Conservation Planning for the Coastal Prairie Region of Louisiana

Bradley A. Pickens¹, Sammy L. King², Bill Vermillion³, Latimore Smith⁴, and Larry Allain⁵,

¹207 School of Renewable Natural Resources
LSU Agricultural Center
Baton Rouge, LA 70803

²Louisiana Cooperative Fish and Wildlife Research Unit
USGS
School of Renewable Natural Resources
LSU Agricultural Center
Baton Rouge, LA 70803

³Gulf Coast Joint Venture
700 Cajundome Boulevard
Lafayette, LA 70506

⁴The Nature Conservancy
Louisiana Field Office
PO Box 4125
Baton Rouge, LA 70821

⁵USGS National Wetlands Research Center
700 Cajundome Boulevard
Lafayette, LA 70506

Preferred Citation:
Pickens, B., S. L. King, B. Vermillion, L. Smith, and L. Allain. 2009. Conservation Planning for the Coastal Prairie Region of Louisiana. A final report from Louisiana State University to the Louisiana Department of Wildlife and Fisheries and the U.S. Fish and Wildlife Service in fulfillment of Agreement Nos. #644821/513-700205 (LDWF) and #201816N759 (USFWS).
Acknowledgements

We thank the many wildlife experts who met with us and contributed their knowledge of particular species and bird guilds. The experts included all authors of our report and the following individuals: Barry Wilson (USGS/Gulf Coast Joint Venture), Mike Hoff (USFWS), Fred Kimmel (LDWF), Scott Durham (LDWF), Larry Reynolds (LDWF), Michael Brasher (Gulf Coast Joint Venture /Ducks Unlimited), Bob Dew (Ducks Unlimited), Clint Jeske (USGS), Wayne Norling (USGS), and George Archibald (International Crane Foundation). These individuals assisted with discerning important variables during habitat model development. Thomas Hymel (LSU AgCenter) also provided valuable information. We thank Melanie Driscoll (National Audubon Society), Clint Jeske (USGS), and Wayne Norling (USGS) for their comments on the original manuscript. Patti Faulkner and Beau Gregory (The Louisiana Natural Heritage Program) were invaluable in providing wading bird data and assisting with coastal prairie information. We thank Richard Martin and Dan Weber (The Nature Conservancy) for their insights and providing direction for our research project. Rachel Villani, Hugo Gee, Ehren Banfield, and Karen Wiens provided vital assistance in the field, and Corin Schowalter provided GIS technical assistance.
Table of Contents

Chapter I: Synthesis of Coastal Prairie Ecosystem and Rice Agriculture………………………………………………….5

Chapter II: Introduction to the Project………………………………10

Chapter III: Wetland and Grassland Bird Habitat Suitability Models………………………………………………….14

Chapter IV: Other Considerations for Ranking Habitat for Coastal Prairie Restoration……………………………...35

Chapter V: Validation of Models……………………………………37

Chapter VI: Integrating Habitat Suitability Models for Conservation Planning: An Example……………………………50

Chapter VII: Stakeholders and Landowners in the Region…………54

Chapter VIII: Conclusions…………………………………………58

Appendix A: Habitat Suitability Maps……………………………...60
Appendix B: Maps of human population density, topography, Chinese Tallow invasion potential…………………………………………...75

Appendix C: Habitat variable rankings…………………………………80
Chapter I: Synthesis of Coastal Prairie Ecosystem and Rice Agriculture

Coastal Prairie

The Louisiana Coastal Prairie ecosystem once encompassed approximately 1 million hectares (2.5 million acres), but has since been reduced to less than 1% of its original range (see Smith 1993, Allain et al. 2004). The remaining prairie is extremely fragmented and requires active management to maintain its community structure. Today, approximately 40 ha (100 acres) of upland (mesic) prairie and 250 ha (600 acres) of wet prairie are known to remain and most are degraded by disturbance and woody plant encroachment (USGS website: http://www.nwrc.usgs.gov/prairie/tcpr.htm). Additionally, only 11 of 63 existing prairie fragments are >4 ha (>11 acres), and many are simply along railroads or roadsides (unpublished data, Louisiana Natural Heritage Program). These remaining remnants generally provide poor quality habitat for animal species due to their small size and degraded condition.

To date, over 546 ha (1,350 acres) have been planted with native prairie plant species in southwestern Louisiana (unpublished data). However, efforts to restore coastal prairie in Louisiana have been limited to small areas and have shown varied success. Currently, the largest planting is at the Durald Unit of Lacassine National Wildlife Refuge. Due to limited resources and reliance on hand collected seeds from remnants, most plantings have low plant species diversity.

The dominant soils in the southwestern Louisiana (SWLA) prairie region are Alfisols that are underlain by an impervious clay pan 15 to 45 cm below the surface that prevents downward percolation of water and inhibits upward movement of capillary water. The region is underlain by Pleistocene deposits, known in Louisiana as the Prairie Formation, that range from 20 m in
elevation inland to within 1 m above sea level near the coast. Undulating streams on this relatively flat landscape, along with sea-level changes over millions of years, have resulted in heterogeneous sediment deposits and landforms where soils and vegetation vary with only slight differences in elevation (Smiens et al. 1991).

Fire, grazing, and drought are thought to be the primary factors resulting in the establishment and maintenance of grassland species. Once prairie is established, competition for soil nitrogen and other nutrients is likely to further limit woody plant growth. Riparian areas in SWLA were historically forested and were known as “gallery forests” (Vidrine et al. 2001); these forests probably existed because of flooding and sedimentation that resulted in optimal conditions for trees (e.g. soils were not clay).

There are few accounts of the physical attributes, plants, or animals of the coastal prairie ecosystem in Louisiana. We know that coastal prairie near St. Martinville and Cote Blanche Landing were inhabited by Attakapas Native Americans into the late 1800's or early 1900's (Fortier 1891). From these early descriptions, it was noted that, "The coast of Louisiana is flat, but in the Attakapas country five islands or elevations break the monotony. These are rugged and abrupt and present some beautiful scenes" (Fortier 1891). Hill (1906) states that coastal prairie is poorly drained and rainfall does not have distinct pathways because of the flatness. Further, Hill (1901) described the coastal prairie as "an extensive flat" and a level plain with irregular topography. Acadian settlers (Cajuns) also described marais (translated as “little marsh”) and platins (small, round ephemeral wetlands), as pockets of marsh within the coastal prairie that were formed by slight changes in topography that created depressional wetlands (Vidrine et al. 2001). Kane (1943) also describes the Louisiana coastal prairie as having numerous wet areas, which made traveling hazardous; these included “boglike flats” and natural ponds.
The coastal prairie of Louisiana is a tallgrass prairie ecosystem with over 500 plant species recorded in remaining remnants (Allain et al. 2004). Vegetation can vary from upland species in the north where it borders longleaf pine flatwoods to wetland species in the south where prairie intergrades with fresh water marsh. In wet Prairie remnants, vegetation is often a mixture of obligate wetland plants and upland species, including upland species occurring on “mima mounds” (Grace et al. 2000b). Mima mounds were once common and still exist at some coastal prairie remnants; these structures are mounds of soil elevated by <1 m in height and 5-10 m in diameter (Grace et al. 2000a). The origin of mima mounds and their effect on coastal prairie plants and animals remains largely unknown; however, microtopography (i.e. moisture) has been found to explain variation in plant species richness in a Vermilion Parish prairie remnant (Grace et al. 2000a).

Although there is not an explicit description of wildlife that occupied the coastal prairie, we can make some inferences from historical accounts. Whooping Cranes and Attwater’s Greater Prairie-Chickens were once common in coastal prairie, but now have been extirpated from Louisiana. The Attwater’s Greater Prairie-Chicken is now restricted to extremely small populations west of Houston (e.g. Attwater Prairie Chicken National Wildlife Refuge); the last known location in Louisiana was near Vinton, LA in 1919 (Lowery 1974). Whooping Cranes historically wintered in Louisiana coastal prairie and were described as being abundant in parts of the prairie region (Allen 1952). Wintering songbirds, such as Le Conte's Sparrow and Henslow's Sparrow, were likely to have wintered in great numbers, while Northern Bobwhite probably had substantial resident populations that used brushy areas of the prairie. Abundant winter rainfall, platins, and bayou flooding probably provided wetland prairie for use by wintering ducks and a variety of rails (e.g. Sora, King Rail, Yellow Rail, etc.). In a similar
historical prairie system in Oregon, Taft and Haig (2003) concluded that winter/spring flooded wetland prairie, floodplains, and relatively sparse emergent marshes once accommodated abundant ducks, shorebirds, Sandhill Cranes, geese, and wading birds. Wetland prairie and pockets of marsh within the Louisiana coastal prairie may have also provided habitat to migrating shorebirds, breeding King Rails, and Mottled Ducks. However, the quantity and importance of these seasonal wetlands within the coastal prairie remains unknown.

The coastal prairie region has now been modified in numerous ways. Since the late 1800's, rice has been extensively planted in the region. To accommodate rice, the land has been leveled and the hydrology has been severely altered by the extensive building of levees and ditches. The result is a very controlled, extensively drained and altered hydrological regime. Human development remains a threat to the region as Lake Charles and Lafayette continue to expand in size and population. An invasive exotic tree species, Chinese tallow (*Triadica sebifera*), has a major impact on both grassland and wetland habitats in the southern United States. Extensive remote sensing of SWLA has found tallow to be most abundant in wet deciduous forests, followed by evergreen forests, estuarine wetlands, cultivated lands, and grasslands (Ramsey et al. 2005). Chinese tallow continues to threaten existing prairie fragments.

**Rice**

Worldwide, numerous studies have found rice fields to be important habitats for wintering and breeding waterbirds (Elphick and Oring 1998, Tourenq et al. 2001, Elphick and Oring 2003, Tourenq et al. 2004, Pierluissi and King 2008). In Louisiana, studies have shown waterbirds use rice fields extensively (Huner et al. 2002, Hohman et al. 1994, Pierluissi 2006, Cox and Afton 1997). Despite these studies, research has only begun to examine the effect of variable agricultural landscapes, including the effects of fragmentation, on waterbird
communities (see Chan 2007, Elphick in press). Therefore, further studies are needed to enable successful conservation planning in rice regions. In fact, conservationists and biologists stress the need to identify critical bird areas in the rice region of Louisiana and elsewhere (Sanchez-Guzman et al. 2007, Melanie Driscoll, personal communication, National Audubon Society), and ecological research will assist with these efforts.

The rice region of SWLA is critical for migrating and wintering shorebirds, wintering ducks, and many waterbird species. At least 4 million ducks winter in the Chenier Plain of Louisiana annually (Esslinger and Wilson 2001). The loss of coastal marsh in the Chenier Plain has equaled nearly 20% of Louisiana's marsh loss from 1978 to 1990 (Esslinger and Wilson 2001), and this is likely to place more importance on the interior, agricultural duck habitat. Of course, duck hunting is a major economic and recreational activity in SWLA and the Gulf Coast that results in substantial income for private landowners and businesses (e.g. Louisiana AgSummary 2006).

