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Distribution and habitat associations of breeding secretive marsh birds in the Mississippi Alluvial Valley of northeast Louisiana

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DISTRIBUTION AND HABITAT ASSOCIATIONS OF BREEDING SECRETIVE MARSH
BIRDS IN THE MISSISSIPPI ALLUVIAL VALLEY OF NORTHEAST LOUISIANA

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The School of Renewable Natural Resources

by
Jonathon Valente
B.A. Miami University, 2004
May 2009

DEDICATION

To my mom and dad, for being the kind of parents who are interested in whatever it is that I am interested in.

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ABSTRACT

Populations of many North American secretive marsh birds (SMBs) have declined over the past 30 years, primarily as a function of wetland loss. Ranges for many of these species encompass Louisiana and researchers have investigated various characteristics associated with breeding populations in coastal wetlands, yet similar knowledge is lacking for other parts of the state. I investigated distributions and habitat characteristics associated with breeding SMBs in wetlands and rice fields of the lower Mississippi Alluvial Valley (MAV) of northeast Louisiana. In the 2007 and 2008 breeding seasons we conducted repeated bird surveys in 118 wetlands and 76 rice fields. Common Moorhens (*Gallinula chloropus*), Least Bitterns (*Ixobrychus exilis*) and Purple Gallinules (*Porphyryula martinica*), were the most commonly detected species in wetlands while breeding King Rails (*Rallus elegans*) and American Coots (*Fulica americana*) were rare. I built predictive wetland habitat models for Common Moorhens, Least Bitterns and Purple Gallinules in each year based on vegetation characteristics recorded within 100 m (local) and 1 km (landscape) of wetland sampling points. In general, local areas with greater coverage of water and robust emergent vegetation seem to attract breeding SMBs. No other local upland habitat characteristics or landscape cover variables were consistently, significantly associated with occupancy for any species across years. Wetlands dominated by robust emergent vegetation are rare in this region and birds may have to utilize them wherever they are available, disregarding other local and landscape habitat features. In 2007 no breeding individuals from any of these species were encountered in rice fields and only 7 rice sites were occupied by any species in 2008. Rice in the MAV does not reach a height adequate to support breeding SMBs (~ 65-70 cm) until late May at the earliest, 1-2 months after the breeding season commences. However, King Rails, Least Bitterns, Common Moorhens and American Coots were all observed

in rice fields between June and August of both years. Thus, it is possible that rice fields in the MAV are used by late season breeders or birds rearing a second brood.

CHAPTER 1

INTRODUCTION

The term “secretive marsh birds” (SMBs) refers to a group of species that are considered to be marsh-dependent and includes all rails, bitterns, moorhens and gallinules (Conway 2005). While populations of many of these species are broadly distributed across North America, SMBs remain one of the most poorly studied avian groups. For most species we lack basic information on population sizes, breeding and foraging ecology, migration patterns and habitat requirements (Eddleman et al. 1988). Additionally, we lack effective means of monitoring population trends, as emergent wetland communities are not adequately sampled by most bird surveys (Robbins et al. 1986; Gibbs and Melvin 1993). Moreover, on account of the secretive nature of these species, they are often difficult to detect even when appropriate habitat is sampled and birds are present (Allen et al. 2004; Conway and Gibbs 2005; Conway 2005). By playing callback recordings of these species, detection probabilities can be increased and variance can be decreased among surveys but this technique is not widely utilized (Allen et al. 2004; Conway and Gibbs 2005).

Evidence suggests that many SMB species have suffered drastic population declines over the past 30 years (Eddleman et al. 1988; Timmermans et al. 2008) which may be primarily attributable to wetland loss (Conway et al. 1994; Eddleman et al. 1988). In the United States it is estimated that initially there were 89.4 million hectares of wetlands in the lower 48 states; by the 1980s that area had been reduced to an estimated 42.1 million hectares (Dahl 1990). The southeastern U.S., which has some of the highest breeding and wintering densities of various SMB species, holds nearly half of the wetlands within the conterminous United States, but losses there accounted for 89% of the net wetland loss (105,000 hectares/yr) between the mid-1970s and the mid-1980s (Hefner et al. 1994). Louisiana alone lost 46% of its wetlands between the

1780s and the 1980s (Dahl 1990). Moreover, palustrine and riverine wetlands, those most important as SMB habitat, are among the most threatened (Eddleman 1988).

The U.S. Fish and Wildlife Service reports that the United States has halted this net loss, and is actually gaining wetland area annually (Dahl 2006). Additionally, rice area has been increasing globally (Lawler 2001) and many SMB species have been documented utilizing these agricultural wetlands as breeding habitat (Meanley 1953; Helm et al. 1987; Hohman et al. 1994; Pierluissi 2006). However, there is no indication that populations of SMB species have responded to this increase in wetland area with increases in population sizes. One possible explanation for this is that remaining wetlands do not exhibit habitat characteristics appropriate for breeding SMBs. Consequently, it is important to develop a thorough understanding of the habitat resources these birds are selecting for during the breeding season.

Avian habitat selection is a multi-phase, multi-scale process (Johnson 1980; Burger 1985; Kristan III 2006). Previous research has indicated that wetland site characteristics at multiple scales can influence where a bird chooses to breed, yet the relative importance of those scales in the selection process may be different for different species (Naugle et al. 1999; Naugle et al. 2001). Recent studies demonstrate the importance of landscape-level habitat characteristics on wetland bird communities (Brown and Dinsmore 1986; Fairbairn and Dinsmore 2001; Riffell et al. 2003; Guadagnin et al. 2005; Guadagnin and Maltchik 2007) and individual species (Naugle et al. 1997; Naugle et al. 1999; Taft and Haig 2006). Wetland complexes are generally more valuable for birds than isolated wetlands in fragmented landscapes (Brown and Dinsmore 1986; Fairbairn and Dinsmore 2001; Naugle et al. 2001; Riffell et al. 2003; Paracuellos and Telleria 2004; Guadagnin and Maltchik 2007; Taft and Haig 2006). Upland landscape characteristics are also important as several studies have shown decreased avian biodiversity in

wetlands located within landscapes heavily impacted by humans (Naugle et al. 2001; Mensing et al. 1998).

At a finer scale, the size of the individual wetland can affect breeding bird use as well (Naugle et al. 1997; Naugle et al. 1999; Benoit and Askins 2002; Guadagnin and Maltchik 2007), with larger wetlands being generally more attractive. Additionally, within a given wetland, food availability (Orians and Wittenberger 1991), vegetation structure (Johnson and Dinsmore 1986; Reid 1989; Orians and Wittenberger 1991; Robert et al. 2000; Osnas 2003; Lor and Malecki 2006) and water depth (Reid 1989; Robert et al. 2000; Osnas 2003; Lor and Malecki 2006) are also important habitat characteristics influencing nest placement and brood use. Thus, if wetlands are not located within an attractive landscape context, breeding birds may avoid them despite the presence of appropriate nesting habitat, and wetlands with quality nesting structure and food resources may never be found by these same species if they are not located within appealing landscapes. Multi-scale habitat selection models are therefore more useful at predicting organism locations than are their single-scale counterparts (Kristan III 2006; Meyer and Thuiller 2006).

Louisiana is within the breeding range of several SMB species, and studies have shown that Purple Gallinules, King Rails, Common Moorhens, and to a lesser extent Least Bitterns, nest both successfully and in relatively high densities along the state's coast (Helm et al. 1987; Hohman et al. 1994; Pierluissi 2006). The majority of this work has focused on agricultural wetlands, and of these studies, only Pierluissi (2006) utilized a multi-scale approach; he investigated nest densities of SMB species as a function of the habitat immediately adjacent to targeted rice fields as well as characteristics within 1km of the edges of those fields. Even so, he did not include variables from different scales into the same models, making it difficult to interpret the relative importance of variables from one scale to the next. Moreover, these studies

took place on the Gulf Coastal Plain (GCP) in landscapes dominated by vast complexes of agricultural wetlands. Wetlands located in the Mississippi Alluvial Valley (MAV) of Louisiana, on the other hand, were predominantly created by the Mississippi River and are located within landscapes dominated by non-wetland agricultural crops and remnant tracts of dense bottomland hardwood forest. Rice fields in the region likely differ from those of the GCP as well, as they are subjected to different agricultural practices (e.g. later planting dates, different rice varieties, etc). Thus wetlands (agricultural and other) of Louisiana's MAV may differ greatly from those of the GCP in terms of hydrologic characteristics, vegetation structure and composition, and landscape context.

The objectives of this study were to 1) identify which SMB species breed in the MAV of northeast Louisiana, 2) identify local and landscape level habitat characteristics associated with wetlands utilized by each breeding species, 3) identify local and landscape level habitat characteristics associated with rice fields utilized by each breeding species, and 4) qualitatively compare the utility of wetlands and rice fields in providing habitat for breeding SMBs in the region.

CHAPTER 2

DISTRIBUTION AND HABITAT ASSOCIATIONS IN WETLANDS OF NORTHEAST LOUISIANA

INTRODUCTION

The breeding ranges of numerous secretive marsh bird (SMB) species span the Mississippi Alluvial Valley (MAV) of northeast Louisiana, including the King Rail (*Rallus elegans*), Common Moorhen (*Gallinula chloropus*), Purple Gallinule (*Porphyrio martinica*), Least Bittern (*Ixobrychus exilis*) and American Coot (*Fulica americana*; Dunn and Alderfer 2006). However, we know very little about local distributions of these species because wetland habitats are poorly represented in most breeding bird monitoring programs like the North American Breeding Bird Survey (Robbins et al. 1986; Gibbs and Melvin 1993), and such programs do not utilize techniques to effectively sample SMB communities (Allen et al. 2004; Conway and Gibbs 2005; Conway 2005).

Wetlands in this area were predominantly created and hydrologically influenced by the Mississippi River. Today, an extensive levee system along the river has isolated most of these wetland bodies. Additionally, the landscape, which was historically dominated by dense bottomland hardwood forest, has been heavily altered in the past 200 years with > 80 % being converted to agriculture (TNC 2009). In the MAV region of Arkansas, Budd (2007) found that breeding SMBs are generally rare with no species occupying > 22% of his surveyed wetlands. To my knowledge no one has explored which SMB species breed in Louisiana's MAV, to what extent these wetlands are being utilized, what habitat features are available, or which of those features are important for breeding SMBs.

Numerous studies have investigated SMB nesting site characteristics, describing the impacts of vegetation cover (Johnson and Dinsmore 1986; Popper and Stern 2000; Robert et al.

2000; Naugle et al. 2001; Lor and Malecki 2006), water depth (Reid 1989; Popper and Stern 2000; Robert et al. 2000; Lor and Malecki 2006), vegetation height (Reid 1989; Flores and Eddleman 1995; Legare and Eddleman 2001; Gaines et al. 2003; Lor and Malecki 2006) and vegetation composition (Johnson and Dinsmore 1986; Reid 1989; Flores and Eddelman 1995; Robert et al 2000; Popper and Stern 2000) around active nests. However, there continues to be some speculation over the relative importance of these variables. Lor and Malecki (2006), for instance, found a general trend indicating there was a higher probability of encountering a nest of each of 5 SMB species at sites with increased emergent vegetation, horizontal cover and shallow water depths. Rehm and Baldassarre (2007), on the other hand, investigated the abundance of these same 5 species in some of the exact same areas and discovered that interspersed, as measured by edge density, was the best predictor of abundance for 4 out of those 5 species.

At broader scales, wetland size may be either important (Brown and Dinsmore 1986; Naugle et al. 2001; Budd 2007) or unimportant (Brown and Dinsmore 1986; Naugle et al. 2001; Benoit and Askins 2002; Rehm and Baldassarre 2007) in predicting occupancy and abundance. Furthermore, hydrologic characteristics of the wetland system can also impact site usage (Legare and Eddleman 2001; DesGranges et al. 2006; Timmermans et al. 2008). However, few studies have evaluated the influence of landscape context on wetland occupancy by SMBs, and even fewer have explicitly investigated habitat selection by these species at multiple spatial scales simultaneously, or compared the relative importance of those scales in the decision making process (but see Naugle et al. 2001; Pierluissi 2006; Rehm and Baldassarre 2007).

Research Objectives

- 1) Identify which secretive marsh bird species breed in the MAV of northeast Louisiana.
- 2) Model site occupancy as a function of habitat variables at multiple spatial scales for each breeding species to identify habitat characteristics those species are selecting.

Hypotheses

- 1) We will find 5 SMB species breeding in the MAV of Louisiana: American Coots (*Fulica americana*), Common Moorhens (*Gallinula chloropus*), King Rails (*Rallus elegans*), Least Bitterns (*Ixobrychus exilis*) and Purple Gallinules (*Porphyryula martinica*).
- 2) Within a wetland, occupancy of all breeding SMB species will be positively associated with the amount of robust emergent vegetation. All breeding SMB species will be positively associated with the amount of water and negatively associated with cover by tall trees at both local and landscape scales.

METHODS

Site Selection

My study area encompassed most of the Mississippi Alluvial Valley (MAV) and portions of the Gulf Coastal Plain in Louisiana north of 31°1'2" north latitude and east of 92°10'15" west longitude (Figure 2.1). I began wetland site selection by digitizing every wetland (n = 318) on all Wildlife Management Areas (WMA; n = 8), National Wildlife Refuges (NWR; n = 6) and WRP easements (n = 35) I was allowed access to in the study region using ESRI® ArcMap™ 9.1 (Copyright ©1999-2005 ESRI Inc.). In Arizona, Conway et al. (1993) found that the mean distance Clapper Rails moved from their activity center was between 126 m and 157 m during the breeding season. Thus, in order to reduce the probability of detecting the same bird at 2 different sites, I had ArcMap™ randomly place one point on the perimeter of each wetland with the stipulation that all points had to be at least 700 m apart. About one third of the sampling sites were eliminated for logistical reasons (e.g. location relative to other sites, distance from nearest lodging, etc.). I randomly selected 114 wetlands, with one sampling point on each wetland, from the remaining to be used as our study sites in 2007. I found each point with a GPS unit and I placed a flag on the edge of the water of the target wetland as close to that point as possible.

When points were found to be logistically inaccessible, they were moved to an accessible spot located as close to the original point as possible, while still maintaining the 700 m minimum distance from other sampling points.

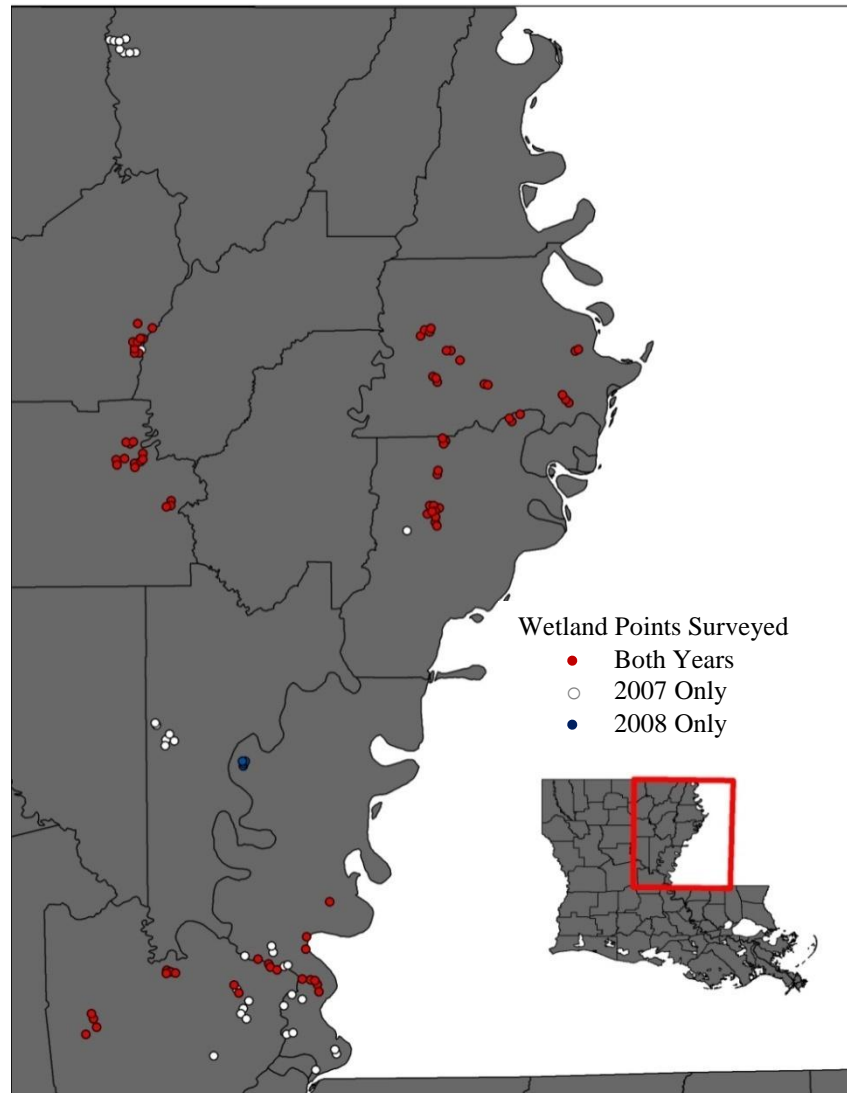


Figure 2.1: This map depicts the northeast region of Louisiana where our study was focused, and the 118 points we sampled over the course of 2007 and 2008.

My goal in 2008 was to replicate our surveys from the previous season at as many of the same sample points as possible, but a site was only considered a replicate if we could survey from within 20 m of the 2007 point. Thus, due to large scale flooding throughout much of the spring, I was only able to replicate the surveys at 79 (69.3%) of the sites from the previous

season; four sites not surveyed in 2007 were also added in 2008 to fill in a large geographic gap in Concordia Parish (Figure 2.1). In all we sampled wetlands on 6 WMAs, 4 NWRs and 25 WRP easements (Appendix A).

Bird Sampling Protocol

In the summer of 2007, 4 observers conducted 712 total bird surveys (6.25 surveys/site) between 18 March and 25 June. In 2008, 3 observers conducted 615 total bird surveys (7.41 surveys/site) between 5 April and 17 June. In both years, each site was surveyed once or twice approximately every 15 days. Individual sites were surveyed 1-7 times each in 2007 and 2-8 times each in 2008.

Bird survey procedures followed the Standardized North American Marsh Bird Monitoring Protocols (Conway 2005). Surveys were conducted both in the mornings and the evenings; morning bird surveys began half an hour before sunrise and concluded no later than 2.5 hours after sunrise. Evening bird surveys began 2.5 hours before sunset and concluded no later than half an hour after sunset. Surveys were never conducted in inclement weather (i.e. wind > 20 km/h, heavy precipitation), and we rotated the observers sampling each site to minimize the impact of observer bias. Additionally, each point was located on a survey route which included several other survey points that could all be sampled in a single morning or evening. Each time a survey route was sampled, it was sampled in the opposite direction of which it was previously. That is, the first time the survey route was conducted site A would be sampled first and site Z sampled last; then the second time the survey route was conducted, site Z would be sampled first and site A last, and so on.

