Partners in Flight

Bird Conservation Plan

Gulf Coastal Prairie

Bird Conservation Region (BCR) 37

Gulf Coast Bird Observatory

Gulf Coast Joint Venture

Partners In Flight
Landbird Conservation Plan

BCR 37:
Gulf Coastal Prairie

VERSION 1.3: October 2008

Cerulean Warbler
Photo by Michael L. Gray

Northern Bobwhite
Photo by Michael L. Gray

Le Conte's Sparrow
Photo by Michael L. Gray

Golden-winged Warbler
Photo by Wayne Nicholas

Loggerhead Shrike
Photo by Michael L. Gray

Swainson's Warbler
Photo by Michael L. Gray

Seaside Sparrow
Photo by Michael L. Gray

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Executive Summary

Partners in Flight (PIF) has coordinated a continental plan for conservation of landbird species. Due to many factors, landbird populations have declined, and there is a need to develop strategies for conservation of avian populations and habitats at the Bird Conservation Regions (BCR) level. The PIF process is designed to provide the framework to develop and implement habitat conservation actions on the ground that may prevent the need for future species listings. The goal is to ensure long-term maintenance of healthy populations of native landbirds.

This plan covers the United States portion of BCR 37, the Gulf Coastal Prairie. Four species of concern, and one suite of species were selected by a committee of landbird experts, and conservation recommendations were developed for each species and suite, with the expectation that actions proposed would benefit a number of species with similar habitat requirements. The selected species are Seaside Sparrow, Northern Bobwhite, Loggerhead Shrike, Le Conte's Sparrow, and a suite of warblers (Cerulean, Swainson's, and Golden-winged) which represent migrants that use Gulf Coast stopover habitat. Research priorities with direct application to future plan refinements are identified herein.

Acronyms and Abbreviations Used

ac - acre

BBS – Breeding Bird Survey

BCR – Bird Conservation Region

CBC – Christmas Bird Count

CRP – Conservation Reserve Program

ft – feet

GCJV – Gulf Coast Joint Venture

GIS – Geographic Information System

ha – hectare

IA – Initiative Area

km – kilometer

LA - Louisiana

LWG – Landbird Working Group

m – meter

mi - mile

MERT – Monitoring, Evaluation, and Research Team

MS - Mississippi

NABCI – North American Bird Conservation Initiative

NBCI – Northern Bobwhite Conservation Initiative

NLCD – National Landcover Database

NRCS – Natural Resources Conservation Service

NRI – Natural Resources Inventory

NWR – National Wildlife Refuge

PIF – Partners in Flight

ppt – parts per thousand

TNC – The Nature Conservancy

TPWD – Texas Parks and Wildlife Department

TX - Texas

USFWS – United States Fish and Wildlife Service

WHIP – Wildlife Habitat Incentives Program

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Introduction

In 2004, Partners in Flight (PIF) published the North American Landbird Conservation Plan to provide a continental synthesis of priorities and objectives to guide landbird conservation actions at the national and international scales (Rich et al. 2004). A step-down approach has been developed to implement these actions at the local level. The following introduction, approach, and process were adapted from Rosenberg and Robertson, 2003.

Continental and local declines in numerous bird populations have led to concern for the future of migratory and resident landbirds. Reasons for declines are complex. Habitat loss, degradation, and fragmentation on breeding and wintering grounds and along migratory routes have been implicated for many species. Additional factors may include reproductive problems associated with brood parasitism and nest predation. Scientists and the concerned public agreed that a coordinated, cooperative conservation initiative focusing on nongame landbirds was needed to address the problem of declining species. In 1990, PIF was conceived as a voluntary, international coalition of government agencies, conservation organizations, academic institutions, private industry, and other citizens dedicated to reversing the downward trends of declining species and "keeping common birds common." PIF functions to direct resources for the conservation of landbirds and their habitats through cooperative efforts in the areas of monitoring, research, management, and education, both nationally and internationally. The foundation for PIF's long-term strategy for bird conservation is a series of scientifically based landbird conservation plans, of which this document is one. The geographical context of these plans is either physiographic areas, modified from original strata devised by the Breeding Bird Survey (BBS) (Robbins et al. 1986), or Bird Conservation Regions (BCRs), which represent a further modification of PIF's original physiographic regions. Although priorities and biological objectives are identified at the physiographic area or BCR level, implementation of PIF objectives will take place at different scales, including individual states, federal agency regions, and joint ventures.

Goal

The goal of each PIF landbird conservation plan is to ensure long-term maintenance of healthy populations of native landbirds. This document was prepared to facilitate that goal by stimulating a proactive approach to landbird conservation. The conservation plan primarily, but not exclusively, addresses nongame landbirds, which have been vastly underrepresented in conservation efforts, and many of which are exhibiting significant declines that may be arrested or reversed if appropriate management actions are taken. The PIF approach differs from many existing federal and state-level listing processes in that it (1), is voluntary and non-regulatory, and (2), focuses proactively on relatively common species in areas where conservation actions can be most effective, rather than the frequent local emphasis on rare and peripheral populations. PIF landbird conservation planning, therefore, provides the framework to develop and implement habitat conservation actions on the ground that may prevent the need for future species listings.

Process

PIF landbird conservation planning emphasizes effective and efficient management through a four-step process designed to identify and achieve necessary actions for bird conservation:

(1) Identify species and habitats most in need of conservation;

(2) Describe desired conditions for these habitats based on knowledge of species life history and habitat requirements;

(3) Develop biological objectives that can be used as management targets or goals to achieve desired population levels;

(4) Recommend conservation actions that can be implemented by various entities at multiple scales to achieve biological objectives. Throughout the planning process and during the implementation phase, this strategy emphasizes partnerships and actions over large geographic scales. Information and recommendations in the plans are based on sound science and consensus among interested groups and knowledgeable individuals. Specific methodologies used and assumptions made during this planning process are described within the plan or in its appendices. Additional details on PIF history, structure, and methodology can be found in Finch and Stangel (1993) and Bonney et al. (2000).

The Gulf Coast Joint Venture (GCJV) has an interest in this plan because the JV boundary closely mirrors the BCR boundary, and the JV is now including landbird conservation planning along with existing initiatives for waterfowl habitat conservation planning.

Similar to PIF, the GCJV has committed to a framework for conservation that includes the following steps:

(1) Identify species priorities;

(2) Establish population metric objectives;

(3) Identify limiting factors;

(4) Use knowledge of population-habitat relationships in biological models to generate quantified habitat objectives, spatially explicit at appropriate scales;

(5) Identify critical model assumptions and other information needs to improve decision-making;

(6) Implement habitat conservation;

(7) Conduct research and evaluation;

(8) Re-plan.

This document represents a merging of these two processes to meet the needs of PIF and the GCJV partnership.

Implementation

This landbird conservation strategy is one of many recent efforts to address conservation of natural resources and ecosystems of the Gulf Coast. It is intended to supplement and support other planning and regional conservation efforts [e.g. The Nature Conservancy's (TNC) Ecoregion Plans, the North American Bird Conservation Initiative (NABCI), U.S. Fish and Wildlife Service (USFWS) Ecosystem Plans, GCJV Initiative Area Plans, Important Bird Areas initiatives] by describing a conservation strategy for landbirds that are often not addressed or only incidentally addressed in other plans. PIF strategies for landbird conservation are one of several existing and developing planning efforts for bird conservation. PIF landbird conservation plans are intended to complement other initiatives such as the North American Waterfowl Management Plan, United States Shorebird Conservation Plan, and North American Waterbird Conservation Plan. Ongoing efforts to integrate with these initiatives during implementation of integrated conservation landscape designs, will help ensure that healthy populations of native bird species continue to exist and that all of our native ecosystems have complete and functional avifaunal communities. In particular, the emerging NABCI will provide a geographical and political framework for achieving these ambitious goals across Canada, Mexico, and the United States.

THE PLANNING UNIT

Physical Features and Vegetation

This plan encompasses the area covered by NABCI BCR 37, the Gulf Coastal Prairie. The area extends along the coast of the Gulf of Mexico from the Mississippi/Louisiana border to the central coast of Tamaulipas, Mexico. This plan, however, does not address the portion of the BCR within Mexico, though many of its management recommendations are applicable there. The inland boundary of this area ranges from 9 miles (mi) [15 kilometers (km)] to 93 mi (150 km) from the coast, capturing a complex of marshes, upland grassland, and some forested habitat (Pashley et al. 2000). Southern portions of the region also support thornscrub and some of the last remaining sabal palm (*Sabal mexicana*) forest.

Incorporated in this BCR are over 15 million acres (ac) [6 million hectares (ha)] of water, marsh, and upland habitat (see Figure 1, Appendix A, and Table 1 below). The topography is generally flat in most of the area with elevations ranging from sea level to 250 feet (ft) [75 meters (m)] above mean sea level (Pashley et al. 2000).

Mild winters and warm subtropical summers with abundant (29-59 inches, 75-150 centimeters) annual rainfall typify weather conditions across the area. The majority of this area is non-forested and exists as a complex of marshes and grasslands, though nearly all grassland habitats have been converted to agricultural or pastoral use.

Table 1: 2001 National Landcover Database Types for BCR 37

Cover Type	Acres	Hectares
High Intensity Developed	141,728.33	57,355.42
Medium Intensity Developed	368,508.74	149,130.18
Low Intensity Developed	532,404.07	215,456.28
Developed Open Space	276,799.71	112,016.87
Cultivated	3,299,006.32	1,335,060.49
Pasture/Hay	2,730,025.39	1,104,802.08
Grassland	779,540.96	315,469.03
Deciduous Forest	312,146.28	126,321.12
Evergreen Forest	250,380.74	101,325.49
Mixed Forest	80,077.55	32,406.23
Scrub/Shrub	1,111,973.00	449,999.51
Palustrine Forested Wetland	1,214,697.25	491,570.54
Palustrine Scrub/Shrub Wetland	246,467.03	99,741.67
Palustrine Emergent Wetland	1,241,001.46	502,215.47
Estuarine Forested Wetland	0.0	0.0
Estuarine Scrub/Shrub Wetland	6,225.73	2,519.46
Estuarine Emergent Wetland	2,140,040.14	866,043.52
Unconsolidated Shore	178,459.31	72,219.92
Bare Land	62,019.52	25,098.41
Water	1,215,505.65	491,897.68
Palustrine Aquatic Bed	21,848.53	8,841.79
Estuarine Aquatic Bed	56,965.81	23,053.25

Forested areas occur primarily along major riverine systems and on coastal cheniers (ancient beachfront ridges), mottes and salt domes, palm forests, thorn-scrub, and man-made levees and spoil banks (Pashley et al. 2000).

The upland areas and barrier islands of the immediate coast of Louisiana from the mouth of the Mississippi to the Texas coast are some of the youngest in North America, formed less than 3,000 years ago (Barrow and Fontenot 2006). The glacial events (and interglacials) of the Pleistocene caused rivers to deposit sediments during rises in sea level, which led to the formation of the present-day marshes, swamps, and natural levees. Oceanic waves then reworked the sediment into new beachheads, which remained as relict beach ridges and barrier islands.