Numerous wetland birds use rice habitat throughout the year in SWLA. The quantity of wintering and migratory shorebirds in the region accounts for a substantial portion of North American populations for some species (Norling et al. 2005). Sandhill Cranes have recently returned to Louisiana and use the agricultural landscape extensively (McGowan 2003). King Rails are another species that appear to have a stronghold in Louisiana, despite major declines elsewhere (Hohman et al. 1994, Pierluissi 2006, Pierluissi and King 2008). In addition, fallow fields continue to provide habitat for Bobwhites and grassland songbirds, while pastures provide habitat for Loggerhead Shrikes. Crawfish ponds are used by numerous wading birds, including the Little Blue Heron, whose populations have been in decline (Huner et al. 2002). Drawdowns of crawfish ponds also provide habitat for fall migrating shorebirds.
Chapter II: Introduction to the Project

Currently, a Farm Bill Conservation Reserve Enhancement Program (CREP) is being considered to restore up to 5,666 ha (14,000 acres) [previously 11,331 ha or 28,000 acres] of coastal prairie on agricultural lands in SWLA. A similar U.S. Department of Agriculture program has already been approved by Louisiana (the Gulf Coast Prairies SAFE program) and will restore 1,416 ha (3,500 acres) of grasslands to the region. These grasslands will have limited plant diversity, but will likely support many grassland birds of concern. Certainly, grassland birds such as Northern Bobwhite, Henslow's Sparrow, Le Conte's Sparrow, and nesting Mottled Ducks have been in decline and are in need of additional habitat. The Conservation Reserve Program (CRP) is well known to provide important habitat for grassland birds and ducks in North America (Kantrud 1993, Hughes et al. 1999, Gray and Teels 2006, Herkert 2007), and direct scientific research is needed to maximize CRP benefits (Gray and Teels 2006).

The restoration of coastal prairie could have enormous benefits for many grassland birds if the prairie is configured to meet species’ habitat requirements. For instance, Bobwhites require shrub habitat and hedge rows/edges, songbirds prefer open grasslands, and nesting Mottled Ducks are probably sensitive to the area of grassland in the landscape. In addition, Bobwhite populations will need to exist near a prairie restoration site if the species is to benefit from the increased grassland.

Meanwhile, prairie restoration will reduce wetland habitat for many bird species in the region. The most notable reason for this trade-off is the human-altered ecosystem of SWLA, and our lack of knowledge/funding to recreate coastal prairie topography and hydrology. In regard to hydrology, restored prairies are not likely to function as wetland habitat as historical coastal prairie once did. Meanwhile, rice habitat will be lost. In addition, shorebirds and ducks probably
have altered their migration routes and wintering grounds to take advantage of the available rice habitat while avoiding areas now devoid of wetland habitats. This means rice is now a critical habitat and a decline in rice acreage could trigger unknown changes in bird populations. The configuration of available rice habitat and lost rice habitat will determine the effect on wetland birds. For instance, Purple Gallinules and King Rails avoid rice fields with nearby trees (Pierluissi 2006). Mottled Ducks (Johnson et al. 1991), Little Blue Herons, and King Rails (personal observation) also use ditches, so rice fields with substantial ditches are more valuable than fields without ditches. Wintering ducks and shorebirds generally use both rice and coastal marsh, so rice fields in close proximity to the coast are ideal for them.

In summary, the trade-off of wetland/rice habitat and coastal prairie restoration necessitates that we have a decision-making framework in place to optimize the use of SWLA for both grassland and wetland birds. To accomplish this optimization, we must evaluate the spatial differences in habitat suitability for grassland and wetland birds in SWLA.

**Habitat Suitability and Conservation Planning**

Habitat suitability models are a useful tool in conservation planning (Root et al. 2003, Wilson et al. 2005). Since their development in the 1980’s (Yahner et al. 2005), advances in Geographic Information Systems (GIS) and remote sensing have enhanced our ability to make habitat suitability maps for species at broad spatial scales. Ideally, the modeling process includes the collection of preliminary data on which a model is developed, and then more, independent data, is used to validate the model (Guisan and Zimmermann 2000). However, the entire process can be data intensive, too costly for management agencies to perform, and may take several years to complete a single species model. Land-use decisions often require decisive action even though a great deal of uncertainty may still exist. Therefore, many authors have offered
methodology to expedite the process of habitat modeling (Carter et al. 2006, Dayton and Fitzgerald 2006) and conservation planning (Root et al. 2003). In particular, a few studies have been successful extrapolating habitat associations discovered by field study or from expert opinions to GIS variables on broad landscapes (Carter et al. 2006, Dayton and Fitzgerald 2006).

In SWLA, the examination of multiple species and multiple bird groups is necessary to assist stakeholders in making overall land-use decisions in the region. Therefore, our objective was to develop spatially explicit habitat suitability models for both wetland and grassland birds of concern to assist with conservation planning for the region. To facilitate conservation planning, we also wanted to establish a working group of individuals and agencies that had a vested interest in the region.

**Study Area**

Our study area encompassed the entire 1 million hectares (2.5 million acres) of historical coastal prairie in SWLA, including the proposed CREP area (Figure 1). Coastal marsh borders our study area to the south and forest cover dominates to the north, while the Atchafalaya Swamp borders to the east.

The soils contain substantial clay with a thin top layer of loess, and this soil type easily produces waterlogged conditions as well as very dry, rock-hard conditions (Vidrine et al. 2001). The most common soil types in the region are Crowley silt loam (CrA) in Acadia and Jefferson Davis Parishes; Mowata-Vidrine silt loam (Mt) in Calcasieu, Evangeline, and Vermilion Parishes (Soil Survey Staff, Natural Resources Conservation Service, data accessed 2008). The region is primarily agricultural, which includes rice, soybean, sugarcane, pasture, crawfish ponds, and other aquaculture. Individual rice fields are often rotated with several crops, particularly crawfish, fallow, and soybean fields.
Figure 1. The study area encompasses the historical coastal prairie region. Canopy cover is shown in green to the north and in riparian areas. Marsh is displayed in blue-green primarily to the south of our study area and major water bodies are in dark blue. Gray polygons indicate Wildlife Management Areas and Wildlife Refuges. The CREP area is highlighted in black and extends from the southwest to the northeast.
Chapter III: Wetland and Grassland Bird Habitat Suitability Models

Habitat Suitability Index

Our approach to developing habitat suitability indices consisted of the following: 1) Identifying target grassland and wetland bird species; 2) Identifying habitat associations of species by using scientific literature and expert opinion; 3) Transferring the habitat associations to available GIS layers and performing spatial analysis; 4) Developing habitat suitability models; and 5) Validating the models whenever possible.

Identification of Target Species

We chose to target bird species because SWLA provides critical habitat for shorebirds, waterbirds, ducks, and is a potential haven for grassland bird species. Target bird species fell under four broad groups: shorebirds, waterbirds (including rails, cranes, etc.), ducks, and land birds (Table 1). We started with a list of species of concern developed by the Gulf Coast Joint Venture office. We then excluded species whose habitat did not include rice fields or grasslands. Next, we added the Purple Gallinule to the list since this species is known to use rice extensively in SWLA. After developing the focal list, we grouped species based on a scientific literature review. For instance, shorebird studies often included many species, but did not necessarily include the species we had on our target bird list. Therefore, we used broad generalities from these shorebird studies to develop models.
Table 1. Target bird species in SWLA rice fields and grasslands.

<table>
<thead>
<tr>
<th>Wetland Birds</th>
<th>Grassland Birds</th>
</tr>
</thead>
<tbody>
<tr>
<td>King Rail</td>
<td>Buff-breasted Sandpiper</td>
</tr>
<tr>
<td>Purple Gallinule</td>
<td>Le Conte’s Sparrow</td>
</tr>
<tr>
<td>Northern Pintail</td>
<td>Henslow’s Sparrow</td>
</tr>
<tr>
<td>Gadwall</td>
<td>Northern Bobwhite</td>
</tr>
<tr>
<td>Blue-winged Teal</td>
<td>Loggerhead Shrike</td>
</tr>
<tr>
<td>Green-winged Teal</td>
<td>Mottled Duck</td>
</tr>
<tr>
<td>Little Blue Heron</td>
<td>Sandhill Crane</td>
</tr>
<tr>
<td>Western Sandpiper</td>
<td>Whooping Crane</td>
</tr>
<tr>
<td>Hudsonian Godwit</td>
<td></td>
</tr>
<tr>
<td>Stilt Sandpiper</td>
<td></td>
</tr>
<tr>
<td>Short-billed Dowitcher</td>
<td></td>
</tr>
</tbody>
</table>
Geographic Information Systems (GIS) Layers

The GIS data sources we used for the project are found in Table 2; all data were projected to NAD 1983, Zone 15 N. Variables were modified as follows: 1) The 2001 National Land Cover Data (NLCD) was poor at distinguishing agricultural fields from pasture lands, so the NLCD was not used. We used aerial photography from the spring of 2004 to estimate land cover densities by first placing sample points in a 2.5 km grid over the entire study area. We then classified each point into the following categories: rice, fallow rice, tilled (not rice), forest, marsh, pasture, shrub, scrub/clearcut, water, and human structures. Human structures were defined as an area dominated by human landscaping (e.g. multiple houses). Individual farm houses were ignored and the nearest land use clockwise from the house was identified. Rice fields and fallow rice fields were distinguished by the presence of levees. We distinguished fallow fields by examining till lines, or lack thereof, and by observing the amount of standing water in rice fields. Grasses from the previous year made many fallow fields easy to identify because of photographic texture. For a preliminary investigation of King Rail habitat in Texas, aerial photography was obtained in the summer, and fallow fields could not be distinguished from active rice fields. Tilled lines and levees were primarily used to distinguish rice fields from pastures in Texas.

2) We supplemented the stream/ditch data by digitizing additional ditches that were observable from aerial photography at the scale of 1:5000. All ditches surrounded by canopy cover were eliminated from the GIS layer since rails and other species do not tend to use forested wetlands. From the ditch data layer, we also deleted all rivers and water bodies >40 meters in width.
Table 2. GIS data layers used as the basis of our habitat suitability models.