Each survey included a 1-minute “settling” period, a 5-minute silent period and a 6-minute callback period. The 6-minute callback period consisted of playing 30 seconds of calls from 6 secretive marsh bird species followed by 30 seconds of silence. Calls were played from

an RCA RP2700A portable CD player and broadcast through RadioShack™ speakers. The sound system was checked once per week to ensure that the sound level remained between 80 and 90 dB at 1 m in front of the speakers. Speakers were always placed upright on the ground and were pointed toward the center of the target wetland during the first survey at each site; that fixed speaker direction was used during each subsequent survey. The order in which species' calls were played was 1) Least Bittern, 2) King Rail, 3) American Bittern, 4) Common Moorhen, 5) Purple Gallinule, and 6) American Coot. While I did not expect to find American Bitterns nesting in the study region, Pierluissi (2006) found that the call of this species seemed to elicit responses from King Rails, so I incorporated it into my study design. Sora calls were not played because my study region is outside of the species' breeding range, but detections of this species were recorded. Once the 6-minute callback period concluded, the survey was complete and the observer moved on to the next site.

Each bird detected was listed individually (see bird survey data sheet, Appendix B). The first time an individual was detected, its distance from the sampling point was recorded and an H (heard) or S (saw) was placed in the box reserved for the appropriate 1-minute interval in which it was detected. An H or an S was then recorded in the appropriate box for each subsequent 1-minute interval in which that same bird was detected. It was up to the observer to determine whether a detection was a new bird or one that had been previously recorded. Birds detected during the 1 minute settling period were also recorded, and that detection was deemed to be the first encounter with that individual. Thus, distance to that individual was estimated at that time (despite the fact that the survey had not technically started) and an H or an S was placed in the "before" column next to the listed individual. Indications of breeding activity (i.e. courtship displays, nests, nest building, or hatch year birds) were recorded in the "comments" column when noticed.

Local Scale Habitat

In order to characterize local habitat availability, we conducted one vegetation survey at each site in each year. In 2007 the vegetation surveys were conducted between 1 June and 11 June by 4 different observers, and in 2008 the survey was conducted between 6 June and 27 June by only 1 observer. At each sampling point a circle with a 100 m radius was marked out and broad wetland and upland habitat characteristics were recorded (see vegetation data sheet, Appendix C). Wetland habitat was considered the proportion of the survey circle covered by water, and the remaining area was considered uplands. Upland habitat was broken down into 5 categories, defined by the structure of the dominant vegetation type. These categories included agriculture, grass and weeds, trees ≤ 3 m tall, trees between 3 and 10 m tall, and trees ≥ 10 m tall. The numbers recorded for wetland area and the 5 upland types summed to 100% for each site.

Within the associated flooded area we estimated the percentage of open water, the percentage containing floating or submerged vegetation, and the percentage covered by herbaceous emergent or woody emergent vegetation. The sum of these numbers could add up to $>100\%$ as certain species of floating/submerged vegetation could occupy the same horizontal space as emergent vegetation. Each of the 3 wetland vegetation groups was then broken down further into all species that comprised that group. Usually it was possible to quantify standing water coverage for all species within a vegetation category, but occasionally there would be a small group of species that occurred infrequently; in this case those species would be combined and listed as “other” in the species column and a pooled estimate of their standing water coverage was recorded. For each species identified we then recorded: the percentage of the habitat category which it comprised; the percentage of the standing water that species covered; density, ranked on a scale of 1-5 (see vegetation data sheet, Appendix C); mean height of that

plant species above the water level; and we characterized its distribution as either, random, even, single patch, multiple patches, edge only or other.

Water depths were also taken at each site using 2 methods. In the first method, a line perpendicular to the water's edge was drawn and water depths at 1, 10 and 50 m from the shoreline were measured. Water depths were categorized as either shallow (< 30.5 cm), moderate (30.5-61 cm), deep (> 61 cm), or not applicable (if there was no water present at that point). For the second method, the goal was to take 3 water depths from randomly selected open water patches and 3 water depths from randomly selected herbaceous emergent vegetation patches. For this, a direction was randomly selected that pointed out into the wetland. The observer would then walk in that direction until he or she encountered the first patch of open water or herbaceous vegetation that was at least 5 m from the survey point and record a water depth. The observer would then continue moving down the line until open water or herbaceous vegetation was reached again and record a second depth, and so on. There had to be at least 20 m between open water depth measurements and at least 20 m between herbaceous vegetation water depth measurements, but there could be less than 20 m between an open water depth measurement and an herbaceous emergent one. If the observer encountered the wetland's edge or was unable to move further down the randomly selected line, he or she would stop and randomly select another direction to walk, and so on, until 6 water depth measurements had been taken.

Landscape Scale Habitat

Landscape scale habitat information was collected by drawing a 1 km circle around each sampling point over digital ortho imagery taken in 2007 as part of the National Agriculture Imagery Program. We then printed copies of each site and in the field we classified each part of the landscape into one of 5 categories: 1) agriculture; 2) residential, grassland or pasture; 3)

wetland or permanent water; 4) young reforested (i.e. dominated by trees ≤ 3 m); or 5) forest (i.e. dominated by trees ≥ 3 m). Later I digitized the area within 1 km of a survey point using ESRI® ArcMap™ 9.1 (Copyright ©1999-2005 ESRI Inc.), and calculated the proportion of the area surrounding each point that was comprised of each of these 5 variables. I was not able to obtain ortho imagery for 2008, so landscape scale variables were calculated for sites sampled in 2008 with information from the 2007 photographs. Thus, landscape scale habitat information is identical in 2007 and 2008 for those sites sampled both years.

Data Analyses

If detections per survey round dropped to 0 for a given species before mid-May, I assumed that species did not breed in the region. To reduce the possibility of including migrant birds in my analysis of breeding site selection, I truncated all surveys conducted prior to the 28 April in both years, which eliminated one 2008 site from further analyses because all surveys at that site were conducted prior to 28 April. Naïve estimates of occupancy were calculated for each species by dividing the number of sites where the species was encountered by the total number of sites surveyed. Naïve estimates of relative abundance were calculated by dividing the number of individuals encountered by the total number of surveys conducted.

Modeling Procedures

Due to the secretive nature of these species, it seemed likely that detection probabilities would be far less than 1, a problem which could result in misclassifying sites as “unoccupied.” To account for this, I used the likelihood-based approach put forth by MacKenzie et al. (2002) to model both occupancy (ψ) and detection probability (P) simultaneously. Using this approach, occupancy can be modeled as a logistic function of site-specific covariates and detection probability can be modeled as a logistic function of both site-specific and survey-specific

covariates. Maximum likelihood theory is then employed to simultaneously estimate the parameters in these logistic models to identify the best possible model to explain the data.

One of the fundamental assumptions of the MacKenzie et al. (2002) model is that, at the species level, sites are closed to changes in occupancy status during the season. In other words, each site is either always occupied, or always unoccupied by a breeding species. Within a given breeding season, if a wetland ever went dry or endured drastic habitat alterations (e.g. a couple of wetlands were drained and disked by land managers during the course of our study) it was determined to be in potential violation of the closure assumption, and all surveys conducted at that site from then on were eliminated from further analyses. Sites that had no water within 100 m (2007 $n = 8$; 2008 $n = 6$) at the time of the vegetation survey were eliminated from further analyses. Due to logistical constraints one wetland in 2007 was only sampled once, and in 2008 we did not collect habitat information on four wetlands; all of these sites were eliminated from habitat modeling as well.

For modeling purposes, a site was considered to be “occupied” by a species only if that species was ever detected within 100 m of the survey point. This was necessary since I was primarily interested in modeling occupancy as a function of habitat and my local vegetation surveys only encompassed 100 m of each survey point. If the species was never detected within 100 m, the site was considered to be unoccupied during every survey conducted there, regardless of whether the species was detected at a distance greater than 100 m or not. If, however, the species was detected within 100 m during any breeding survey at a given site, then all detections ≤ 300 m were included as part of that site’s detection history (species identification at a distance of > 300 m was questionable). This ensures that the habitat models are applicable to sites where the species was indeed using that particular habitat, yet relaxes the assumption that a species detected within 100 m must *always* be within 100 m.

Prior to creating and comparing models, I identified which variables were candidates for inclusion in the analyses. Variables potentially influencing detection probability included: 1) whether the survey was conducted in the morning or evening; 2) the amount of time until, or which had passed since sunrise or sunset; 3) the Julian date; and 4) the observer conducting the survey. I also re-structured several wetland habitat variables for modeling purposes to 1) reduce variation resulting from observer bias, and 2) to combine structurally similar vegetation.

Because density and distribution of wetland plants were recorded individually for each plant species instead of for structural groups, and because these variables proved difficult to estimate in the field due to extreme variability, they were excluded from analyses. Estimates of water depth were also excluded from analyses because our methods of measuring depth turned out to be extremely ineffective due to difficulties maneuvering through the wetlands; as a result the water depth data were incomplete and unreliable.

Vegetation height had very little meaning for floating and floating-leaved plants, so all floating vegetation was combined into the same category. While I acknowledge that structurally insignificant floating plants such as *Lemna minor* and *Azolla caroliniana* may be important food resources, especially for Common Moorhens, American Coots and Purple Gallinules, it was very difficult to quantify the availability of these species in the field and thus areas covered by only these species were considered open water. There was a bimodal distribution in herbaceous emergent vegetation height with a natural break occurring around 0.75 m, so this value was used as a distinction for short and tall herbaceous emergent plants. I did not separate robust emergent plants into the same height categories because only 2 sites in 2007 and 0 sites in 2008 had robust emergent vegetation < 0.75 m tall. Woody emergent plants were divided into 2 similar categories, where short woody plants were defined as < 3 m, and tall woody plants were defined as ≥ 3 m.

Due to high correlation among landscape variables, I conducted a principal components analysis (PROC PRINCOMP, SAS Institute 2002-2003) on those 5 characteristics in each year. In both years the first 3 principal components accounted for > 85% of the variability in the landscape, so the principal components scores for those variables were included to represent a site's landscape (Table 2.1).

I examined Pearson correlation coefficients to look for potential multicollinearity problems among variables across scales (PROC CORR, SAS Institute 2002-2003). The amount of the standing water dominated by open water and the proportion of the local area covered by grass or weeds were both highly correlated ($|r| > 0.3$) with several other measures in both years; these variables were eliminated from further analyses. There was a similar problem with the proportion of the local area covered by short trees in 2008, and this variable was removed from modeling analyses in 2008 only. Correlation did not exceed ± 0.35 for any combination of the remaining variables in either year. All variables that were considered as candidates to be included in habitat models are found in Table 2.2.

Table 2.1: Coefficient values of the Eigen vectors for each landscape scale principal component. Separate principal components analyses were conducted for each year at each scale. The variables measured at this scale were proportion of the 1 km area around the survey point dominated by water, agriculture, residential/grasslands, young reforested areas, and forest.

Year	Principal Component	Water	Agriculture	Res/Grass	Reforest	Forest	Variance Explained	Cumulative Variance Explained
2007	PC1	0.17	0.39	-0.11	0.56	-0.70	0.37	0.37
	PC2	0.76	-0.26	0.43	-0.31	-0.27	0.27	0.64
	PC3	-0.29	0.63	0.67	-0.27	-0.04	0.21	0.85
	PC4	-0.30	-0.53	0.58	0.54	-0.03	0.15	1.00
	PC5	0.46	0.32	0.13	0.48	0.66	0.00	1.00
2008	PC1	0.20	-0.34	0.41	-0.59	0.58	0.41	0.41
	PC2	0.69	0.20	0.51	0.02	-0.47	0.28	0.70
	PC3	-0.17	0.84	-0.03	-0.52	0.05	0.20	0.90
	PC4	-0.64	0.01	0.74	0.18	-0.11	0.10	1.00
	PC5	0.21	0.38	0.14	0.59	0.66	0.00	1.00

Table 2.2: Definitions of all covariates which were considered candidates to be included in modeling analyses.

Variable	Definition
<u>Survey</u>	<u>Variable recorded for each survey which indicates:</u>
Obs	The observer who conducted the survey: there were 6 total observers over the course of the 2 year study
Day	The julian date on which the survey was conducted
Time	The number of minutes until or since sunrise or sunset at the moment the survey began
Eve	Whether the survey was conducted in the morning or evening
<u>Wetland Variables</u>	<u>Variables represent the proportion of the standing water within 100m of the survey point covered by:</u>
Rob	Robust emergent vegetation (<i>Typha spp.</i> and <i>Zizaniopsis miliacea</i>)
Sh_Em	Non-robust herbaceous emergent vegetation < 0.75 m tall (<i>e.g. Ludwigia spp.</i> , <i>Alternanthera philoxeroides</i> , <i>Carex spp.</i> , <i>Sagittaria spp.</i> , etc.)
T_Em	Non-robust herbaceous emergent vegetation ≥ 0.75 m tall (<i>e.g. Carex spp.</i> , <i>Juncus effuses</i> , <i>Rhynchospora spp.</i> , etc.)
Sh_Wood	Woody vegetation < 3 m tall
T_Wood	Woody vegetation ≥ 3 m tall
Float	Floating and floating-leaved vegetation (<i>Nelumbo lutea</i> , <i>Eichhornia crassipes</i> , <i>Potamogeton spp.</i> , and <i>Utricularia spp.</i>)
<u>Other Local Variables</u>	<u>Variables represent the proportion of the 100 m radius circle around the survey point covered by:</u>
Water	Standing water
Ag	Upland dominated by agriculture
Sh_Trees*	Upland dominated by trees < 3 m tall
T_Trees	Upland dominated by trees ≥ 3 m tall
<u>Landscape Variables</u>	<u>Variable represents the score of the:</u>
PC1**	First principal component at the 1 km scale
PC2**	Second principal component at the 1 km scale
PC3**	Third principal component at the 1 km scale

* Variable was only used in 2007 analyses. It was eliminated from habitat modeling procedures in 2008 due to high correlation with other variables.

** Principal component analyses were conducted separately for 2007 and 2008 so the Eigen vectors representing PC1, PC2 and PC3 are not the same between years. See Table 2.1 for description of the principal components.

I developed separate habitat models for each species so I could investigate similarities and differences in habitat selection among them. I also modeled occupancy separately for each year because of differences in habitat conditions between years. The development of habitat models required several steps and all covariates were standardized prior to these analyses.

I first modeled detection probability as a function of all possible combinations of survey-specific covariates (Table 2.2) while keeping occupancy constant using Program Presence 2.2 (<http://www.mbr-pwrc.usgs.gov/software/presence.html>). Program Presence constructs and compares models using the methods of MacKenzie et al. (2002). I distinguished among these models using Akaike's Information Criterion (AIC), and the model with the lowest AIC value was considered the simplest, most explanatory (Burnham and Anderson 2002).

I next reduced the number of habitat variables to be included in each global model using simple logistic regression. I modeled each habitat variable individually using naïve occupancy estimates as the response (PROC LOGISTIC, SAS Institute 2002-2003) and only those significant at the $\alpha = 0.15$ level were included in the global model. This liberal α -level was used to avoid eliminating potentially important variables too early in the process.

I combined the results from these first two steps to create a global occupancy model for each species by year combination. This global model included all survey-specific variables from the top detection probability model and all habitat variables retained based on results of the simple logistic regression analyses. I then assessed the fit of the global model in each candidate set using the methods described by MacKenzie and Bailey (2004). I calculated the Pearson's chi-square test statistic for the global model and then assumed that model was correct and used a parametric bootstrap procedure to generate 10,000 new data sets. This gave me a distribution of X^2 values given the model was correct, and I calculated the probability of observing a X^2 value larger than the one for the original model. If that probability was < 0.05 then the model was

assumed to be a poor fit for the data. Lastly I tested the models for overdispersion (\hat{c}) by dividing the observed X^2 value by the mean X^2 value from the bootstrapped data sets. Values of $\hat{c} > 1$ indicate that there is more variation within the data than is explained by the model (MacKenzie et al. 2006). If there was no evidence of lack of fit, I proceeded with model selection using Akaike's Information Criterion corrected for small sample sizes (AIC_C) to distinguish among models (Burnham and Anderson 2002:66). If, however, there was evidence of lack of fit in the global model, then $QAIC_C$ values were calculated for each candidate and used to distinguish among them (Burnham and Anderson 2002:70). I assumed that all models with a lower AIC_C or $QAIC_C$ also fit the data, explaining a similar amount of variance using fewer parameters (MacKenzie et al. 2006). From here on, it can be assumed that when I write AIC_C , I mean either AIC_C or $QAIC_C$.

Once I had assessed the fit of the global model, I held the covariates explaining detection probability constant and compared all possible combinations of habitat variables in the global model. For each competing model, then, I calculated a Δ_i value using the formula $\Delta_i = AIC_{Ci} - AIC_{Cmin}$ where AIC_{Ci} is the value calculated for the model being tested and AIC_{Cmin} is the value for the best model. AIC_C weights were then calculated for each model based on these values the formula $\omega_i = e^{-1/2\Delta_i} / \sum e^{-1/2\Delta_i}$. This value can be interpreted as the amount of support for the individual model being the best model to explain the data given that one of the models is in fact the best.

I determined the magnitude and direction of the effect of each variable on occupancy by calculating the natural average of the parameter estimates from all candidate models (Burnham and Anderson 2002:152); standard errors for these parameter estimates were calculated as the square root of an unconditional estimate of variance (Burnham and Anderson 2002:162). Due to the complexities of this procedure, I was not able to calculate degrees of freedom for these

averaged models, and thus I relaxed the α level and calculated significance of model averaged parameters based on the standard normal distribution. Variable effects which were significant at the $\alpha = 0.15$ level were considered to have an important influence on occupancy.

RESULTS

Distribution

Non Breeding Species

In 2007, 11 American Bitterns were encountered at 11 different sites, but none were detected after May 2 while 2008 yielded 17 American Bitterns at 12 different sites with none detected after May 4 (Figure 2.2). In 2007, 14 Soras were encountered at 9 different sites, yet none were detected after April 30 and 2008 yielded another 14 Soras at 8 different sites with none detected after May 10 (Figure 2.2). Additionally, we detected no indications of breeding behavior among these birds (i.e. courtship displays, nests, nest building, or hatch year birds) during the time they were present. These data and observations seem to indicate that American Bitterns and Soras do not breed in the MAV of northeast Louisiana.

Occasional Breeders

In 2007 we encountered 415 American Coots at 43 different sites with only 1 individual recorded after May 7, and in 2008 we encountered 354 American Coots at 27 sites with 8 individuals recorded after May 6 at 5 different sites (Figure 2.3). We observed no breeding behavior for American Coots at any site over the course of the 2 seasons, but presence of individuals in early to mid June of both years may indicate that a few of these birds actually remain in the MAV to breed. In 2007 we encountered just 2 King Rails at 2 different sites with the latest detection occurring on March 30 (Figure 2.3); there were no indications of King Rail breeding behavior in 2007. In 2008 we encountered 14 King Rails at 6 different sites with 8 detections occurring after April 15 at 3 different sites (Figure 2.3); paired individuals were noted

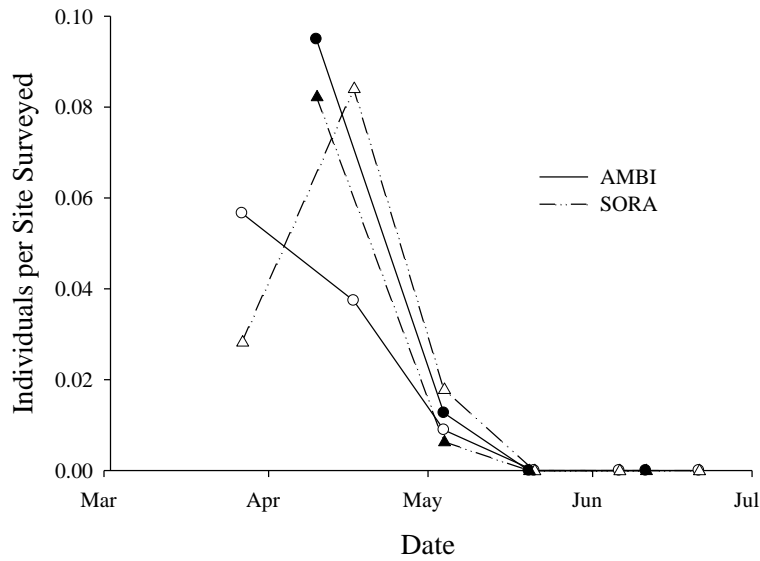


Figure 2.2: The number of American Bitterns (AMBI) and Soras (SORA), SMB species which do not breed Louisiana’s MAV, encountered per site during each round of surveys in 2007 and 2008. All surveys conducted during a single round of surveys were combined into 1 data point, and that point is plotted on the X-axis as the date in the middle of that survey round. Lines with open symbols represent trends from 2007 and those with closed symbols represent trends from 2008.