Some marsh habitats in the BCR still remain close to pre-settlement condition. The vegetative composition of marsh is determined by the salinity, and types range from salt marsh to freshwater marsh. Salt marsh is nearest the coast, is subjected to regular tidal inundation, and is usually dominated by smooth cordgrass (*Spartina alterniflora*) (TNC 2006). Salt marsh typically has a salinity of around 16 parts per thousand (ppt). Brackish marsh is typically inland of salt marsh, and is subject to a reduced tidal influence. Marshhay cordgrass (*Spartina patens*) is the dominant plant and grows in open conditions interspersed with ponds, pools, and water channels (TNC 2006). Brackish marsh salinities average about 8 ppt. Further inland, intermediate marsh is subjected to periodic influx of salt water and has a year-round average salinity in the range of 3-4 ppt. Intermediate marshes are characterized by heavy ground cover of emergent wetland plants with scattered small open water ponds. Plant species richness is relatively high, with marshhay cordgrass often the dominant species. Fresh marsh typically has little to no tidal influence. Salinity averages 1 ppt, and dominant plant species include bull-tongue arrowhead *(Sagittaria lancifolia)*, maidencane *(Panicum hemitomon)*, and spikerush *(Eleocharis sp.)*. The loss of coastal wetlands in Louisiana due to saltwater intrusion, sediment input deficits, land subsidence, and other factors is staggering. Approximately 19,125 ac (7,739 ha) of coastal wetlands, roughly 80% of the total national loss, were lost in Louisiana each year between 1978 and 2000 (Barras et al. 2004). In Texas, by 1992, an average annual net loss of 5,700 ac (2,300 ha) had occurred (Moulton et al. 1997).

Inland of coastal marshes, grasslands were the primary plant community from southwestern Louisiana to the forested riparian zone of the Rio Grande River in south Texas, extending beyond the Rio Grande into northeastern Mexico. Humid and subhumid tallgrass coastal prairies once covered nearly 10-12 million acres (4-5 million ha) of the BCR (Allain et al. 1999, TNC 2002). As much as 99% of the original prairies have been converted to agriculture (Pashley et al. 2000). Relatively few unaltered examples of this habitat currently exist to use as models in restoration.

The south and central Texas coasts are a mosaic of agricultural land, pasture, wetlands, oak mottes, riparian forest, and semi-open thornscrub [primarily mesquite (*Prosopis sp.*) and huisache (*Acacia farnesiana*)]. These transitional thornscrub habitats occur mainly on clay or shell ridges and spoil banks near coastal bays (Bezanson 2000). Forested areas still exist along the large river bottoms, such as the Brazos and San Bernard Rivers. These forested river bottoms provide vital habitat to transient migrant landbirds in spring and fall. Forested habitat also exists on mottes in the southern portions of Texas. These mottes are former beach or sand ridges that support live oak (*Quercus virginiana*) and various prairie grasses (Bezanson 2000).

The Chenier Plain, a sub-region of this BCR, is located along the Gulf coast from Atchafalaya Bay, Louisiana, westward to East Bay, Texas. It extends inland from 10-40 mi (16-64 km) and contains a total area of 320,000 acres (129,500 ha). Marshes and coastal prairies are the dominant habitat in this sub-region with wooded habitats comprising only a small percentage of the total area of the Chenier Plain. The most prominent upland areas in the Chenier Plain are the cheniers themselves, narrow strips of woody vegetation on higher, ancient beach ridges. These cheniers typically occur as long narrow bands of woodland that run parallel to the Gulf coast and range in width from 100-1,640 ft (30-500 m), and in length from 1/2 -31 mi (1-50 km) or longer (Barrow et al. 2000). Cheniers are usually surrounded by marsh habitat and may be only a few inches to as much as 10 ft (3 m) above the marsh. This slight rise in elevation is enough to change the plant community from marsh to a forest dominated most often by hackberry (*Celtis laevigata*) and live oak. Overgrazing has reduced understory vegetation and hindered regeneration of trees and shrubs in many cheniers.

Bottomland hardwood forest occurs along the major river systems that cross the Chenier Plain. These riparian forests range in composition from bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) in lower areas to hackberry, ash (*Fraxinus sp*.), elm (*Ulmus sp*.), water and willow oak (*Quercus nigra* and *Quercus phellos*) in higher elevations (Pashley et al. 2000). Invasion by non-native species is an especially common problem in woodland and grassland areas. Chinese tallow (*Triadica sebifera*) is the most common invasive woody plant in this area, often forming dense, almost monotypic stands covering hundreds of acres.

Within BCR 37, the Deltaic Plain of Louisiana lies to the east of the Chenier Plain. This region is largely dominated by marsh habitats, with forested habitat present along the Mississippi River and its current and abandoned distributary channels. Additional forested habitat, important to transient landbirds, is found on shell middens scattered in the marsh, canal spoil banks, and on Grand Isle, a forested barrier island. The Deltaic Plain has suffered the most egregious land losses in the BCR, with erosion, subsidence, and sea level rise cited as primary causes.

The extreme eastern edge of BCR 37 falls within the coastal fringe of Hancock County, Mississippi. Habitat there is predominantly tidally-influenced marsh, with small areas of shrub-scrub and woodlands.

Natural Disturbances

Historically, fire (Perez 2006) and tropical weather systems were the most prevalent natural disturbances in this region. It has been estimated that as much as 90% of the prairie was burned every 4-6 years, and fire was likely more frequent (1-3 years) when influenced by early Native Americans (Perez 2006). Natural fires and drought preclude woody species from dominating grasslands. Grazing by bison also helped maintain the prairie structure, but obviously this impact was far less than the current extensive grazing by livestock. Palatable native grasses such as big bluestem *(Andropogon gerardii),* Indiangrass *(Sorghastrum nutans),* and eastern gamagrass *(Tripsacum dactyloides)* often decline after long periods of heavy use by grazers. Certain introduced species, such as vaseygrass *(Paspalum urvillei)* from South America, are adapted to cattle grazing and persist in overgrazed prairie (Allain et al. 1999).

The passage of hurricanes and tropical storms along the Gulf Coast can have significant effects on coastal habitats. These storms inundate the prairies and marshes with salt water and change the soil conditions, marsh vegetation composition and coverage, and extent of canopy gaps through tree fall in forested habitats.

History and Land Use

BCR 37 covers a very broad area and array of habitats, with a varied history and land use. Eastward, in the marshes of Louisiana from the mouth of the Mississippi River westward to the state's central coast, the first European settlers included the Acadians or "Cajuns." The first Acadians from Nova Scotia arrived in New Orleans in 1764. Over the next 25 years, Acadian exiles from all over North America and Europe immigrated to Louisiana to avoid persecution. They were settled west and south of New Orleans, and were quick to establish themselves as subsistence farmers, hunters, fishermen, and trappers in the extensive marshlands. Most transportation was by boat, because there were no roads. The swamps and marshes of this Deltaic Plain were heavily modified by the construction of canals for commerce and levees as protection against flooding. These alterations are considered to be primary reasons behind extensive land loss in the region—canals by allowing saltwater intrusion and interrupting sediment and freshwater sheet flow and levees by terminating sediment pulses that formerly nourished marshes and offset erosion and subsidence losses.

In general, the Chenier Plain of western coastal Louisiana and extreme southeastern Texas is characterized by marshes and prairies (now under cultivation) interspersed with scattered forested areas, which occupy relict beach ridges, natural levees, salt domes, and earth and shell mounds. The character of the wooded area varies according to soil types, salinity, age, proximity of drainages, and other factors. The initial Indian inhabitants were displaced by the Cajuns and other immigrants, who usually converted the prairies, higher marshes and ridges to pasture and agriculture. Rail systems began to appear in the late 1800's, facilitating the conversion of the prairies from the arpent-strip farms of the Cajuns and the rectangular Spanish sitio grants for ranching to expansive rice fields farmed by Midwestern immigrants who arrived at the beginning of the 20th century. Since then, over 556,000 ac (225,000 ha) of rice cultivation has developed within 100 mi (160 km) of the coast of Louisiana (Huner et al. 2002). At least a quarter of that area is also used for crawfish cultivation. As the Chenier Plain landscape has evolved, rice and crawfish farming have provided a partial substitute for wetland loss for shorebirds, waterfowl, and colonial waterbirds. In addition to agriculture and cattle ranching, oil and gas production is now prevalent along the coastal plain, and development of primary and secondary residential areas and support services has occurred in the higher and larger areas such as Grand Chenier, Louisiana.

In the early 1800's, the Upper Texas Coast was mostly coastal prairies and marshes, with the exceptions of the gallery forests of the large bayous and extensive bottomland hardwood forests associated with the large rivers that flowed into the Gulf (Brazos, San Bernard, and Colorado). The privateer Jean Lafitte arrived on Galveston Island in 1817 and made it his base of operations. The little village he established contained huts for the pirates, a large slave market, boarding houses for visiting buyers, a shipyard, saloons, pool halls, gambling houses and Lafitte's own mansion, the "Maison Rouge" (Galveston Island Convention & Visitors Bureau 2006). After Lafitte and his men were forced from Galveston, the island became an established port of entry for goods from all over the world, and the city prospered as one of the major ports on the Gulf. At the same time, Augustus and John Allen were trying to establish a city along Buffalo Bayou to the north to compete with Galveston as a port. The bayou was indeed navigable, but Houston lagged behind Galveston until the latter city was devastated by the hurricane of 1900. It was after the hurricane that the need for an inland port in this area was realized, and Houston began to grow. At the close of the nineteenth century, Houston was already thriving as a regional center of rail transportation and exportation of wheat, cattle, rice, and sugar. The discovery of oil at Spindletop near Beaumont in 1901 ushered in the oil boom, and Houston began its rapid growth, with refineries and oil fields springing up and displacing prairies around the ship channel and other surrounding areas (Wooster and Sanders 1997).

West and south of the booming city of Houston, the vast coastal prairies were being converted to agriculture. Wheat, corn, potatoes, and cattle were the primary commodities until rice production took off in the early part of the 20^{th} century. This rice production attracted many wintering ducks and other game birds, and hunting became a major enterprise as ducks and geese moved their wintering grounds inland to take advantage of the new food source. The success of rice farming greatly reduced the amount of native prairie, which negatively affected species such as Attwater's Greater Prairie-Chicken (Gore 1994). By the 1970's, Houston began to expand rapidly westward, and urban development became the chief threat to the prairies of the upper Texas coast.

Accounts by Vernon Bailey and others during their Biological Survey of Texas from 1889 to 1905 (Schmidly 2002) described the central Texas coast around Matagorda Bay—"wide prairies stretch all over the county, low and often under water, which is all of the same character except along the Bay shore where it is mixed with sand and intersected by pools of salt water." He also noted that "mankind has modified the topography of the county in one respect. It, the county, is well settled and has been so for seventy years and all of the river land has been cut into small pastures about a mile square in each, so wild animals were quickly exterminated." Cattle ranching and agriculture were firmly established along this area of the coast, and Corpus Christi became a major port, and opened the area to importing and exporting crops and livestock. Oil and gas production also became an important industry.

The Nueces River, whose mouth empties into the Nueces Bay west of Corpus Christi, forms the northern edge of what is known today as the Tamaulipan Thornscrub or South Texas Brushlands (Pashley et al. 2000). This area extends into Mexico to southern Tamaulipas. In the mid-1800's, at the end of the Mexican War, the area was described "almost level as the ocean, which it strikingly resembles when clothed with tall grass, which is ever fanned by the bland southern breeze. Except a motte or small chaparral of bushes at long intervals, it is destitute of timber" (Riley 1997). William Loyd noted in 1891 that the land near the mouth of the Nueces River "is still covered with a dense scrubby jungle almost impassable" (in Schmidly 2002). The history of the region was forever set when northeastern immigrants Richard King and Mifflin Kenedy met and formed a shipping company on the Rio Grande in 1848 (Tunnell and Judd 2002). Four years later, King made a trip on horseback from the Rio Grande to the Nueces River and immediately decided to begin acquiring land in this area for cattle ranching. Kenedy soon bought an interest in the holdings and also began to acquire land. The partnership was dissolved in 1867, but both men continued to expand their ranching empires. Today the Kenedy Ranch covers over 499,000 ac (202,000 ha), and the King Ranch is approximately 825,000 ac (334,000 ha). While the extensive grazing activities profoundly affected the landscape and changed its character from grassland to thornscrub, private ownership of this amount of coastal land was critical in protecting it from the development that would have likely occurred. The ranches also protected the Coastal Sand Plains (South Texas Eolian Sand Sheet), a unique, 2 million ac (809,000 ha) area of sand uplands with grasslands and large live oak—mesquite mottes.