<table>
<thead>
<tr>
<th>Data Layer</th>
<th>Source</th>
<th>Modifications/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ditches</td>
<td>Redistricting Census 2000 TIGER/Line Files [machine-readable data] / prepared by the U.S. Census Bureau-Washington, DC; 2000. <a href="http://www.esri.com/data/download/census2000_tigerline/index.html">http://www.esri.com/data/download/census2000_tigerline/index.html</a></td>
<td>Using aerial photographs, ditches were added; waterways were deleted if they were &gt;40 m in width or within forested areas</td>
</tr>
<tr>
<td>Canopy cover</td>
<td>USGS: Derived forest % cover from 2001 NLCD <a href="http://seamless.usgs.gov/website/seamless/viewer.htm">http://seamless.usgs.gov/website/seamless/viewer.htm</a></td>
<td>Canopy cover was consistently underestimated compared to 2004 aerial photos</td>
</tr>
<tr>
<td>Remnant Prairies</td>
<td>Louisiana Natural Heritage Program. Updated 2007.</td>
<td></td>
</tr>
</tbody>
</table>
Spatial Analysis

We used the Spatial Analyst tool in ArcGIS 9.1 (ESRI, Redlands, CA) to estimate density and neighborhood statistics. In this manner, we calculated the ditch density by length (meters of ditches/km²), land cover densities, canopy cover, and roads. This neighborhood analysis, or “moving-window,” approach performs an analysis for every cell based on its surrounding data values. For most species models, we calculated land cover density within a 5-km radius because we wanted to ensure that we used several aerial photograph land cover surveys in our estimation (surveys were spaced every 2.5 km). Due to a relatively low pasture density on the landscape, pastures were observed in areas initially ranked "0" (non-habitat). Therefore, we ranked pastures 1-3 instead of 0-3, so we did not exclude areas with potential habitat. Other scales of analysis were based on literature review, territory sizes, and the smallest scale in which the raw data showed considerable variation.

Each data layer was converted to a quantile ranking (0-3 or 1-3) which was relative to the entire study area. For example, the best 33% of the study area was given a ranking of "3," the next best quantile, 33-66%, was given a "2," and the worst quantile, 66-99% was given a "1." Zeros were used to indicate obvious non-habitat areas, but zeros were not used for all variables (e.g. ditches, precipitation, pasture). We put together habitat suitability models using the methods presented by Dayton and Fitzgerald (2006) by multiplying each of the variable rankings together. This method is helpful for eliminating non-habitat and gives strong preference for spatial locations with multiple high ranking variables. Final habitat suitability indices (HSI's) were transformed to a 0 to 5 ranking using the natural breaks function in ArcGIS. This modeling approach is simple and easily repeatable for many species. One major advantage of this methodology is that data specific to bird species in SWLA is not always available, but we can
still build models based on scientific literature as well as expert opinion. The main disadvantages are that some species have never been well studied and each variable is equally weighted in the models.

**Habitat Associations Used to Produce Habitat Suitability Models**

The following section summarizes the scientific literature and expert opinion we used to create our habitat suitability models. Variables for each model were chosen by known habitat associations and by the opinion of experts from the U.S. Geological Survey, Gulf Coast Joint Venture, Louisiana Department of Wildlife and Fisheries, Ducks Unlimited, and others (Table 3). At the end of each section, we have included the corresponding names of GIS files in our electronic database.
Table 3. The composition of habitat suitability models by species or bird guild. The scale of spatial analysis is indicated in parenthesis.

For example, the density of rice fields was calculated within a 5-km radius of a cell.

**Wetland Birds**

<table>
<thead>
<tr>
<th>Species</th>
<th>Variables in Habitat Suitability Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>King Rail / Purple Gallinule</td>
<td>Rice density (5 km), ditch density (1 km), and canopy cover (1 km)</td>
</tr>
<tr>
<td>Winter Ducks (N. Pintail, Gadwall, Green-winged Teal, and Blue-winged Teal)</td>
<td>Rice &amp; fallow density (5 km), Nov-Mar precipitation, and distance from marsh (15 km increments)</td>
</tr>
<tr>
<td>Winter Shorebirds (Nov-Feb)</td>
<td>Rice density (5 km), Nov-Feb precipitation, distance from marsh (15 km increments), and canopy cover (3 km)</td>
</tr>
<tr>
<td>Spring Migrating Shorebirds (Mar-May)</td>
<td>Rice density (5 km), canopy cover (3 km)</td>
</tr>
<tr>
<td>Little Blue Heron (breeding)</td>
<td>Distance from rookery (15 km increments), rice (5 km), and ditch density (3 km)</td>
</tr>
</tbody>
</table>
Table 3 (continued).

**Grassland Birds**

<table>
<thead>
<tr>
<th>Species</th>
<th>Variables in Habitat Suitability Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Le Conte's Sparrow, Henslow's Sparrow</td>
<td>Fallow rice &amp; shrub density (5 km) and canopy cover (1 km)</td>
</tr>
<tr>
<td>N. Bobwhite</td>
<td>Fallow rice/shrub density (5 km) and canopy cover (1 km)</td>
</tr>
<tr>
<td>Loggerhead Shrike</td>
<td>Pasture density (5 km) and canopy cover (1 km)</td>
</tr>
<tr>
<td>Buff-breasted Sandpiper</td>
<td>Pasture density (5 km) and canopy cover (3 km)</td>
</tr>
</tbody>
</table>

**Grassland and Wetland Birds**

<table>
<thead>
<tr>
<th>Species</th>
<th>Variables in Habitat Suitability Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mottled Duck</td>
<td>Rice density (5 km), pasture density (5 km), and ditches (3 km)</td>
</tr>
<tr>
<td>Sandhill Crane</td>
<td>Rice density (10 km) and pasture density (10 km)</td>
</tr>
<tr>
<td>Whooping Crane</td>
<td>Pasture density (10 km), distance from marsh (15 km increments),</td>
</tr>
<tr>
<td></td>
<td>and road density (5 km)</td>
</tr>
</tbody>
</table>
King Rail (*Rallus elegans*) and Purple Gallinule (*Porphyryla martinica*)

The King Rail and Purple Gallinule have similar habitat requirements (Pierluissi 2006), so we developed one habitat model for the two species. Pierluissi (2006) showed that King Rail and Purple Gallinule presence and nest density were both positively associated with ditches and negatively associated with tree cover in SWLA rice fields. In Pierluissi's study, ditches were quantified from aerial photography and discernable ditches were generally >1.5 m in width (personal communication, Pierluissi, USFWS). There was not a strong association with rice area within 1 km or on adjacent fields (Pierluissi 2006). However, Pierluissi's study took place within an area of SWLA that had an overall high amount of rice acreage, and the study was relatively localized in the overall landscape. Therefore, we assumed King Rails and Purple Gallinules are more likely to be found in areas with a high density of rice agriculture compared to low rice density areas.

For King Rails and Purple Gallinules, we used ditch density, canopy cover, and rice density to determine habitat suitability. We used a 1-km radius for our spatial analysis of canopy cover and ditches, since rails have relatively small territories. We counted any canopy cover >22% of the area as a zero ranking, since these were basically forested areas and none of our points could be placed there. The rest of the canopy cover densities were divided into rankings of 1-3; 3 being the least amount of canopy cover. For the habitat model, we counted both rice and marsh as habitats, and this was calculated with a 5-km radius. Ditch density was calculated as ditch length/km².

**Database files:** ditches/ditches_1kre, Canopy_cov/canop1k_re, Land_cover/rice_mar5kre

Sandhill Cranes (*Grus canadensis*)
Sandhill Cranes were once extirpated from Louisiana, but the state currently has two substantial winter populations. One population near Cheneyville was discovered in 1966 with 17-100 birds (Smith 1978) and another population was discovered in Holmwood in 1980 with 12 birds (Dewhurst and Zwank 1985). Since then populations have expanded to 1,100 in Cheneyville and 670 in Holmwood (McGowan 2003). Sandhills feed in both rice and pasture lands as well as roosting in flooded rice fields in SWLA (McGowan 2003). Pastures are also well known to be preferred habitat for Sandhill Cranes in other regions (Iverson et al. 1987, Nesbitt and Williams 1990, Littlefield 2002). Fallow fields, however, are seldom used (personal communication, Mike Hoff, USFWS).

We modeled Sandhill Crane habitat using pasture and rice density. We used land cover density estimates with a 10-km radius because Sandhill Cranes in SWLA are known to move up to 12.1 km between feeding and resting grounds (McGowan 2003). Validation of the Sandhill Crane model was not possible due to only one population being present within our study area, but radio telemetry locations of cranes fit our model well (Sammy King, unpublished data). Our model also showed a large area of suitable habitat, and Sandhill Cranes in Louisiana may not be numerous enough yet to inhabit these areas.

**Database files:** Land_cover/rice_mar10kre, Land_cover/pasture10kre

**Northern Bobwhite** (*Colinus virginianus*)

Bobwhites in open, agricultural habitats tend to prefer landscapes with a moderate amount of woody edge (30-60 m/ha), row crops (40-70%), grassland (12-25%), and a heterogeneous land cover (Roseberry and Sudkamp 1998). Bobwhites are also known to use fallow fields extensively for nesting (White et al. 2005) and for general habitat use (Taylor et al. 1999), while avoiding the use of cropland (Taylor et al. 1999). Improved pastures in SWLA are
heavily grazed and often contain Bermuda grass, which is structurally poor habitat for Bobwhite (personal communication, Fred Kimmel, LDWF). This situation is similar to Texas, where heavy grazing pressure strongly decreases Bobwhite abundance (Lusk et al. 2002). Therefore, we considered permanent pasture as non-habitat in our model (i.e. pasture density was not a variable). There is some thought that precipitation may be beneficial for Bobwhite during the summer brood-rearing season (personal communication, Fred Kimmel, LDWF), but a recent study in Texas found only a minimal effect (Lusk et al. 2002).

To model Bobwhites, we used fallow rice field density and canopy cover. The home ranges of Bobwhite usually have a diameter of <1000 m (Taylor et al. 1999, Townsend et al. 2003), and habitat characteristics are most correlated with Bobwhite nest sites within a 1-km radius (White et al. 2005). We estimated canopy cover within a 1-km radius, and fallow-shrub density was estimated within a 5-km radius due to our land cover survey design. Canopy cover ≥22% was given a ranking of zero because these areas were forested. The remaining quantiles were ranked 1-3 as follows: 1 = the most canopy cover, 2 = no canopy cover, and 3 = some canopy cover; 3 was generally similar to the recommended 30-60 m of edge per ha (Roseberry and Sudkamp 1998) (Appendix C). Canopy cover was underestimated due to GIS layer errors, so even the "no canopy cover" areas often had sparse canopy cover or tall shrubs.

**Database files:** Land_cover/fall_shrb5kre, Canopy_cov/nobo_cano1kre

**Loggerhead Shrike (Lanius ludovicianus)**

Loggerhead Shrikes use grasslands with heterogeneous heights, including sparsely vegetated areas (Michaels and Cully 1998), and they extensively use pastures in agricultural settings (Gawlik and Bildstein 1990, Smith and Kruse 1992). Although ungrazed pastures may
be preferred (Brooks and Temple 1990, Smith and Kruse 1992), results have also found a preference for grazed pastures over ungrazed grasslands (Gawlik and Bildstein 1990). The second well-known variable known to affect shrike habitat suitability are scattered trees, which shrikes use for hunting perches and nesting (Michaels and Cully 1998). More specifically, the area of pasture and the number of perch sites have been associated with shrike nests, while no preference exists for row crops or hayfields (Esely and Bollinger 2001, Fornes 2004). With these two variables, habitat suitability models have previously been developed for Loggerhead Shrikes (Brooks and Temple 1990, Lauver et al. 2002). In addition, habitat effects have been found at scales of 400 m (Brooks and Temple 1990), 750 m (Novak 1995), 10 ha (Lauver et al. 2002), 25 ha and 50 ha (Brooks and Temple 1990, Fornes 2004); the scale may depend on the variability within the study site (Esely and Bollinger 2001).

