $\beta$  (Lower 95% CI, Upper 95% CI) = -0.002 (-0.057, 0.053),  $p = 0.938$ , but had a weak positive effect on yellow rail presence in 2011:  $\beta$  (Lower 95% CI, Upper 95% CI) = 0.093 (0.003, 0.183),  $p = 0.043$ . Mean percent marsh/fen was significantly higher at the 2010 study sites than the 2011 study sites (Table 4-6), although this was not driven by a difference between the ten sites at which yellow rail presence had been detected in prior years and the remaining sites (Table 4-7).

Table 4-5 Parameter estimates, odds ratios, and AIC<sub>c</sub> values and weights for the top-scoring models from a set of seven candidate models that were tested in SAS (using PROC GLIMMIX) to evaluate the influence of landscape-scale habitat variables on the presence of yellow rails at 74 wetlands in south-central Manitoba in 2010-2011. The reference year in the analysis was 2011.

Model Parameters	Parameter Estimates (Lower 95% CI, Upper 95% CI)	Odds ratios (Lower 95% CI, Upper 95% CI)	<i>p</i> -value	AIC <sub>c</sub>	ΔAIC <sub>c</sub>	AIC <sub>c</sub> Weight
<b><i>Habitat Composition</i></b>						
Habitat richness	-0.496 (-1.007, 0.014)	0.609 (0.365, 1.014)	0.061	100.41	0	0.434
Year	-6.703 (-13.384, 0.022)	0.001 (1.540E-06, 1.022)	0.053			
Habitat richness*year	0.646 (0.084, 1.207)	1.908 (1.088, 3.343)	0.027			
<b><i>Habitat Amount</i></b>						
%Marsh/fen	0.093 (0.007, 0.179)	1.097 (1.007, 1.196)	0.038	100.84	0.43	0.350
Year	2.327 (0.433, 4.222)	10.247 (1.542, 68.170)	0.019			
% Marsh /fen*year	-0.095 (-0.196, 0.006)	0.909 (0.822, 1.006)	0.070			
<b><i>Habitat Fragmentation</i></b>						
Mean marsh shape	2.601 (-0.478, 5.679)	13.477 (0.620, 292.657)	0.102	103.28	2.87	0.103
<b><i>Null</i></b>						
Intercept	-0.163 (-0.620, 0.295)	0.850 (0.538, 1.343)	0.488	104.15	3.74	0.067

Table 4-6 The range and mean of each of the landscape-scale habitat variables from the 43 study sites surveyed in 2010 and the 31 study sites surveyed in 2011. All sites were located in south-central Manitoba. The *t*-values and *p*-values are from Welch's *t*-tests to determine if the means of each variable were significantly different between years ( $\alpha = 0.1$ ).

Landscape Variable	Min 2010	Max 2010	Min 2011	Max 2011	Mean 2010	Mean 2011	<i>t</i> -value	<i>p</i> -value
% marsh/fen	3.623	68.289	0.035	46.134	17.760	12.894	1.84	0.070*
% all forest	0.991	75.890	0.660	73.155	32.855	31.151	0.40	0.694
% cropland	0	77.996	0	36.633	5.764	6.186	-0.15	0.877
% grassland/ hayland	7.084	66.277	12.514	81.382	36.784	45.680	-2.44	0.017*
habitat richness	7	18	9	17	11.23	12.39	-2.12	0.037*
marsh/fen shape	1.330	2.073	1.117	1.752	1.567	1.457	3.04	0.003*
marsh/fen proximity	0.837	461.229	0.051	667.101	55.995	58.726	-0.11	0.911

\* = means were significantly different between years ( $\alpha = 0.1$ )

Table 4-7 The range and mean of each of the landscape-scale habitat variables from the 10 study sites, surveyed in 2010, at which yellow rail presence had been detected in prior years (i.e. Known Sites), and the remaining 64 study sites (i.e. Other Sites). All sites were located in south-central Manitoba. The *t*-values and *p*-values are from Welch's *t*-tests to determine if the means of each variable were significantly different between years ( $\alpha = 0.1$ ). None of the *t*-test results were significant.

Landscape Variable	Min of Known Sites	Max of Known Sites	Min of Other Sites	Max of Other Sites	Mean of Known Sites	Mean of Other Sites	<i>t</i> -value	<i>p</i> -value
% marsh/fen	4.169	68.289	0.035	46.134	19.341	15.156	0.71	0.496
% all forest	0.991	60.407	0.660	75.890	25.705	33.147	-1.21	0.231
% cropland	0	78	0	36.633	10.937	5.160	0.74	0.480
% grassland/hayland	7.084	57.138	12.514	81.382	34.168	41.502	-1.36	0.179
habitat richness	8	18	7	18	12.6	11.578	0.92	0.377
marsh/fen shape	1.330	2.073	1.117	1.966	1.606	1.508	1.20	0.257
marsh/fen proximity	0.837	196.7	0.051	667.101	55.351	57.418	-0.06	0.953