Bailey and his co-workers explored the mouth of the Rio Grande during 1891. They found tall stands of native sabal palm and dense forests of cedar elm (*Ulmus crassifolia*) and Texas ebony (*Ebenopsis ebano*). They also described the numerous "resacas", abandoned stream channels that act as sumps during floods. These resacas retained water for most of the year (Schmidly 2002). Most of the dense forest along the Rio Grande was gone by this time, cleared for timber and settlements. These settlements were established in the early and mid-1800's to support the agriculture and ranching operations in the Valley, especially those spurred on by the Santa Anita Land Grant of 1790. Most cattle and agricultural goods were carried by boat down the Rio Grande to the Gulf. This area was a blending of the region's frontier cultures, rowdy politics, and periodic violence. When the railroads arrived in the early 1900's, growth and development accelerated due to the ease of moving products to market and people to the Valley.

PRIORITY BIRD SPECIES

Species Prioritization

Approximately 318 species of birds occur regularly in BCR 37 as permanent residents, summer residents, or winter residents. At least 45 additional species regularly migrate through the BCR in spring and/or fall. Included among those species are numerous landbirds of high conservation concern (See Table 9, Appendix B). When the GCJV assumed responsibility for landbird conservation planning within BCR 37, the partnership faced difficult choices regarding landbird species to serve as priorities for planning. The GCJV Management Board directed the partnership's technical advisory arm—the Monitoring, Evaluation, and Research Team (MERT)—to review PIF's list of priority landbirds for BCR 37, and select a subset of species (i.e., 6-8) for initial conservation planning and action in the JV area.

In November 2005, the Landbird Working Group (LWG) of the GCJV MERT met to select priority landbird species using the criteria at right.

Landbird species Criteria:

- List should include approximately 6 species.
- Species should regularly occur within the GCJV boundaries.
- Management actions taken within the GCJV boundaries should have the potential to positively influence priority species' population trends.
- Species should be identified in the North American Landbird Conservation Plan as in need of conservation action to increase or maintain population levels.

"Final" list of priority species, GCJV Landbird Working Group:

Northern Bobwhite
Loggerhead Shrike
Le Conte's Sparrow
Seaside Sparrow
Migratory Landbird Suite (Cerulean/Golden-winged/ Swainson's Warblers)

The LWG began with a list of priority landbird species for BCR 37, gradually narrowing the list down. The LWG refrained from simply picking the highest ranking species on the BCR 37 PIF list for the following reasons: (1) the list considers only breeding distributions, thus excluding many species for which GCJV habitats are critically important during migrations and/or winter, (2) some high scoring PIF species are on the periphery of their range in BCR 37 (Swallow-tailed Kite, Audubon's Oriole, Scaled Quail, Northern Beardless-Tyrannulet), (3) regional expertise regarding species distributions was sometimes considered more reliable than the coarse spatial resolution of the PIF continental scoring process, (4) threatened and endangered species for which plans and conservation actions are already in place and active were not selected (Attwater's Greater Prairie-Chicken, Aplomado Falcon), (5) for some species, population bottlenecks can not be addressed through habitat actions in BCR 37 (Tamaulipas Crow), and (6) the LWG assumed, in some cases that habitat actions for lower ranking species would be sufficient to sustain population objectives for certain high ranking species (actions for Migrant Suite providing for Painted Bunting, or actions for LeConte's Sparrow providing for Henslow's Sparrow).

The selected species are not intended to serve as umbrella species, but we do anticipate that a number of species will benefit from the habitat implemented for the selected species. Selection of priority species does not preclude the future development of habitat objectives for other species as necessary.

Northern Bobwhite, Loggerhead Shrike, and Seaside Sparrow garnered the strongest support from members of the LWG. Swainson's Warbler, Painted Bunting, and Le Conte's Sparrow were also highly considered. Ultimately, the migratory landbird suite was selected in an effort to represent the range of desired habitat conditions for migration stopover sites. Cerulean Warbler is a canopy specialist, Golden-winged Warbler is a mid-story specialist, and Swainson's Warbler is an understory/thicket specialist. The LWG assumes that the habitat requirements of resident and migrant Painted Bunting will be captured by habitat planning for the migratory landbird suite.

Habitats and Priority Species Accounts

The introduction sections for each species or species-group below provide detailed habitat descriptions, to the extent that they have been identified and documented, including some descriptions that have been documented to vary by locale and/or study. Habitat objectives for each species or species-group are necessarily more general in nature and are intended to provide broad guidance at landscape scales, with local conservation decisions expected to be additionally informed by competent field biologists with expertise in local habitat conditions and management responses.

Salt and Brackish Marsh

Of the marsh types present in BCR 37, salt marsh is nearest the coast and is subjected to regular tidal inundation. Most salt marshes are located at the mouth of estuaries, where sediment is deposited to allow the growth of grasses. Salt marshes are dominated by salt-tolerant grasses, such as smooth cordgrass, marshhay cordgrass, black needlerush (*Juncus roemarianus*), and saltwort (*Batis maritima*). The mean salinity of salt marsh is about 16 ppt. Brackish marsh is inland of salt marsh and is subject to a reduced tidal influence. Marshhay cordgrass is the dominant plant and grows in open conditions interspersed with ponds, pools, and water channels (TNC 2006). Brackish marsh salinities average about 8 ppt. Figure 2, Appendix A depicts the extent of salt, brackish and intermediate marsh in BCR 37.

Seaside Sparrow

Seaside Sparrow is a permanent resident in BCR 37. Population estimates are 5,000 individuals in Louisiana, 60,000 in Texas, and 20 in the BCR 37 portion of Mississippi [Rocky Mountain Bird Observatory (RMBO) 2007]. Given Louisiana's extensive coastal marshes, the estimated greater abundance in Texas versus Louisiana is questionable and may be related to better sampling of salt/brackish marsh habitat by the BBS in Texas (B. Ortego 2008, personal communication). PIF recommends maintaining current population levels (Rich et al. 2004). This species has been assigned a population trend score of 3 (Panjabi et al. 2005), which indicates an uncertain trend due to highly variable data or small sample size. This species is potentially threatened due to shrinking marsh habitat. Louisiana alone lost about 19,125 ac (7,739 ha) of marsh each year between 1978 - 2000, which is approximately 80% of the nation's yearly coastal marsh loss (Barras et al. 2004).

Photo by Michael L. Gray

Seaside Sparrow

Seaside Sparrows occupy tidal marshes along the Gulf and Atlantic coasts. The sparrows require nesting sites above spring tides, and pools and creek edges, where birds can forage on open mud and at bases of rooted vegetation (Post and Greenlaw 1994). The Gulf populations of Seaside Sparrow are not migratory, and northeastern populations probably do not winter along the Gulf.

Territory sizes vary across the species' range (Post and Greenlaw 1994). In relatively unaltered marsh habitat, birds in their northern range occupy smaller territories than southern birds (Post and Greenlaw 1994). Territories in relatively unaltered coastal marsh average smaller than territories in ditched marshes (Post and Greenlaw 1994). Foraging may occur in different areas from nesting territories (Post and Greenlaw 1994). Mean territory size is highly variable, from less than a quarter of an acre (0.1 ha) to about 16 acres (~6 ha) (Post and Greenlaw 1994).

Nelson's Sharp-tailed Sparrow, Northern Harrier, and Short-eared Owl are other landbird species of concern that are found in this habitat. All three species are winter residents in BCR 37. Interspecific aggression occurs regularly between Seaside and Sharp-tailed Sparrows, with Seaside usually dominant in any encounter. While Gulf coast Seaside Sparrows likely maintain territories in the non-breeding season, Sharp-tails form loose winter feeding flocks. It is not known if, or to what extent, these feeding flocks interact with individual Seaside Sparrows. Any management activities that increase suitable marsh habitat for Seaside Sparrows would increase winter feeding habitat for Sharp-tailed Sparrows, especially in areas of smooth cordgrass (J. Arvin 2007, personal communication). However, in southern coastal Texas, sea ox-eye daisy (*Borrichia frutescens*) may be more important as a nest substrate than smooth cordgrass (B. Ortego 2008, personal communication).

While found in salt marshes, Northern Harriers and Short-eared Owls are more common in freshwater marshes and prairies, so management activities regarding Seaside Sparrows would likely have only marginally significant impacts on these raptors. Northern Harriers do prey on rice rats (*Oryzomys palustris*), which are a known nest predator and nest-site competitor for Seaside Sparrows (Post and Greenlaw 1994).

Loss of coastal marsh habitat is likely the greatest limiting factor for Seaside Sparrows, through development activities such as filling, draining, diking, and pollution, as well as marsh loss due to natural processes. In areas where marsh-ditching occurs, foraging habitat is eliminated, or negatively impacted from vegetation changes due to altered hydrology (Post and Greenlaw 1994). Reduction in habitat also potentially increases competition for nest sites in black needlerush with rice rats.

The population target for Seaside Sparrow from Rich et al. (2004) suggests that the goal should be to maintain current abundance levels. However, the species is not well monitored by the BBS and development of an alternate monitoring program for this species and others using its habitat may be desirable or necessary (Dunn et al. 2005).

Creation and/or restoration of marsh habitat for Seaside Sparrow should provide large (see Habitat Model below) areas of medium height smooth cordgrass, interspersed with numerous ponds, tidal creeks, and bare ground areas (Post and Greenlaw 1994). Managers of ditched marshes could plug selected ditches to enhance Seaside Sparrow habitat (Post and Greenlaw 1994). In instances of beneficial use of dredged material, creation of marsh-elevation islands with some shallow waterbodies, and scattered woody shrubs may encourage Seaside Sparrow colonization (Post and Greenlaw 1994). Post and Greenlaw (1994) also suggest control of mammalian predators as a measure to increase or sustain Seaside Sparrow populations.

Gabrey and Afton (2000) studied the abundance of sparrows in recently burned, unburned, and two-year and greater post-burn plots in Louisiana. The authors found that abundance of male sparrows decreased in burned plots during the first breeding season post-burn, but was higher than that of unburned plots during the second breeding season post-burn. They recommend that marsh management plans in the Gulf Coast Chenier Plain integrate waterfowl and Seaside Sparrow management by maintaining a mosaic of burned and unburned marshes and allowing vegetation to recover for at least two growing seasons before re-burning a marsh. This fire frequency recommendation from *Spartina*-dominated marshes may or may not translate to marshes in coastal Mississippi, where rushes (*Juncus sp.)* dominate and historical fire return frequency may have been longer (i.e., about every 7 years) (M. Woodrey 2008, personal communication).

Using published species habitat requirements and PIF population estimates, we developed a habitat model to estimate habitat needs for Seaside Sparrow. The habitat model assumes that the availability of nesting sites is the limiting factor for this species, because although feeding and nesting often occur in different areas of marsh, the feeding areas required are less specific than nesting areas.

A cursory examination of the 2001 National Landcover Database (NLCD) overlain with polygons depicting federal, state, and non-profit conservation organization lands (i.e., National Wildlife Refuges, State Wildlife Management Areas and Parks, TNC and National Audubon Society Preserves, etc.) in BCR 37 indicates the possibility of achieving a significant portion of Seaside Sparrow population and habitat goals on extant conservation lands in the BCR. The habitat objective can be improved by a more accurate estimate of existing population size and a refined estimate of truly suitable marsh habitat.