We used pasture density and canopy cover as variables in our model. We ranked pasture density within a 5-km radius of a cell to allow for accurate interpolation of land cover data. For canopy cover, we used a 1-km radius to determine canopy density. The canopy cover layer derived by USGS consistently underestimated canopy cover depicted on aerial photographs, so we used the expert opinion of Bill Vermillion (Gulf Coast Joint Venture) to identify the percentage of canopy cover in our GIS layer that best described suitable shrike habitat in relation to aerial photography (Appendix C). Our ranking eliminated all forested areas.

**Database files:** Canopy_cov/nobo_cano1kre, Land_cover/pasture5kre

**Grassland Birds- Henslow's** (*Ammodramus henslowii*) and **Le Conte's Sparrow** (*Ammodramus leconteii*)

Breeding grassland songbirds have been extensively studied, yet winter habitat use of songbirds has received little attention. In Texas, Igl and Ballard (1999) found Le Conte's
Sparrow, Grasshopper Sparrow, Savannah Sparrow, and Eastern Meadowlarks to primarily use grassland and shrub-grassland in winter. Parkland, brushland, and woodlands all had considerably fewer of these grassland songbirds. In particular, Le Conte's Sparrow density (birds/10 ha) was found to be the following in winter: grassland = 9.2, shrub-grass = 11.6, parkland= 2.7, brushland= 3.7, and woodland= 0.4 birds/ha (Igl and Ballard 1999). In Texas coastal prairie, Le Conte's Sparrow was found to be more abundant with medium vegetation density and sparse shrubs (Baldwin et al. 2007).

We developed the grassland songbird model using canopy cover and the land covers classified as fallow rice fields and shrubs. Shrub land cover was classified as land with substantial scattered shrubs (>20% of a field) within a grassland area. Fields with >50% shrubs were further classified as "scrub forest," and were not considered favorable to grassland birds. Similar to Northern Bobwhite, pastures in SWLA are too heavily grazed, and the exotic Bermuda grass provides poor habitat structure for grassland songbirds.

Although there is no direct evidence of habitat area determining winter songbird distribution or abundance, we assumed that more habitat is better for the species in our model. Large grasslands are not needed to avoid nest predators in winter, but birds are likely to be attracted to plentiful food sources and vegetative cover. We used canopy cover as a negative effect in our model since grassland songbirds are less abundant when significant woody cover is present (Igl and Ballard 1999). Fallow-shrub density (5 km) was ranked 1-3. We did not use the zero ranking because fallow or shrub land cover samples were relatively rare and were not always sampled even though they were present in very low densities on the landscape. Canopy cover was rated from 0-3 because extensively forested areas are essentially non-habitat (rank=0).
Canopy cover density was calculated at a 1-km scale since home-ranges of sparrows are usually <10 ha (Bechtoldt and Stouffer 2005, Ginter and Desmond 2005).

**Database files:** Land_cover/fall_shrb5kre, Canopy_cov/canop1kre

**Whooping Crane (Grus americana)**

Road density (meters/km²) at a 5-km scale, pasture density at 10-km scale, and distance from marsh (15,000 m increments) were used to build the Whooping Crane model. Whooping Cranes are likely to use marsh in the winter, but will also visit nearby pastures to feed on grasses, acorns, and invertebrates (Stevenson and Griffith 1946, Chavez-Ramirez et al. 1996). However, prairie restoration with tall grasses and bushes will not likely benefit Whooping Cranes (personal communication, George Archibald, International Crane Foundation). In addition to pasture, it would probably be beneficial for the species to avoid human contact, hunters, and other possible disturbances. Therefore, road density was included as a negative effect on Whooping Crane habitat suitability. We chose the pasture density radius of 10-km, since Sandhill Cranes move >10 km daily (McGowan 2003) and we had no data on Whooping crane movement distances.

**Database files:** Land_cover/pasture_10kre, Roads/roads_5kre, Dist_marsh/dist_mars_re

**Mottled Ducks (Anas fulvigula)**

We concentrated on Mottled Duck breeding season habitat for our habitat suitability model. Rice agriculture and the resulting flooded fields are major foraging habitats and their scarcity is a limiting factor for Mottled Ducks in SWLA (Zwank et al. 1989, Durham and Afton 2006). However, nests are probably not productive within rice fields because of high predator abundances on levees that constitute the only available dry ground. Temporary fallow fields are not used as nest sites (Durham and Afton 2003). Additionally, low Mottled Duck nest success has been found on small, isolated grasslands (Durham and Afton 2003). This is consistent with
other breeding duck (Phillips et al. 2003, Horn et al. 2005) and grassland songbird studies (Herkert et al. 2003), which show that larger grasslands, or a higher percent of grassland on the landscape, have higher nest success compared to smaller, isolated grasslands. For example, Horn et al. (2005) found landscapes with 45-55% grassland had higher nest success than landscapes with only 15-20% grasslands; distance to field edge was also important in areas with a high percentage of grassland (Horn et al. 2005).

Specifically, the Mottled Duck management plan (Wilson 2007) states that blocks of 202-405 ha (500-1000 acres) of grassland are ideal nesting habitat. The ideal habitat mosaic is 405 ha (1,000 acres) of permanent pasture (or grassland) alongside 607 ha (1,500 acres) of rice in an agricultural rotation, which would result in >202 ha (>500 acres) of planted rice during any given year. This ideal landscape is similar to Mottled Duck habitat in Florida, where 1/3 of the preferred prairie habitat is palustrine or lacustrine wetlands (Johnson et al. 1991). Mottled Ducks in Florida also preferred ditch habitat in 4 of 5 years, while avoiding flooded uplands and wet prairies (Johnson et al. 1991). Similar to Florida, Mottled Ducks in Louisiana use canals within marshes when other water is unavailable (Zwank et al. 1989). Ditches and canals are consistently used by Mottled Ducks in the rice region; canals were preferred habitat during May (Zwank et al. 1989). High rainfall in March-August has been positively correlated to Florida Mottled Duck fall age ratios, which supports the notion of higher productivity with more rainfall (Johnson et al. 1984). However, the spatial variability of breeding season rainfall in our study area is low (March-August total precipitation ranges from 69-84 cm or 27-33 inches), and Scott Durham (LDWF) only found a weak correlation between annual rainfall and age ratios in Louisiana Mottled Ducks (in Wilson 2007).
High quality habitat in our model was characterized by a relatively high density of rice fields, pasture, and ditches. We ranked pasture from 1-3 instead of 0-3 because we noted that small amounts of pasture were present where pasture density was calculated to be 0%. Again, this was probably a result of only 13 land cover surveys per density estimate and low pasture densities in the landscape. Plus, as noted above, Mottled Ducks will nest in areas without considerable pasture, even if these nests tend to fail.

**Database files:** Land_cover/rice_mar5kre, Land_cover/pasture_5kre, ditches3k_re

**Little Blue Heron** (*Egretta caerulea*)

Little Blue Herons forage in freshwater ponds, shallow lakes, marshes, inland streams, and the fringes of large bodies of water (Bent 1963). They also use rice fields, crawfish ponds, and ditches in SWLA (personal observation, Bradley Pickens, LSU). Little Blue Herons tend to nest in inland rookeries rather than coastal rookeries, and they nest in colonies of a few birds to over 100 birds (Bent 1963). Few studies have been conducted with Little Blue Herons, so we largely depended on habitat associations of other heron species.

Generally, the locations of wading bird rookeries are associated with nearby foraging habitat (Gibbs 1991, Kelly et al. 2008). In particular, a European tree-nesting heron located rookeries in areas surrounded by abundant rice agriculture (Tourenq et al. 2004). Distances wading birds travel for foraging differ by species, but Bateman (1970) reported a Little Blue Heron traveling 29 km daily and wading birds generally used a 32-km radius around their rookery. Kelly (2008) suggested that foraging habitats up to 10-km from rookeries are important to wading birds, and Huner and Musumeche (1999) found birds to use rice fields within 15-20 km of a nesting site.
For the Little Blue Heron habitat suitability model we used the following variables: distance from known rookery with Little Blue Herons present, rice density, and ditch density. We used recent data on rookery locations and species composition for our habitat model (Green et al. 2006). We ranked the distance to rookery in increments of 15 km.

**Database files:** Land_cover/rice_mar5kre, Rookery/LBHE_rook.shp, Ditches/ditch3k_re

**Migrating Grassland Shorebirds: Buff-breasted Sandpiper (Tryngites subruficollis)**

Upon an initial investigation, Buff-breasted Sandpipers do appear to migrate through Louisiana, but Long-billed Curlews appear to rarely use Louisiana in their regular migratory movements (see Norling et al. 2005; Rachel Villani, personal communication, LSU). Therefore, we disregarded curlews in our model building. To model Buff-breasted Sandpipers, we used canopy cover (3 km) and pasture density (5-km scale) as habitat variables. Buff-breasted Sandpipers use grasslands extensively in their breeding and wintering grounds (Lanctot and Laredo 1994, Isacch et al. 2005), including heavily grazed pastures in South America (Lanctot et al. 2004). Little is known, however, about these birds during migration. Norling et al. (2005) did record 606 Buff-breasted Sandpipers in rice fields in 1998, but 567 of the birds were in Texas where pastures tend to dominate the overall landscape (only birds 39 in Louisiana). To our knowledge, there is no estimate of the population size that migrates through Texas. There is sparse evidence of grasslands being used (Lanctot and Laredo 1994), but we are aware of no studies that have formally quantified habitat use during migration in Louisiana or elsewhere. Other non-breeding shorebirds tend to use pasture vegetation <20 cm in height (Colwell and Dodd 1997), and this discounts the use of fallow fields in SWLA. Canopy cover is likely to be avoided due to avian predators of shorebirds and the visual obstruction imposed by trees.

**Database files:** Canopy_cov/canop_3kre, Land_cover/pasture_5kre
Wintering and Migratory Wetland Shorebirds

Shorebirds are well known to move between inland and coastal areas (Takekawa et al. 2002), so the distance to coastal marsh is probably an important variable for shorebirds wintering in agricultural environments. Marshes are certainly used for foraging and could be very important habitat, although the full extent of its use remains unknown (Botton et al. 1994, Burger et al. 1997). Greater inland shorebird abundances are often associated with years of higher precipitation (Shuford et al. 1998, Taft and Haig 2006b). We infer this precipitation association to result in spatial differences in habitat use with greater numbers of inland shorebirds expected in regions with higher precipitation. Satellite imagery provided by the Gulf Coast Joint Venture office shows a strong tendency for the area north and east of White Lake, LA to have more water on the landscape. This spatial extent generally coincides with the combined rice and precipitation data layers.