### 4.3.2 Patch Scale

The best-fitting model at the patch scale was the global model, which contained all of the patch-scale variables, year, and the interaction terms between percent cattail and year and percent shrub and year (Table 4-8). None of the other interaction terms were significant, so they were dropped from the final model set. Within the global model, the 95% confidence intervals did not include zero for only two variables: percent rush and percent shrub x year. Yellow rail presence was positively related to the proportion of rushes at this scale (Table 4-8). When the data were analyzed separately by year, yellow rail presence was not influenced by the patch-scale proportion of shrubs in 2010:  $\beta = 0.423$  (-0.190, 1.030),  $p = 0.170$ , or in 2011:  $\beta = -0.185$  (-0.726, 0.350),  $p = 0.487$ . Thus, the importance of the percent shrub x year term in the global model appears to be driven primarily by the effect of year. The importance of all other variables in the global model was considered to be negligible, as all the 95% confidence intervals included zero. There were no competing models ( $\Delta AIC_c < 2$ ) at this scale. The model with the next lowest  $\Delta AIC_c$  score ( $\Delta AIC_c = 5.42$ ) contained focal wetland area (Table 4-8). The null model was the least-supported model in terms of its  $\Delta AIC_c$  score ( $\Delta AIC_c = 9.05$ , Table 4-8). Mean patch-scale characteristics of the 2010 sites were similar to those of the 2011 sites (Table 4-9), although mean water depth and mean wetland size were significantly higher in 2010 than 2011, while mean percent *Poaceae* was lower in 2010 than in 2011 (Table 4-9). None of these differences could be attributed to differences between mean variables between the ten sites at which yellow rail presence had been confirmed in prior years and the remaining study sites (Table 4-10).

Table 4-8 Parameter estimates, odds ratios, and AIC<sub>c</sub> value and weight of the top model from a set of six candidate models tested in SAS (using PROC GLIMMIX) to evaluate the influence of patch-scale habitat variables on the presence of yellow rails at 78 wetlands in south-central Manitoba in 2010-2011. There were no competing models at this scale ( $\Delta\text{AIC}_c < 2$ ), but the model with the next-lowest  $\Delta\text{AIC}_c$  score is shown for comparison, as is the null model.

Model & Parameters	Parameter Estimate (Lower 95% CI, Upper 95% CI)	Odds ratios (Lower 95% CI, Upper 95% CI)	<i>p</i> -value	AIC <sub>c</sub>	$\Delta\text{AIC}_c$	AIC <sub>c</sub> Weight
<b><i>Global</i></b>						
Wetland area	0.003 (-0.001, 0.007)	1.003 (0.999, 1.007)	0.136			
Water depth	-0.086 (-0.181, 0.009)	0.918 (0.834, 1.009)	0.082			
% <i>Cyperaceae</i>	0.039 (-0.020, 0.097)	1.040 (0.980, 1.102)	0.201			
% <i>Poaceae</i>	-0.013 (-0.092, 0.066)	0.987 (0.912, 1.068)	0.752			
% Rush	0.149 (0.019, 0.279)	1.161 (1.019, 1.322)	0.028	95.16	0	0.819
Year	-0.892 (-2.930, 1.136)	0.410 (0.053, 3.114)	0.049			
% Cattail	-0.434 (-0.929, 0.062)	0.648 (0.395, 1.064)	0.091			
% Cattail*Year	0.506 (-0.012, 1.024)	1.659 (0.988, 2.784)	0.060			
% Shrub	-0.312 (-0.725, 0.102)	0.732 (0.484, 1.107)	0.144			
% Shrub*Year	0.675 (0.014, 1.335)	1.964 (1.014, 3.780)	0.049			
<b><i>Wetland Area</i></b>						
Wetland Area	0.003 (3.668E-05, 0.006)	1.003 (1.000, 1.006)	0.051	105.73	5.42	0.054
<b><i>Null</i></b>						
Intercept	-0.206 (-0.652, 0.240)	0.814 (0.521, 1.271)	0.369	109.36	9.05	0.009

Table 4-9 The range and mean of each of the patch-scale habitat variables from the 44 study sites surveyed in 2010 and the 34 study sites surveyed in 2011. All sites were located in south-central Manitoba. The *t*-values and *p*-values are from Welch's *t*-tests to determine if the means of each variable were significantly different between years ( $\alpha = 0.1$ ).