Because of this species' need for disturbance to maintain habitat interspersion, information on the frequency of burning and other disturbance regimes on public and private marshlands in the BCR is needed. Given the prevalence of winter burning for marsh management in the Gulf Coast Joint Venture region, more information regarding the effects of winter

Habitat model:

- Assume a male territory size of 9 ac (4 ha) (Werner and Woolfenden 1983)
- Assume each territory occupied by 1 male and 1 female
- Assume that the BCR 37 breeding population is 65,000 birds (RMBO 2007)
- Assume 1:1 male-to-female population ratio (Post and Greenlaw 1994), so BCR 37 population contains approximately 32,500 males
- PIF recommendation is to maintain current population levels
- Viable population size = 500 breeding pairs (Twedt et al. 1999)
- A block of approximately 10,000 ac (4,047 ha) of suitable salt/brackish marsh habitat is required to support a viable population of Seaside Sparrow (Twedt et al. 1999)
- Approximately 650,000 ac (263,045 ha) of habitat in block sizes of at least 10,000 ac are needed to maintain current Seaside Sparrow populations in BCR 37
- A portion of each habitat block should be burned every 3 years

Seaside Sparrow Key Information

- Population Goal: 65,000 birds
- Modeled habitat characteristics: patches of salt or brackish marsh at least 10,000 ac in size, portions of which are burned every three years.
- Area requirement: 650,000 ac

Seaside Sparrow Research and Monitoring Needs:

- Assess suitability of habitat patches identified by NLCD and accuracy of PIF population estimates for Seaside Sparrow in BCR 37, possibly using a multi-species survey design according to the Conway marshbird monitoring protocol (Conway and Nadeau 2006)
- Determine territory size in BCR 37
- Assess accuracy of PIF/RMBO population estimates for Texas and Louisiana
- Determine ideal season, frequency, and ignition pattern of prescribed fire
- Collect and incorporate information on frequency of burning and other disturbance regimes on public and private lands, BCR 37
- Simulate population response to predicted habitat changes such as projected sea level changes
- Assess degree of interaction/competition with other marsh-inhabiting species of concern
- Assess the effectiveness of Seaside Sparrow habitat planning and management in addressing the needs of other priority emergent marsh birds
- Quantify productivity response to mammalian predator control

versus growing season burns would aid determination of the most desirable fire regime for Seaside Sparrow and other high-priority marsh species. The GCJV LWG assumes that a combination of growing season and dormant season fires would be optimal for priority marsh birds in the region. Because there is anecdotal evidence that a fire ignited around an area's perimeter and allowed to burn towards the center (i.e., a ring fire) can cause significant mortality for certain marsh bird species, studies comparing the impacts of different prescribed burn ignition strategies on priority marsh species would also be useful.

Grasslands

The grasslands of coastal Texas and Louisiana extend 31-80 mi (50-130 km) inland from the Gulf marshes, from an elevation of sea level to 246 ft (75 m) (Hatch et al. 1990). The original vegetation types of these coastal grasslands were tallgrass prairie and oak woodlands (Perez 2006). Dominant grass species in coastal prairie include little bluestem (*Schizachyrium scoparium*), big bluestem, Indiangrass and Gulf cordgrass (*Spartina spartinae*). Introduced grasses include coastal bermudagrass (*Cynodon spp.)*, bahiagrass (*Paspalum notatum*), and other exotics. These introduced grasses often grow in monocultures and have had a profound negative effect on native grassland birds by reducing plant diversity, cover, and food (Brennan et al. 2005).

In pre-settlement times, these prairies covered a vast area [over 12 million ac (5 million ha)] of the coast (Allain et al. 1999) and were described by explorers as wide, flat, treeless plains dissected by wooded streams and rivers (Inglis 1964). Today, less than 2% of those coastal prairies remain (Katy Prairie Conservancy 2006). Most of the acreage has been converted to row crop agriculture or exotic grass pasture. In addition, the suppression of fire has led to the proliferation of shrubs and non-native trees such as Chinese tallow. The coast is also the most heavily populated area of the states, and development pressure increases yearly. Figure 3, Appendix A, shows the approximate extent of grasslands, pasture, and hay in BCR 37 today.

The three grassland birds addressed by this plan, Le Conte's Sparrow, Northern Bobwhite, and Loggerhead Shrike, inhabit slightly different niches in coastal grasslands.

1. Le Conte's Sparrow

Photo by Michael L. Gray

Le Conte's Sparrow

Le Conte's Sparrow is a wintering species in BCR 37. Its primary habitat needs in this season are periodically (approximately every three years) disturbed grasslands, preferably consisting largely of native bunch grasses of moderate density, such that birds can move through the grasses at ground level, yet have cover from avian and other potential predators (Lowther 2005, Winter et al. 2005). As a winter visitor, Le Conte's Sparrow is susceptible to many of the same problems as other grassland birds on the Gulf Coast. Habitat fragmentation, destruction of native prairie plant assemblages, overgrazing, suppression of fire, and invasive exotics are all factors in limiting suitable winter habitat for this sparrow.

Le Conte's Sparrow is found in old fields and prairies with dense cover, and in moist weedy or grassy fields of *Andropogon* and *Schizachyrium* species (Lowther 2005, Lowery 1974, Imhof 1962). The birds appear to maintain territories and regular spacing in winter; however, territory size varies across sites, probably related to seed abundance (Grzybowski 1983). Minimum grassland patch size for wintering Le Conte's Sparrow is not known, but Winter et al. (2005) found no recognizable influences of patch size and percent shrub cover on Le Conte's Sparrow densities during the breeding season in Minnesota and South Dakota. Those authors cautioned, however, that patches surveyed may have been too large, and shrub/tree cover too sparse, to evoke a response. Patches sampled by Winter et al. (2005) ranged from about 6-3,076 ac (2.4-1,246 ha), with a mean of approximately 558 ac (226 ha). While moist habitats are not required for breeding (Cooper 1984), these habitats seem to be preferred in winter (Lowther 2005).

Dependence on native grasslands is a feature shared by other declining coastal prairie species, including Northern Bobwhite, Eastern Meadowlark, Northern Harrier, Attwater's Greater Prairie-Chicken, and Loggerhead Shrike. Le Conte's has unique microhabitat requirements, including tall grass and moist areas (Lowther 2005), but habitat management for other grassland species will benefit this sparrow.

The global population of Le Conte's Sparrow is estimated at 3,000,000 individuals (RMBO 2007). Population estimates have not been derived by PIF for either Texas or Louisiana (Rosenberg 2005). Winter population estimates at several lightly grazed refuges in Texas range between 1.0 and 7.6 birds per acre (2.4 - 18.8 birds per hectare)(Grzybowski 1982). Baldwin (2005) recorded an average density of 2.0 Le Conte's Sparrow per acre (4.9 birds per hectare) during work on Brazoria National Wildlife Refuge (NWR), Texas. Estimating populations accurately is difficult because the species is not detected easily. PIF recommends maintaining current levels (Rich et al. 2004). This species has been assigned a population trend score of 3 (Panjabi et al. 2005), which indicates an uncertain trend due to highly variable data or small sample size.

Le Conte's Sparrow abundance and distribution in BCR 37 is believed to fluctuate greatly from year to year. These variations are probably due to rainfall and the birds' sensitivity to local conditions (Grzybowski 1982). Because the birds prefer tall grass, sparse to moderate litter, and little woody vegetation, the pattern of burning or grazing is critical (Baldwin 2005, Dechant et al. 1999). The birds will avoid fields that have been burned within a year, or fields that have never been burned. Baldwin (2005) recommended maintenance of a mosaic of areas with differing burn rotations of 2 and 3 years, with an emphasis on reducing woody vegetation, for this species and other grassland birds in Texas coastal prairie habitat. Haying or mowing may negatively impact usage as well (Dechant et al. 1999), but the effects of grazing are unclear (Bock et al. 1993). Interestingly, although this species requires areas with sparse woody vegetation, Baldwin (2005) found a positive correlation between Le Conte's Sparrow abundance and the presence of dwarf wax myrtle (*Morella cerifera*) at Brazoria NWR, Texas.

The population objective for the species is to maintain the current global level. To derive an estimate of the number of Le Conte's Sparrow wintering in BCR 37, we used the PIF global population estimate apportioned to states and BCRs using Christmas Bird Count (CBC) data. We analyzed 1985/86-2005/06 bird per party-hour data for Le Conte's Sparrow in states within the species' winter range. For each state, we averaged these data across years and across CBC circles to arrive at an average relative bird density by state. For each state, we multiplied its relative bird density by the area of the state to arrive at relative bird abundance. These state-specific relative bird abundances were then expressed as percentages of the sum of all relative bird abundances across states. Multiplying these percentages by the global population estimate yields a winter population estimate for each state.

The process described above suggests that Texas hosts approximately 67.26% of the global population of Le Conte's Sparrow in winter, or about 2,017,804 individuals, and that Louisiana hosts approximately 9.14% of the population, or about 274,132 individuals. To step those state population estimates down to BCR 37, we further analyzed 1985/86-2005/06 bird per party-hour data from CBC for portions of Louisiana and Texas inside BCR 37. For the portions of each state inside BCR 37, we averaged these data across years and across CBC circles to arrive at an average relative bird density. We then multiplied these relative bird densities by their area to arrive at relative bird abundance. For each state, the relative bird abundance within BCR 37 was expressed as a percentage of the state total relative bird abundance derived in the above paragraph. These represent estimates of the proportion of each state's population of Le Conte's Sparrow wintering inside BCR 37. Multiplying these percentages by their respective state total population estimate yields a Le Conte's Sparrow over-wintering population of approximately 266,724 birds for the BCR 37 portion of Texas, and 86,800 birds for the BCR 37 portion of Louisiana.

To derive a population estimate for Le Conte's Sparrow in the BCR 37 portion of Mississippi, we analyzed NLCD data for that area and assumed that grassland and pasture/hay habitat could support Le Conte's Sparrow densities similar to those observed by Grzybowski

Habitat Model:

- Both anecdotal and empirical evidence point to the fact that availability of suitable grassland wintering habitat (i.e., food resources) is the most important factor influencing Le Conte's Sparrow winter survival.
- There are a variety of grassland types present in BCR 37, however, including remnant coastal prairie, improved pasture, coastal dune grasslands and fallow fields and information on their individual values to Le Conte's Sparrows is lacking. Based on information from the breeding grounds and on local research by Grzybowski (1982) and Baldwin (2005), it is believed that native bunchgrass-dominated grasslands subject to periodic disturbance such as prescribed fire on about a three-year interval, or moderate grazing constitute suitable to optimal habitat in BCR 37
- Grzybowski (1982) measured densities of wintering grassland birds, including Le Conte's Sparrow, by habitat treatment type at Welder Wildlife Refuge, TX, He recorded Le Conte's Sparrow densities of 1.1 and 7.6 birds/ac (2.6 - 18.8 birds/ha) in two moderately grazed grassland sites, and 1.0 birds/ac (2.4 birds/ha) at a lightly grazed grassland site.
- Baldwin (2005) recorded densities of 2.0 Le Conte's Sparrow/ac (4.9 birds/ha) at Brazoria NWR, TX.
- All these estimates occurred on lands managed for wildlife. Because the majority of BCR 37 is privately-owned, with wildlife production typically not the primary landowner objective, we used the most conservative density estimate (1.0 Le Conte's Sparrow/ac) for habitat objective calculations.

(1982) in Texas, and described in the following paragraph. Under those assumptions, the BCR 37 portion of Mississippi could support approximately 200 Le Conte's Sparrow.