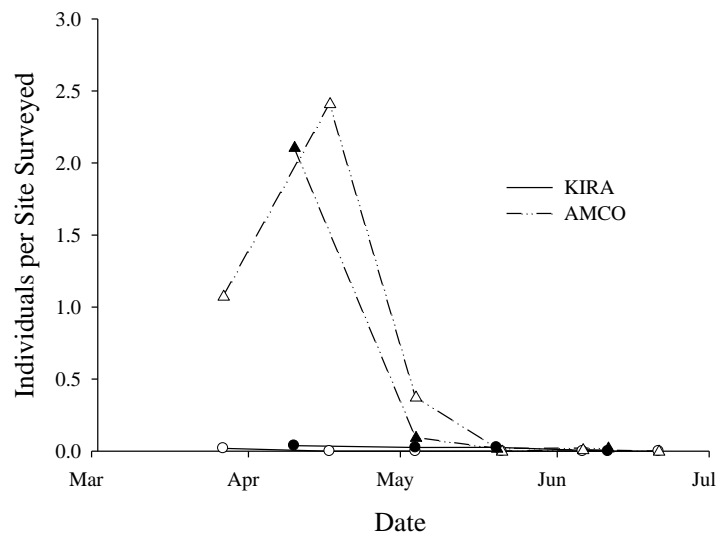


Figure 2.3: The number of King Rails (KIRA) and American Coots (AMCO), SMB species which breed occasionally or rarely in Louisiana’s MAV, encountered per site during each round of surveys in 2007 and 2008. All surveys conducted during a single round of surveys were combined into 1 data point, and that point is plotted on the X-axis as the date in the middle of that survey round. Lines with open symbols represent trends from 2007 and those with closed symbols represent trends from 2008.

at each of these 3 sites. This information, when paired with detection dates, would seem to indicate that these birds were indeed breeding in small numbers in the MAV in 2008.

Breeding Species

In the summer of 2007 we conducted 499 bird surveys during the breeding season at 114 different sites (4.38 surveys/site) from April 29 through 25 June, and in 2008 we conducted 457 breeding bird surveys at 82 sites (5.57 surveys/site) from 28 April through 17 June. Three secretive marsh bird species, Common Moorhens, Least Bitterns and Purple Gallinules, were encountered fairly regularly during the breeding seasons of both years, and occupied a relatively large proportion of sites over that time period (Figure 2.4a). In both years we encountered 1 or more of these species of secretive marsh birds at >35% of surveyed sites during the breeding season (Figure 2.5a).

In 2007 we encountered Common Moorhens 269 times at 40 different sites; 216 of those detections occurred during the breeding season and 34 of those sites were occupied during the breeding season. In 2008 we encountered Common Moorhens 536 times at 44 different sites; 343 of those detections occurred during the breeding season and 37 of those sites were occupied during the breeding season. In both years the species was present throughout the duration of the survey period (Figure 2.6), and signs of breeding (i.e. courtship behavior, copulation, nests and hatch year birds) were noted on multiple occasions. Individuals were detected within 100 m of the survey point at 68% ($n = 23$) and 76% ($n = 28$) of occupied sites in 2007 and 2008 respectively.

Least Bitterns were encountered 50 times at 26 sites in 2007; 36 of those detections occurred during the breeding season and 20 of those sites were occupied by Least Bitterns during the breeding season. In 2008, Least Bitterns were encountered 111 times at 18 sites; 96 of those

detections occurred during the breeding season and all 18 sites were occupied during the breeding season. The species was present throughout the duration of the survey period in both years (Figure 2.6), and signs of breeding (i.e. paired individuals, nests and eggs) were noted on multiple occasions. Individuals were detected within 100 m of the survey point at 75% ($n = 15$) and 89% ($n = 16$) of occupied sites in 2007 and 2008 respectively.

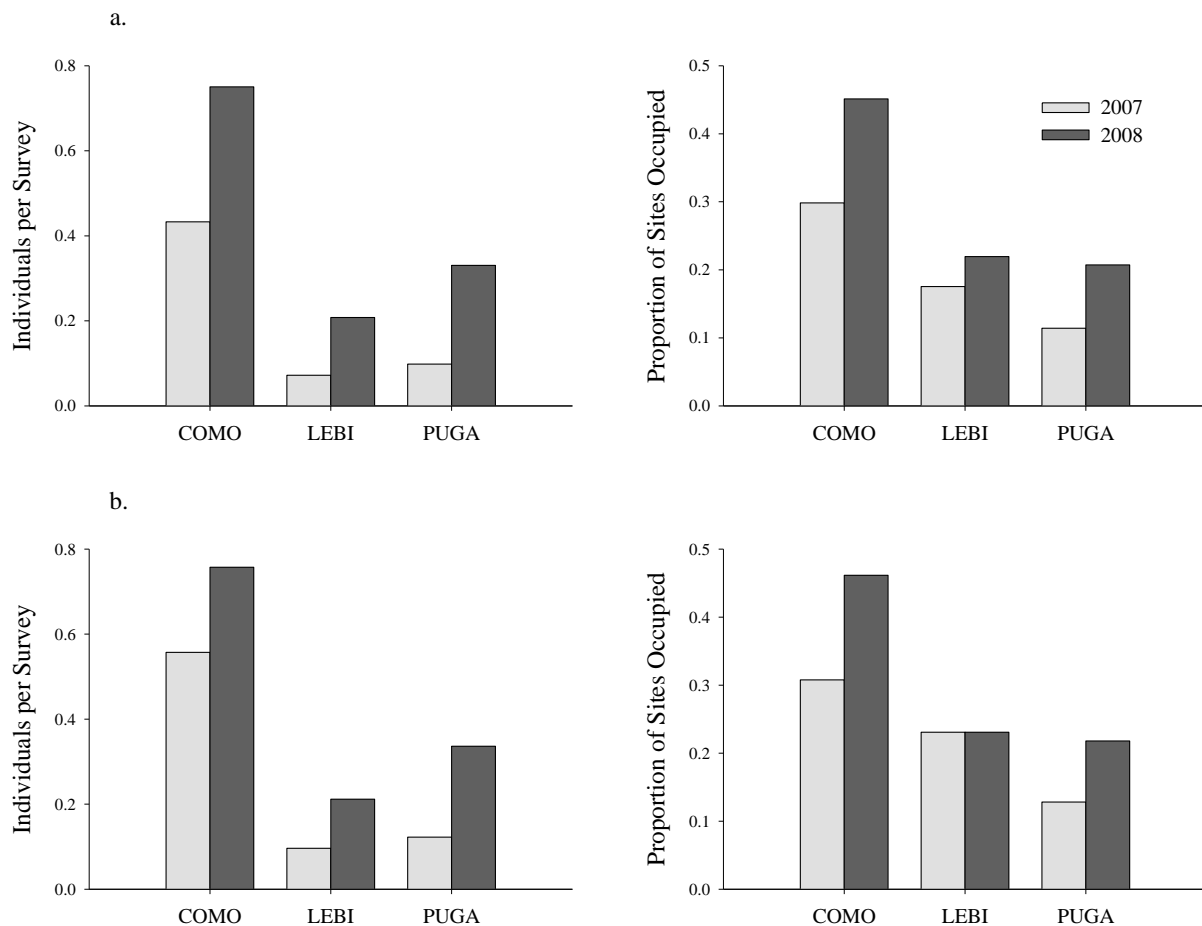


Figure 2.4: Three SMB species, Common Moorhens (COMO), Least Bitterns (LEBI) and Purple Gallinules (PUGA) were encountered regularly during the breeding season in the MAV of Louisiana. These graphs show the number of individuals encountered per breeding survey, and the naïve occupancy estimate for each species at a) all sites, and b) only those sites surveyed in both 2007 and 2008. It should be noted that these estimates do not account for the low detection probabilities of these birds, nor for differences in detection probabilities among species. It should also be noted that data from 2007 and 2008 differ in terms of the actual sites surveyed, as well as the time intervals over which those surveys occurred.

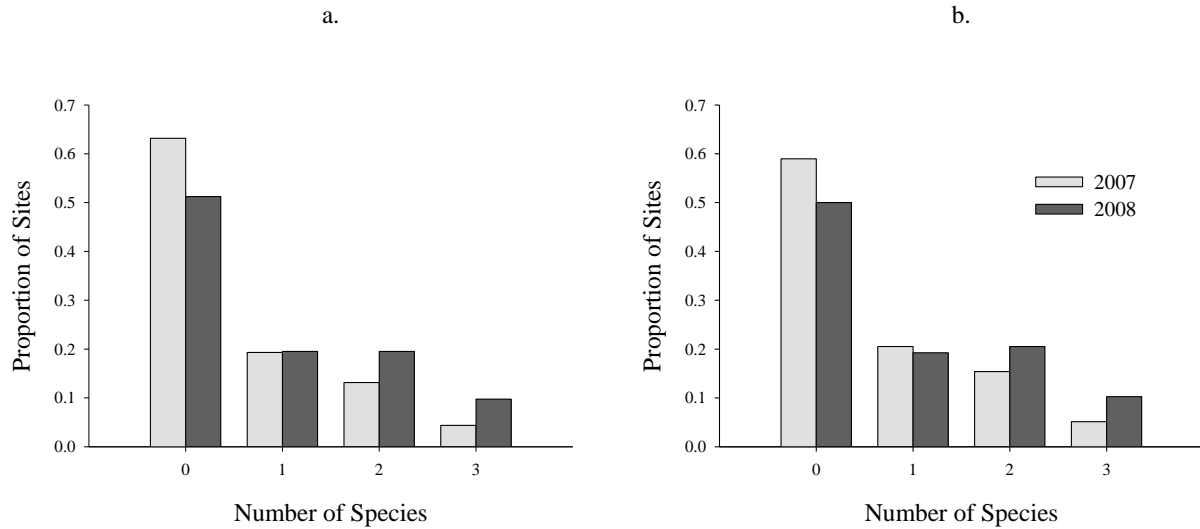


Figure 2.5: The number of breeding SMB species which used a) all sites and b) only those sites surveyed in both years. It should be noted that these naïve estimates of site occupancy by each species do not account for the low detection probabilities of these birds, nor for differences in detection probabilities among species. It should also be noted that data from 2007 and 2008 differ in terms of the actual sites surveyed, the time intervals over which those surveys occurred, and the survey effort per site.

In 2007 we encountered Purple Gallinules 50 times at 13 different sites; 49 of those detections occurred during the breeding season and all 13 sites were occupied during the breeding season. In 2008 we encountered Purple Gallinules 174 times at 18 different sites; 151 of those detections occurred during the breeding season and we detected Purple Gallinules at 17 of those 18 sites during the breeding season. In both years the species was present throughout the duration of the survey period (Figure 2.6), and signs of breeding (i.e. courtship behavior and hatch year birds) were noted on multiple occasions. Individuals were detected within 100 m of the survey point at 92% ($n = 12$) and 88% ($n = 15$) of occupied sites in 2007 and 2008 respectively.

We encountered a greater number of breeding individuals per survey in 2008 than in 2007 for all 3 species and all were encountered at a greater proportion of sites in 2008 as well (Figure 2.4a). The proportion of sites where we encountered at least one secretive marsh bird

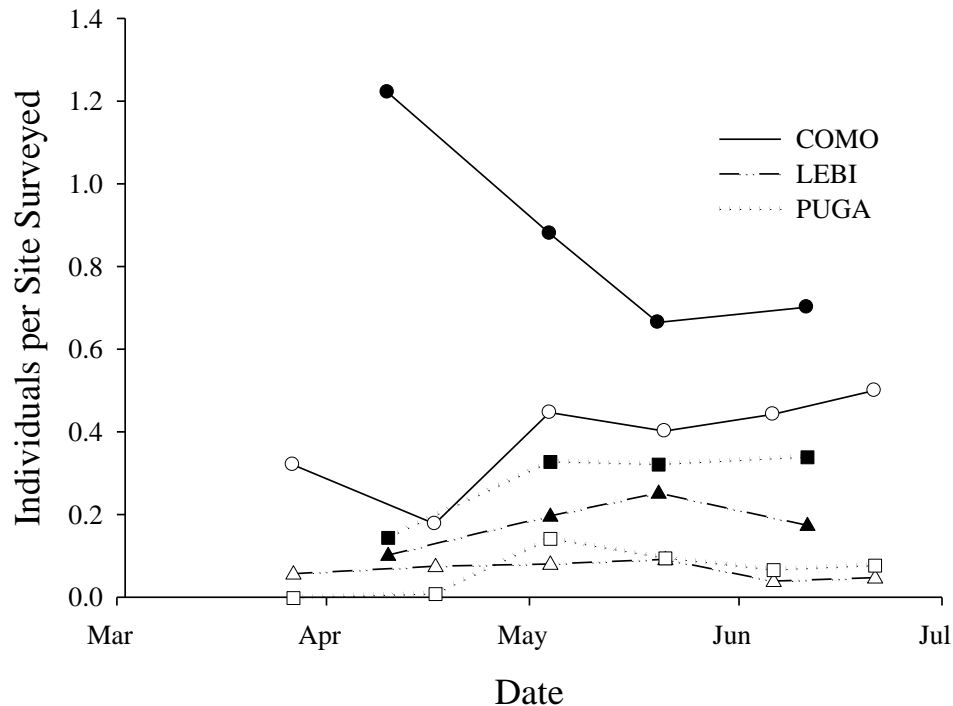


Figure 2.6: The number of Common Moorhens (COMO), Least Bitterns (LEBI) and Purple Gallinules (PUGA), SMB species which regularly Louisiana’s MAV, encountered per site during each round of surveys in 2007 and 2008. All surveys conducted during a single round of surveys were combined into 1 data point, and that point is plotted on the X-axis as the date in the middle of that survey round. Lines with open symbols represent trends from 2007 and those with closed symbols represent trends from 2008.

species was also greater in 2008 (Figure 2.5a). While these results from the two years are not directly comparable because they are not based on identical sites or survey effort per site, comparison of the 78 sites which were surveyed in both years yield very similar patterns. The number of individuals encountered per survey was higher in 2008 for all species when only considering these sites, and the proportion of sites where Common Moorhens and Purple Gallinules were encountered was also higher in 2008 (Figure 2.4b); however, the proportion of sites where Least Bitterns were encountered was identical between the 2 seasons (Figure 2.4b). Additionally, analyses of these 78 sites do still indicate that a larger proportion of sites were used by at least 1 species of breeding secretive marsh bird in 2008 than in 2007 (Figure 2.5b).

Caution should still be taken when considering these results since sites were surveyed more intensively in 2008 (5.76 surveys/site) than in 2007 (4.40 surveys/site).

Habitat Models

Common Moorhens

Habitat models created for 2007 were based on detection histories and habitat variables at 105 sites (4.50 surveys per site), and those created for 2008 were based on information from 73 sites (5.81 surveys per site). In 2007 the best model explaining detection probability for Common Moorhens included an effect of time before or after sunrise or sunset; in 2008 the best model indicated that birds were more detectable in the morning versus the evening and that detection probabilities differed by observer (Table 2.3). Estimates of detection probability ranged from 0.38 – 0.68 in 2007 and from 0.42 – 0.78 in 2008. Four habitat variables in 2007 and 3 in 2008 were included in the global model based on simple logistic regression analyses (Table 2.4). The results of the bootstrapping procedure indicated that the global model in 2007 provided a good fit for the data ($X^2 = 3.86$, $p = 0.57$) with no signs of overdispersion ($\hat{c} = 0.65$). While the global model in 2008 was not considered a poor fit at the $\alpha = 0.05$ level of significance ($X^2 = 11.58$, $p = 0.06$), it did show evidence of overdispersion ($\hat{c} = 1.74$), so QAIC_C values were used to distinguish habitat models in that year.

A comparison of all habitat models I examined for Common Moorhens is presented in Table 2.5. Model averaged parameter estimates indicate that in both years the proportion of the local scale covered by water had a positive influence on Common Moorhen occupancy (Figure 2.7). The only other variable retained in both years, proportion of the standing water covered by robust emergent vegetation, also exhibited a positive influence on occupancy (Figure 2.7). The proportion of the standing water covered by tall, non-robust emergent vegetation showed a negative effect on occupancy in 2007 (Figure 2.7), yet was not even included in the global model

Table 2.3: Comparison of all models investigating survey-specific covariate impacts on detection probabilities for Common Moorhens in 2007 and 2008. Covariates included in the top model of each year were used as explanatory variables for detection probability for all models investigating the impact of habitat covariates on occupancy.

2007					2008				
Model	K	AIC	Δ AIC	AIC wgt	Model	K	AIC	Δ AIC	AIC wgt
P(Time) Psi(.)	3	258.80	0.00	0.21	P(Eve, Obs) Psi(.)	5	314.16	0.00	0.20
P(.) Psi(.)	2	258.81	0.01	0.21	P(Eve) Psi(.)	3	314.18	0.02	0.19
P(Eve) Psi(.)	3	259.86	1.06	0.12	P(Day, Eve, Obs) Psi(.)	6	315.63	1.47	0.09
P(Time, Eve) Psi(.)	4	260.20	1.40	0.11	P(Day, Eve) Psi(.)	4	315.65	1.49	0.09
P(Day) Psi(.)	3	260.79	1.99	0.08	P(Time, Eve, Obs) Psi(.)	6	316.13	1.97	0.07
P(Day, Time) Psi(.)	4	260.80	2.00	0.08	P(Time, Eve) Psi(.)	4	316.18	2.02	0.07
P(Day, Eve) Psi(.)	4	261.82	3.02	0.05	P(Obs) Psi(.)	4	316.64	2.48	0.06
P(Day, Time, Eve) Psi(.)	5	262.20	3.40	0.04	P(.) Psi(.)	2	317.45	3.29	0.04
P(Obs) Psi(.)	5	263.03	4.23	0.03	P(Day, Time, Eve, Obs) Psi(.)	7	317.58	3.42	0.04
P(Time, Obs) Psi(.)	6	263.20	4.40	0.02	P(Day, Time, Eve) Psi(.)	5	317.65	3.49	0.03
P(Eve, Obs) Psi(.)	6	264.11	5.31	0.01	P(Time, Obs) Psi(.)	5	317.83	3.67	0.03
P(Time, Eve, Obs) Psi(.)	7	264.59	5.79	0.01	P(Day, Obs) Psi(.)	5	318.23	4.07	0.03
P(Day, Obs) Psi(.)	6	265.01	6.21	0.01	P(Time) Psi(.)	3	318.83	4.67	0.02
P(Day, Time, Obs) Psi(.)	7	265.11	6.31	0.01	P(Day) Psi(.)	3	319.04	4.88	0.02
P(Day, Eve, Obs) Psi(.)	7	266.11	7.31	0.01	P(Day, Time, Obs) Psi(.)	6	319.31	5.15	0.01
P(Day, Time, Eve, Obs) Psi(.)	8	266.53	7.73	< 0.01	P(Day, Time) Psi(.)	4	320.33	6.17	0.01

Table 2.4: P-values for the parameter estimates resulting from simple logistic regression analyses. Occupancy of each species in each year was regressed on habitat variables individually, and those which were significant at the $\alpha = 0.15$ level (highlighted in bold) were retained for further exploration. Numbers are omitted for variables which were removed from analyses due to problems with multicollinearity.