Canopy cover is likely to deter shorebird use because it provides habitat for avian predators of shorebirds (Page and Whitacre 1975, Cullen and Robertson 1999, Ydenberg et al. 2004, Pomeroy 2006), although we have not found any direct correlation between shorebirds and canopy cover in the literature. Lastly, rice density is likely to affect shorebirds, since more habitat is likely to attract and support more shorebirds. Taft and Haig (2006a) found that wetland density affected shorebird (Dunlin) abundance, but only in the drier of two years. Very little is known about the spatial distribution of other shorebirds in relation to environmental variables other than local prey densities (Botton et al. 1994, Elias et al. 2000, Placyk and Harrington 2004).

To model winter shorebird habitat, we used canopy cover (3 km), rice density (5 km), precipitation (November-February), and distance from marsh (15 km increments). The scale of our spatial analysis (3-5 km) is similar to other shorebird studies. For instance, Taft and Haig
(2006a) used a 3-km radius and Butler et al. (2002) used a 2-km radius to effectively relate landscape variables to shorebirds. Further evidence of relevant spatial scales are given by Farmer and Parent (1997), who observed that 90% of shorebirds moved <10 km from release sites. Butler et al. (2002) also found Western Sandpipers to move 4-6 km daily. Meanwhile, our study area ranged widely in winter precipitation (Nov.-March: 38-84 cm or 15-33 inches) (Appendix C).

For spring migrating shorebirds, we simply used rice density (5 km) and canopy cover (3 km) in the model. Since shorebirds are moving northward, the distance from marsh is probably irrelevant to these birds. The consistent flooding of rice fields during spring shorebird migration probably negates any precipitation differences.

**Database files: (Winter shorebirds):** Land_cover/rice_mar5kre, Canopy_cov/canop3kre, Dist_marsh/dist_mars_re, Precip/nov_mar_re

**Database files: (Spring shorebirds):** Land_cover/rice_mar5kre, Canopy_cov/canop3kre

**Winter ducks:** Gadwall (*Anas strepera*), Northern Pintails (*Anas acuta*), Blue-winged Teal (*Anas discors*), Green-Winged Teal (*Anas crecca*)

Detailed distribution data and broad-scale habitat use of wintering ducks is generally lacking for our focal species with the exception of the Pintail, which has been the subject of several studies. Therefore, we clumped all the focal species together into a single “winter duck” model.

Wintering ducks, including Teal, Pintail, and Gadwall, often travel away from diurnal locations to forage at night (Paulus 1984, Cox and Afton 1997, Anderson and Smith 1999, Guillemaing et al.2002). For example, Cox and Afton (1996) found Pintails left Lacassine National Wildlife Refuge to forage at night on 198 of 208 occasions (n=108 females). The
distances Pintails traveled also increased later in the winter, and travel distances ranged from 8.7-24.4 km (Cox and Afton 1996). Again, Pintails used more non-refuge areas nocturnally compared to refuges (coastal marsh), while diurnal use of refuges was dependent on hunting seasons (Cox and Afton 1997). Similarly, in the Pacific Northwest, American Widgeon and Pintails moved a maximum of 6 km from coastal to farmland habitats, and use of coastal marsh was much higher in the vicinity of farmlands (Lovvorn and Baldwin 1996).

Cox and Afton (1997) found that wintering Pintails in Louisiana used agricultural areas (rice/fallow/pasture) from 67.6% to 92.7% of total nocturnal locations. Both rice and fallow/pastures were used extensively nocturnally, and use of these habitats appeared to be tied to whether rice or fallow/pastures were more abundant on the landscape (Cox and Afton 1997). In Louisiana, Pintails tend to move to coastal areas, then move to agricultural fields during November and December when fields are wetter (Cox and Afton 2000). Supporting this generality, other research has shown that Pintails select for flooded fields when they are available, but use marsh when agricultural lands are drier (Ji and Jeske 2000, Fleskes et al. 2003). The available food supply for Pintails is generally thought to be greater in interior agricultural lands when these habitats are available (Ballard et al. 2004), but marsh food supplies may also influence interior habitat use (Lovvorn and Baldwin 1996).

For the winter duck habitat suitability model we used rice/fallow rice density, distance from marsh (15 km increments), and winter precipitation (Nov-March) as variables. Rice and fallow rice field density on the landscape represent interior habitat available for winter ducks. Our distance to marsh ranking takes into account the flexibility of feeding behaviors and seasonal movements of winter ducks. Spatial differences in rainfall influence which fields are flooded and which fields remain dry. There were remarkable differences in winter precipitation
within SWLA, with the eastern and southern portions of our study area receiving much more precipitation (Appendix C).

**Database files:** Land_cover/fallrice_5kre, Dist_marsh/dist_mars_re, Precip/nov_mar_re
Chapter IV: Other Considerations for Ranking Habitat for Coastal Prairie Restoration

In our study, we examined additional data and maps not directly related to bird habitat suitability (Appendix B). First, we obtained data from the U.S. Census Bureau (2000) and converted it to show population density within our study area. This data layer can be useful for identifying areas under threat from urban development. Secondly, we used state LIDAR (light detection and ranging) data and calculated the standard deviation of elevation within a 3-km radius of a cell. Although the LIDAR data may be accurate to within 0.3 to 0.6 m (1-2 feet), errors in relative elevation remain undocumented. Nonetheless, we were able to show areas in the region that appear to have maintained at least some elevation heterogeneity. Elevation heterogeneity can be useful for identifying areas for restoration that can sustain a diverse assemblage of coastal prairie plants and habitats. Thirdly, we used the study of Ramsey et al. (2005) to rank the risk of Chinese Tallow invasion according to its relative abundance in broad habitat classes. We calculated Tallow risk within a 3-km radius of each cell, and this map basically reflects the fact that Chinese Tallow is most abundant in riparian habitats, although the species is also common in agricultural land. Further research may be needed to determine if specific soil types within agricultural lands are especially susceptible to Chinese Tallow invasion.

Lastly, we ranked SWLA according to distance from coastal prairie remnants. This ranking should be considered if a goal is to build upon, or in the vicinity of, existing prairie remnants. For instance, this strategy may ease management costs and logistical constraints as well as assist with maintaining the genetic integrity and viability of native plant species. Of course, the gene flow and connectivity of plant populations depends on pollinators, wind, dispersal mechanisms, and the landscape configuration. In fact, if gene flow is the primary
motivation for restoring coastal prairie in the vicinity of remnants, all remnants should be considered and restored prairie should be within 800 m of coastal prairie (personal communication, Larry Allain, USGS) (Appendix B). For other purposes (i.e. management), we also developed a map using only the “major prairie remnants” (Appendix B). We defined major prairie remnants as being greater than 13 ha (>32 acres), since all other remnants were very small (<4 ha or <10 acres). We then used the 0 to 5 ranking system to classify the distance from major prairie remnants at equal, 10,000 m, intervals.
Chapter V: Validation of Models

Validation of King Rail Model

Methods

To validate our King Rail habitat suitability model, we performed a series of roadside call-back surveys of breeding King Rails in our study area. We selected King Rail survey locations in Louisiana by randomly plotting points in our study area (ESRI, ArcMap 8.01) and then driving transects until 10 points in rice fields were recorded at 1500 m intervals or until the next nearest rice field. We chose survey points spaced by >1500 m to ensure that survey points were independent of each other, and this is well beyond the suggested minimum of 400 m for marsh birds (Conway 2008). Transects were driven in a pre-determined direction, but often became irregular due to road orientation and the placement of active rice fields. Due to low rice field density and accessibility, two transects were combined and one transect only had seven points. In 2007, we placed 30 points north and 30 points south of Interstate-10, which divided the study area. In 2008, we plotted 5 random transects in our study area, but had difficulty placing 2 additional transects due to low rice field densities. Since we also lacked surveys in our highest suitability classes, we placed the final 2 transects in general areas of high suitability according to our model. All 2008 transects were located >10 km from 2007 survey points to maximize the distribution of survey points. In addition, survey points in Texas (n=17) were determined from examining the Texas King Rail habitat suitability model and concentrating survey efforts in general areas of expected high suitability. Since we only had one day available to perform surveys in Texas, this strategy was needed to efficiently locate rice fields and determine if King Rails were present in the Texas region.
All surveys were conducted from 30 minutes before sunrise until 1000 a.m., however, surveys were often completed by 0930 a.m. We also reversed the order of survey points along each transect to minimize any time of day effect. In 2007, we performed three rounds of surveys at each of the 60 points. Surveys were performed on June 12-13, June 21-23, and June 28-29. In June 2008, 3 surveys were conducted at each point with 3-7 days between surveys.

We used the standardized marsh bird surveying protocol (Conway and Timmermans 2005). Upon reaching a survey point, we surveyed one pre-determined side of a rice field by auditory and visual observation for 5 minutes during a passive period. We then used a portable CD/MP3 player and 80-90 decibel speakers (at 1 m) to play 30 seconds of marsh bird calls followed by 30 seconds of silence. Songs of American Bittern, King Rail, Purple Gallinule, and King Rail (2nd call-back) were played in their respective order. Approximate distances to birds were recorded to the nearest 10 m.

Analysis

We used SAS version 9.1 (SAS Institute 2004) for all data analyses. Since we had an equal survey effort at all locations, we simply classified KingRails as present or absent at each survey location. We performed a logistic regression (0 or 1 for each survey location) using year as a covariate and the King Rail habitat suitability index as the main effect. As part of our analysis of King Rail distributions in Louisiana, we also used a Moran's I test to examine if the distribution was clumped or random (Fortin and Dale 2005). A clumped distribution could indicate birds are responding to larger spatial scales than we expected, or the behavioral ecology of King Rails may require multiple individuals within a close proximity to each other. For example, mating systems, such as leks or polyandry, require a small population instead of
isolated pairs. Due to a small sample size, we did not perform statistics on Texas King Rail survey data.

Survey points were located exclusively in rice fields, and logistically, we had difficulty placing survey points in areas with sparse rice fields. Therefore, we tested the possibility that our survey points were already biased towards areas we expected to have high King Rail suitability. To do this, we placed 112 random points over our HSI map, which was the maximum number of points that could be placed with >5 km between points. We then examined the rankings (0-3) of rice density, ditch density, canopy cover, and the habitat suitability index (HSI) at the random points and compared them with the rankings at all of our survey locations. We discarded any random points that landed in forested, riparian areas.

Results

We recorded 37 King Rail presences and 91 absences in both years combined. King Rails were observed in 21% of survey points in 2007 and 35% of the points in 2008. We found the King Rail habitat suitability index (HSI) was positively related to King Rail presence (Wald chi-square= 8.3, p<0.005). The relationship between presence/absence and the HSI was linear (Figure 2). Meanwhile, year had no effect on King Rail presence (Wald chi-square= 3.5, P=0.06). In our single survey effort in Texas, we had 7 King Rail presences in 14 survey locations.