Landscape Variable	Min 2010	Max 2010	Min 2011	Max 2011	Mean 2010	Mean 2011	<i>t</i> -value	<i>p</i> -value
Wetland size (ha)	0.360	1882.440	0.180	707.660	167.071	64.074	1.85	0.068*
Water depth (cm)	0	52.314	0	37.136	12.841	4.475	3.41	0.001*
% <i>Cyperaceae</i>	8.636	77.424	0.625	81.667	42.348	43.002	0.02	0.983
% <i>Poaceae</i>	0	45.758	0.909	42.424	10.228	17.918	-3.07	0.003*
% Rush	0	30.455	0	26.212	5.662	6.687	-0.67	0.5046
% Cattail	0	28.276	0	19.242	3.956	3.180	0.75	0.4571
% Shrub	0	13.939	0	11.667	2.562	2.853	-0.19	0.8467

\* = means were significantly different between years ( $\alpha = 0.1$ )

Table 4-10 The range and mean of each of the patch-scale habitat variables from the 10 study sites, surveyed in 2010, at which yellow rail presence had been detected in prior years (i.e. Known Sites), and the remaining 68 study sites (i.e. Other Sites). All sites were located in south-central Manitoba. The *t*-values and *p*-values are from Welch's *t*-tests to determine if the means of each variable were significantly different between years ( $\alpha = 0.1$ ). None of the *t*-test results were significant.

Landscape Variable	Min of Known Sites	Max of Known Sites	Min of Other Sites	Max of Other Sites	Mean of Known Sites	Mean of Other Sites	<i>t</i> -value	<i>p</i> -value
Wetland size (ha)	6.660	1882.440	0.180	707.660	383.085	83.806	1.64	0.134
Water depth (cm)	0.167	22.664	0	52.314	6.045	9.658	-1.31	0.206
% <i>Cyperaceae</i>	20.345	77.424	0.625	81.667	46.060	42.129	0.82	0.416
% <i>Poaceae</i>	1.364	31.515	0	45.758	13.337	13.616	-0.2	0.839
% Rush	0	30.455	0	26.212	6.617	6.034	0.12	0.907
% Cattail	0	28.276	0	23.000	7.694	3.018	1.49	0.168
% Shrub	0	13.636	0	13.939	3.419	2.582	0.64	0.537

### 4.3.3 Plot Scale

Yellow rail presence was confirmed at 76 of the 161 points (47.2%) that were surveyed over the two years of the study: 55 (50.5%) in 2010 and 21 (40.4%) in 2011. None of the interaction terms between the variables and year were significant at this scale, so all were removed from the final models. The top model at this scale contained water depth (Table 4-11). There were three competing models: two containing vegetation composition variables, and the null model (Table 4-11). Due to the ranking of the null model as a competing model ( $\Delta AIC_c < 2$ ), it could not be concluded that any of the other models were better supported (Arnold 2010). Furthermore, the 95% confidence intervals for the habitat variables in all competing models included zero; thus, none of the habitat variables were important influences on yellow rail presence at the plot scale. Habitat variables at the plot-scale transects were similar in both years, with a few exceptions: mean water depth was greater in 2010 than in 2011, and percent *Poaceae* and vegetation density were lower in 2010 than in 2011 (Table 4-12). Some plot-scale habitat variables differed between the ten wetlands at which yellow rail presence had been confirmed in prior years and the remaining wetlands: mean water depth was lower at plot-scale transects from the ten known wetlands, while the proportion of dead vegetation and canopy closure were higher along plot-scale transects from the ten known wetlands (Table 4-13).

Table 4-11 Parameter estimates, odds ratios and AIC<sub>c</sub> values and weights for the top model and competing models ( $\Delta AIC_c < 2$ ) from the set of nine candidate models that were tested in SAS (using PROC GLIMMIX) to evaluate the influence of plot scale characteristics on the presence of yellow rails at 161 survey points at wetlands in south-central Manitoba in 2010-2011.

Model & Parameters	Parameter Estimates (Lower 95% CI, Upper 95% CI)	Odds ratios (Lower 95% CI, Upper 95% CI)	<i>p</i> -value	AIC <sub>c</sub>	$\Delta AIC_c$	AIC <sub>c</sub> Weight
<b><i>Water Depth</i></b>						
Water depth	-0.072 (-0.154, 0.010)	0.931 (0.857, 1.010)	0.087	185.71	0	0.272
<b><i>Vegetation Composition &amp; Water Depth</i></b>						
% Cattail	-0.107 (-0.250, 0.036)	0.899 (0.779, 1.037)	0.147	185.78	0.07	0.263
% Shrub	-0.104 (-0.259, 0.051)	0.901 (0.772, 1.052)	0.195			
Water depth	-0.082 (-0.174, 0.010)	0.921 (0.840, 1.010)	0.088			
<b><i>Null</i></b>						
Intercept	-1.293 (-3.183, 0.597)	0.274 (0.041, 1.817)	0.184	186.61	0.9	0.174
<b><i>Vegetation Composition</i></b>						
% Cattail	-0.121 (-0.272, 0.030)	0.886 (0.762, 1.030)	0.120	186.69	0.98	0.167
% Shrub	-0.092 (-0.258, 0.074)	0.912 (0.773, 1.077)	0.280			

Table 4-12 The range and mean of each of the plot-scale habitat variables from the 109 survey points surveyed in 2010 and the 52 surveyed in 2011. All sites were located in south-central Manitoba. The *t*-values and *p*-values are from Welch's *t*-tests to determine if the means of each variable were significantly different between years ( $\alpha = 0.1$ ).