	COMO		LEBI		PUGA	
Habitat Variable	2007	2008	2007	2008	2007	2008
Sh_Em	0.73	0.82	0.33	0.03	0.43	0.79
T_Em	0.11	0.62	0.30	0.64	0.27	0.38
Rob	0.02	0.04	< 0.01	< 0.01	0.02	0.01
Sh_Wood	0.26	0.61	0.35	0.62	0.34	0.91
T_Wood	0.92	0.20	0.84	0.30	0.55	0.18
Float	0.23	0.32	0.09	0.35	0.01	0.30
Water	< 0.01	< 0.01	0.03	0.04	< 0.01	< 0.01
Ag	0.42	0.53	0.40	0.93	0.58	0.65
Sh_Trees	0.81	-	0.01	-	0.17	-
T_Trees	0.19	0.01	0.02	0.46	0.07	0.09
PC1	0.12	0.63	0.78	0.18	0.78	0.17
PC2	0.40	0.93	0.22	0.14	0.31	0.99
PC3	0.57	0.38	0.10	0.87	0.25	0.77

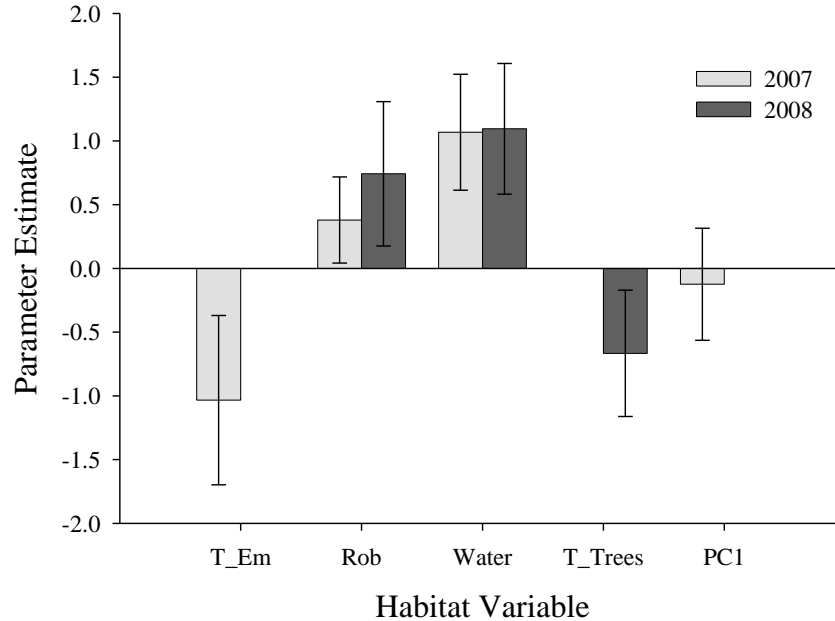


Figure 2.7: Model-averaged estimates and 85% confidence intervals for logistic regression coefficients of standardized habitat variables modeled to explain site occupancy by breeding Common Moorhens. Simple logistic regression analyses indicated that T_Trees in 2007 and T_Em and PC1 in 2008 showed no signs of significantly influencing occupancy, so these variables were not included in the global habitat models in their respective years.

Table 2.5: Comparison of models investigating the impact of habitat variables on site occupancy by Common Moorhens. All possible combinations of variables retained from simple logistic regression analyses were compared (Table 2.4).

2007					2008				
Model	K	AIC _C	Δ AIC _C	AIC _C wgt	Model	K	QAIC _C	Δ QAIC _C	QAIC _C wgt
P(Time) Psi(T_Em, Rob, Water)	6	241.37	0.00	0.38	P(Eve, Obs) Psi(Water)	7	174.76	0.00	0.25
P(Time) Psi(T_Em, Water)	5	242.06	0.69	0.31	P(Eve, Obs) Psi(Rob, Water)	8	174.94	0.18	0.23
P(Time) Psi(T_Em, Rob, Water, PC1)	7	243.28	1.91	0.13	P(Eve, Obs) Psi(Rob, Water, T_Trees)	9	174.98	0.22	0.23
P(Time) Psi(T_Em, Water, PC1)	6	243.86	2.49	0.11	P(Eve, Obs) Psi(Water, T_Trees)	8	175.45	0.69	0.18
P(Time) Psi(Rob, Water)	5	246.43	5.06	0.03	P(Eve, Obs) Psi(Rob, T_Trees)	8	177.71	2.95	0.06
P(Time) Psi(Rob, Water, PC1)	6	247.68	6.31	0.02	P(Eve, Obs) Psi(T_Trees)	7	179.62	4.86	0.02
P(Time) Psi(Water)	4	248.64	7.27	0.01	P(Eve, Obs) Psi(Rob)	7	180.06	5.30	0.02
P(Time) Psi(Water, PC1)	5	249.51	8.14	0.01	P(Eve, Obs) Psi(.)	6	181.40	6.64	0.01
P(Time) Psi(T_Em, Rob)	5	254.27	12.90	< 0.01					
P(Time) Psi(Rob)	4	254.89	13.52	< 0.01					
P(Time) Psi(T_Em, Rob, PC1)	6	254.83	13.46	< 0.01					
P(Time) Psi(Rob, PC1)	5	255.16	13.79	< 0.01					
P(Time) Psi(T_Em)	4	257.07	15.70	< 0.01					
P(Time) Psi(T_Em, PC1)	5	257.04	15.67	< 0.01					
P(Time) Psi(PC1)	4	258.27	16.90	< 0.01					
P(Time) Psi(.)	3	258.80	17.43	< 0.01					

in 2008 (Table 2.4). Similarly, the proportion of the local area dominated by tall trees exhibited a negative influence on occupancy in 2008, but was not included in the global model in 2007. The only landscape variable included in either model set (PC1, 2007) exhibited no significant influence on occupancy.

Least Bitterns

The best model explaining detection probability for Least Bitterns in both years included an observer effect, and in 2008 it also included the effect of time before or after sunrise or sunset (Table 2.6). Estimates of detection probability ranged from 0.1 – 0.45 in 2007 and from 0.15 – 0.75 in 2008. For this species, 6 habitat variables in 2007 and 4 in 2008 were included in the global model based on simple logistic regression analyses (Table 2.4). Results from the bootstrapping procedure indicated that the global model provided a good fit for the data in both 2007 ($X^2 = 4.19$, $p = 0.31$; $\hat{c} = 0.74$) and 2008 ($X^2 = 8.45$, $p = 0.38$; $\hat{c} = 0.92$).

A comparison of all habitat models for Least Bitterns is presented in Table 2.7. Model averaged parameter estimates indicate that the proportion of the standing water covered by robust emergent vegetation had a positive influence on Least Bittern occupancy in both years (Figure 2.8). Interestingly, the proportion of the local area covered by water, did not significantly influence occupancy in either year. The landscape variable PC3 had a positive effect on occupancy in 2007 and the proportion of the standing water covered by short, non-robust emergent vegetation negatively impacted occupancy in 2008. No other local or landscape variables significantly influenced occupancy in any either year.

Purple Gallinules

The best model explaining detection probability of Purple Gallinules in both years included no survey-specific covariates (Table 2.8). Detection probability was estimated to be 0.43 in 2007 and 0.57 in 2008. Global models for this species contained 4 habitat variables in

Table 2.6: Comparison of all models investigating survey-specific covariate impacts on detection probabilities for Least Bitterns in 2007 and 2008. Covariates included in the top model of each year were used as explanatory variables for detection probability for all models investigating the impact of habitat covariates on occupancy.

2007					2008				
Model	K	AIC	Δ AIC	AIC wgt	Model	K	AIC	Δ AIC	AIC wgt
P(Obs) Psi(.)	5	172.32	0.00	0.22	P(Time, Obs) Psi(.)	5	206.92	0.00	0.22
P(.) Psi(.)	2	173.27	0.95	0.14	P(Obs) Psi(.)	4	207.45	0.53	0.17
P(Day, Obs) Psi(.)	6	173.96	1.64	0.10	P(Time, Eve, Obs) Psi(.)	6	208.68	1.76	0.09
P(Time, Obs) Psi(.)	6	174.24	1.92	0.09	P(Eve, Obs) Psi(.)	5	208.79	1.87	0.09
P(Eve, Obs) Psi(.)	6	174.27	1.95	0.08	P(Day, Time, Obs) Psi(.)	6	208.89	1.97	0.08
P(Day) Psi(.)	3	174.86	2.54	0.06	P(Day, Obs) Psi(.)	5	209.44	2.52	0.06
P(Time) Psi(.)	3	175.13	2.81	0.05	P(Time) Psi(.)	3	209.68	2.76	0.06
P(Eve) Psi(.)	3	175.20	2.88	0.05	P(.) Psi(.)	2	210.07	3.15	0.05
P(Day, Time, Obs) Psi(.)	7	175.84	3.52	0.04	P(Day, Time, Eve, Obs) Psi(.)	7	210.64	3.72	0.04
P(Day, Eve, Obs) Psi(.)	7	175.90	3.58	0.04	P(Day, Eve, Obs) Psi(.)	6	210.77	3.85	0.03
P(Time, Eve, Obs) Psi(.)	7	176.16	3.84	0.03	P(Eve) Psi(.)	3	211.41	4.49	0.02
P(Day, Time) Psi(.)	4	176.67	4.35	0.03	P(Time, Eve) Psi(.)	4	211.42	4.50	0.02
P(Day, Eve) Psi(.)	4	176.78	4.46	0.02	P(Day, Time) Psi(.)	4	211.66	4.74	0.02
P(Time, Eve) Psi(.)	4	177.01	4.69	0.02	P(Day) Psi(.)	3	212.07	5.15	0.02
P(Day, Time, Eve, Obs) Psi(.)	8	177.73	5.41	0.01	P(Day, Time, Eve) Psi(.)	5	213.39	6.47	0.01
P(Day, Time, Eve) Psi(.)	5	178.52	6.20	0.01	P(Day, Eve) Psi(.)	4	213.40	6.48	0.01

Table 2.7a: Comparison of models investigating the impact of habitat variables on site occupancy by Least Bitterns in a) 2007 and b) 2008. All possible combinations of variables retained from simple logistic regression analyses were compared (Table 2.4).

a.	2007				
	Model	K	AIC _C	Δ AIC _C	AIC _C wgt
	P(Obs) Psi(Rob, T_Trees, PC3)	8	142.87	0	0.13
	P(Obs) Psi(Rob, Water, Sh_Trees, PC3)	9	143.04	0.17	0.12
	P(Obs) Psi(Rob, Water, T_Trees, PC3)	9	143.97	1.1	0.07
	P(Obs) Psi(Rob, PC3)	7	144.13	1.26	0.07
	P(Obs) Psi(Rob, Water, PC3)	8	144.2	1.33	0.06
	P(Obs) Psi(Rob, T_Trees)	7	144.27	1.4	0.06
	P(Obs) Psi(Rob, Water, Sh_Trees, T_Trees, PC3)	10	144.54	1.67	0.05
	P(Obs) Psi(Rob, Sh_Trees, T_Trees, PC3)	9	144.85	1.98	0.05
	P(Obs) Psi(Rob, Sh_Trees, PC3)	8	145.1	2.23	0.04
	P(Obs) Psi(Rob, Float, T_Trees, PC3)	9	145.19	2.32	0.04
	P(Obs) Psi(Rob, Float, Water, Sh_Trees, PC3)	10	145.48	2.61	0.03
	P(Obs) Psi(Rob, Water, T_Trees)	8	145.83	2.96	0.03
	P(Obs) Psi(Rob, Float, T_Trees)	8	146.23	3.36	0.02
	P(Obs) Psi(Rob, Float, Water, T_Trees, PC3)	10	146.37	3.5	0.02
	P(Obs) Psi(Rob, Float, PC3)	8	146.46	3.59	0.02
	P(Obs) Psi(Rob, Sh_Trees, T_Trees)	8	146.56	3.69	0.02
	P(Obs) Psi(Rob, Float, Water, PC3)	9	146.58	3.71	0.02
	P(Obs) Psi(Rob)	6	146.89	4.02	0.02
	P(Obs) Psi(Rob, Float, Water, Sh_Trees, T_Trees, PC3)	11	147.04	4.17	0.02
	P(Obs) Psi(Rob, Float, Sh_Trees, T_Trees, PC3)	10	147.29	4.42	0.01
	P(Obs) Psi(Rob, Float, Sh_Trees, PC3)	9	147.48	4.61	0.01
	P(Obs) Psi(Rob, Water)	7	147.61	4.74	0.01
	P(Obs) Psi(Rob, Float, Water, T_Trees)	9	147.78	4.91	0.01
	P(Obs) Psi(Rob, Water, Short, T_Trees)	9	147.93	5.06	0.01
	P(Obs) Psi(Rob, Water, Sh_Trees)	8	148.26	5.39	0.01
	P(Obs) Psi(Rob, Float, Sh_Trees, T_Trees)	9	148.45	5.58	0.01
	P(Obs) Psi(Rob, Sh_Trees)	7	148.6	5.73	0.01
	P(Obs) Psi(Rob, Float)	7	148.64	5.77	0.01
	P(Obs) Psi(Rob, Float, Water, Sh_Trees)	9	149.04	6.17	0.01
	P(Obs) Psi(Rob, Float, Water)	8	149.17	6.3	0.01
	P(Obs) Psi(Rob, Float, Water, Sh_Trees, T_Trees)	10	149.55	6.68	< 0.01
	P(Obs) Psi(Rob, Float, Sh_Trees)	8	149.99	7.12	< 0.01
	P(Obs) Psi(Water, Sh_Trees, PC3)	8	154.6	11.73	< 0.01
	P(Obs) Psi(Water, Sh_Trees, T_Trees, PC3)	9	156.97	14.1	< 0.01
	P(Obs) Psi(Float, Water, Sh_Trees, PC3)	9	156.99	14.12	< 0.01
	P(Obs) Psi(Float, Water, Sh_Trees, T_Trees, PC3)	10	159.42	16.55	< 0.01
	P(Obs) Psi(Water, Sh_Trees)	7	160.59	17.72	< 0.01

(table continued)

P(Obs) Psi(Float, Water, Sh_Trees)	8	161.26	18.39	< 0.01
P(Obs) Psi(Water, Sh_Trees, T_Trees)	8	161.87	19	< 0.01
P(Obs) Psi(Float, Water, Sh_Trees, T_Trees)	9	162.64	19.77	< 0.01
P(Obs) Psi(Water, T_Trees, PC3)	8	164.58	21.71	< 0.01
P(Obs) Psi(Sh_Trees, T_Trees, PC3)	8	165.41	22.54	< 0.01
P(Obs) Psi(Water, T_Trees)	7	165.88	23.01	< 0.01
P(Obs) Psi(Float, Water, T_Trees)	8	166.21	23.34	< 0.01
P(Obs) Psi(Sh_Trees, T_Trees)	7	166.26	23.39	< 0.01
P(Obs) Psi(Float, Water, T_Trees, PC3)	9	166.31	23.44	< 0.01
P(Obs) Psi(T_Trees, PC3)	7	166.49	23.62	< 0.01
P(Obs) Psi(T_Trees)	6	166.92	24.05	< 0.01
P(Obs) Psi(Float, Sh_Trees, T_Trees)	8	167.17	24.3	< 0.01
P(Obs) Psi(Sh_Trees, PC3)	7	167.28	24.41	< 0.01
P(Obs) Psi(Float, T_Trees)	7	167.36	24.49	< 0.01
P(Obs) Psi(Float, Sh_Trees, T_Trees, PC3)	9	167.36	24.49	< 0.01
P(Obs) Psi(Float, T_Trees, PC3)	8	168.09	25.22	< 0.01
P(Obs) Psi(Sh_Trees)	6	168.33	25.46	< 0.01
P(Obs) Psi(Water, PC3)	7	168.35	25.48	< 0.01
P(Obs) Psi(Float, Sh_Trees, PC3)	8	169.1	26.23	< 0.01
P(Obs) Psi(Float, Sh_Trees)	7	169.13	26.26	< 0.01
P(Obs) Psi(Float, Water, PC3)	8	169.64	26.77	< 0.01
P(Obs) Psi(Float, Water)	7	169.71	26.84	< 0.01
P(Obs) Psi(Water)	6	169.98	27.11	< 0.01
P(Obs) Psi(PC3)	6	172.74	29.87	< 0.01
P(Obs) Psi(.)	5	172.93	30.06	< 0.01
P(Obs) Psi(Float)	6	172.93	30.06	< 0.01
P(Obs) Psi(Float, PC3)	7	173.84	30.97	< 0.01

b.

2008

Model	K	AIC_c	Δ AIC_c	AIC_c wgt
P(Time, Obs) Psi(Sh_Em, Rob)	7	182.34	0	0.23
P(Time, Obs) Psi(Rob)	6	182.76	0.42	0.19
P(Time, Obs) Psi(Sh_Em, Rob, Water)	8	182.99	0.65	0.17
P(Time, Obs) Psi(Rob, Water)	7	183.25	0.91	0.15
P(Time, Obs) Psi(Sh_Em, Rob, PC2)	8	184.25	1.91	0.09
P(Time, Obs) Psi(Rob, PC2)	7	184.78	2.44	0.07
P(Time, Obs) Psi(Sh_Em, Rob, Water, PC2)	9	185	2.65	0.06
P(Time, Obs) Psi(Rob, Water, PC2)	8	185.5	3.16	0.05
P(Time, Obs) Psi(Sh_Em, Water, PC2)	8	201.22	18.88	< 0.01
P(Time, Obs) Psi(Sh_Em, Water)	7	202.56	20.22	< 0.01
P(Time, Obs) Psi(Sh_Em, PC2)	7	203.11	20.77	< 0.01
P(Time, Obs) Psi(Sh_Em)	6	204	21.66	< 0.01
P(Time, Obs) Psi(Water, PC2)	7	205.33	22.99	< 0.01
P(Time, Obs) Psi(Water)	6	205.79	23.45	< 0.01
P(Time, Obs) Psi(PC2)	6	207.63	25.29	< 0.01
P(Time, Obs) Psi(.)	5	207.82	25.47	< 0.01

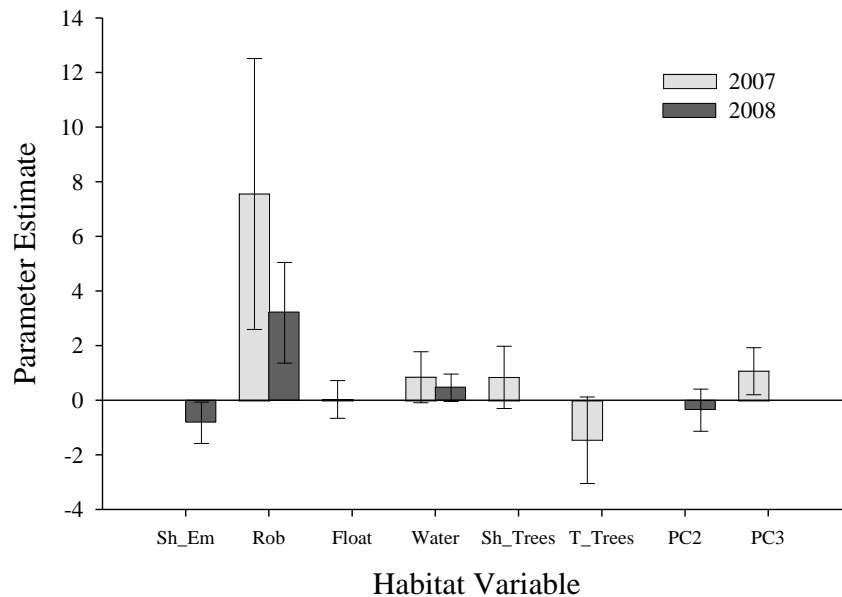


Figure 2.8: Model-averaged estimates and 85% confidence intervals for logistic regression coefficients of standardized habitat variables modeled to explain site occupancy by breeding Least Bitterns. Simple logistic regression analyses indicated that Sh_Em and PC2 in 2007 and that Float, T_Trees and PC3 in 2008 showed no signs of significantly influencing occupancy, so these variables were not included in the global habitat models in those respective years. The variable Sh_Trees was excluded from modeling procedures in 2008 due to problems with multicollinearity.