The winter population estimates for the BCR 37 portions of Texas, Louisiana, and Mississippi described above coupled with density estimate of 1.0 birds/ac yields the following:

- Texas – 266,724 Le Conte's Sparrow require approximately 266,724 ac (107,939 ha) of suitable habitat.
- Louisiana – 86,800 Le Conte's Sparrow require approximately 86,800 ac (35,126 ha) of suitable habitat.
- Mississippi – 200 Le Conte's Sparrow require approximately 200 ac (80 ha) of suitable habitat.

Analysis of Le Conte's Sparrow CBC counts in the Texas portion of BCR 37 from 1985-86 to 2005-06 indicates that approximately 76.64% were from the GCJV Texas Mid-Coast Initiative Area (IA), approximately 16.57% were the Texas portion of the GCJV Chenier Plain IA, and about 6.79% were from the GCJV Laguna Madre IA. Based on those proportions, recommended allocation of Le Conte's Sparrow habitat objectives by Texas IAs are as follows:

Table 2: Le Conte's Sparrow Habitat Objectives by Initiative Area, Texas

Texas Mid-Coast IA	Chenier Plain IA (Texas)	Laguna Madre IA
204,417 ac (82,724 ha)	44,196 ac (17,885 ha)	18,110 ac (7,328 ha)

Both CBC data and Lockwood and Freeman (2004) indicate that Le Conte's Sparrow becomes increasingly uncommon south of Texas' central coast. We therefore recommended that the majority of habitat provisioning for the species in the Laguna Madre IA be concentrated in the northern part of that IA (roughly from Kingsville north).

Analysis of Le Conte's Sparrow CBC counts in the Louisiana portion of BCR 37 from 1985-86 to 2005-06 indicates that approximately 77.63% were from CBCs in the Louisiana portion of the GCJV Chenier Plain IA and about 22.37% were from the GCJV Mississippi River Coastal Wetlands IA. Based on those proportions, recommended allocation of Le Conte's Sparrow habitat objectives by Louisiana IAs is as follows:

Table 3: Le Conte's Sparrow Habitat Objectives by Initiative Area, Louisiana

Chenier Plain IA (Louisiana)	Mississippi River Coastal Wetlands IA
67,382 ac (27,268 ha)	19,418 ac (7,857 ha)

The Natural Resources Conservation Service (NRCS) Wildlife

Habitat Management Institute recommends that grassland patches managed for an array of nesting birds should be 500 acres or greater in size [United States Department of Agriculture 1999a (USDA)]. The minimum habitat block size for wintering Le Conte's Sparrow has not been identified, but small sites (< 200 ac or 81 ha) should probably be within a larger matrix (approximately 2,000 ac or 810 ha) of agriculture, pasture, or low intensity residential lands. Project Prairie Birds data (Texas Parks and Wildlife Department 2007) and other extant grassland bird data, analyzed in conjunction with land cover data such as NLCD, may be warranted to help address minimum block size and habitat interspersion questions. We opine that a properly managed native grassland site of 500 acres in BCR 37 should support Le Conte's Sparrow densities in the range observed by Grybowski (1982) and Baldwin (2005) during winter months. Habitat provided for Le Conte's Sparrow should be primarily vegetated in native grasses and subject to periodic disturbance, preferably fire, to reduce litter and limit shrub growth. Baldwin (2005) indicates that a 3-year fire frequency is suitable to optimal for sites in the Texas Mid-Coast IA. We assume that the same frequency would also be suitable to optimal for sites in other IAs. Ideally, areas managed for Le Conte's Sparrow would consist of a matrix of burned and unburned blocks, with all blocks burned every three years, but

Le Conte's Sparrow Research and Monitoring Needs:

- Acquire and analyze Project Prairie Bird and other data to determine suitable grassland patch size and landscape habitat matrix needed to support wintering birds
- Assess accuracy of PIF-derived population estimates for Le Conte's Sparrow in BCR 37
- Determine ideal mix of growing season and dormant season burns
- Assess effects of haying and grazing and the timing of those activities
- Assess the effectiveness of Le Conte's Sparrow habitat planning and management in addressing the needs of other priority grassland birds
- Simulate the impacts of predictions for cultivation of native grasses for ethanol production on Le Conte's Sparrow and other priority grassland birds

Le Conte's Sparrow Key Information

- Population Goal: 353,724 birds
- Modeled habitat characteristics: patches of native upland grasses ideally ≥ 500 ac in size, portions of which are disturbed, ideally through prescribed fire, every three years. Grass density should allow movement of birds at ground level, but provide overhead screening from avian predators
- Area requirement: 353,724 ac

on a staggered rotation, so that some habitat would be available to birds every winter. Le Conte's Sparrow will not use recently burned sites (less than 1 year post-burn). Their abundance peaks the second year post-burn, then begins to taper off the third year post-burn. Optimal burn season to provide Le Conte's Sparrow winter habitat is believed to range from approximately late March to late August, but it is also important to stagger disturbance times across and among sites. Ideally, a combination of growing season and dormant season burns should be used with growing season burns predominant.

Where prescribed fire is not an option, other disturbance methods may be beneficial. Grzybowski (1982) classified his grassland study sites on Welder Wildlife Refuge, Texas, by grazing intensities. He described three grazing intensities: 1) Lightly Grazed—dominant palatable grasses uniformly grown to heights approaching their maximum potential height; 2) Moderately Grazed—dominant palatable grasses occurring in distinct clumps; and 3) Heavily Grazed —dominant palatable grasses absent or present only in widely scattered clumps and/or grazed to near ground level. Grzybowski (1982) found that Le Conte's Sparrow occurred on Lightly Grazed and Moderately Grazed sites, but not on Heavily Grazed sites. Highest densities occurred on Moderately Grazed sites.

Mowing or haying may also be used to set back succession in the absence of fire or grazing. However, over time, plant species diversity may decline. We suggest that no winter (December through February) haying or mowing take place on Le Conte's Sparrow habitat sites (GCJV LWG 2006, personal communication). As with recommendations for fire above, optimal time for mowing or haying is from approximately late March to late August in order to provide winter habitat for Le Conte's Sparrow, but it is more important that disturbance time be staggered across and among sites, taking into account other priority grassland bird habitat objectives.

2. Northern Bobwhite

Northern Bobwhite is a permanent resident species in BCR 37. In Texas, the most dramatic quail reductions have occurred in the eastern half of the state, from east and north of a line from Fort Worth to Corpus Christi (Brennan et al. 2005). In Louisiana, primary quail habitat is in the northwestern and central part of the state, although the species is found throughout Louisiana (Lowery 1974). Texas' Northern Bobwhite population has declined approximately 5.6% per year since 1980 (Brennan et al. 2005). The Louisiana Quail and Grassland Bird Task Force states that the species has


Photo by Michael L. Gray

Northern Bobwhite

declined 75% since 1966 in that state (Louisiana Department of Wildlife and Fisheries 2005). PIF has assigned a population trend score of 5 to the species, indicating a significant decrease in population (Rich et al. 2004, Panjabi et al. 2005).

Northern Bobwhites use early successional habitat in a variety of landscape settings, including prairies, agricultural and pasture lands, open pine and pine-hardwood forests with well-developed grass/forb understories, and shrub-grassland range habitats (Brennan 1999, Burger 2001). They thrive in an interspersed mix of native bunchgrasses, forbs, and low woody cover. Maintenance of grassland habitat for Northern Bobwhite requires periodic disturbance, such as prescribed fire, disking, or carefully controlled grazing, to keep desirable bunchgrass and woody vegetation densities. Brennan et al. (2004, 2005) recommend that bunchgrass clumps for nesting Northern Bobwhites should be about 9 inches in diameter, at least 8 inches, but preferably 12 – 16 inches tall, and at densities of 300-500 clumps per acre. Adequate cover to escape predators is a critical component of suitable habitat. In addition, this cover must be close enough to food sources to allow birds safe passage, but not dense enough to impede travel on the ground (Jackson et al. 1990). Ideally, cover should consist of dense shrubs 3 – 10 ft tall, juxtaposed according to the "Hutchins 50:50 rule" which states that Northern Bobwhite should never be more than 50 yards from a clump of brush 50 ft in diameter (Brennan et al. 2005). For native rangelands in coastal Texas, Perez (2006) describes optimal brush canopy coverage as 15-30%, evenly distributed throughout the management unit, closed above, but open (up to about a foot) at ground level.

Northern Bobwhite is considered an indicator species for grassland habitat loss in BCR 37 (Brennan et al. 2005). Other declining grassland birds in this BCR that share a similar habitat include Eastern Meadowlark, Loggerhead Shrike, Northern Harrier, and Attwater's Greater Prairie-Chicken. While exact requirements vary for these species, they share a need for habitat elements that are becoming scarce such as native prairie plant assemblages, regeneration of habitat by fire, intact and contiguous landscapes, lack of invasive exotics, and low fire ant (*Solenopsis invicta*) density.

There are numerous habitat factors that have impacted bobwhite populations. The most important is probably habitat fragmentation (Brennan et al. 2005) due to changes in farming practices that favor large patches of uniform crops. Guthery (1997) demonstrated that in populations subject to hunting and weather catastrophes, a minimum of 700 birds is necessary to maintain a population for 100 years. A population of 700 requires approximately 3,500-7,000 ac (1,400-2,800 ha) of suitable habitat (Brennan et al. 2005). Very few parcels of land are left in the coastal prairies that meet this criterion.

The suppression of fire in coastal prairies has led to encroachment of dense brush, rendering much of this habitat suboptimal to unsuitable as Northern Bobwhite habitat (Smeins et al. 1991). Historically, fire was critical in order to maintain the native prairies of the coastal plains, with as much as 90% of coastal prairies burned every 4-6 years, or more frequently from anthropogenic (Native American) ignition (Perez 2006). Currently prescribed burning is an important management tool to combat degradation of prairies in the coastal plain, but increasing residential development in formerly rural areas makes prescribed burning more difficult.

Alteration of rangelands has occurred in several ways that have impacted quail populations. Many exotic grass species introduced for livestock forage are unsuitable as quail habitat due to their propensity to form thick mats of stems, which do not allow ground-level movement of birds. Throughout much of BCR 37, the first step for restoring Northern Bobwhite populations will be reduction or removal of exotic pasture grasses, such as bermudagrass and bahiagrass, and replacement with a diversity of native bunchgrasses and forbs (Brennan et al. 2005). Brush removal to increase grass production for grazing often creates habitat that lacks adequate cover for quail. Selective brush control, however, can be a beneficial tool for increasing quail habitat (Brennan et al. 2005). Grazing can create areas favorable for quail by disturbing rangeland soils, which allows certain food plants and grasses to grow. However, unless carefully controlled, grazing can remove significant cover and native bunchgrasses and render an area unsuitable for quail (Brennan et al. 2005).

Additional, detailed information regarding management of grassland, agricultural, and forested habitat for Northern Bobwhite can be accessed through the Northern Bobwhite Conservation Initiative [(NBCI), NBCI 2002], Brennan et al. 2005, and numerous other sources including many of the references in this section.

Other factors affecting quail populations include fire ants (Perez 2006), possible hunting pressures (Burger et al. 1995), and mammalian predators during the nesting season (Brennan et al. 2005). Burger et al. (1998) demonstrated that the timing of mortality has a marked effect on populations and trends. Higher overwinter survival facilitated a larger breeding population which resulted in a strong positive population trajectory.

Much has been written about strategies for returning bobwhite to their previous population levels (e.g., Brennen et al. 2005, Perez 2006). Before levels can be restored, the current declines must be stopped. For Texas, the objective is to stabilize quail populations in ten years (Brennan et al. 2005).