Plot Variable	Min 2010	Max 2010	Min 2011	Max 2011	Mean 2010	Mean 2011	<i>t</i> - value	<i>p</i> -value
Water depth (cm)	0	47.000	0	33.406	10.511	4.244	4.34	<0.0001*
% Cattail	0	39.091	0	40.556	2.643	3.207	-0.50	0.616
% Forbs	0	58.182	0.909	29.545	7.335	8.427	-0.91	0.364
% Shrub	0	27.727	0	21.818	2.706	3.121	-0.51	0.612
% <i>Cyperaceae</i>	0.909	83.636	0	90.455	47.442	45.526	0.50	0.615
% <i>Poaceae</i>	0	68.182	0	60.455	9.661	14.761	-2.25	0.026*
% Rush	0	53.636	0	35.455	6.300	7.057	-0.45	0.652
Maximum Vegetation Height (cm)	17.500	154.519	59.800	179.386	107.389	104.959	0.53	0.597
Vegetation density	3.182	25.962	2.526	21.692	11.058	12.462	-1.85	0.067*
% Dead vegetation	6.111	58.182	5.000	61.818	32.436	35.847	-1.46	0.146
Canopy closure (%)	13.068	100	8.333	100	72.619	73.128	-0.14	0.887

\* = means were significantly different between years ( $\alpha = 0.1$ )

Table 4-13 The range and mean of each of the plot-scale habitat variables from the 35 survey points, surveyed in 2010, in wetlands at which yellow rail presence had been detected in prior years (i.e. Known Sites), and the 126 survey points in the remaining study wetlands (i.e. Other Sites). All sites were located in south-central Manitoba. The *t*-values and *p*-values are from Welch's *t*-tests to determine if the means of each variable were significantly different between years ( $\alpha = 0.1$ ). None of the *t*-test results were significant.

Plot Variable	Min of Known Sites	Max of Known Sites	Min of Un-known Sites	Max of Un-known Sites	Mean of Known Sites	Mean of Un-known Sites	<i>t</i> -value	<i>p</i> -value
Water depth (cm)	0	32.827	0	47.000	3.824	9.782	-3.96	0.0002*
% Cattail	0	39.091	0	40.556	2.419	2.938	-0.41	0.684
% Forbs	0	58.182	0	34.091	9.351	7.226	1.57	0.118
% Shrub	0	17.727	0	27.727	2.701	2.878	-0.19	0.848
% <i>Cyperaceae</i>	0.909	83.636	0	90.455	49.096	46.192	0.73	0.468
% <i>Poaceae</i>	0	68.182	0	60.455	15.171	10.235	1.44	0.576
% Rush	0	53.636	0	35.455	9.870	5.621	1.68	0.101
Maximum Vegetation height (cm)	68.596	152.154	17.500	179.386	103.360	107.505	-0.94	0.351
Vegetation density	5.692	22.500	2.526	25.962	12.521	11.231	1.49	0.138
% Dead vegetation	8.182	58.182	5.000	61.818	37.441	32.454	2.01	0.049*
Canopy closure (%)	61.023	100	8.333	100	87.344	68.739	7.03	<0.0001*

\* = means were significantly different between sites ( $\alpha = 0.1$ )

#### 4.3.4 Distribution of Yellow Rails in South-Central Manitoba

Yellow rails appeared to be broadly distributed throughout the study area (Figure 4-5). Yellow rail presence was detected at 25 new (i.e. previously unsurveyed) sites. Of the 35 wetlands at which yellow rails were detected, the majority were on land that was privately owned (Table 4-14).

Table 4-14 Land ownership of wetlands in south-central Manitoba at which yellow rails were detected in 2010-2011 in south-central Manitoba. NCC = Nature Conservancy of Canada, TGPP = Tall Grass Prairie Preserve.

Land Ownership	% of occupied wetlands
Private	71.4
Private/Crown	5.7
Private/Wildlife Management Area	2.9
Crown	5.7
Wildlife Management Area	8.6
Conservation Agency (NCC, TGPP)	5.7





Figure 4-2 Distribution of wetlands in south-central Manitoba that were surveyed in 2010-2011. Wetlands at which yellow rails were detected are denoted by closed triangles, while those at which yellow rails were not detected, after two rounds of surveys, are denoted by open triangles.