2007 and 3 in 2008 (Table 2.4). No landscape variables were included in the global models for this species in either year. Results from the bootstrapping procedure indicated that the global model provided a good fit for the data in 2007 ($X^2 = 3.86$, $p = 0.57$; $\hat{c} = 0.65$). While there was no significant evidence of lack of fit in 2008 ($X^2 = 17.35$, $p = 0.10$), there were signs of overdispersion ($\hat{c} = 1.81$) and QAIC_C values were used to distinguish among models in that year.

A comparison of all habitat models for Purple Gallinules is presented in Table 2.9. The proportion of the local area covered by standing water and the proportion of the standing water covered by floating vegetation both exhibited a positive influence on Purple Gallinule occupancy in 2007 (Figure 2.9). The proportion of the local area covered by water also had a positive influence on occupancy in 2008, but the proportion of the standing water covered by floating vegetation was not included in the global model in this second year. The proportion of the

standing water covered by robust emergent vegetation had a positive influence on occupancy in both years. The proportion of the local area covered by tall trees was included in global models in both years, but it did not exhibit a significant influence on occupancy in either year.

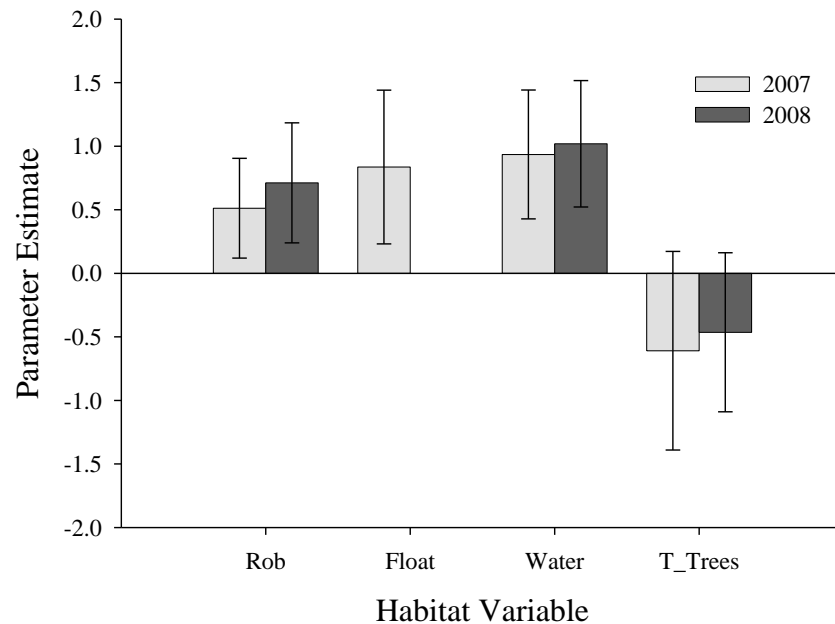


Figure 2.9: Model-averaged estimates and 85% confidence intervals for logistic regression coefficients of standardized habitat variables modeled to explain site occupancy by breeding Purple Gallinules. No landscape scale variables were included in the global models as determined by simple logistic regression analyses. Additionally, there were no indications that Float in 2008 influenced occupancy (Table 2.4), so this variable was not included in the global habitat model in that year.

DISCUSSION

Distribution

The results of my study indicate that breeding SMB species richness and abundance is lower than I expected. Only 3 of the 5 SMB species I expected to find in the MAV of northeast Louisiana were common breeders. Common Moorhens, Least Bitterns and Purple Gallinules were observed on several wetlands while King Rails and American Coots were rarely detected. I expected to find more American Coots, but my results coincide with observations of local land

Table 2.8: Comparison of all models investigating survey-specific covariate impacts on detection probabilities for Purple Gallinules in 2007 and 2008. Covariates included in the top model of each year were used as explanatory variables for detection probability for all models investigating the impact of habitat covariates on occupancy.

2007					2008				
Model	K	AIC	Δ AIC	AIC wgt	Model	K	AIC	Δ AIC	AIC wgt
P(.) Psi(.)	2	156.87	0.00	0.20	P(.) Psi(.)	2	196.57	0.00	0.24
P(Day) Psi(.)	3	157.23	0.36	0.16	P(Time) Psi(.)	3	197.02	0.45	0.19
P(Time) Psi(.)	3	157.77	0.90	0.13	P(Day) Psi(.)	3	198.19	1.62	0.11
P(Day, Time) Psi(.)	4	157.87	1.00	0.12	P(Day, Time) Psi(.)	4	198.49	1.92	0.09
P(Eve) Psi(.)	3	158.19	1.32	0.10	P(Eve) Psi(.)	3	198.57	2.00	0.09
P(Day, Eve) Psi(.)	4	158.63	1.76	0.08	P(Time, Eve) Psi(.)	4	198.66	2.09	0.08
P(Time, Eve) Psi(.)	4	159.29	2.42	0.06	P(Day, Time, Eve) Psi(.)	5	200.14	3.57	0.04
P(Day, Time, Eve) Psi(.)	5	159.47	2.60	0.05	P(Day, Eve) Psi(.)	4	200.19	3.62	0.04
P(Obs) Psi(.)	5	161.28	4.41	0.02	P(Obs) Psi(.)	4	200.47	3.90	0.03
P(Day, Obs) Psi(.)	6	161.69	4.82	0.02	P(Time, Obs) Psi(.)	5	201.00	4.43	0.03
P(Time, Obs) Psi(.)	6	162.05	5.18	0.01	P(Day, Obs) Psi(.)	5	202.10	5.53	0.02
P(Day, Time, Obs) Psi(.)	7	162.34	5.47	0.01	P(Eve, Obs) Psi(.)	5	202.47	5.90	0.01
P(Eve, Obs) Psi(.)	6	162.79	5.92	0.01	P(Day, Time, Obs) Psi(.)	6	202.48	5.91	0.01
P(Day, Eve, Obs) Psi(.)	7	163.28	6.41	0.01	P(Time, Eve, Obs) Psi(.)	6	202.63	6.06	0.01
P(Time, Eve, Obs) Psi(.)	7	163.72	6.85	0.01	P(Day, Eve, Obs) Psi(.)	6	204.10	7.53	0.01
P(Day, Time, Eve, Obs) Psi(.)	8	164.08	7.21	0.01	P(Day, Time, Eve, Obs) Psi(.)	7	204.13	7.56	0.01

Table 2.9: Comparison of models investigating the impact of habitat variables on site occupancy by Purple Gallinules in 2007 and 2008. All possible combinations of variables retained from simple logistic regression analyses were compared (Table 2.4).

2007					2008				
Model	K	AIC _C	Δ AIC _C	AIC _C wgt	Model	K	QAIC _C	Δ QAIC _C	QAIC _C wgt
P(.) Psi(Rob, Float, Water)	5	142.83	0.00	0.35	P(.) Psi(Rob, Water)	5	107.17	0.00	0.34
P(.) Psi(Rob, Float, Water, T_Trees)	6	143.80	0.97	0.22	P(.) Psi(Water)	4	107.68	0.51	0.27
P(.) Psi(Float, Water)	4	144.21	1.38	0.18	P(.) Psi(Rob, Water, TallTrees)	6	108.84	1.67	0.15
P(.) Psi(Float, Water, T_Trees)	5	144.57	1.74	0.15	P(.) Psi(Water, TallTrees)	5	109.69	2.52	0.10
P(.) Psi(Rob, Float, T_Trees)	5	148.12	5.29	0.03	P(.) Psi(Rob, TallTrees)	5	110.82	3.65	0.06
P(.) Psi(Rob, Water)	4	148.75	5.92	0.02	P(.) Psi(Rob)	4	110.83	3.66	0.05
P(.) Psi(Rob, Water, T_Trees)	5	149.50	6.67	0.01	P(.) Psi(.)	3	112.79	5.62	0.02
P(.) Psi(Rob, Float)	4	149.57	6.74	0.01	P(.) Psi(TallTrees)	4	113.22	6.05	0.02
P(.) Psi(Float, T_Trees)	4	150.20	7.37	0.01					
P(.) Psi(Water)	3	150.26	7.43	0.01					
P(.) Psi(Water, T_Trees)	4	150.50	7.67	0.01					
P(.) Psi(Float)	3	152.73	9.90	< 0.01					
P(.) Psi(Rob, T_Trees)	4	152.76	9.93	< 0.01					
P(.) Psi(Rob)	3	153.83	11.00	< 0.01					
P(.) Psi(T_Trees)	3	155.10	12.27	< 0.01					
P(.) Psi(.)	2	156.99	14.16	< 0.01					

managers and biologists that American Coots are rarely encountered after mid May. The extremely low numbers of breeding King Rails was surprising. Several King Rails were encountered during the migration period and several wetlands had attributes which would presumably be attractive to breeding individuals of this species (Reid 1989; Meanley 1992; Darrah 2008). Budd (2007) also found very low numbers of breeding King Rails in the MAV of Arkansas. His results, when combined with my findings, seem to indicate that this species simply does not breed frequently in the lower MAV. King Rail populations are depressed throughout most of its range and adequate habitat in this region may simply be underutilized. However, Pierluissi (2006) found a negative correlation between King Rail nest densities and local cover by tall trees around rice fields and it is possible that these birds are genetically programmed to avoid the historically forested regions of the MAV.

Common Moorhens were the most widely distributed breeder in both years, followed by Least Bitterns and then Purple Gallinules. Interestingly, Budd (2007) found similar naïve occupancy rates for Least Bitterns in wetlands of Arkansas' MAV, yet he encountered Common Moorhens and Purple Gallinules very infrequently. For Purple Gallinules, this discrepancy is likely due to a simple latitudinal gradient because lower Arkansas is at the northern extreme of the species' breeding range (Dunn and Alderfer 2006). Common Moorhens, on the other hand, breed as far north as the Great Lakes (Dunn and Alderfer 2006), and further research relating to this species' habitat requirements, local range distributions and migration patterns is necessary to determine exactly why Common Moorhens are more common in certain parts of the MAV.

Habitat

My analyses of habitat characteristics indicate that local habitat conditions, particularly the availability of robust emergent vegetation and water, were generally more important than all measured landscape characteristics. All 3 of the most common species were selecting for

wetlands with greater robust emergent vegetation cover, yet availability of such structure was limited. Of my randomly selected wetland sites, 84% and 73% in 2007 and 2008 respectively had < 10% cover by robust emergent vegetation. Numerous researchers have documented the partiality of Least Bitterns for wetlands dominated by cattail (*Typha spp.*; Mancini and Rusch 1988; Gibbs and Melvin 1990; Frederick et al. 1990) and cutgrass (*Zizaniopsis miliacea*; Winstead and King 2006). Similarly, Common Moorhens (Brackney 1979; Post and Seals 2000; Bannor and Kiviat 2002) and Purple Gallinules (Helm et al. 1987; West and Hess 2002) also seem to exhibit a preference for these plant species. However, these latter 2 species are commonly associated with other floating plants (e.g. *Eichornia crassipes*, *Nelumbo lutea*, *Potamogeton spp.*) and emergent plants (e.g. *Sagittaria spp.*, *Juncus spp.*, *Scirpus spp.*) as well (Bannor and Kiviat 2002; West and Hess 2002) outside of the MAV. Robust emergent plants provide excellent structure for the birds which bend and weave the broad leaves to build a nesting platform over standing water (Gibbs et al. 1992; Bannor and Kiviat 2002; West and Hess 2002). Additionally, SMBs are well concealed within dense cattail and cutgrass stands making them much less susceptible to predators. Other vegetation types may not provide a solid foundation on which to build a nest, or possibly do not provide ample cover, rendering adults, eggs and chicks vulnerable to predation.

The proportion of the local area covered by water also positively influenced occupancy by Common Moorhens and Purple Gallinules in both years yet did not significantly affect Least Bitterns in either year. Numerous marsh-dependent birds are attracted to larger wetlands (Brown and Dinsmore 1986; Naugle et al. 2001), and previous studies have shown that Common Moorhens use larger wetlands more frequently (Chabot 1996; Ritter and Savidge 1999), while wetland size is generally not a significant predictor of Least Bittern occupancy or abundance (Brown and Dinsmore 1986; Budd 2007; Rehm and Baldassarre 2007). Budd (2007) measured

wetland area in a similar manner to mine (i.e., proportion of a 400 m radius circle covered by water), and for Least Bitterns his findings were also similar to mine. His best model explaining occupancy for this species did not include the measure of wetland area. He did not, however, have a large enough sample size to model occupancy for Common Moorhens or Purple Gallinules. To my knowledge no previous studies have investigated the relationship between wetland size and use by Purple Gallinules. I cannot say with any certainty that my results indicate a preference for larger wetlands by Common Moorhens and Purple Gallinules, but the probability of encountering one of these species definitely increased with the amount of water within 100 m of a survey point.

Several habitat variables were important in one year or for a given species; some of these results may have been affected by our methods. For example, the proportion of the standing water covered by floating vegetation positively influenced occupancy for Purple Gallinules in 2007 yet this pattern was not observed in 2008. However, Common Moorhens and Purple Gallinules appeared to use floating water hyacinth (*Eichornia crassipes*) fairly regularly in the field, and both were observed exhibiting courtship behavior and rearing broods on dense hyacinth mats in both years. This observed positive association with water hyacinth may have been statistically diluted in the analyses by some of the other variables included in the floating vegetation category.

Similarly, in 2008, Common Moorhen occupancy exhibited a negative association with the proportion of the local area covered by tall trees but the trend was not seen in 2007. Other researchers have found evidence to suggest that Purple Gallinules (Pierluissi 2006) and Least Bitterns (Pierluissi 2006; Winstead and King 2006; Budd 2007) avoid wetlands surrounded by forest, but my data did not reveal such a pattern. While my results for Common Moorhens are inconclusive, it would appear as though the proportion of the local area covered by forest is not a

strong deterrence for any of the species. In the MAV, tall bottomland hardwood forest is still one of the dominant land cover types, and presence of tall trees was recorded within our local survey area at > 75% of our sites in both years. In this region, then, wetlands with quality nesting structure in areas with low forest cover may be rare.

Finally, Least Bitterns were positively associated with the third landscape principal component in 2007. This variable was strongly, positively associated with the proportion of the landscape covered by agriculture and residential/grassland areas and negatively associated with the proportion covered by water and young reforested areas (Table 2.1). Thus the positive association with this variable would seemingly indicate that Least Bitterns are actually attracted to human disturbed landscapes. In light of the fact that Least Bitterns have been shown to avoid forested areas (Pierluissi 2006; Winstead and King 2006; Budd 2007), it is feasible that these birds are exhibiting some affinity for more open landscapes, and that open landscapes in this region happen to be dominated by humans. However, the third principal component in 2008 was structurally similar to the third principal component in 2007, yet there was no indication at all of its influencing Least Bittern breeding site selection in this second year. Further research is necessary to determine whether or not Least Bitterns are indeed attracted to human dominated landscapes, but these results seem to indicate that habitat characteristics within 1 km of a wetland site play very little role in the habitat selection process for SMBs.

The inconsistency in effects of landscape characteristics could be at least partially influenced by the fact that landscape scale habitat information was based on aerial photographs taken in 2007, and that the MAV was subjected to substantially more water in the spring of 2008 than it was in 2007. The Mississippi River spent 20 days above flood stage in Baton Rouge during the course of the breeding season in 2008, while it spent 0 days above flood stage in 2007. Consequently, the landscape may have looked different to breeding SMBs in the second season

than it did in the first, and our landscape scale data may not be indicative of the way habitat was actually perceived. Further evidence to support this interpretation stems from the fact that when considering only those sites surveyed in both seasons, both Common Moorhens and Purple Gallinules were more broadly distributed in 2008 than in 2007. Moreover, our global models for these species fit the data in 2007 but showed signs of overdispersion in 2008. If this lack of fit was indeed caused by poor estimation of landscape scale characteristics in the second year, then there may be indications that relative importance of landscape variables in the habitat selection process may be greater in wetter years.

Management

Of the 118 randomly selected wetlands we surveyed over the course of 2 years, approximately 80% of them were either created or subjected to some form of water control (e.g. levees, flooding, draining, etc.) and several were actively managed as moist soil units. However, in my study area the best sites for breeding SMBs (i.e. those with abundant flooded robust emergent vegetation) were found on wetlands where it appeared as though little management took place. The fact that only 3 of 5 SMB species were encountered in large numbers could indicate that current design and control strategies of these wetlands do not create adequate habitat for these birds during the breeding season. One of the primary goals of moist soil management is to provide food and habitat for migrating and wintering waterfowl (Strader and Stinson 2005), yet my results indicate that SMBs tend to prefer a different vegetation structure and composition than ducks (Rundle and Fredrickson 1981; Fredrickson and Taylor 1982; Eddleman et al. 1988). When I pooled the data across both years I found that approximately 82% of flooded robust emergent patches ≥ 0.1 acre were utilized by at least 1 breeding SMB species, indicating that these species do not require large tracts of habitat, and I believe wetlands could be managed for both wintering waterfowl and breeding SMBs simultaneously.

Over the course of my 2 year study only 11% ($n = 4$) of those sites with $\leq 5\%$ water cover at the local scale were occupied by any breeding SMBs whereas 43% ($n = 61$) of sites with $> 5\%$ water cover at the local scale were occupied. Those sites which had very little water in July (when our vegetation surveys were conducted) generally represent the most highly manipulated systems where water was drawn down to promote the establishment of annual plants with high seed production value. Additionally, because robust emergent plants compete for resources with these annual plants, the common practice at such sites is to reset succession when robust emergents exceed a certain coverage threshold (Gray et al. 1999; Bowyer et al. 2005). Kross and colleagues (2007) found actively managed moist soil units in the MAV produced more seeds and tubers (food for ducks) than passively managed areas and recommend disking, mowing and applying herbicides annually or in alternate years. These treatments remove water from moist soil units during the peak of the SMB breeding season and prevent the establishment of plants which provide required structure. I am aware of no wetlands within this region currently being managed to promote growth of robust emergent vegetation, or targeted toward providing breeding habitat for SMBs.