An important impediment to the restoration of quail habitat in the southeast is the changing public expectations for resource stewardship. As Burger (2001) points out: “Public perceptions of conservation remain linked with a single-minded focus on climax forest systems. Thus a ‘not so subtle’ conservation bias against early successional systems seems evident.” Since most natural disturbance processes have been disrupted in the southeast, human intervention with substitute disturbance regimes will be needed to create and maintain suitable bobwhite habitat. However, this is often in conflict with management strategies that favor the creation of wooded areas. In other southeastern states such as Georgia and Virginia, the focus of intensive quail management has shifted to private lands with the help of incentives for landowners (Barbour 2006, Burger 2001). Since 95% of the land in Texas is privately owned (A. Sansom 2007, personal communication) a similar strategy might be appropriate in parts of BCR 37. Several landowner incentive programs exist, such as Texas Parks and Wildlife Department's (TPWD) Pastures for Upland Birds, the Farm Service Agency's Conservation Reserve Program (CRP) Practice 33, Habitat Buffers for Upland Birds, and the NRCS Wildlife Habitat Incentives Program (WHIP). However, current landowner participation in these programs within BCR 37 is not sufficient to sustain populations of Northern Bobwhite and other priority grassland birds. Some of this lack of participation is due to inadequate advertisement of the conservation program options or perceived conflicts with current land uses. These information gaps and misconceptions should and can be relatively easily addressed through an effective landowner outreach program. This has been done in other states and BCRs with positive outcomes for grassland birds and other wildlife species.

Brennan et al. (2004) stepped-down and refined NBCI (2002) population and habitat objectives to the BCR level for Texas. The objective of both documents is to restore quail densities to 1980's levels.

Habitat Model:

Northern Bobwhite thrive in an interspersed mix of early successional habitats that provide nesting substrate, brood rearing cover, feeding and loafing areas, and escape cover. Native bunchgrasses provide ideal nest sites (USDA 1999b). Nests are typically located in grass clumps in close proximity to woody cover or edges, and bare soil (USDA 1999b). Brood-rearing cover is typically more open at ground level (i.e., up to 70% bare ground) than nesting habitat, enabling movement of chicks (USDA 1999b). Tall grasses, shrubs, and other low woody vegetation, with bare ground patches to facilitate movement, are used for loafing and escape cover (USDA 1999b).

The 2002 NBCI outlined a plan (Dimmick et al. 2002) to restore Northern Bobwhite populations to 1980 levels. Data from 1999 was used to illustrate declines and to provide a basis for comparisons to 1980. The NBCI assumes that nesting, brood-rearing, loafing, and escape cover can be provided through improvements to, and/or conversions of, a portion of the existing agricultural and forest land base. The targeted agricultural and forest management practices for BCR 37 are listed below.

Targeted Agricultural And Forest Management Practices

- Establishment of native warm season grass and forb field borders around agricultural fields – Planted or volunteer native grass and forb field borders, at least 15 feet wide, and optimally 30 feet wide or wider (Dimmick et al. 2002, Harper et al. 2007), can provide one or more of the cover/habitat types discussed above, dependent upon the condition of adjacent areas. Periodic disturbance, such as prescribed burning or light disking, is required on about a 3-year interval to maintain ground-level openness and to set back succession to forest (Dimmick et al. 2002, Harper et al. 2007).
- Conversion of exotic grass pasture and hayfields to native grasses—Mat-forming exotic grasses limit ground-level movement of quail, especially chicks. Establishment and appropriate management of native bunchgrass pastures and hayfields can provide nesting substrates, and brood, loafing, and escape cover (Dimmick et al. 2002, Harper et al. 2007). Native warm season grass haying dates are typically later than most commonly grown exotic forage grasses, and many grassland bird species can successfully complete nesting (Dimmick et al. 2002). The NBCI recommends that stubble heights resulting from grazing or haying should be at least 9 inches tall. Prescribed fire is recommended on a 3-year interval (Dimmick et al. 2002), and can be rotationally-applied to stands to ensure availability of cover (Harper et al. 2007).
- Implementation of quail-friendly rangeland management practices— Use of best management practices on rangeland, including rotational grazing, reduced stocking rates, use of prescribed fire on about a 3-year interval, control, but not elimination, of brush, and replacement of exotic forage with native grasses and forbs has the potential to provide a significant portion of the BCR 37 Northern Bobwhite population objective (Dimmick et al. 2002, Brennan et al. 2004). Brennan et al. (2004, 2005) recommended that grazing levels should leave between 300-500 nest sites per acre, with nest sites defined as bunchgrass clumps, about 9 inches in diameter and at least 8 inches, but preferably, 12 – 16 inches tall.
- Conversion of agricultural fields to native grasslands through the USDA CRP
- Conversion of extant exotic CRP grasslands to native grasses

Population and habitat objectives calculated using NBCI assumptions for Louisiana and Texas are described below. For both states, we adopt the NBCI objective to restore the density of bobwhites found on 1980 habitats to the available bobwhite habitat in 1999.

Louisiana, BCR 37

Potential habitat in the LA portion of BCR 37 in 1980 is derived from Appendix D of the NBCI, the NRCS 1982 Natural Resources Inventory (NRI), and assumes that all cover types except rangeland represent potential Northern Bobwhite habitat. Population trends are from state quail route data, and harvest data are derived from state hunter questionnaires. Potential habitat in 1999 is derived from Appendix E, NBCI, 1997 NRI data, and assumes that cropland, pasture/hay, and pineland cover types represent potential Northern Bobwhite habitat.

Louisiana, BCR 37: Estimates and Assumptions

- 1980 harvest estimate, = 40,720 birds
- 1980 potential habitat, = 5,609,500 ac
- population decline of 53% from 1980 - 1999
- 1980 harvest represents 33% of total pre-harvest population
- 1999 potential habitat = 4,538,400 ac
- A covey = 12 birds

Intermediate Calculations:

- 1980 population = 40,720 harvest/33% harvest rate = 123,394 birds
- 1980 density = 123,394 birds/5,609,500 ac = 1 bird/45 ac
- 1999 population = 1980 population x 0.47 = 57,995 birds
- 1999 coveys = 57,995 birds/12 birds per covey = 4,833 coveys
- Population objective = 1980s density/1999 habitat = (1 bird/45 ac) x 4,538,400 ac = 100,853 birds
- Covey objective = 100,853 birds/12 birds per covey = 8,404 coveys
- Covey deficit = 8,404 objective-4,833 coveys in 1999 = 3,571 coveys

Potential Habitat from 1997 NRI

- 1997 cropland, LA BCR 37 = 3,250,800 ac
- 1997 pasture/hay, LA BCR 37 = 609,300 ac
- 1997 pineland, LA BCR 37 = 678,300 ac
- Total potential habitat = 4,538,400 ac
- 4,538,400 ac/45 ac per bird = 100,853 birds or 8,404 coveys

100,853 birds (8,404 coveys) are required to meet 1980 Northern Bobwhite densities on existing habitat. The 1999 covey estimate for LA BCR 37 is 4,833 coveys. Thus, 3,571 new coveys are needed to achieve the desired density.

Assumptions regarding improvable habitats and population impacts:

- Up to 1% of cropland can be improved by the use of native grass/forb field borders and 8 ac of field borders will produce 1 covey
- Up to 2% of pasture/hay can be converted to native grasses and 12 ac of native pasture/hay will produce 1 covey
- Up to 10% of pinelands can be thinned and burned and 150 ac of improved pineland will produce 1 covey
- Up to 26,000 ac of native grass may be established through LA CREP II (a new Farm Bill conservation program anticipated for delivery in 2008 in LA BCR 37) and support 1 covey/12 ac

The covey objective can be obtained through a nearly infinite combination of acreage allocations to the improvable habitat types listed above. We chose to allocate acreages to the 4 above categories proportionately and in a manner that met the target without surplus.

Potential coveys achieved through actions on Habitat Types listed above:

- Improvable cropland ac, 1997 LA BCR 37 = 3,250,800 ac X 0.046% = 15,080 ac/8 ac per covey = 1,885 coveys
- Improvable pasture/hay, 1997 LA BCR 37 = 609,300 ac X 0.928% = 5,663 ac/12 ac per covey = 471 coveys
- Improvable pineland, 1997 LA BCR 37 = 678,300 ac X 4.63% = 31,466 ac/150 ac per covey = 210 coveys
- LA CREP II grass = 12,061 ac/12 ac per covey = 1,005 coveys
- Total new coveys = 3,571

Texas, BCR 37

Assumptions used by Brennan et al. (2004) to calculate Northern Bobwhite population and habitat objectives for BCR 37 differ from those used in the NBCI and the Louisiana calculations above. Our calculations differ from those in Brennan et al. (2004) in that we did not consider 1997 forested acres as potential quail habitat. Additionally, we chose to vary the proportions of improvable habitat from those used by Brennan et al. (2004), to produce the desired population objective with a minimal surplus.

Texas, BCR 37 Estimates & Assumptions:

- 1980 harvest estimate, = 53,696 birds
- 1980 potential habitat = 13,089,900 ac
- Harvests represent 10% of total/preharvest populations
- 1999 harvest estimate, = 17,410 birds
- A covey = 12 birds

Potential habitat in the BCR 37 portion of Texas in 1980 is derived from Appendix E (the NRCS 1982 NRI) of Brennan et al. (2004), and assumes that cropland, pasture/hay, and rangeland cover types represent potential Northern Bobwhite habitat.

Intermediate Calculations:

- 1980 population = 53,696 birds/10% harvest rate = 536,960 birds
- 1980 density = 536,960 birds/13,089,900 ac = 0.0410 birds/ac
- 1999 population = 17,410 birds/10% harvest rate = 174,100 birds
- 1999 coveys = 174,100 birds/12 birds per covey = 14,508 coveys
- Population objective = 1980s density/1999 habitat = 0.0410 birds per ac x 12,806,100 ac = 525,050 birds
- Covey objective = 525,050 birds/12 birds per covey = 43,754 coveys
- Covey deficit = objective 43,754 - 14,508 coveys in 1999 = 29,246 coveys

Potential bobwhite habitat from 1997 NRI:

- 1997 cropland, TX BCR 37 = 5,009,900 ac
- 1997 pasture/hay, TX BCR 37 = 2,125,900 ac
- 1997 rangeland, TX BCR 37 = 5,670,300 ac
- Total potential habitat = 12,806,100 ac

525,050 birds are required to meet 1980 Northern Bobwhite densities on existing habitat. The 1999 Northern Bobwhite population estimate is 174,100 birds, so subtracting that from 525,050 yields 350,950 birds, or 29,246 coveys. This is the target number of coveys needed to achieve 1980's densities on the current land base, excluding forested acres.

Assumptions regarding iimprovable habitats and population impacts:

- 7% of cropland can be improved, and 100 ac of improved cropland will produce 1 covey
- 14% of pasture/hay can be improved, and 100 ac of improved pasture/hay will produce 1 covey
- 40% of rangeland can be improved, and 100 ac of improved rangeland will produce 1 covey
- 40% of CRP grassland can be improved, and 100 ac of improved CRP grassland will produce 1 covey

Potential coveys achieved through actions listed above:

- Improvable cropland ac, 1997 TX BCR 37 = 5,009,900 ac X 0.07 = 350,693 ac/100 acres per covey = 3,506 coveys
- Improvable pasture/hay, 1997 TX BCR 37 = 2,125,900 ac X 0.14 = 297,626 acres/100 ac per covey = 2,976 coveys
- Improvable rangeland, 1997 TX BCR 37 = 5,670,300 ac X 0.4 = 2,268,120 ac/100 ac per covey = 22,681 coveys
- Improvable CRP grassland, 1997 TX BCR 37 = 20,900 ac X 0.4 = 8,360 ac/100 acres per ac = 83 new coveys
- Total coveys produced = 29,246

Mississippi, BCR 37

The NBCI does not report any harvest information for the Mississippi portion of BCR 37, so it is not possible to calculate 1980 population densities and set goals based upon currently available habitat per NBCI methodology. PIF estimates current Northern Bobwhite in that region at 120 birds, but assigns its lowest level of confidence to that estimate (RMBO 2007). A tentative goal is to increase that population to 240 birds, per PIF population goals (i.e., double existing population).