## **DISCUSSION**

### **4.4.1 Influence of Landscape-, Patch- and Plot-Scale Variables on Habitat Suitability for Yellow Rails**

At the landscape scale, the habitat richness and habitat amount models, which both included interaction terms with year, were the best-supported models. Due to the confidence intervals associated with habitat richness including zero in both years, the importance of this variable was negligible. The support for this model may have been related to the different response by yellow rails to habitat richness between years. This difference may have been related to the higher proportion of sites at which yellow rails were detected in 2010 compared to 2011. The probability of yellow rail presence at wetlands in 2010 may have been higher because a larger number of wetlands were surveyed in 2010 as compared to 2011. Or, the higher likelihood of yellow rail presence in 2010 may have been related to the ten sites, all surveyed in 2010, at which yellow rails had been detected in prior years. Although landscape richness at these sites did not differ from all other sites, individual yellow rails may have returned to those sites if they had previously bred successfully at them. However, little is known about site fidelity in this species (Bookhout 1995), so no conclusions can be made at this time.

Landscape-scale percent marsh/fen had a positive effect on yellow rail presence in 2011. Interestingly, mean landscape-scale percent marsh/fen was lower for wetlands surveyed in 2011 than for those surveyed in 2010. Again, this was not driven by a difference between mean marsh/fen in the landscapes of the ten previously surveyed wetlands and all other study wetlands. Thus, the amount of marsh/fen habitat in the landscape may only be important for yellow rails below a certain threshold, which may occur between 12% marsh/fen (the mean in 2011) and 17% marsh/fen (the mean in

2010). The positive association with marsh/fen habitat may reflect the hierarchical habitat selection process: birds may initially select landscapes with high proportions of potential habitat, and then attempt to locate suitable patch(es) of habitat within the landscape (Fairbairn and Dinsmore 2001, Kristan 2006). Abundant marsh/fen habitat within the landscape could also be important if yellow rails forage at multiple wetlands during the breeding season. Black terns (*Chidonias niger*) use numerous wetlands for foraging (Dunn and Agro 1995), and have been shown to associate with high wetland-density landscapes (Naugle et al. 1999). It is not known if breeding yellow rails use multiple wetlands to meet their resource needs, but Robert and Laporte (1999) found that yellow rails in Québec moved to different wetlands towards the end of the breeding season, just prior to moulting. Yellow rails might select landscapes with high proportions of wetlands to facilitate late summer movements among these wetlands with varying amounts of suitable resources. This trend has also been found in other wetland-nesting bird species (Riffell et al. 2003) and in other secretive marsh bird species, including California black rail (Spautz et al. 2005), pied-billed grebe (Hay 2006) and American bittern (Hay 2006). Clarification of the threshold below which the amount of marsh/fen habitat in the 3-km landscape begins to influence yellow rail presence would be beneficial for land management or conservation efforts aimed at identifying or protecting wetlands for yellow rails. Furthermore, the importance of marsh/fen habitat in the landscape that was seen here could suggest that future wetland loss in the area surrounding suitable wetlands could be detrimental for this species of Special Concern.

At the patch scale, percent rush and the interaction of percent shrub and year appeared to be the most important variables influencing yellow rail presence at the study

sites. The positive association between yellow rail presence and the proportion of rushes might be related to the dietary needs of yellow rails, as rush vegetation is known to be a component of the diet of this species (Robert et al. 1997). Interestingly, rushes had a stronger influence on yellow rail presence than the other vegetation types that were evaluated, including sedges, to which yellow rails are most often described as being associated with (e.g. Fuller 1938, Walkinshaw 1939, Lane 1962, Sherrington 1994). Thus, rushes may be a better indicator of suitable yellow rail habitat than was previously known, and should not be overlooked when identifying potential yellow rail habitat in the future.

Due to the 95% confidence intervals including zero, the influence of percent shrubs at the random transects on the presence of yellow rails in both years was thought to be minimal. Instead, the importance of the percent shrubs x year term in the global model may have been driven by the higher probability of detecting rails in 2010 as compared to 2011. This difference may be related to differences in sample sizes between the two years of the study. Further study is needed to evaluate the influence of shrubs on habitat suitability for this species.

At the plot scale, none of the habitat variables that were measured were found to influence yellow rail presence at the survey points. However, habitat characteristics along transects at the survey point may not have adequately represented fine-scale habitat selection for yellow rails. At night, male yellow rails are believed to remain close to their nests (Bookhout and Stenzel 1987). However, locations of yellow rails detected during the night surveys in this study were estimated to range from several meters to over 200 m away from the survey points. Thus, vegetation transects that extended just 50 m beyond

the survey point likely failed to characterize the habitat in the immediate vicinity of a large proportion of the vocalizing yellow rails in this study. An evaluation of the habitat characteristics near yellow rail nests would likely lead to a better understanding of the fine-scale habitat suitability requirements for this species.