The Moran's I test (Z score =3.56, p<0.05) found King Rail presence locations to be clumped. Basically, this result indicated that if a survey point had a King Rail present, nearby survey points were more likely to have King Rails present compared to random chance. We also found our survey locations were in areas with higher habitat suitability in comparison to random points. Compared to random points, our results showed that the survey locations had a higher
habitat suitability index (mean ± SE) (2.75 ± 0.11 vs. 1.96 ± 0.13; t-statistic=4.77, df=240, p<0.0001), less canopy cover (2.48 ± 0.07 vs. 1.84 ± 0.10, t-statistic = 5.46, df=240, p<0.0001), and more rice (2.24 ± 0.06 vs. 1.81 ± 0.08, t-statistic = 4.61, df=240, p<0.0001). However, there was no difference between ditch densities (1.81 ± 0.08 vs. 1.84 ± 0.07, t-statistic = -0.29, df=240, p=0.78).

**Discussion**

Our results showed that our model worked well at predicting King Rail presence in SWLA and provides further support for our modeling process. Essentially, we used the King Rail habitat associations discovered by Pierluissi and King (2008) to extrapolate King Rail presence to the entire coastal prairie/rice region of SWLA. In addition to these known habitat associations, we also assumed that rice field density was related to King Rail presence. This validation data is critical because it provides support for our ability to take known habitat associations discovered by localized field studies and convert these variables (e.g. canopy cover, ditches) into readily available GIS data for a much larger study area.

Unfortunately, we had difficulty placing survey points in areas with a low rice field density. This difficulty limited are ability to discern if the density of rice fields is correlated with King Rail presence. Ditch length and canopy cover could be estimated at any spatial scale above 30 m, but land cover estimates were restricted to a 5-km scale. The advantage of using a 5-km scale is that our rice density ranking is probably reliable over the long-term. For instance, farmers can rotate their crops within this radius and no change in rice acreage will have occurred. The broad ranking system we used is also likely to be robust to small changes in agricultural practices (Appendix C). Based on our validation results and our failed attempts to place survey points in predicted areas of low rice density, the land cover estimation we developed from 2004
aerial photography appeared to work well. Of course, our model could be improved by examining long-term changes in rice field density on the landscape. This could also lead to more refined land cover estimates; however, this assumes that the current conditions for rice growing persist.

We only collected exploratory data in Texas rice fields, but we found a high number of King Rails per survey point (7 King Rail presences in 14 points). These presence locations also corresponded well to our HSI (personal observation). In fact, our model was valuable for locating rice fields in Texas because our suitability index coincided well with rice field locations in a pasture-dominated landscape. Due to numerous private roads and large tracts of land, we strongly recommend that future researchers contact private landowners where surveys can be performed.

The connection of our King Rail habitat suitability model to data on King Rail presence in SWLA is very important for identifying critical rice habitat and estimating the number of breeding King Rails in Louisiana. This information can also be used to identify the impact of various land use scenarios. However, the presence of a species is not always indicative of successful reproduction. Therefore, the next steps to understanding how our King Rail habitat suitability model predicts high quality habitat is to perform long-term monitoring and/or to determine the rate of reproductive success (e.g. fledglings) in different parts of SWLA. Our King Rail habitat suitability model provides a framework and spatial scale for such research to be performed.
Figure 2. The relationship between the King Rail HSI and the percent of survey points with King Rails present in Louisiana during 2007 and 2008. The sample size for each cohort is noted above each bar.

Validation of Migrating and Wintering Shorebirds

Methods

To validate our shorebird habitat suitability indices, we used data from a 2-year study performed by Wayne Norling, Clint Jeske, and Paul Chadwick (USGS National Wetlands Research Center) in the winter and spring months of 1996-97 and 1997-98 (Norling et al. 2005).
Thirty randomly selected roadside survey routes were located within our study area. Rice fields and fields in rotation with rice were selected for intensive surveys. At least six rice fields and six fields in rotation with rice were surveyed about every 2 weeks along each route. The area of each field (ha) was calculated from aerial photography; only the areas that could be viewed from roadsides were included in these estimates (i.e. the area beyond visual obstructions was not included). We divided the survey seasons into "wintering" shorebirds (November-February) and "spring migratory" shorebirds (March-May). We eliminated resident and short-distance migratory shorebirds from the analysis (Killdeer, Black-necked Stilts, and Willets), since we were only interested in long-distance migratory shorebirds.

**Analysis**

Since repeated surveys were performed, we used the mean density of shorebirds and total species richness per survey route in our analyses. Exact GPS locations were unavailable, but we approximated survey points from available maps of the points. To simplify our abundance analysis, we clumped the small, difficult to identify sandpipers into a single class called "peeps." We used non-parametric tests to analyze the abundance data because the residuals were not normally distributed and to limit the influence of outliers, which are common with congregating wintering birds. Spearman rank correlations were used to determine whether the diversity and abundance of species was correlated with habitat suitability indices. Since the number of survey fields and their sizes differed, we used the hectares of each survey route to calculate the density of shorebirds on each transect (mean birds/ha). The exact locations of individual surveys were not recorded in the field. Thus, the habitat suitability indices of survey routes were estimated by creating a 3-km buffer around each transect centroid and the mean HSI value was computed within this area.
Results

Winter Shorebirds

According to precipitation data from Abbeville, LA, the winter of 1996-97 (November-Feb.) was near the long-term average (+2.5 cm), but 1997-98 was considerably above normal (+22.8 cm). Winter shorebird abundance changed dramatically between years. In year one (1996-97), 4669 shorebirds (1.5 ± 0.31 birds/ha) were counted, whereas 10871 (3.0 ±0.61 birds/ha) were counted in year 2. Nine species were recorded in year 1, and 16 species were recorded in year 2 (1997-98).

We also did not perform abundance analysis on species present at <3 sites. In year 1, we found the abundance of Lesser Yellowlegs, Dowitchers, and peeps were positively related to the habitat suitability index (Table 4). Meanwhile, Greater Yellowlegs and Black-bellied Plover abundance was not related to the index. In year 2, we found Black-bellied Plover abundance was positively related to the habitat suitability index (Table 5). Meanwhile, Greater & Lesser Yellowlegs, Dowitchers, and peeps were not related to the index.

The winter shorebird habitat suitability index was positively related to species richness in year 1 (n=30, r=0.50, p=0.005) and in year 2 (n=30, r=0.34, p=0.07). Species richness was not related to hectares of rice fields surveyed in year 1 (n=30, r=0.18, p=0.33) or year 2 (n=30, r=0.09, p=0.63). Annual differences in species richness may be attributed to the first year being a trial year for the study, and the "peep" sandpipers were more likely to be identified to species in the second year (5 of the 7 species absent in year 1 were peeps).
Table 4. Year 1 (1996-1997). Spearmen rank correlations between shorebird abundance and the winter shorebird habitat suitability index. * indicates a significant relationship ($\alpha = 0.05$)

<table>
<thead>
<tr>
<th>Species</th>
<th>R-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesser Yellowlegs*</td>
<td>0.42</td>
<td>0.02</td>
</tr>
<tr>
<td>Greater Yellowlegs</td>
<td>-0.05</td>
<td>0.80</td>
</tr>
<tr>
<td>Dowitchers*</td>
<td>0.37</td>
<td>0.04</td>
</tr>
<tr>
<td>Peeps*</td>
<td>0.39</td>
<td>0.03</td>
</tr>
<tr>
<td>Black-bellied Plovers</td>
<td>0.33</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Table 5. Year 2 (1997-1998). Spearmen rank correlations between shorebird abundance and the winter shorebird habitat suitability index; * indicates a significant relationship ($\alpha = 0.05$)

<table>
<thead>
<tr>
<th>Species</th>
<th>R-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesser Yellowlegs</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>Greater Yellowlegs</td>
<td>-0.03</td>
<td>0.86</td>
</tr>
<tr>
<td>Dowitchers</td>
<td>0.35</td>
<td>0.06</td>
</tr>
<tr>
<td>Peeps</td>
<td>0.34</td>
<td>0.06</td>
</tr>
<tr>
<td>Black-bellied Plovers*</td>
<td>0.55</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Spring Migratory Shorebirds

In the first spring, 2183 migrating shorebirds were recorded and 2300 shorebirds were recorded in the second spring. Spring migratory shorebird abundances did not differ between
year 1 and year 2 (year 1 = 9.3 ± 1.8 birds/ha, year 2 = 8.5 ± 1.1 birds/ha), so we analyzed both years together.

For spring migratory shorebirds, only Dowitcher and Hudsonian Godwit abundance was positively associated with the habitat suitability index (Table 6). Species richness was positively related to the HSI (r=0.40, p=0.03), and species richness was not related to hectares surveyed (r=-0.21, p=0.26).

Table 6. Relationship between spring migratory shorebird habitat suitability index and spring migratory shorebird abundance; * indicates a significant relationship (α= 0.05)

<table>
<thead>
<tr>
<th>Species</th>
<th>R-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesser Yellowlegs</td>
<td>-0.01</td>
<td>0.96</td>
</tr>
<tr>
<td>Greater Yellowlegs</td>
<td>-0.11</td>
<td>0.57</td>
</tr>
<tr>
<td>Dowitchers*</td>
<td>0.60</td>
<td>0.0004</td>
</tr>
<tr>
<td>Peeps</td>
<td>0.33</td>
<td>0.08</td>
</tr>
<tr>
<td>Black-bellied Plovers</td>
<td>0.05</td>
<td>0.77</td>
</tr>
<tr>
<td>Hudsonian Godwit*</td>
<td>0.36</td>
<td>0.049</td>
</tr>
<tr>
<td>Ruddy Turnstone</td>
<td>0.06</td>
<td>0.74</td>
</tr>
<tr>
<td>Dunlin</td>
<td>0.30</td>
<td>0.10</td>
</tr>
<tr>
<td>Semi-palmated Plover</td>
<td>0.22</td>
<td>0.25</td>
</tr>
<tr>
<td>Whimbrel</td>
<td>-0.02</td>
<td>0.91</td>
</tr>
</tbody>
</table>

Discussion

Our habitat suitability models for winter and spring migratory shorebirds had mixed success at predicting shorebird abundances in 1996-1998. Similar to other shorebird studies,
winter shorebird abundance in SWLA agricultural habitat increased substantially in a year with relatively high precipitation. Our analysis found that winter shorebird species richness was positively correlated to our HSI in both years. However, the model predicted abundances better in the first year when precipitation was near normal. In 1997-98, high amounts of precipitation probably made water less limiting on the agricultural landscape. Therefore, birds were not concentrated in the areas that we predicted. For example, we predicted birds to be attracted to areas of relatively high winter rainfall because of increased wet habitats. However, if rainfall is generally high in a given year, moist soil and shallow water habitats are likely to be plentiful over the entire the landscape. The result is likely to be a lack of broad-scale habitat selection for shorebirds (e.g. Taft and Haig 2006). The spring migratory shorebirds were consistent in their yearly abundance, and our spring shorebird model explained a similar amount of variance compared to the winter HSI.