Management for breeding SMBs may be incorporated into an overall wetland management strategy by allowing ditches, deeper water bodies, moist soil units or parts of units already dominated by robust emergents to remain flooded during the spring and summer. Both cattail and cutgrass initially germinate on moist mudflats when water is drawn down, so designing wetlands with gradual slopes would help promote establishment of these species. Breeding SMBs would also benefit from longer wetland management cycles (i.e. > 3 years prior to disturbance) because this would allow for the development of robust emergent communities. However, further research is necessary to understand what percentage and interspersions of robust emergent vegetation is optimal for these breeding birds, and to quantify the effects of integrating

SMB and winter waterfowl management. Future studies should also focus on identifying whether or not King Rails would breed in these wetlands given intensive, targeted management.

Lastly, it is important to note that my wetland sites were also heavily utilized by colonial wading birds. At least 1 wading bird species was encountered at 82% of study sites over the 2 years, and 1 wetland actually contained a rookery. Little Blue Herons and Great Egrets were particularly widely distributed as they occupied 64% and 62% of sites respectively. Further research into wetland use by these species is necessary to understand how management decisions influence populations of colonial wading birds as well.

CHAPTER 3

DISTRIBUTION AND HABITAT AVAILABILITY IN RICE FIELDS OF NORTHEAST LOUISIANA

INTRODUCTION

Secretive marsh birds (i.e. rails and bitterns) are wetland dependent and drastic losses of wetland area over the past 200 years may be contributing to population declines for several of these species (Eddleman et al. 1988). During this same period that natural wetland area has been declining, land covered by agricultural wetlands has been increasing. Annually rice occupies 1,500,000 km² of land, more than any other agricultural crop in the world, and 40% of the world's population depends on it as a primary food source (Fasola and Comin 1992 as cited in Fasola and Ruiz 1996). Moreover, an estimated 57% of rice fields occupy former wetland areas (Lawler 2001). Virtually all rice production requires flooding and draining of fields so these areas simulate temporary wetlands which can provide habitat and resource alternatives to many wetland-dependent species (Lawler 2001).

Avian use of rice fields has been studied extensively throughout the world. Rice fields in the Mediterranean region, for instance, provide breeding, foraging, wintering and stopover habitat at various times of the year for many European species (Fasola and Ruiz 1996). Maeda (2001) recorded 50 species of birds utilizing rice fields over the course of a year in the Kanto Plain of central Japan, with waterbird abundance being greatest during the cultivation season. Tourenq and colleagues (2004) found that heron rookeries in the Camargue region of France tend to be located in areas surrounded by a high proportion of rice fields, suggesting that these birds may be selecting sites near rice agriculture. In fact, it is estimated that agricultural habitats support 50-100% of herons during the peak of the breeding season in most parts of the Mediterranean region (Fasola et al. 1996). In the state of Louisiana, 72% of the 147 documented

waterbird species have been observed using rice field habitat, including various species of grebes, pelicans, cormorants, anhingas, wading birds, waterfowl, coots, rails, gallinules, shorebirds, gulls, terns and kingfishers (Huner et al. 2002).

Breeding bird use of agricultural wetlands has received little attention, though several SMB species have been recorded nesting (often very successfully) in the rice fields of southwest Louisiana (Hohman et al. 1994; Pierluissi 2006) and central Arkansas (Meanley 1953), including King Rails, Purple Gallinules, Common Moorhens and Least Bitterns. In the summer rice fields exhibit many of the attributes commonly required by these species, including shallow water, dense emergent vegetation and food resources like rice seeds, aquatic invertebrates, amphibians and fish (Czech and Parsons 2002). Helm et al. (1987) found that Common Moorhens and Purple Gallinules had larger average clutch sizes in rice fields than in natural marshes, and such results may indicate that agricultural wetlands are functionally equivalent to, or perhaps even higher quality habitat than natural wetlands for breeding SMBs.

Specific local and landscape characteristics associated with rice fields can make some more attractive to breeding birds than others. Pierluissi (2006) showed that habitat features both immediately adjacent to rice fields as well as within 1 km of those fields can influence breeding densities of SMB species; his results indicated that these birds generally prefer rice fields surrounded by ditches and avoid tall trees. While tall trees may be inhabited by predators, birds can nest, forage and conceal themselves in flooded ditches before rice is tall enough to use for these purposes. The structure provided by vegetation in ditches may be especially important to breeding SMBs in the lower MAV where breeding behavior has been observed in early March (Meanley 1953), but rice does not reach the appropriate height to support nests (~ 70 cm; Pierluissi 2006) until early May to early June.

We know very little about the distribution of breeding SMBs in the Mississippi Alluvial Valley (MAV) of Louisiana, and even less about their use of agricultural wetlands in the region. Cultivation procedures here such as planting date, harvest date, planted rice varieties and flooding regimes differ from those used in coastal rice fields. In order to better understand the utility of agricultural wetlands as breeding SMB habitat in this region, we must identify which species are utilizing MAV rice fields and what specific habitat features influence site selection.

Research Objectives

- 1) Identify which secretive marsh bird species breed in rice fields of Louisiana's MAV.
- 2) Model site occupancy as a function of habitat variables at multiple spatial scales for each breeding species to identify habitat characteristics those species are selecting for.

Hypotheses

- 1) We will find 5 SMB species breeding in the rice fields of Louisiana's MAV: American Coots (*Fulica americana*), Common Moorhens (*Gallinula chloropus*), King Rails (*Rallus elegans*), Least Bitterns (*Ixobrychus exilis*) and Purple Gallinules (*Porphyryula martinica*).
- 2) At all scales, all breeding SMB species will show a positive association with the amount of available rice and the amount of available water as well as a negative association with the area covered by tall trees.

METHODS

Site Selection

My study area encompassed most of the MAV and portions of the Gulf Coastal Plain in Louisiana north of 31°1'2" north latitude and east of 92°10'15" west longitude (Figure 3.1). We were granted access to approximately 4000 ha of rice fields on 7 private farms and approximately 140 ha on 1 National Wildlife Refuge (NWR). I digitized all rice fields using

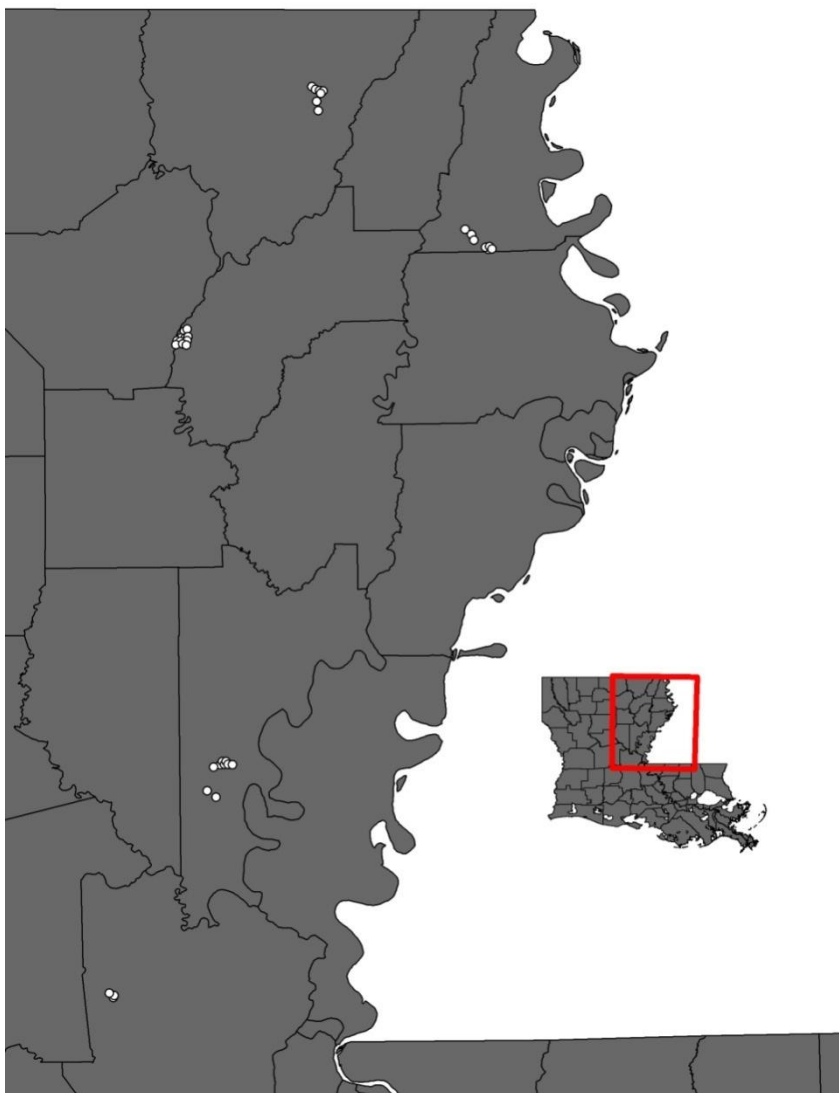


Figure 3.1. This map depicts the northeast region of Louisiana where our study was focused. Each white dot represents 1 of the 37 rice field sampling points we surveyed in 2007.

ESRI® ArcMap™ 9.1 (Copyright ©1999-2005 ESRI Inc.). In Arizona, Conway et al. (1993) found that the mean distance Clapper Rails moved from their activity center was between 126 m and 157 m during the breeding season. Thus, in order to reduce the probability of detecting the same bird at 2 different sites, we had ArcMap™ randomly place one point on the perimeter of each rice field with the stipulation that all points had to be at least 700 m apart. About one third of the resulting 113 sampling sites were eliminated for logistical reasons (i.e. location relative to other sites, distance from nearest lodging, etc.). We randomly selected 37 rice fields, with one

sampling point on each rice field, from the remaining to be used as our study sites in 2007.

These fields were distributed across 4 different farms and 1 NWR. Each randomly selected point was downloaded to a GPS unit which we used to find point locations in the field. Upon finding each point, we placed a flag on the edge of the target rice field as close to that point as possible. The locations of these flags were then marked with the GPS unit and became our official sampling points (Figure 3.1). When points were found to be logistically inaccessible in the field, they were moved to an accessible spot located as close to the original point as possible, while still maintaining the 700 m minimum distance from other sampling points.

In 2008 we selected all new sites using an identical procedure. Many of our sites were located on the same farms, but rotating planting practices on those farms meant that few of those fields which were planted in rice in 2007 were planted in rice again in 2008. In the second season, 84 rice fields were identified on 5 different rice farms and 39 were selected as sites (Figure 3.2).

Bird Sampling Protocol

In the summer of 2007, 4 observers helped conduct bird surveys between 20 March and 24 June. In 2007 we found no breeding SMBs utilizing rice fields prior to fields being flooded in mid May and as a result we did not begin sampling rice fields in 2008 until then. Thus, in 2008, 4 observers conducted bird surveys between 19 May and 22 August. In both years, each site was surveyed once or twice approximately every 15 days. Individual sites were surveyed 6-7 times each in 2007 and 5-8 times each in 2008.

Bird survey procedures followed those set forth by the Standardized North American Marsh Bird Monitoring Protocols (Conway 2005). Surveys were conducted both in the mornings and the evenings; morning bird surveys began half an hour before sunrise and concluded no later than 2.5 hours after sunrise while evening bird surveys began 2.5 hours before sunset and

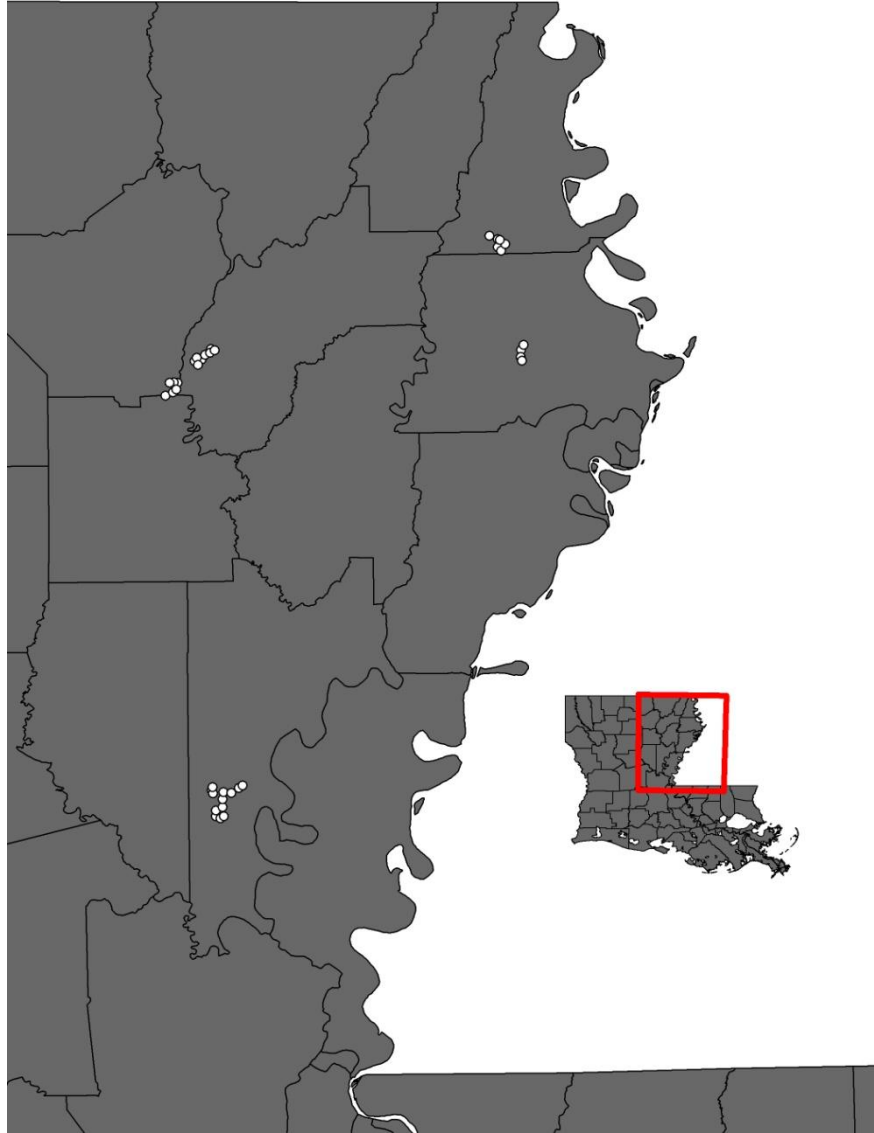


Figure 3.2. This map depicts the northeast region of Louisiana where our study was focused. Each white dot represents 1 of the 39 rice field sampling points we surveyed in 2008.

concluded no later than half an hour after sunset. Surveys were never conducted in inclement weather (i.e. wind > 20 km/h, heavy precipitation), and we rotated the observers sampling each site to minimize the impact of observer bias. Additionally, each point was located on a survey route which included several other survey points that could all be sampled in a single morning or evening. Each time a survey route was sampled, it was sampled in the opposite direction of which it was previously. That is, the first time the survey route was conducted site A would be

sampled first and site Z sampled last; then the second time the survey route was conducted, site Z would be sampled first and site A last, and so on. This minimized variability in bird response resulting from time of day.

Each survey included a 1-minute “settling” period, a 5-minute silent period and a 6-minute callback period. The 6-minute callback period consisted of playing 30 seconds of calls from 6 secretive marsh bird species followed by 30 seconds of silence. Calls were played from an RCA RP2700A portable CD player and broadcast through RadioShack™ speakers. Speakers were always placed upright on the ground and checked to ensure that the sound level was between 80 and 90 dB at 1 m in front of the speakers. Speakers were pointed toward the center of the target rice field during the first survey at each site, and that fixed speaker direction was used during each subsequent survey. The order in which species’ calls were played was 1) Least Bittern, 2) King Rail, 3) American Bittern, 4) Common Moorhen, 5) Purple Gallinule, and 6) American Coot. While we did not expect to find American Bitterns nesting in our study region, Pierluissi (2006) found that the call of this species seemed to elicit responses from King Rails, so we incorporated it into our study design. Sora calls were not played because the lower MAV is outside of the species’ breeding range, but detections of this species were recorded as well. Once the 6-minute callback period concluded, the survey was complete and the observer moved on to the next site.

Each bird detected was listed individually (see bird survey data sheet, Appendix B). The first time an individual was detected, its distance from the sampling point was recorded and an H (heard) or S (saw) was placed in the box reserved for the appropriate 1-minute interval in which it was detected. An H or an S was then recorded in the appropriate box for each subsequent 1-minute interval in which that same bird was detected. It was up to the observer to determine whether a detection was a new bird or one that had been previously recorded. Birds detected

during the 1 minute settling period were also recorded, and that detection was deemed to be the first encounter with that individual. Thus, distance to that individual was estimated at that time (despite the fact that the survey had not technically started) and an H or an S was placed in the “before” column next to the listed individual. Indications of breeding activity (i.e. courtship displays, nests, nest building, or hatch year birds) were recorded in the “comments” column when noticed.

Local Scale Habitat

Each time we visited a rice field to conduct a bird survey we recorded the mean rice height for the target field and whether or not the field was flooded. These were the only habitat characteristics recorded on each visit. Thorough local habitat surveys were conducted once at each site between 1 June and 7 June 2007, and between 19 August and 22 August 2008; 4 observers conducted local habitat surveys in the first year while only 1 conducted surveys in the second. We drew a 100 m radius circle around each sampling point and recorded the proportion of the circle covered by rice, other water, and uplands. Virtually all water at this scale that was not within the rice field itself was contained in ditches, so from here on I will refer to the area covered by other water as ditches. Upland habitat was broken down into 5 categories, defined by the structure of the dominant vegetation type. These categories included agriculture, grass and weeds, trees ≤ 3 m tall, trees between 3 and 10 m tall, and trees ≥ 10 m tall. The numbers recorded for rice area, ditch area and the 5 upland types summed to 100% for each site.

Ditch Characteristics

Within the associated ditch habitat we estimated the percentage of open water, the percentage containing floating or submerged vegetation, and the percentage covered by herbaceous emergent or woody emergent vegetation (note that the sum of these numbers could add up to $>100\%$ as certain species of floating/submerged vegetation could occupy the same

horizontal space as emergent vegetation). Each of the 3 ditch vegetation groups was then broken down further into all species that comprised that group. Usually it was possible to quantify ditch coverage for all species within a vegetation category, but occasionally there would be a small group of species that occurred infrequently; in this case those species would be combined and listed as “other” in the species column and a pooled estimate of their ditch coverage was recorded. For each species identified we then recorded: the percentage of the habitat category which it comprised; the percentage of the ditch that species covered; density, ranked on a scale of 1-5 (see vegetation data sheet, Appendix C); mean height of that plant species above the water level; and we characterized its distribution as either, random, even, single patch, multiple patches, edge only or other.