Overall, few of the habitat variables that were tested in this multiple spatial-scale study were found to influence yellow rail presence. Interestingly, the majority of the water depth and vegetation characteristic variables were not found to influence yellow rail presence at either the patch or plot scales. Some level of habitat selection appears to be occurring at the wetland (i.e. patch) scale, as the proportion of rushes was found to influence yellow rail presence at this scale. Furthermore, the importance of the amount of marsh/fen habitat in the landscape suggests that habitat selection may be occurring at the landscape scale as well. As the effects of landscape characteristics on habitat suitability for other species have been shown to differ with spatial extent (Fuhlendorf et al. 2002, Steffan-Dewenter et al. 2002, Schmidt et al. 2007), it would be beneficial to repeat the landscape-scale analysis using a broader (e.g. 5 km) or narrower (e.g. 500 m) spatial extent.

Some caution should be taken when evaluating the results presented here. First, the large number of models relative to the sample size was not ideal. However, this study represents a preliminary evaluation of the variables affecting yellow rail habitat suitability at multiple spatial scales, and, therefore, it was important to include a broad variety of variables. It would be beneficial to repeat this study with a larger sample size to determine if the trends are consistent.

Second, it is important to note that for large study wetlands, the 50-m vegetation transects that were used in this study are only representative of edge vegetation, and do not adequately characterize interior vegetation zones. Thus, when assessing wetlands for their potential suitability for yellow rails, the patch-scale trends found here should only be used to evaluate the suitability of edge habitat. Finally, it should be noted that both 2010 and 2011 were wet years in the study area due to above-normal precipitation levels (Manitoba Water Stewardship 2010, 2011). It would be beneficial to repeat the study in years with normal or below-average precipitation levels to determine if the influences on habitat suitability for yellow rails remain the same.

#### 4.4.2 Yellow Rail Distribution in South-Central Manitoba

Yellow rails were found throughout the study area in south-central Manitoba. The identification of 25 new (i.e. previously unsurveyed) yellow rail summer locations was informative, as only 26 known summer locations (not including Hudson Bay) of yellow rails in Manitoba were documented in the recent COSEWIC status assessments (Alvo and Robert 1999, COSEWIC 2009). South-central Manitoba likely harbours a significant amount of breeding habitat for yellow rail.

Yellow rails were detected at 45% of the southern Interlake sites surveyed. Many additional potentially suitable wetlands were identified in this area while scouting study sites in 2010-2011, but were not surveyed due to their proximity (i.e. within 6 km) to study sites that had already been established. Due to this abundance of potential suitable habitat, there are likely dozens of wetlands within the southern Interlake region that are occupied by yellow rails during the breeding season. Wetlands were less abundant in the areas to the east and south-east of Winnipeg, so fewer study wetlands were established in

these areas. Nevertheless, yellow rails were detected at 50% of the study wetlands in these areas, suggesting that these areas contain considerable yellow rail breeding habitat as well. Further surveying of wetlands in south-central Manitoba is warranted.

The vast majority of wetlands at which yellow rail presence was confirmed were found on privately-owned land. The majority of the lands immediately surrounding these wetlands were used for agricultural production, particularly native or planted grasslands used for grazing or haying. The amount of agriculture in the landscape did not significantly influence habitat suitability for yellow rails. If these wetland sites are conducive to successful yellow rail breeding, it could suggest that the conservation of yellow rail habitat might be compatible with some forms of agricultural land use surrounding the wetlands. Informing landowners about the benefits of wetlands would still be important for preventing the degradation or destruction of wetlands on these privately-owned lands. Yellow rails were also detected on several of the Wildlife Management Areas and Crown lands that were surveyed. Future yellow rail surveys on these lands would also be beneficial for monitoring yellow rail populations.

In conclusion, south-central Manitoba appears to be an important breeding area for yellow rails, with much potential habitat. However, few of the habitat variables evaluated in the multiple spatial scale analysis of yellow rail habitat suitability were found to be influential. Some level of habitat selection may occur at the landscape scale, in landscapes with low proportions of marsh/fen habitat, with the likelihood of yellow rail presence increasing with the amount of marsh/fen within 3 km of the focal wetland. Preventing further marsh/fen loss may be critical for maintaining yellow rail habitat suitability in south-central Manitoba. In addition, habitat suitability appears to be

somewhat influenced by the overall vegetation characteristics of the focal wetland, as yellow rail presence was found to be positively related to the proportion of rushes.

Although this study should be replicated to determine if the same variables are identified as important influences on yellow rail habitat suitability in other years, the influential variables identified here could be used as a starting point for the development of management or conservation strategies for this species of Special Concern.



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## **CHAPTER 5: MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS**

Despite its listing as a species of Special Concern on the federal species at risk list, population monitoring and habitat conservation efforts have been minimal for the yellow rail. Such efforts have been hampered by an incomplete understanding of the effectiveness of survey methods for yellow rail, and a lack of knowledge about the suitability of wetland habitats for this species. This study was undertaken to help fill in some of these knowledge gaps. The two main objectives of the study were: 1) to evaluate the detection probability of yellow rails during call-broadcast, repeat-visit night surveys, and to determine if this detection probability is influenced by temporal or environmental variables, and 2) to evaluate the influence of local- and landscape-scale variables on habitat suitability for yellow rails in south-central Manitoba, using a multiple spatial scale approach.