A few species abundances were well correlated to our HSI models, especially the Dowitchers and peeps. Although the amount of variation our models explained was relatively low, these broad-scale relationships are a beginning to a more thorough understanding of the spatial relationships of shorebirds in SWLA. Certainly, species specific differences may exist, but not enough information is currently available to model such differences. In addition, the use of marsh by shorebirds is poorly understood and marsh habitat use may affect the location of agricultural habitat use. Our validation results were also limited to approximate locations of bird surveys because specific GPS locations were unavailable. The maps we used to locate survey locations were likely prone to errors of unknown magnitude. Another source of error could be the time lag from the surveys to our land cover estimation using 2004 aerial photography and canopy cover from 2001 satellite data.
Validation of Northern Bobwhites

To validate the Bobwhite model, we compared points where bobwhites were known to be present to random points, which are assumed to be absent locations (see Chefaoui and Lobo 2008). This methodology is useful when true absent locations are unknown. We combined all presence locations recorded by the Louisiana Department of Wildlife and Fisheries in the last 5 years (unpublished data) and our own Bobwhite locations that were recorded during June King Rail surveys in 2007-2008. The results equaled 31 Bobwhite locations. We used ArcGIS to plot 31 random locations within the minimum convex polygon of our Bobwhite surveys. We also deleted any random location that was surrounded by forest, since this was never considered potential habitat.

Results

A logistic regression found that Bobwhite presence was positively associated with the Bobwhite habitat suitability index (df=1, Wald chi-square=6.9, p=0.009). The mean HSI for present locations was 3.26 ± 0.20 SE and the HSI for absent (random) locations was 2.35 ± 0.23 SE.

Discussion

The HSI worked well at distinguishing present and absent locations of Bobwhites. In particular, the area near Mamou, Louisiana (Evangeline Parish) had eight of the Bobwhite locations, and this corresponded with one of the largest areas with an HSI value of 5. Another transect in north Jefferson Davis Parish had 5 presence locations, and both of these areas had a high density of fallow fields according to our aerial photography analysis. Meanwhile, Evangeline Parish had canopy cover rankings of 2 and 3, while the Jefferson Davis transect had rankings of 2. The other survey transects showed a relatively low density of Bobwhites.
The 2001 USGS canopy cover data certainly underestimated canopy cover that was represented on the 2004 aerial photography. This is probably due to remote sensing errors and successional processes that can quickly change habitat. For example, we found one particular area to be open according to the canopy cover data, but an observation found the area to be covered with Chinese Tallow in 2008. There is currently no accurate data available to precisely assess shrub cover, and narrow, linear hedgerows appear to be poorly represented in the USGS canopy cover data layer. Of course, it is possible that the scattered trees shown in the canopy cover data are correlated with early successional habitat or hedgerows. However, improving the quality of this data would greatly enhance our ability to discriminate Bobwhite habitat. Nonetheless, our model did tend to describe the best Bobwhite habitat according to the validation data currently available.
Chapter VI: Integrating Habitat Suitability Models for Conservation Planning: An example

Conservation planning for SWLA can be developed from any combination of the habitat suitability indices we have developed, and we encourage interested agencies and individuals to use this information. However, our objective here is to make inferences about the habitat models as a whole, and to examine how the overall grassland and wetland bird habitat may interact in the region.

In this regard, we used a Principal Components Analysis (PCA) to converge all grassland bird models and all wetland bird models into two maps. PCA analyses are often used to reduce the number of variables and to identify simpler, latent variables. For example, a single latent variable of alligator “body size” may be determined from measurements of head width, body length, body width, and weight. The “body size” value then represents the best correlation of all the measurements.

The result of our map-based PCA analysis (the 1st PCA eigenvector) can be used to show where grassland or wetland bird models are correlated. Our overall wetland bird model included the areas with the highest combined suitability for Little Blue Herons, King Rails, spring migrating shorebirds, wintering shorebirds, wintering ducks, Sandhill Cranes, and Mottled Ducks. The grassland bird model identified the area best suited for the overall combination of grassland songbirds, Bobwhite, Loggerhead Shrike, and Buff-breasted Sandpiper. It is important to note that the PCA analysis weighs each habitat suitability model equally in the final, overall map, and it is not meant to reflect particular species. We used the Sandhill Crane and Mottled Duck in the wetland bird model because a balance of rice wetlands and pastures are required for these species, and we wanted to ensure the conservation of their current high quality habitats. In
essence, the wetland bird model depicts where rice should be maintained or promoted and the grassland bird model shows where additional grassland can be most beneficial. We did not use the Whooping Crane index in a PCA model because we did not include a wetland component in the model, and yet we are aware that this is a possibly important component.

**Results**

The results show that most models within the grassland bird and wetland bird categories were well correlated (Table 6). For example, the Bobwhite and grassland songbird (Le Conte’s Sparrow/Henslow’s Sparrow) models were highly correlated ($r=0.85$) and both were well correlated with the overall grassland bird PCA map ($r=0.85$ and $r=0.82$). This has strong implications because the addition of coastal prairie to these particular high quality areas (e.g. HSI values of $>4$) will likely benefit both grassland bird guilds.

The overall wetland bird PCA model also represented species well. The one exception was the Sandhill Crane ($r=0.44$ correlated with the PCA map). This is likely because pasture density was a major part of the model, and this was incompatible with other wetland bird habitat. All other habitat models were represented well in the PCA map ($r >0.70$), and this means targeting habitat for one particular wetland bird species will also conserve other wetland birds.

**Discussion**

The results of our PCA analyses are valuable because they show multi-species conservation is very much possible in the rice/coastal prairie region of SWLA. Each of our habitat models were developed independently of other species models. In other words, scientific literature and expert opinions always guided our variable selection for individual models. The only variable that we were unable to obtain was a GIS layer of crawfish pond density in region. Therefore, our model correlations were not due to a limited supply of GIS layers. Instead,
evidence suggests two simple conclusions. First, wetland birds were related to water on the landscape. Whether it was winter precipitation, length of ditches, distance to marsh, or rice, water was a common theme in our habitat models. These water-related variables were at least partially correlated with each other. Secondly, the opposite effect appeared to occur with grassland birds. We hypothesize that the lack of water in particular areas produced more fallow fields and pastures that were associated with our grassland bird models. These findings show the importance of managing for grassland and wetland bird habitats in the appropriate spatial locations within the coastal prairie region of SWLA.
Table 6. Correlation matrices for all habitat suitability indices and the overall Principal Components Analysis (PCA) maps for grassland and wetland birds.

<table>
<thead>
<tr>
<th>Habitat Suitability Index</th>
<th>Grassland Bird PCA Map</th>
<th>Bobwhite</th>
<th>Buff-breasted Sandpiper</th>
<th>Grassland Songbirds</th>
<th>Loggerhead Shrike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassland Bird PCA Map</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bobwhite</td>
<td>0.85</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buff-breasted Sandpiper</td>
<td>0.70</td>
<td>0.36</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grassland Songbirds</td>
<td>0.82</td>
<td>0.85</td>
<td>0.50</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Loggerhead Shrike</td>
<td>0.79</td>
<td>0.58</td>
<td>0.70</td>
<td>0.45</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat Suitability Index</th>
<th>Wetland Bird PCA map</th>
<th>Mottled Duck</th>
<th>Spring Shorebirds</th>
<th>Winter Ducks</th>
<th>Winter Shorebirds</th>
<th>King Rail</th>
<th>Little Blue Heron</th>
<th>Sandhill Crane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland Bird PCA Map</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mottled Duck</td>
<td>0.70</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring Shorebirds</td>
<td>0.84</td>
<td>0.62</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter Ducks</td>
<td>0.76</td>
<td>0.41</td>
<td>0.54</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter Shorebirds</td>
<td>0.89</td>
<td>0.57</td>
<td>0.77</td>
<td>0.71</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>King Rail</td>
<td>0.77</td>
<td>0.59</td>
<td>0.81</td>
<td>0.48</td>
<td>0.72</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Blue Heron</td>
<td>0.82</td>
<td>0.68</td>
<td>0.68</td>
<td>0.69</td>
<td>0.76</td>
<td>0.66</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Sandhill Crane</td>
<td>0.44</td>
<td>0.33</td>
<td>0.31</td>
<td>0.27</td>
<td>0.35</td>
<td>0.19</td>
<td>0.24</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Chapter VII: Stakeholders and Landowners in the Region

Landowner Data

Understanding land ownership patterns can assist with the implementation of conservation programs in SWLA. Parish tax assessors are the primary source of this information, but in most cases data is only available in a bulky, hard copy formats (with the exception of Acadia Parish). In addition, the hard copies documenting land ownership are only linked to large, hard copy aerial photography that cannot be readily scanned. These data availability limitations mean that any effort to accumulate contact information for landowners that are eligible for conservation programs must be developed efficiently and pragmatically. Efficiency could maximized by restricting landowner contacts to those with a minimum area of land ownership, specifying particular locations within a Parish, and other criteria derived to meet the goals of a specific conservation program. Imposing such limitations on gathering contact information also makes sense because a massive time and effort is also required to contact individuals via phone, letter, or in person.

The one exception to this data limitation is Acadia Parish, which has ArcGIS data readily available. Therefore, we examined Acadia Parish landowner data to provide some general insights about land ownership patterns in SWLA. These patterns should facilitate the use of land ownership data for conservation programs in SWLA. We found 40,067 landowners in Acadia Parish and calculated the frequency distribution of landowners according to the amount of land they owned (Table 7).
Table 7. The frequency distribution of landowners in Acadia Parish, Louisiana according to the amount of land they own.

<table>
<thead>
<tr>
<th>Hectares under ownership</th>
<th>Acres under ownership</th>
<th>Cumulative people</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥810</td>
<td>≥ 2000</td>
<td>2</td>
</tr>
<tr>
<td>≥405</td>
<td>≥1000</td>
<td>3</td>
</tr>
<tr>
<td>≥364</td>
<td>≥900</td>
<td>5</td>
</tr>
<tr>
<td>≥324</td>
<td>≥800</td>
<td>8</td>
</tr>
<tr>
<td>≥283</td>
<td>≥700</td>
<td>13</td>
</tr>
<tr>
<td>≥243</td>
<td>≥600</td>
<td>28</td>
</tr>
<tr>
<td>≥202</td>
<td>≥500</td>
<td>49</td>
</tr>
<tr>
<td>≥162</td>
<td>≥400</td>
<td>83</td>
</tr>
<tr>
<td>≥121</td>
<td>≥300</td>
<td>158</td>
</tr>
<tr>
<td>≥81</td>
<td>≥200</td>
<td>297</td>
</tr>
<tr>
<td>≥40</td>
<td>≥100</td>
<td>941</td>
</tr>
<tr>
<td>≥20</td>
<td>≥50</td>
<td>1964</td>
</tr>
<tr>
<td>&gt;0</td>
<td>&gt;0</td>
<td>40067</td>
</tr>
</tbody>
</table>

Based on these results, we collected landowner data for several Parishes that were high on our priority list for grassland restoration and were located within the proposed CREP area. The data consists of addresses of landowners with greater than 40 or 80 ha (100 or 200 acres) of land, which depended on the number of potential landowners in the particular region. For example, Acadia Parish (above) had 941 people with ≥100 acres, but only 297 people owned land over ≥200 acres. Since contacting 941 people in a single Parish would be unlikely, we would recommend being efficient and contacting fewer people with ≥200 acres of land. Of course, the logistics of such an operation and the concerns of a particular agency would control how many landowners are contacted and where land is targeted for a conservation program.
Meetings