Landscape Scale Habitat

Landscape scale habitat information was collected by drawing a 1 km circle around each sampling point over digital ortho imagery taken in 2007 as part of the National Agriculture Imagery Program. We then printed out the aerial photographs of each site and took them into the field where we classified each part of the landscape into one of 5 categories: 1) agriculture; 2) residential, grassland or pasture; 3) wetland or permanent water; 4) young reforested (i.e. dominated by trees ≤ 3 m); or 5) forest (i.e. dominated by trees ≥ 3 m). Later I digitized the area within 1 km of a survey point using ESRI® ArcMap™ 9.1 (Copyright ©1999-2005 ESRI Inc.), and calculated the proportion of the area surrounding each point that was comprised of each of these 5 variables. I was not able to obtain ortho imagery for 2008, so landscape scale variables were calculated for sites sampled in 2008 with information from the 2007 photographs. Thus, landscape scale habitat information is identical in 2007 and 2008 for those sites sampled both years.

Data Analyses

In 2007, only surveys conducted after 29 April were included in analyses of breeding birds (see Chapter 2). All surveys conducted in 2008 were considered part of the breeding season. Naïve estimates of occupancy were calculated for each species by dividing the number of sites where the species was encountered by the total number of sites surveyed.

Pierluissi (2006) found that rice needed to be both flooded and approximately 65-70 cm tall before SMBs would begin nesting in it. Thus, sites were deemed “adequate breeding habitat” when the target rice field was flooded and the rice height was ≥ 65 cm. Naïve estimates of occupancy within adequate fields were calculated by dividing the number of sites each breeding species was detected in by the number of sites that achieved these characteristics during the course of our surveys.

Four sites were eliminated from habitat analyses on account of missing data. Due to extremely low numbers of detections and the extremely low number of surveys conducted within adequate breeding habitat, I was not able to model either detection probabilities or site occupancy of any species. Instead, I graphed the distribution of proportion values for each habitat variable recorded at the 72 remaining sites. This information gives us an idea of what types of habitat are commonly available to breeding SMBs at rice fields in the MAV. Information from all sites over both years was pooled for these analyses because there was no replication at any site between years.

RESULTS

In both years, rice planting began in early April and continued until the first week of May. The earliest fields began to germinate in the first 2 weeks of May, and fields with emergent rice were finally flooded anywhere from the 2nd week of May to the last week of June. Draining the fields for harvest began in early August.

In 2007 we conducted 185 bird surveys during the breeding season (5.0 surveys/site) and in 2008 we conducted 273 total surveys (7.0 survey/site). However, rice did not reach the ~65 cm necessary to support nesting until early to late June. Thus, in 2007, only 10 total surveys were conducted at 9 different sites while the rice field characteristics were adequate for breeding birds (1.11 surveys/site); in 2008, 77 surveys were conducted at 34 sites (2.26 surveys/site) while rice field characteristics were adequate (Figure 3.3). Far more sites achieved characteristics adequate for breeding SMBs and more surveys were conducted at those sites in 2008 because we began and continued surveying later in the summer.

In 2007 we recorded 7 total breeding SMBs, 6 Common Moorhens and 1 American Coot. All 7 birds were encountered at the same site, and all were calling from a wetland approximately 50 m away from the sample point; in other words, no breeding SMBs were detected utilizing any rice fields in 2007 (though 3 King Rails were incidentally detected in early June in rice fields which we did not sample). In 2008 we recorded 12 total breeding SMBs, 9 Least Bitterns, 2 King Rails and 1 American Coot. Breeding birds were recorded at 7 different sites (Figure 3.4), and never was more than 1 species encountered at a single site; all birds recorded were actually located within rice. Additionally, 1 Common Moorhen and approximately 5 King Rails were incidentally encountered in rice fields which we did not sample. In neither year was any breeding bird recorded in a non-flooded field, or within rice less than 70 cm tall, and no birds were encountered at a distance > 250 m.

Because points were placed on the edges of rice fields, the local area around the average site was dominated by rice, grass (e.g. levees), other agriculture and ditches; very few sites had any tree cover (Figure 3.5). Of the 72 sites included in habitat analyses, 19 did not have any flooded ditches within 100 m. For those sites that did, the ditches themselves were dominated by open water and non-robust emergent vegetation (Figure 3.6), primarily comprised

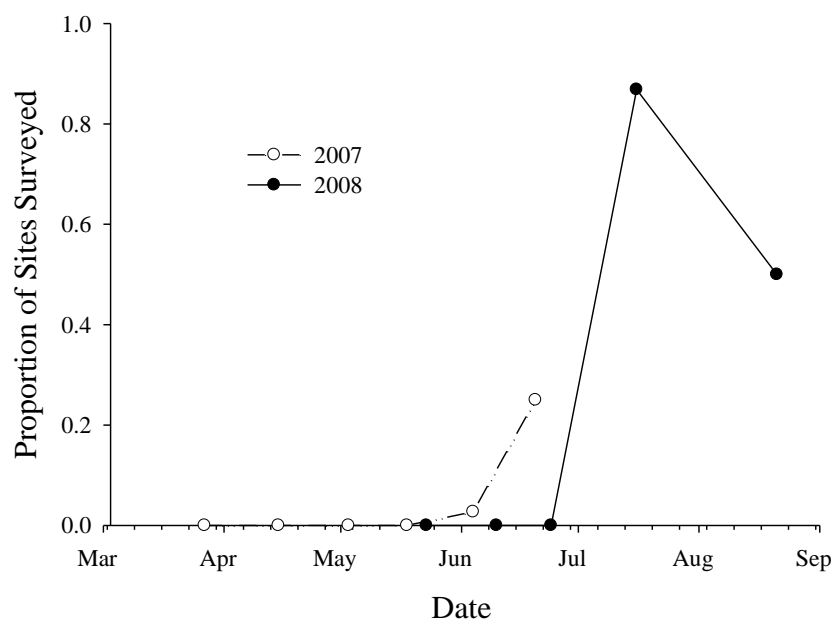


Figure 3.3. Proportion of sites surveyed during each survey round which had conditions adequate for supporting breeding SMBs (i.e. field flooded and rice ≥ 65 cm tall). All surveys conducted during a single round of surveys were combined into 1 data point, and that point is plotted on the X-axis as the date in the middle of that survey round.

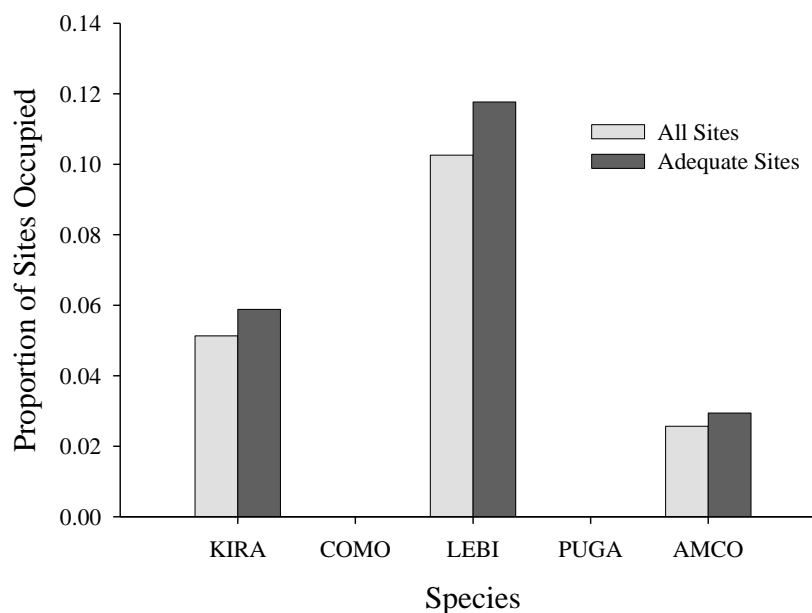


Figure 3.4. Naïve occupancy estimates for sites surveyed in 2008. A total of 39 sites were surveyed in 2008 (All Sites) and surveys were conducted at 34 of those sites during a period when the rice was flooded and ≥ 65 cm tall (Adequate Sites). Similar information is not presented for sites surveyed in 2007 because no individuals of any species were detected at any sites in that year.

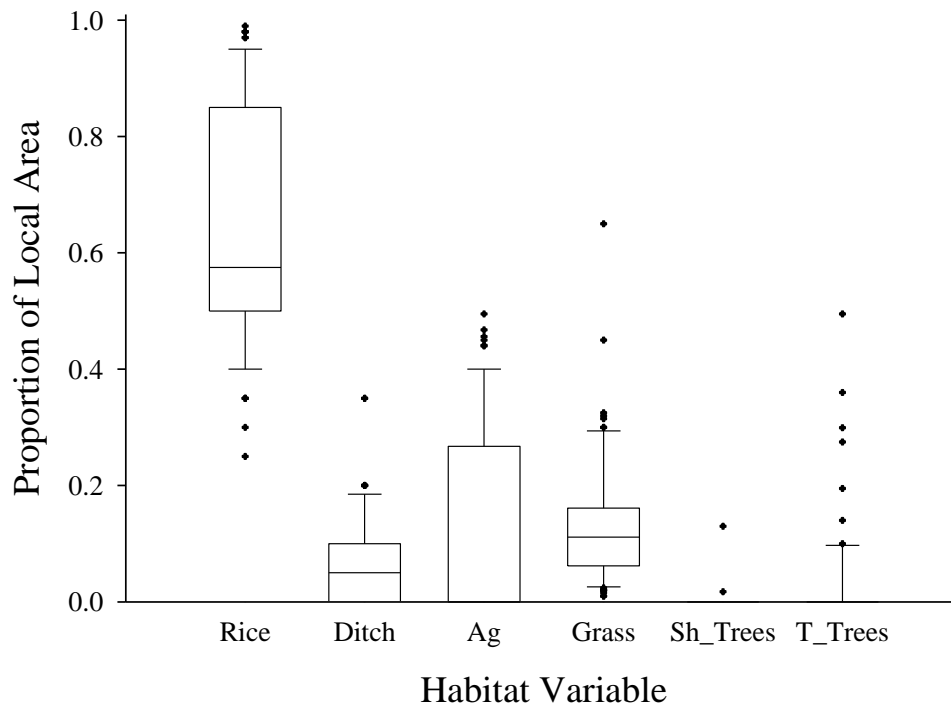


Figure 3.5. Boxplots representing the distribution of local habitat variable proportions from all rice field sites ($n = 72$). The box contains the middle 50% of the data and the whiskers extend to the 10th and 90th percentiles. Variables represent the proportion of the 100 m radius circle around each point that was covered by rice, flooded ditches, other agriculture, grass or weeds, trees < 3 m tall, and trees ≥ 3 m tall.

of erect burhead (*Echinodora spp.*), arrowhead (*Sagittaria spp.*), alligator weed (*Alternanthera philoxeroides*), smartweed (*Polygonum hydropiperoides*), and sedges (*Carex spp.*). Only 3 sites had ditches with any robust emergent vegetation cover and 2 sites had ditches with floating vegetation (Figure 3.6). Numerous sites had ditches with woody emergent vegetation, but these plants were generally very sparse.

The average rice field site was located within a landscape almost entirely dominated by agriculture (Figure 3.7). At this scale, patches of forested and reforested land were common but covered very little area. Similarly, water bodies (i.e. ponds, rivers, large ditches, etc.) were abundant but generally small in size.

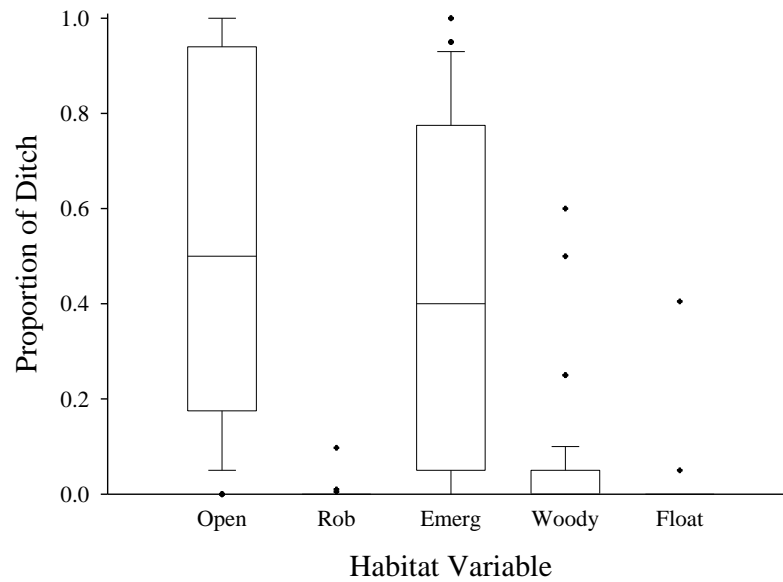


Figure 3.6. Boxplots representing the distribution of habitat variables recorded in ditches from all rice field sites where ditches were present ($n = 53$). The box contains the middle 50% of the data and the whiskers extend to the 10th and 90th percentiles. Variables represent the proportion of the water within 100 m of the survey point that was dominated by open water, robust emergent vegetation, non-robust emergent vegetation, woody vegetation and floating vegetation.

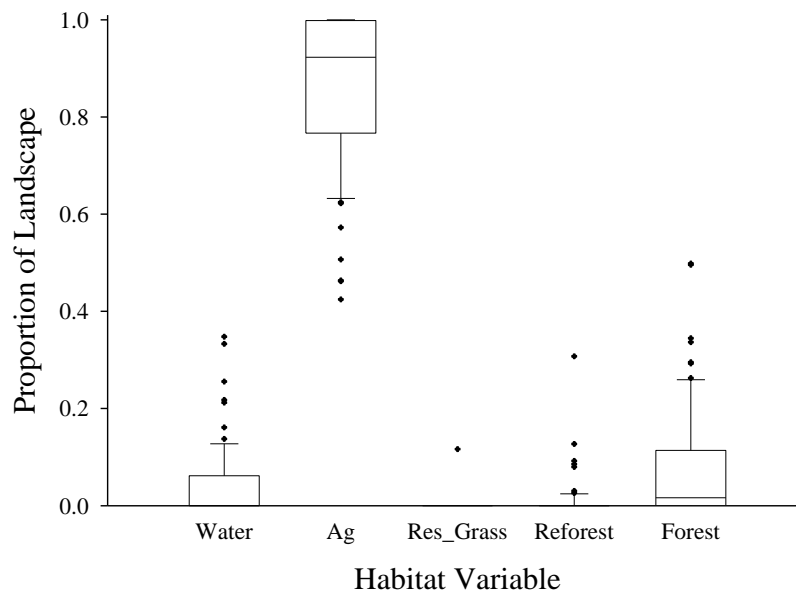


Figure 3.7. Boxplots representing the distribution of landscape habitat variable proportions from all rice field sites ($n = 72$). The box contains the middle 50% of the data and the whiskers extend to the 10th and 90th percentiles. Variables represent the proportion of the 1 km radius circle around each point that was covered by water, agriculture, residential or grassland areas, young forest and mature forest.

DISCUSSION

Common Moorhens, Least Bitterns and Purple Gallinules all nest commonly in the wetlands of Louisiana's MAV (see Chapter 2), yet we detected very low numbers of breeding SMBs within rice fields in this region. None of my fields were occupied by any species in 2007, and only 18% were in 2008 (though my naïve occupancy estimates are likely low due to the low detection probabilities associated with these species). SMBs begin breeding in the MAV several months before the rice is tall enough to be utilized by nesting individuals, and in general ditches around these fields have very little robust emergent vegetation cover. In addition, rice is not one of the dominant crops in the MAV and rice fields tend to be located within highly disturbed agricultural complexes, potentially making them even less attractive to breeding SMBs.

In both years Common Moorhens, Least Bitterns and Purple Gallinules had all begun exhibiting breeding behaviors by the end of April at the latest, and King Rails have been documented copulating in central Arkansas as early as the beginning of March (Meanley 1953). In my study rice in the earliest planted fields did not reach 65 cm until late May in 2007 and late June in 2008. Thus conditions within the fields themselves were not adequate for nesting birds until 1-2 months after the breeding season began.

Pierluissi (2006) reported that the mean nest initiation dates for Purple Gallinules were 13 June and 16 June in 2004 and 2005 respectively, while mean nest initiation dates for King Rails were 1 June and 19 June in the same years. Some of the rice in my study region would have reached 65 cm by this time, yet we still encountered very few birds. Meanley (1953) noted that King Rails utilized overgrown ditches around rice fields early in the breeding season, predominantly building nests in dense stands of cattail, soft rush and sedge. Pierluissi (2006) also found a positive association between ditches around the perimeter rice fields and the density of King Rail and Purple Gallinule nests in those fields. These researchers have suggested that

ditches provide supplemental resources, refuge from agricultural disturbances and more sufficient nesting structure early in the growing season (Meanley 1953; Pierluissi 2006). There were no flooded ditches within 100 m of 26% of my rice sites, and when flooded ditches were present, they were dominated by open water and short, sparse, non-robust emergent vegetation. The ditches around my survey points apparently undergo fairly intensive management which likely renders them unattractive to breeding SMBs.

Pierluissi (2006) found that nest densities of breeding birds were positively associated with the amount of rice in the vicinity. Broader scale analyses of his sites would reveal large areas of coastal marsh to the south which could make the region as a whole much more attractive to breeding SMBs. Rice is not one of the dominant crops grown in the MAV, yet fields are often highly concentrated and the landscapes around several of my survey points were dominated by upwards of 80% rice agriculture. At broader scales, though, the proportion of rice on the landscape would likely decrease and reveal that these concentrated rice patches are located within vast complexes dominated bottomland hardwood forest and other agricultural crops. As a result, it may be difficult for breeding SMBs to locate these isolated concentrations of rice acreage.

Management and Future Research

Farmers and refuge managers could make rice fields more attractive to breeding SMBs by encouraging growth of emergent vegetation in ditches and refraining from mowing or otherwise treating the vegetation in their ditches to provide more cover early in the season. Where possible, planting rice earlier in the year may also increase the probability of attracting these species. Future studies should explicitly address these questions of ditch condition and planting date to see if breeding birds can be enticed to utilize regional rice fields.

Lastly, SMBs did begin utilizing my rice sites later in the summer (June-August) when rice reached 65-70 cm tall. Several of these species are suspected of rearing multiple broods in one season, especially in the southern U.S. which is closer to the wintering grounds for migrants and has a long growing season (Meanley 1992; Bannor and Kiviat 2002). It is possible, then, that rice fields in the MAV provide valuable habitat for late season breeders or birds rearing a second brood. Due to logistical and financial constraints, we were not able to sample rice fields intensively late into the breeding season and further investigation is necessary to understand the value of agricultural wetlands in the MAV for SMBs in the late summer.

CHAPTER 4

CONCLUSIONS

Three SMB species, Common Moorhens, Least Bitterns and Purple Gallinules, breed fairly regularly in wetlands of Louisiana's MAV. Two other species, King Rails and American Coots, breed there occasionally. My results coincide with distributional information found in the Louisiana Breeding Bird Atlas (Wiedenfeld and Swan 2000) for Common Moorhens, King Rails and American Coots. However, this document indicates that there is no evidence of Least Bitterns or Purple Gallinules breeding in most of the Louisiana's northeastern parishes, and should be updated.

Local habitat characteristics are most strongly and consistently associated with use by breeding SMBs in the MAV. In particular, areas with more surface water and greater coverage by robust emergent vegetation seem to attract breeding SMBs. Robust emergent plants which provide both nesting structure and cover from predators may be especially important for breeding SMBs in this region. Wetland managers interested in creating habitat for these birds should hold water on the wetland throughout the spring and summer when the birds are nesting, then slowly draw the water off in mid-late August to allow new robust emergent plants to germinate. I would recommend little other management, as it appeared from my study that the wetlands dominated by robust emergents were also the wetlands that endured the least disturbance.