The focus of Chapter 3 was to quantify yellow rail detection probability during night surveys and to evaluate the factors affecting this detection probability. The use of call-broadcast increased the probability of detecting yellow rails during night surveys, although yellow rail detection probability was high even without call-broadcast. Future yellow rail surveys should employ call-broadcast when possible. However, the high detection probability of yellow rails even without the use of call-broadcast suggests that volunteer night-survey efforts, such as breeding bird atlases or local spring bird counts where the use of call-broadcast may not be possible, can still provide valuable abundance data that can be used to monitor yellow rail populations, provided the surveys are conducted at night and during the peak seasonal vocalization period for yellow rails at the latitude of the study region. Single surveys at each site were not sufficient for detecting

yellow rail presence. Future monitoring efforts should employ at least three surveys per wetland, although it was estimated that four surveys per wetland would be best, to accurately classify wetlands as occupied or unoccupied by yellow rails. Furthermore, yellow rail detection probability was lower in the second half of the survey period (i.e. after mid-June), so completing at least one round of surveys, but preferably two, before this time should help maximize the number of yellow rails detected. Because the timing and length of the seasonal vocalization period of yellow rails varies with latitude, this timeline should only be applied to wetlands within the same latitude as the study region. Finally, yellow rail detection probability during night surveys was not influenced by observer, or environmental variables, so surveys can effectively be conducted using existing yellow rail survey protocols (e.g. Bazin and Baldwin 2007) without further restrictions on appropriate survey conditions. However, further investigation on the effects of ambient light on the probability of detecting yellow rails during night surveys is needed.

In Chapter 4, a multiple spatial scale approach was used to evaluate the influence of plot-, patch-, and landscape-scale characteristics on the suitability of wetland habitat for yellow rails. In general, few habitat characteristics were found to influence yellow rail habitat suitability. At the landscape scale, the amount of marsh/fen habitat in the landscape had a weak positive effect on yellow rail presence in 2011, but not in 2010. As the mean amount of marsh/fen in the landscape was significantly lower in 2011 than in 2010, it was concluded that landscape-scale marsh/fen may only influence habitat suitability of wetlands located in landscapes with low proportions of marsh/fen habitat. At the patch scale, the global model was the highest-ranked model of the set of models

tested. Within this model, yellow rail presence was positively influenced by the proportion of rushes along random transects within the wetland. At the plot scale, none of the habitat variables that were tested were found to influence yellow rail presence. However, this may have resulted from the plot-scale transects failing to adequately describe the fine-scale habitat characteristics with which yellow rails are associating. Habitat variables that appeared to influence yellow rail habitat suitability are summarized in Table 5-1.

Table 5-1 Variables that were found to influence the suitability of wetland habitat in south-central Manitoba for yellow rails at the 3-km landscape, patch (i.e. wetland) and plot (i.e. survey point) scales in 2010-2011.

Scale	Influential Variables in 2010-2011
3-km Landscape Scale	Proportion of marsh/fen (2011 only)
Patch Scale	Proportion of rushes
Plot Scale	None

The results of the multiple spatial scale analysis can be used in the future to identify additional potentially suitable yellow rail habitat in south-central Manitoba. The first step in the identification of suitable habitat for this species could be a coarse evaluation of the target region to identify landscapes with adequate proportions of marsh/fen habitat (landscapes comprising of at least 17% marsh/fen). Accomplishing this step would require GIS layers and FRAGSTATS (McGarigal and Marks 1995), or similar software. Once potentially suitable landscapes are identified, visits to focal wetlands would be required to evaluate the vegetation community composition to determine which wetlands would have high potential for supporting yellow rails during the breeding

season. Wetlands with high proportions of rushes should be considered to be potentially suitable for yellow rails. However, some caution needs to be taken when using this method to identify potential yellow rail habitat. The GIS layers used in this study were limited in that not all wetlands are found on the layers. Approximately 25% of the 82 wetlands surveyed in this study were not found on either the land cover or waterbodies inventory GIS layers that were prepared by the Manitoba Land Initiative. This is due to challenges in interpreting the aerial photos used to digitize the wetlands, and dependent on the time of year when aerial photographs were taken (Frank Wahl, pers. comm.). Therefore, habitat patches that may be suitable for yellow rails would be missed if they are not found on the GIS layers. If enhanced GIS layers are available or developed in the future, they could be used to improve the accuracy of this analysis.