Brad Pickens met with members of the Cajun Prairie Society in April 2007 and examined current remnant coastal prairie and restoration areas. Brad published a 2-page note in the Cajun Prairie Society newsletter in May 2008. Dan Weber (The Nature Conservancy) co-authored this note, and we described the proposed CREP program and its potential effects. The note also included a thorough description of how our bird research can assist both grassland and wetland bird conservation planning. (available on the Cajun Prairie Society web page: www.cajunprairie.org/newsletters/200804.doc)

Our core working group included Bill Vermillion (Gulf Coast Joint Venture), Latimore Smith (The Nature Conservancy), Richard Martin (The Nature Conservancy), Larry Allain (USGS), Sammy King (USGS Louisiana Fish & Wildlife Research Unit), and Bradley Pickens (LSU AgCenter). Our group met consistently, and Brad Pickens met individually with many members of the core working group as well as other agency personnel with a vested interest in the region (e.g. Ducks Unlimited, Louisiana Department of Wildlife and Fisheries). These meetings assessed on-going needs of the agencies and allowed Brad to present habitat models and other data . We also obtained available data along with expert opinions on our models. For example, we met with Fred Kimmel (LDWF), Larry Reynolds (LDWF), Scott Durham (LDWF), Clint Jeske (USGS), Wayne Norling (USGS), Michael Brasher (Gulf Coast Joint Venture/Ducks Unlimited), and Barry Wilson (Gulf Coast Joint Venture/USGS) to discuss our project. We also received valuable input from these individuals. For example, we decided that a habitat map for Mottled Ducks should be displayed by high pasture density areas and high density rice/ditches areas to allow for a better understanding of habitat needs in the region. These maps will assist in identifying which factors may be limiting Mottled Ducks in particular areas.
At various times, our larger group meetings also included Bob Dew (Ducks Unlimited), Michael Brasher (Gulf Coast Joint Venture/Ducks Unlimited), and Barry Wilson (USGS/Gulf Coast Joint Venture). During our larger meetings, we presented detailed information on GIS model development for each species or species group. This allowed us to consider critiques of our models and make adjustments as deemed suitable by the group. We also initiated a conversation of how to best compile our final results into two final prioritization maps.

After completing an overall analysis of the region, we met with individuals from our core working group to discuss possible prairie restoration scenarios. These scenarios were meant to consider agency interests and to maximize benefits to grassland birds while minimizing negative impacts to rice-dependent wetland birds. The result of these meetings was a general consensus of two areas that are best suited for grassland birds (Evangeline Parish and Calcasieu Parish) and one other possible area that had a slightly higher value for grassland birds compared to wetland birds (north Jefferson Davis Parish). We obtained hard copy landowner data for these specific areas and distributed them to The Nature Conservancy.

Brad Pickens presented a research poster at the 2008 Rice Research Station Field Day Poster Session in Crowley, LA. In addition, we presented a talk at the Waterbirds Society conference in Texas in the fall of 2008. We had a larger stakeholder meeting in the fall of 2008. This meeting included an emphasis on both grassland and wetland areas where programs to assist farmers may be implemented to help bird populations. The stakeholder meeting was attended by several representatives from USGS, Gulf Coast Joint Venture, LSU AgCenter rice research station, The Crawfish Association, Ducks Unlimited, Natural Resources Conservation Service, National Audubon Society, and Louisiana Department of Wildlife and Fisheries. We presented our work with this project and had a discussion on possible directions to proceed.
Chapter VIII: Conclusions

Our study has shown that the SWLA rice region has considerable variation in its environmental variables. While other multi-species studies have looked at broad land cover classifications, our study examined an intermediate spatial scale. The coastal prairie/rice region does have distinct differences in ditch density, winter precipitation, canopy cover, land cover densities (e.g. rice, pasture, fallow rice), and other variables that affect the habitat suitability of bird species.

Several research and data needs have been made evident due to our research. A few GIS layers are simply unavailable, and these data layers could improve future modeling efforts. For example, we have no data on the density of crawfish ponds within SWLA. The LSU AgCenter has developed such a data layer for Acadia Parish, but there appears to be no other data available at this time. If this data were available, wading bird, fall migrating shorebirds, and Whooping Crane habitat models could be further developed. Our canopy cover layer could also be improved and refined to identify shrubs and hedge rows for Bobwhites.

We only performed aerial photography surveys for 2004, and we estimated the land cover densities from these results. The broad rankings (0-3) we used in our study were aimed at accounting for some of the annual variability in land cover (i.e. a ranking of 1-10 would have assumed that we could accurately distinguish 10 classes and the classes are consistent in each year). The 0-3 ranking system meant that major changes would have to occur to make our ranking inaccurate. However, if precise land cover mapping were performed for several years, we could improve our models with more precise land cover estimates.

We validated our models by examining the presence or abundance of species whenever possible. There is no doubt that more distribution data would assist in validating many of our...
models, and we have provided a scale of performing such work. For example, Rachel Villani (M.S. student, LSU) is collecting spring migratory shorebird data to test our habitat model. However, research on demography is also critical to our understanding of the SWLA ecosystem and its bird species. More survival and reproductive studies need to be performed for species such as Mottled Duck and King Rail. For instance, Mottled Duck nests were found to have low nest success in one part of SWLA (Durham and Afton 2003). Our habitat model showed that these nests were in an area of high rice field and ditch density, but had few pastures. Therefore, we hypothesize that nest success was low because there was not enough grassland in the landscape. Of course, localized management practices will also influence habitat use of species.

To validate and refine more habitat models, we highly recommend the reporting of spatial locations (GPS coordinates) of bird surveys and of presence locations for birds of conservation concern. Future research should consider the environmental variability in SWLA and explicitly state research limitations and possible variation within the SWLA landscape.
Appendix A- Habitat Suitability Maps- Correlation of All Wetland Birds (Principal Component Analysis- Axis 1)
Appendix A- Habitat Suitability Maps- Correlation of All Grassland Birds (Principal Component Analysis- Axis 1)
Appendix A- Habitat Suitability Maps- Grassland Songbirds
Appendix A- Habitat Suitability Maps- King Rail in Louisiana; Black circles represent KIRA absent locations; green circles represent KIRA present locations in 2007-2008 surveys

King Rail HSI

- 0
- 1
- 2
- 3
- 4
- 5

0 5 10 20 20 Kilometers
Appendix A- Habitat Suitability Maps- King Rail in Texas
Appendix A- Habitat Suitability Maps- Little Blue Heron
Appendix A- Habitat Suitability Maps- Loggerhead Shrike
Appendix A- Habitat Suitability Maps- Mottled Duck; Black triangles are nest locations reported by Durham (2001)
Appendix A- Habitat Suitability Maps- Mottled Duck; Triangles are nest locations reported by Durham (2001)
Appendix A- Habitat Suitability Maps- Northern Bobwhite; Green circles represent locations with Bobwhite known to be present in the last 5 years
Appendix A- Habitat Suitability Maps- Sandhill Crane; Green circles/squares indicate radio telemetry locations of Sandhill Cranes (Sammy King, unpublished data)
Appendix A- Habitat Suitability Maps- Spring Migratory Shorebirds
Appendix A- Habitat Suitability Maps- Winter Shorebirds
Appendix A - Habitat Suitability Maps - Whooping Crane
Appendix A- Habitat Suitability Maps- Winter Ducks
Appendix B- Data from Census Bureau (2000) showing quantiles of people/ha for each census tract. The darker areas represent a higher density of people.
Appendix B- Topography index derived from the standard deviation of LIDAR elevation data. The darker areas represent more elevation heterogeneity.
Appendix B- An index of Chinese Tallow invasion potential. The darker areas represent a higher risk of Chinese Tallow invasion within a 3-km radius of each cell.
Appendix B- Habitat Suitability Maps- Distance from major coastal prairie remnants at 10,000 m increments (major remnants are >4 ha or 10 acres)
Appendix B- Habitat Suitability Maps - Distance from all coastal prairie remnants in 800 m increments
Appendix C- Habitat Variable Rankings

**Rice density (5-km radius)**
3 = 62-100%
2 = 33.3-61.9%
1 = 6-33.2%
0 = 0%

**Pasture density (5-km radius)**
3 = 23.1-100%
2 = 10.2-23%
1 = 0-10.1%

**Rice density (10-km radius)**
3 = 53.7-100%
2 = 26.2-53.6%
1 = 1.5-26.1%
0 = 0%

**Pasture density (10-km radius)**
3 = 16-100%
2 = 8.6-15.9%
1 = 2-8.5%
0 = 0%

**Rice and fallow rice field density (5-km radius)**
3 = 71.4-100%
2 = 41.5-71.3
1 = 6.7-41.4%
0 = 0%

**Fallow rice and shrub density (5-km radius)**
3 = 18.2-54%
2 = 9.2-18.1%
1 = 0-9.2%

**Ditch density by length (1-km radius)**
3 = 1,973-50,310 m/km²
2 = 986-1,972 m/km²
1 = 0-985 m/km²

**Ditch density by length (3-km radius)**
3 = 1,533-22,996 m/km²
2 = 811.6-1,532.9 m/km²
1 = 0-811.5 m/km²
<table>
<thead>
<tr>
<th>Winter precipitation (Nov.-March)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 = 76.7-82.3 cm</td>
</tr>
<tr>
<td>2 = 43.7-49 cm</td>
</tr>
<tr>
<td>1 = 38.1-43.4 cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Canopy cover (1-km radius; for species negatively influenced by trees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 = 0%</td>
</tr>
<tr>
<td>2 = 0.1-5.4%</td>
</tr>
<tr>
<td>1 = 5.5-21.9%</td>
</tr>
<tr>
<td>0 = 22-100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Canopy cover (3-km radius; for species negatively influenced by trees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 = 0-1.5%</td>
</tr>
<tr>
<td>2 = 1.6-7.8%</td>
</tr>
<tr>
<td>1 = 7.9-21.9%</td>
</tr>
<tr>
<td>0 = 22-100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Canopy cover (1-km radius; for species preferring some edge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 = 0.1-9.8%</td>
</tr>
<tr>
<td>2 = 0%</td>
</tr>
<tr>
<td>1 = 9.9-21.9%</td>
</tr>
<tr>
<td>0 = 22-100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from marsh and Distance from rookery</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 = 0-15,000 m</td>
</tr>
<tr>
<td>2 = 15,001-30,000 m</td>
</tr>
<tr>
<td>1 = 30,001-45,000 m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Road density</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 = 6,046-7,495 m/km²</td>
</tr>
<tr>
<td>2 = 7,496-8.705 m/km²</td>
</tr>
<tr>
<td>1 = 8,706-15,417 m/km²</td>
</tr>
</tbody>
</table>
Literature Cited


Durham, R. S. (2001). Nesting ecology of mottled ducks on agricultural lands in southwest Louisiana. Louisiana State University, Baton Rouge, USA.