A revision of the NBCI is planned using 2002 NRI data (Southeast Quail Study Group website, 2008). That revision may result in new population and habitat objectives for BCR 37.

Northern Bobwhite research and monitoring needs most relevant to GCJV planning efforts are listed below. For additional research and monitoring considerations, see Brennan (1999).

Northern Bobwhite Research and Monitoring Needs:

- Assess the effectiveness of Northern Bobwhite habitat planning and management in addressing the needs of other priority grassland birds
- Test habitat carrying capacity assumptions used in developing habitat objectives for Texas and Louisiana BCR 37
- Simulate impacts of the predicted cultivation of native grasses for ethanol production on Northern Bobwhite and other priority grassland birds

Northern Bobwhite Key Information

- Population Goal: 626,143 birds
- Modeled Habitat Characteristics: early successional habitat, 3,500 to 7,000 ac in size including agricultural fields, pastures, native prairies, grass-brush rangelands, and open park-like pine forests. Native bunchgrasses 12 – 16 inches tall, in ~9 inch diameter clumps, ideal as nest sites. 300 – 500 native bunchgrass clumps per acre should be provided for nesting. For escape and brood cover, low woody vegetation is essential, and should be provided in close proximity to nesting habitat. Low woody vegetation cover should be in the range of 15 – 30%. Periodic disturbance, through fire, disking, rotational grazing, or mowing is essential to maintain appropriate habitat structure, and should be applied about every 3 years. Management units can be subdivided and disturbed rotationally to ensure availability of cover.
- Area Requirement: ~2,989,069 ac improved, ~14,355,431 ac in current condition

3. Loggerhead Shrike


Photo by Michael L. Gray

Loggerhead Shrike

Loggerhead Shrike is a permanent resident throughout BCR 37. The populations along the Gulf coast are joined in winter by birds that breed in more northerly areas of the U.S. and Canada (roughly above 40 degrees north latitude). Resident birds remain on territories throughout the year (Yosef 1996). The global population estimate from Rich et al. (2004) is 4.2 million birds, but the same source indicates a steep population decline (population trend score of 5). Possible reasons for this decline include pesticide impacts, loss of habitat due to altered agricultural practices, and complications from the introduction of fire ants (Lymn and Temple 1991).

The preferred habitat of Loggerhead Shrike in breeding season and winter is open country with scattered bushes, including pastures with hedgerows, orchards, and roadway edges (Yosef 1996). Scattered shrubs or trees, particularly thick or thorny species, serve as nesting substrates and hunting perches (Dechant et al. 1998). In a 1991 to 1993 study of Loggerhead Shrikes in Florida pastureland, Yosef (2001) found that the majority of nests were placed in thorny shrubs that were somewhat isolated and not located along fencerows. Species commonly used as nest substrates include hawthorns (*Crataegus* sp.) and eastern red cedar (*Juniperus virginiana*) (Yosef 1996). Thorny vegetation and fences also provide sharp projections, known as impaling stations, required by Loggerhead Shrike to hang prey items for dismembering or storage. This habitat has been steadily shrinking for the past thirty years, with changes in agricultural practices, loss of hayfields, and elimination of hedgerows. Additionally, native grassland restoration and/or management plans often seek to eliminate woody shrubs and trees required by the species for nests and perches (Hands et al. 1989). The GCJV LWG tentatively recommends that 3 - 10 shrubs or small trees per acre should be available for shrike perches and nest substrates.

Loggerhead Shrikes are opportunistic predators, feeding on a wide variety of small prey including insects, small mammals, birds, reptiles, and amphibians (Kridelbaugh 1983). Insects are typically the most frequently consumed prey, with beetles and grasshoppers commonly consumed (Yosef 1996). Prey capture typically takes place in grassland habitats, but it is not entirely clear whether short, medium, or tall grasses are preferred for foraging (Yosef 1996). Michaels and Cully (1998), however, found that structural heterogeneity of herbaceous vegetation was important in site-level habitat selection by Loggerhead Shrike, and suggested that adequate foraging habitat included tall herbaceous vegetation, scattered trees or shrubs, and bare ground areas.

Other grassland birds such as Grasshopper Sparrow and Eastern Meadowlark share similar geographic ranges and habitat requirements in both winter and summer. These two species also show downward population trends, and the loss of native grasslands and changes in agricultural practices have likely impacted these species as well (Vance 1976).

The decline in Loggerhead Shrike populations has been explained by several factors, including those listed above. Undoubtedly, the use of some pesticides was a major factor between 1957 and 1965 (Anderson and Duzan 1978). Organochlorines like DDT were responsible for the thinning of eggshells, killing prey such as grasshoppers, and poisoning the birds themselves. Despite the ban on these pesticides in the 1970's, shrike populations have continued to decline.

Midwestern land cover has changed dramatically in the last 100 years (Sample 1989). Small farms with much pastureland (preferred shrike habitat) have been replaced by large monocultures of alfalfa and corn. Although insufficient breeding habitat has been mentioned as a possible factor behind shrinking shrike populations, Brooks and Temple (1990) found that a significant amount of potential shrike breeding habitat in Minnesota was not utilized. This situation seems to repeat in much of the Midwest (Lymn and Temple 1991). This suggests that lack of breeding habitat, at least in the northern portions of Loggerhead Shrike breeding range, is not a major factor limiting their populations.

While it is known that northern populations of Loggerhead Shrike migrate to the Gulf coast to winter, the exact routes and wintering locales of the various northern populations is not well understood (Yosef 1996). Gulf coast habitats have undergone dramatic changes in the last 40 years, including changes in agricultural practices to "cleaner" farming and larger fields, and expanding residential and commercial development. This decrease in winter habitat (and presumed overwinter mortality impacts) appears to be a significant factor in shrike declines (Temple 1988). Yosef and Grubb (1992) suggested that a loss of hunting perches through habitat change may be a significant contributor to population declines on the wintering grounds. It has also been demonstrated that resident shrikes (which are also declining) will defend the best quality habitat in winter, which forces migrant birds to utilize marginal land (Brooks 1988).

Another potential factor in the decline of Loggerhead Shrike across the Gulf coast is the introduction of imported red fire ants near Mobile, Alabama in the 1930's (Lymn and Temple 1991). The ant has spread across most of nine southeastern states and infests more than 260 million ac (105 million ha) of land (Lofgren 1985). Fire ants and Loggerhead Shrikes often share the same habitat, and the ant is a threat to Loggerhead Shrikes in several ways. Fire ants are aggressive predators and feed on most of the same food items preferred by shrikes, including grasshoppers, crickets, beetles, small mammals, and birds. Also damaging to shrikes were the aggressive fire ant eradication programs using large quantities of pesticides between 1957 and 1977. These toxins not only took a heavy toll on insects that shrikes depend on for food, but also poisoned the birds and affected their ability to hunt (Busbee 1977). Fire ant impacts on wildlife remains a controversial topic, and Yosef and Lohrer (1995) urged caution, as the impacts of broad-scale pesticide applications in an effort to control fire ants may be more damaging to Loggerhead Shrikes than the ants' impacts. Allen et al. (2001), however, found insect volume, insect species richness and diversity, and Loggerhead Shrike abundance to be greater on sites treated with fire ant baits than on control sites.

Despite the negative habitat changes noted above, changes are taking place that may help shrike populations. Loggerhead Shrikes will colonize urban and suburban areas if general habitat parameters are present. This is readily noticeable in the city of Houston (B. Eley 2007, personal observation), where shrike populations have increased in recent years as the city has rapidly expanded its borders. Shrikes have also expanded their range into the Rio Grande Valley of Texas as intensively-farmed agricultural land has been replaced by urbanization (J. Arvin 2007, personal communication). However, breeding success in these habitats is not known.

Management practices to aid Loggerhead Shrikes have been delineated in the comprehensive study by Dechant et al. (1998). These practices are summarized here.

1. Preserve native prairie whenever possible.
2. Take advantage of Farm Bill provisions that encourage conservation activities on agricultural land.
3. Preserve areas of suitable breeding habitat that encompass several territories and are asymmetrical in shape.
4. Maintain low, thick shrubs and bushes along fence lines, abandoned farmyards, and throughout open pastures and fields.
5. Use appropriate combinations of grazing, burning, and mechanical manipulation to control woody vegetation without eliminating it.
6. Where key patches of non-thorny palatable woody vegetation occur, consider fencing to protect them from cattle grazing and/or rubbing.
7. Improve habitats by manipulating herbaceous cover density, planting multiple rows of trees, adding larger blocks of grassland habitat adjacent to strips of woody vegetation, or planting thorny, native vegetation in fencerows
8. Curtail use of pesticides when possible to protect insects and other prey species.

Recent research has rekindled interest in the behavioral aspects of habitat selection, principally *conspecific attraction*. Some passerines (especially grassland species) in the process of selecting territories cue in on the presence of nearby singing males in addition to the structure of the habitat (Ahlering and Faaborg 2006, Muller et al. 1997, Schlossberg and Ward 2004). While this behavior has been long-studied in colonial-nesting species, its occurrence in territorial passerines has only recently been demonstrated. This behavior probably occurs because it gives dispersing males a source of information about the quality of habitat that might be selected for a territory, and it increases opportunities for extrapair fertilizations. While research is still preliminary concerning the use of conspecific attraction in conservation, an artificial stimulus might be useful in attracting birds to suitable, unused habitat. Since Loggerhead Shrikes are highly territorial and are known to engage in extrapair copulation, this conservation strategy could have potential.

To step down PIF's BCR 37 population estimate to the level of GCJV IAs, we reviewed data collected from BBS routes inside or intersecting BCR 37, and grouped them by IA. Only routes with ≥10 years of data were considered. The BBS provides data on average number of species-per-route. For each IA, we multiplied its relative bird density by its area to arrive at relative bird abundance. These IA-specific relative bird abundances were then expressed as percentages of the sum of all relative bird abundances across IAs. Multiplying these percentages by the global population estimate yields a resident population estimate for each IA.

Habitat Model:

- PIF estimates the global Loggerhead Shrike population at 4,200,000 individuals (RMBO 2007) with the estimated resident population in the U.S. portion of BCR 37 at 280,600 birds.
- Louisiana hosts 170,000,
- Texas 110,000
- and Mississippi 600 (RMBO 2007).
- PIF's goal is to double the continental population of Loggerhead Shrike (Rosenberg 2005).