The observed importance of the amount of marsh/fen habitat at the landscape scale in 2011 is important from a management perspective. In this study, the amount of marsh/fen in the 3-km landscape began to influence yellow rail habitat suitability when the proportion of this habitat type in the landscape was only 12%, on average. Thus, landscapes with low proportions of marsh/fen, such as those where wetland loss has been extensive, may not be suitable for yellow rails. Conservation efforts for yellow rails should, therefore, be focused on landscapes with higher proportions of marsh/fen habitat. Furthermore, the positive association between yellow rail presence and the landscape-scale proportion of marsh/fen habitat emphasizes the detrimental effect of wetland loss on this species. Preventing further wetland loss may, therefore, be an integral component of future yellow rail conservation efforts.

In general, the results of the call-broadcast surveys suggest that yellow rails are more common in south-central Manitoba than previously believed. The high incidence of yellow rails on private land is encouraging. Yellow rails also seem to be fairly widespread throughout the study area in south-central Manitoba. In particular, the southern Interlake region has much potentially suitable wetland habitat that has not been surveyed up to this point, and should be explored further. Establishing a yellow rail monitoring program in this area would be useful for identifying additional yellow rail breeding habitat, collecting information about Manitoba's breeding population of yellow rails, and evaluating yellow rail population trends. The trends observed in the multiple spatial scale study conducted here, while preliminary, may be useful in identifying areas of potential yellow rail habitat in south-central Manitoba. Further research on yellow rail habitat suitability, particularly with a larger sample size, a better representation of fine-scale habitat characteristics, and in normal or dry precipitation years, is needed to clarify the habitat suitability requirements for this species of Special Concern.

## LITERATURE CITED

- Bazin, R. and F.B. Baldwin. 2007. Canadian Wildlife Service standardized protocol for the survey of yellow rails (*Coturnicops noveboracensis*) in prairie and northern region. Environment Canada Report, Winnipeg, Manitoba.
- McGarigal, K. and B.J. Marks. 1995. FRAGSTATS: spatial pattern analysis program for quantifying landscape structure. General technical report PNW 351. U.S. Forest Service, Corvallis, Oregon, U.S.A.

Appendix I. Sample yellow rail survey form (Bazin and Baldwin 2007).

2007 Yellow Rail call response survey field data sheet

Site \_\_\_\_\_ Station # \_\_\_\_\_ Site visit # \_\_\_\_\_ Lat. \_\_\_\_\_  
 Date \_\_\_\_\_ Start time \_\_\_\_\_ End time \_\_\_\_\_ Long. \_\_\_\_\_  
 Wind - Beaufort \_\_\_\_\_ Cloud cover<sup>1</sup> \_\_\_\_\_ Temperature \_\_\_\_\_ Precip. \_\_\_\_\_  
 Wind - Direction \_\_\_\_\_ Moon phase<sup>2</sup> \_\_\_\_\_ Moon visibility<sup>3</sup> \_\_\_\_\_ Sp. dir. \_\_\_\_\_  
 Wetland permanency (circle one): permanent semi-permanent seasonal Call type<sup>4</sup> \_\_\_\_\_  
 Water depth (cm) \_\_\_\_\_ Observer(s) \_\_\_\_\_

<sup>1</sup> cloud cover: 0%, 0-25, 25-50, 50-75, 75-100, 100%

<sup>2</sup> moon phase: new, <half, half, >half, full

<sup>3</sup> moon visibility: visible, obscured, absent

<sup>4</sup> elec. or manual

Habitat Data (to be collected on day prior to night survey)			
Date when habitat information collected: _____			
Habitat classes: Cattail _____ Sedge _____ Open water _____			
(% within 50m radius) Mix <sup>5</sup> a) _____ Bulrush _____ Bare ground _____			
(must = 100%) b) _____ Rushes _____ Phragmites _____			
c) _____ Other (please specify) _____			
Wetland cover types: <b>stand emerg</b> _____ open water _____ <b>trees</b> _____			
(% for entire wetland=100%) bare ground _____ <b>shrubs</b> _____			
(provide height as H=high, M=medium, L=low) <sup>5</sup> for mix, provide rough estimate of proportion of each class within stand			

NOTE: secondary species to record in table: AMBI, PBGR, SORA and VIRA (LEBI Manitoba only)

<sup>6</sup> mark 1 for heard, s for seen and 1s for heard/seen

Species	Ambient noise (see back)	call before	Passive <sup>6</sup>					Call <sup>6</sup>			Passive <sup>6</sup>		call after	Call Type(s) (see back)	Distance (m) <sup>7</sup>	Detected previously	Comments
			1 min	2 min	3 min	4 min	5 min	1 min	2 min	3 min	1 min	2 min					

NOTE: additional sp. of interest to record in table:

- Le Conte's Sparrow (LCSP)
- Nelson's Sharp-tailed Sparrow (NSTS)
- Sedge Wren (SEWR)

<sup>7</sup> Distance bands: 0-25m, 25-50m, 50-75m, 75-125m, 125-200m, >200m

Miscellaneous notes:

Other sp. \_\_\_\_\_

\_\_\_\_\_