All commonly breeding SMB species had begun doing so by the end of April in both years, yet rice did not reach a height sufficient to support these birds until at least 1-2 months later. Local and landscape features around these rice fields may deter usage as well because fields tend to be located within highly disturbed settings and abutted by ditches dominated by open water and short non-robust emergent plants. Farmers and managers of refuges which

support rice may increase the utility of their fields for breeding SMBs by leaving water in the ditches in the spring and summer and refraining from otherwise manipulating the vegetation in those ditches.

Selection for specific resources by an organism does not mean those are indicative of quality habitat. Resource selection functions are only one measure of habitat quality, but even more important are survival and reproduction characteristics (Van Horne 1983). My study did not quantify food availability or predator concentrations and I did not measure any variables indicative of breeding success. Rather, I focused on structural characteristics of the wetlands and surrounding landscapes that attract breeding birds. Future research should address whether SMB species are breeding successfully in the MAV and verify that regional wetlands are not ecological traps.

Some of the most salient questions left unresolved from this study involve the status and distribution of breeding King Rails in the MAV. Despite the availability of seemingly appropriate habitat conditions, we did not encounter any breeding King Rails at any of our more natural sites in 2007 ($n = 114$); similarly, we only encountered breeding King Rails at 3 of our more natural sites in 2008 ($n = 82$). Yet in both years we began to incidentally encounter these birds in rice fields during the first week of June. In 2007 none of these encounters occurred at any of our sampling points, and only a couple did in 2008, but these birds definitely appeared to be much more common within rice fields beginning at this time than they had been anywhere else in the region previously. Lowery (1974) indicated that the King Rail “certainly vies with the Sora as the one most frequently encountered in marshy places in the interior parts of the state,” yet the breeding range of the Sora does not encompass any part of Louisiana (Dunn and Alderfer 2006). Thus it is unclear whether the author believed King Rails were abundant during the breeding months and whether my results indicate a regional decline in breeding King Rail

populations in the past 30-40 years or not. Future research should focus on identifying why breeding King Rails are present in such low numbers in the wetlands of the MAV, where the birds found in rice fields are coming from and the why they exhibit synchronization of their arrival time.

Finally, prior to European settlement the growth of robust emergent vegetation would have been limited to permanently and semi-permanently flooded openings in the canopy created by high winds, fluvial geomorphic processes, beavers and fires (Nelms 2001). Thus, it is unclear how much robust emergent vegetation was available in the MAV 200 years ago, and it is questionable whether the region has ever served as a stronghold for breeding SMBs. Despite this, several species actively breed in the MAV today and, given the availability of appropriate habitat characteristics, the region could potentially play an important role in conserving and augmenting populations of these birds.

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APPENDIX A: SITE LOCATIONS

All properties utilized during the study and the number of sample points surveyed on each during each breeding season. Wildlife Management Areas (a.), National Wildlife Refuges (b.), and Wetlands Reserve Program Easements (c.) are listed separately. Some of the points were located on both a NWR or WMA and a WRP easement at the same time, so some points may be accounted for more than once.

a.			b.		
<u>National Wildlife Refuge</u>	<u>2007</u>	<u>2008</u>	<u>Wildlife Management Area</u>	<u>2007</u>	<u>2008</u>
Catahoula Lake	6	0	Boeuf	3	3
Grand Cote	4	4	Buckhorn	10	9
Tensas	9	9	Ouachita	10	9
Upper Ouachita	8	0	Pomme de Terre	1	0
			Red River	16	11
			Three Rivers	9	1

c.				
<u>Parish</u>	<u>Easements</u>	<u>Sites</u>	<u>Easements</u>	<u>Sites</u>
Avoyelles	5	11	3	6
Caldwell	6	14	6	14
Catahoula	2	3	0	0
Concordia	0	0	1	4
Madison	6	11	6	11
Tensas	5	14	5	14

APPENDIX B: BIRD SURVEY DATA SHEET

Pg. ____ of ____

Site	Temperature
Date	Wind Speed
Time	Weather Conditions
Observer	Precipitation
Survey #	

[illegible][illegible]

APPENDIX C: VEGETATION SURVEY DATA SHEET

Wetland Habitat Characteristics at Marshbird Survey Points

Site:	Date:	Observer:	Management Type:
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Management Type = Ditch, Natural, or Managed

At each survey point (100m radius), record %water and %upland habitat (these should equal 100%). Percent open water, %floating/submerged, and %emergent non-woody vegetation should equal 100%. Similarly, upland qualifiers should also equal 100%. Percent woody vegetation represents % within the wetland.

Examples:

- Floating/Submerged Vegetation: duckweed, pondweed, etc.
- Emergent Non-Woody Vegetation: primrose, alligator weed, smartweed, sedges, rushes, cattails, etc.
- Emergent Woody Vegetation: buttonbush, black willow, etc.

% Wetland with Water:		% Upland:	
% Open Water:		% Agriculture & Type:	
% Floating/Submerged Vegetation Cover:		% Grass:	
% Emergent Non-Woody Vegetation Cover:		% With Trees ≤ 10 Ft:	
		% With Trees 11-30 Ft:	
% Woody Vegetation Cover:		% With Trees >30 Ft:	

Percent composition should equal 100%, whereas, the total %cover by species should equal the total listed above for each habitat qualifier. Density estimates reflect the density of vegetative cover (see ranks below). Additionally, for non-woody and woody emergent vegetation, record estimated mean heights (above the water line) for each species.

Floating/Submerged Vegetation					
Species	%Comp	%Cover	Density	Height	Distribution

- | | |
|----------------------|------------------------|
| Distribution | Density Ranks |
| (1) Random | (1) Very Sparse (≤ 5%) |
| (2) Even | (2) Sparse (6-25%) |
| (3) Single Patch | (3) Medium (26-50%) |
| (4) Multiple Patches | (4) Moderate (51-75%) |
| (5) Wetland Edge | (5) Heavy (76-100%) |
| (6) Other | |

Emergent Non-Woody Vegetation					
Species	%Comp	%Cover	Density	Height	Distribution

Water Depth	
1-m (3.3ft) from shore	Shallow (≤12in) Moderate (13-24in) Deep (>24in) Not Applicable
10-m (33ft) from shore	Shallow (≤12in) Moderate (13-24in) Deep (>24in) Not Applicable
50-m (165ft) from shore	Shallow (≤12in) Moderate (13-24in) Deep (>24in) Not Applicable

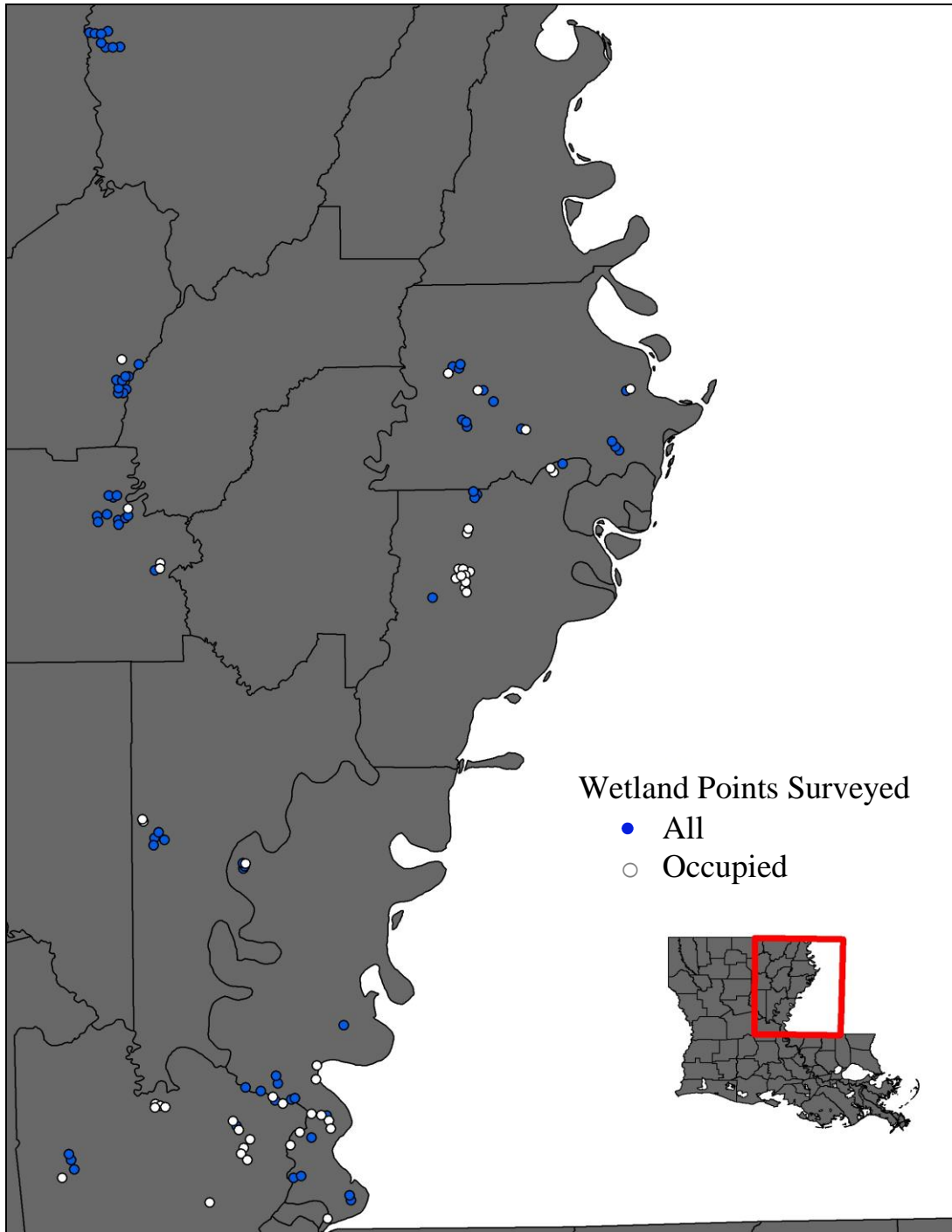
Woody Vegetation					
Species	%Comp	%Cover	Density	Height	Distribution

Within Open Water			
Within Emergent Vegetation			

Comments: _____

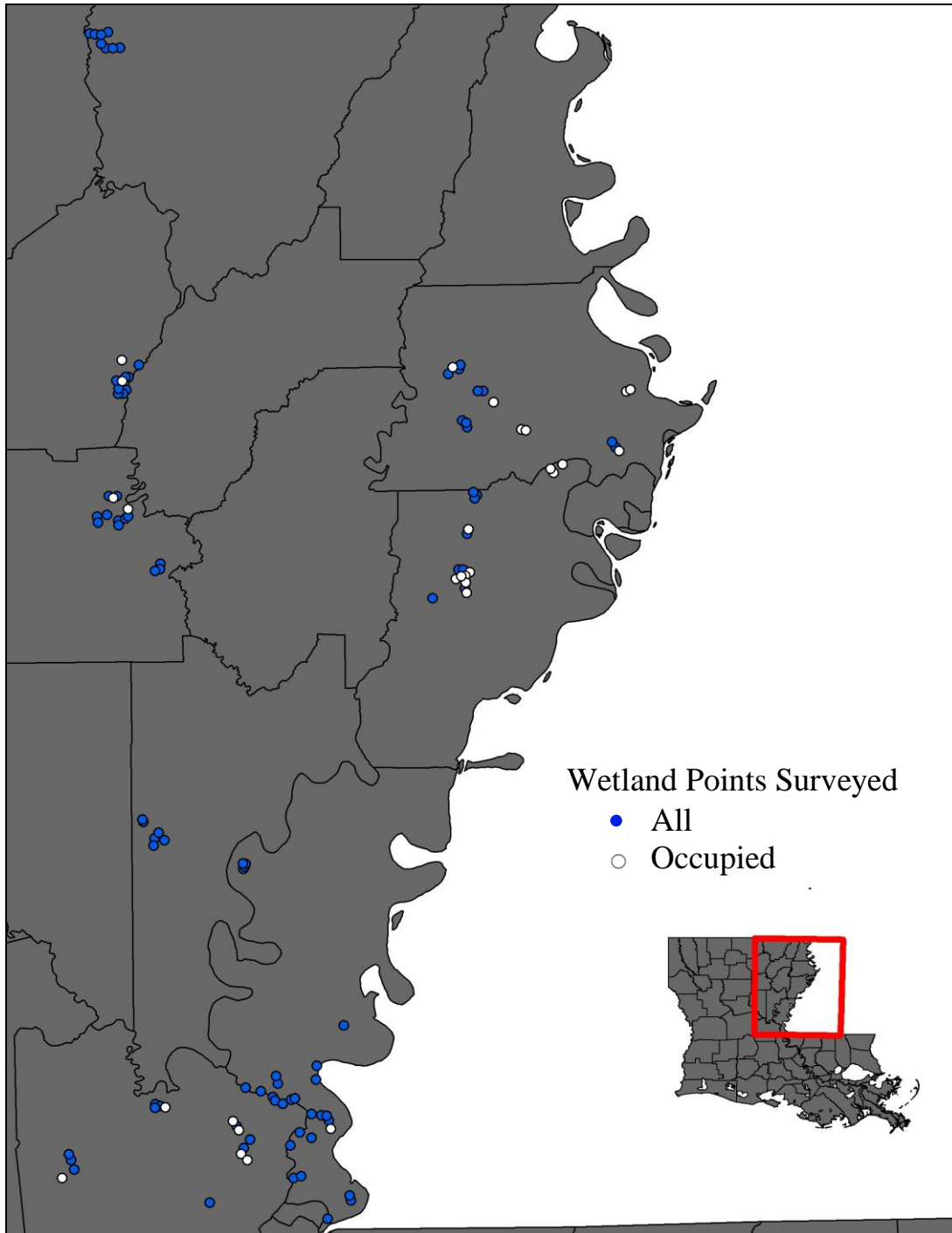
APPENDIX D: WETLAND SITES OCCUPIED BY COMMON MOORHENS

All wetland sites where Common Moorhens were detected during the 2007 and 2008 breeding season. Information from both years is combined into this map.



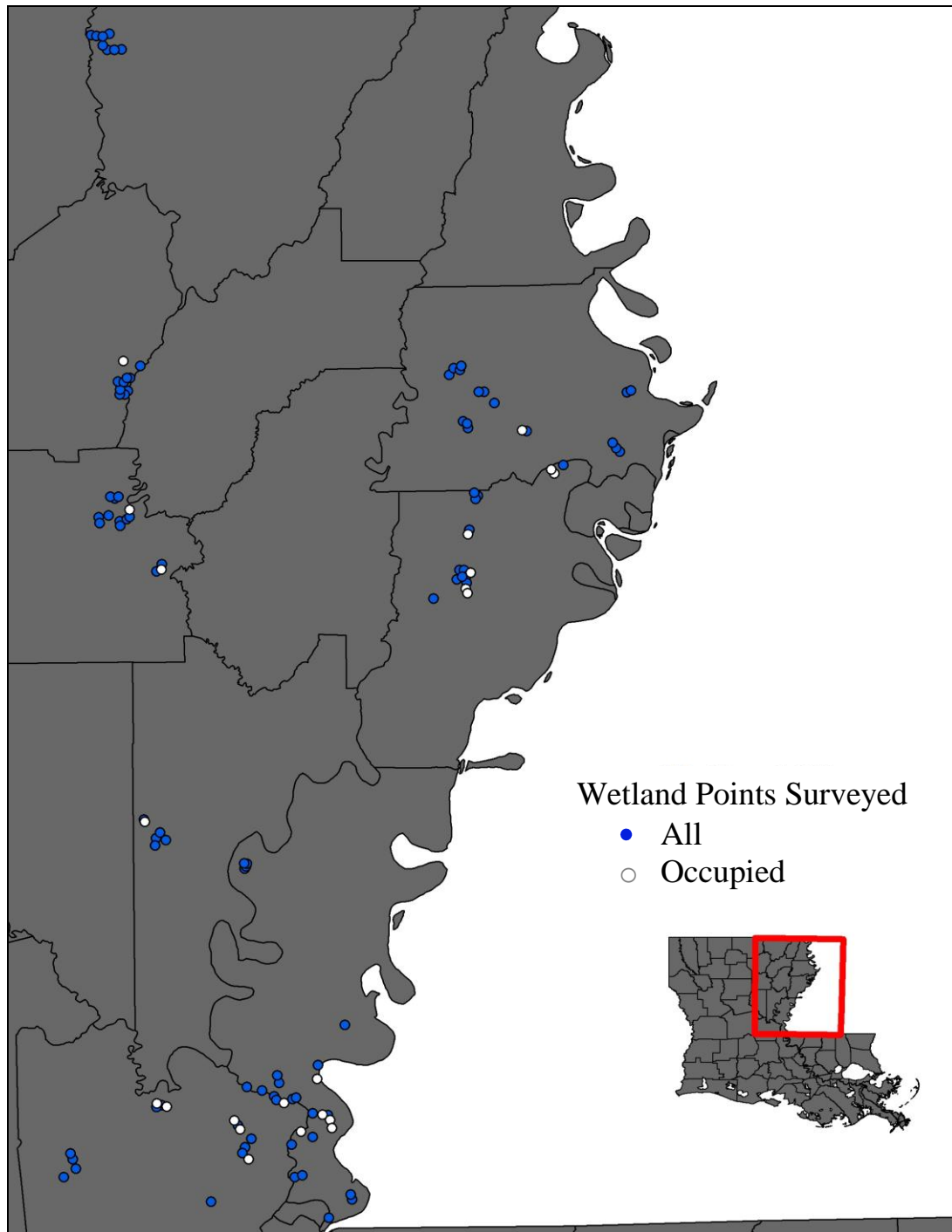
APPENDIX E: WETLAND SITES OCCUPIED BY LEAST BITTERNS

All wetland sites where Least Bitterns were detected during the 2007 and 2008 breeding season. Information from both years is combined into this map.



APPENDIX F: WETLAND SITES OCCUPIED BY PURPLE GALLINULES

All wetland sites where Purple Gallinules were detected during the 2007 and 2008 breeding season. Information from both years is combined into this map.



VITA

Jonathon Valente was born in March 1983, in Naperville, Illinois, to Joseph and Betty Valente. He grew up in Granville, Ohio, and graduated from Granville High School in 2001. He received his Bachelor of Arts Degree with majors in zoology and environmental science from Miami University in Oxford, Ohio, in 2004. While studying at Miami, Jonathon was involved with numerous research projects which addressed questions dealing with primary production, trophic interactions, invasive species and allochthonous resource subsidies in freshwater aquatic systems. In the spring of 2005, he helped monitor 6 bird banding stations in the Siuslaw National Forest in coastal Oregon as part of the Monitoring Avian Productivity and Survivorship (MAPS) program. In the fall of 2005, he moved to Cincinnati, Ohio, where he worked as an educator for the Ohio River Valley Water Sanitation Commission (ORSANCO) teaching high school students about the ways in which shipping impacts the Ohio River ecosystem and how aquatic organisms can be used as indicators of environmental quality. In the fall of 2006, he began his graduate work in the Renewable Natural Resources Department at Louisiana State University. He will receive his Master of Science Degree in May of 2009 with a major in wildlife and a minor in statistics.