Louisiana

- 84.53% of Loggerhead Shrike were detected on BBS routes in the Louisiana Chenier Plain IA; 84.53% of 170,000 = 143,700 resident Loggerhead Shrike in the Louisiana Chenier Plain IA
- 15.47% of Loggerhead Shrike were detected on BBS routes in the Mississippi River Coastal Wetlands IA; 15.47% of 170,000 = 26,299 resident Loggerhead Shrike in the Mississippi River Coastal Wetlands IA

Texas

- 23.13% of Loggerhead Shrike were detected on BBS routes in the Texas Chenier Plain IA; 23.13% of 110,000 = 25,445 resident Loggerhead Shrike in the Texas Chenier Plain IA
- 73.99% of Loggerhead Shrike were detected on BBS routes in the Texas Mid-Coast IA; 73.99% of 110,000 = 81,386 resident Loggerhead Shrike in the Texas Mid-Coast IA
- 2.88% of Loggerhead Shrike were detected on BBS routes in the Laguna Madre IA; 2.88% of 110,000 = 3,168 resident Loggerhead Shrike in the Laguna Madre IA

To derive an estimate of the number of migratory Loggerhead Shrike over-wintering in BCR 37, we used the map and written description of the species' range from the Birds of North America account (Yosef 1996), along with several assumptions:

Assumptions:

- Migratory Loggerhead Shrike populations east of the Rocky Mountains migrate to the southeastern states, Texas, and the Atlantic (Gulf of Mexico) coast of Mexico;
- Migratory Loggerhead Shrike populations west of the Rocky Mountains do not migrate east of the Rocky Mountains;
- For states and provinces intersected by the Rocky Mountains and having a portion of their area east of the Rocky Mountains, the entire state or provincial population of Loggerhead Shrike migrates to the southeastern states and Texas; and,
- The entire Loggerhead Shrike populations of Missouri, Colorado and Nebraska are migratory.

Using the criteria above, states and provinces whose Loggerhead Shrike population migrates to the southeastern states, Texas, and the Atlantic coast of Mexico are Alberta, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Manitoba, Minnesota, Missouri, Montana, Nebraska, North Dakota, Ohio, Ontario, Saskatchewan, South Dakota, Wisconsin, and Wyoming. The estimated population of Loggerhead Shrike from those states and provinces is 1,081,400 (RMBO 2007).

Using the process described for derivation of Le Conte's Sparrow wintering population estimates, we analyzed Loggerhead Shrike CBC data from the winter of 1989-90 to the winter of 2005-06 for the southeastern states, Texas, and Mexico. Approximately 11.35% of Loggerhead Shrike reported during that time period and area were in Louisiana, while 48.95% were recorded in Texas.

- 11.35% of 1,081,400 = 122,709 = Louisiana migratory Loggerhead Shrike winter population
- 48.95% of 1,081,400 = 529,386 = Texas migratory Loggerhead Shrike winter population

We then analyzed CBC average party-hour data for count circles in Louisiana and Texas from 1989-90 to 2005-06 to obtain an estimate of the proportion of Loggerhead Shrike counted inside and outside BCR 37 in those states.

- In Louisiana, 36.44% of Loggerhead Shrike were recorded on counts in BCR 37.
- 36.44% of 122,709 = 44,712 = Louisiana migratory Loggerhead Shrike winter population, BCR 37
- In Texas, 9.33% of Loggerhead Shrike counts were from CBCs in BCR 37.
- 9.33% of 529,386 = 49,368 = Texas migratory Loggerhead Shrike winter population, BCR 37

We then stepped those estimates for each state's portion of BCR 37 to the level of GCJV IA (Table 4).

Louisiana

- 78.24% of Loggerhead Shrike were counted in the Louisiana Chenier Plain IA; 78.24% of 44,712 = 34,982 = Louisiana Chenier Plain migratory Loggerhead Shrike winter population
- 21.76% of Loggerhead Shrike were counted in the Mississippi River Coastal Wetlands IA; 21.76% of 44,712 = 9,729 = Mississippi River Coastal Wetlands IA migratory Loggerhead Shrike winter population

Texas

- 15.30% of Loggerhead Shrike were counted in the Texas Chenier Plain IA; 15.30% of 49,368 = 7,553 = Texas Chenier Plain IA migratory Loggerhead Shrike winter population
- 68.80% of Loggerhead Shrike were counted in the Texas Mid-Coast IA; 68.80% of 49,368 = 33,964 = Texas Mid-Coast IA migratory Loggerhead Shrike winter population
- 15.90% of Loggerhead Shrike were counted in the Laguna Madre IA; 15.90% of 49,368 = 7,850 = Laguna Madre IA migratory Loggerhead Shrike winter population

For Mississippi, the current BCR 37 resident population estimate is 600 birds. CBC circle coverage is very limited for coastal Mississippi in general, and specifically for the BCR 37 portion of that state. Since the estimate for migratory Loggerhead Shrike in the Louisiana portion of BCR 37 is approximately 26.30% of the resident population for that area, and the estimate for migratory Loggerhead Shrike in the Texas portion of BCR 37 is approximately 44.88% of the resident population for that area, we used the average of those two percentages and estimated that roughly 213 (35.59% of 600) migratory Loggerhead Shrike over-winter in the Mississippi portion of BCR 37.

Though the possible reasons for observed declines in Loggerhead Shrike populations are numerous, most can be linked to changes in habitat. We are assuming that availability of suitable foraging habitat is the most important factor in BCR 37. Several studies have investigated Loggerhead Shrike territory sizes. The species account from the Birds of North America (Yosef 1996) reports the following territory sizes:

- Alberta – 33.11 ac (13.4 ha)
- San Clemente Island, CA – 84.02 ac (34 ha)
- Missouri – 11.37 ac (4.6 ha)
- New York – 18.53 ac (7.5 ha)
- Florida – 20.63 ac (8.35 ha)
- Mainland California – 21 ac (8.5 ha)
- Idaho – 21.99 ac (8.9 ha)
- Idaho – 61.78 ac (25 ha)

Loggerhead Shrike Key Information

- Population Goal: 809,778 birds
- Modeled Habitat Characteristics: open grasslands, including native prairie, pastures with hedgerows, orchards, and roadway edges, with scattered (~3 – 10/acre) small trees and large shrubs, preferably thorny, in patches at least 60 ac in size, and preferably 500 acres or larger. Estimated patch size required to sustain a population of 500 breeding pairs is 20,000 acres, and could include a combination of native grasslands, pasture, row crop agriculture, savannah (grassland with scattered trees) and low-intensity residential development. Pesticide use on Loggerhead Shrike habitat should be minimal to nil; however, spot treatment of imported fire ant mounds may be beneficial in some instances.
- Area Requirement: 2,780,690 ac.

Based upon the above, 20 ac (8 ha) was chosen as the average resident Loggerhead Shrike territory size in BCR 37. We also assumed that migratory Loggerhead Shrike have territory sizes of approximately 5 ac (2 ha) per bird in BCR 37, which roughly represents half the territory size of an individual resident Loggerhead Shrike (Table 4). PIF's population objective for Loggerhead Shrike is to double the existing population.

Louisiana BCR 37

- Louisiana Chenier Plain IA
- Population Objective, Resident Loggerhead Shrike = 287,400 birds = 143,700 pairs X 20 ac/pair = 2,874,000 ac (1,163,066 ha)
- Population Objective, Migratory Loggerhead Shrike = 69,964 birds 5 ac/bird = 349,820 ac (141,567 ha)
- Total Louisiana Chenier Plain IA = 3,223,820 ac (1,304,633 ha)
- Mississippi River Coastal Wetlands IA
- Population Objective, Resident Loggerhead Shrike = 52,598 birds = 26,299 pairs X 20 ac/pair = 525,980 ac (212,856 ha)
- Population objective, Migratory Loggerhead Shrike = 19,458 birds X 5 ac/bird = 97,290 ac (39,371 ha)
- Total Mississippi River Coastal Wetlands IA = 623,270 ac (252,228 ha)
- **Total Louisiana BCR 37 = 3,847,090 ac (1,556,862 ha)**

Table 4: Loggerhead Shrike Population and Habitat Objectives, Louisiana BCR 37

Initiative Area	Resident Population Estimate	Resident Population Objective	Migratory Population Estimate	Migratory Population Objective	Habitat Objective (20 ac/ Resident Pair; 5 ac/ Migrant)
LA Chenier Plain	143,700	287,400	34,982	69,964	3,223,820 ac (1,304,633 ha)
MS River Coastal Wetlands	26,299	52,598	9,729	19,458	623,270 ac (252,228 ha)
Total LA BCR 37	**169,999**	**399,998**	**44,711**	**89,422**	**3,847,090 ac (1,556,862 ha)**

Texas BCR 37

- Texas Chenier Plain IA
- Population Objective, Resident Loggerhead Shrike = 50,890 birds = 25,445 pairs X 20 ac/pair = 508,900 ac (205,944 ha)
- Population Objective, Migratory Loggerhead Shrike = 15,106 birds X 5 ac/bird = 75,530 ac (30,566 ha)
- Total Texas Chenier Plain IA = 584,430 ac (236,510 ha)
- Texas Mid-Coast IA
- Population Objective, Resident Loggerhead Shrike = 162,772 birds = 81,386 pairs X 20 ac/pair = 1,627,720 ac (658,715 ha)
- Population Objective, Migratory Loggerhead Shrike = 67,928 birds X 5 ac/bird = 339,640 ac (137,447 ha)
- Total Texas Mid-Coast IA = 1,967,360 ac (796,162 ha)
- Laguna Madre IA
- Population Objective, Resident Loggerhead Shrike = 6,336 birds = 3,168 pairs X 20 ac/pair = 63,360 ac (25,641 ha)
- Population Objective, Migratory Loggerhead Shrike = 15,700 birds X 5 ac/bird = 78,500 ac (31,768 ac)
- Total Laguna Madre IA = 141,860 ac (57,409 ha)
- **Total Texas BCR 37 = 2,693,650 ac (1,090,081 ha)**

Table 5: Loggerhead Shrike Population and Habitat Objectives, Texas BCR 37

Initiative Area	Resident Population Estimate	Resident Population Objective	Migratory Population Estimate	Migratory Population Objective	Habitat Objective (20 ac/ Resident Pair; 5 ac/ Migrant)
TX Chenier Plain	25,445	50,890	7,553	15,106	584,430 ac (236,510 ha)
TX Mid-Coast	81,386	162,772	33,964	67,928	1,967,360 ac (796,162 ha)
Laguna Madre	3,168	6,336	7,850	15,700	141,860 ac (57,409 ha)
Total TX BCR 37	**109,999**	**219,998**	**49,367**	**98,734**	**2,693,650 ac (1,090,081 ha)**

Mississippi BCR 37

- Population Objective, Resident Loggerhead Shrike = 1,200 birds = 600 pairs X 20 ac/pair = 12,000 ac (4,856 ha)
- Population Objective, Migratory Loggerhead Shrike = 426 birds X 5 ac/bird = 2,130 ac (862 ha)

Total Mississippi BCR 37 = 14,130 ac (5,718 ha)

Table 6: Loggerhead Shrike Population and Habitat Objectives, Mississippi BCR 37

Resident Population Estimate	Resident Population Objective	Migratory Population Estimate	Migratory Population Objective	Habitat Objective (20 ac/ Resident Pair; 5 ac/ Migrant)
600	1,200	213	426	14,130 ac (5,718 ha)

The total area of BCR 37 is approximately 16,444,683 ac (6,655,000 ha), divided among the three states as follows:

- TX BCR 37 – 10,182,719 ac (4,120,800 ha)
- LA BCR 37 – 6,239,658 ac (2,525,100 ha)
- MS BCR 37 – 22,487 ac (9,100 ha)

The 2001 NLCD categorizes habitat in BCR 37 as the classes listed below. To assess the capacity of existing BCR 37 habitat to meet resident Loggerhead Shrike habitat objectives, a (liberal) percentage was assigned to each NLCD class, denoting potentially available Loggerhead Shrike habitat, shown in the table below:

Table 7: Percent Potential Loggerhead Shrike Habitat by NLCD Class

NLCD Class	Percent Potentially Available as Loggerhead Shrike Habitat
Developed, High Intensity	0
Developed, Medium Intensity	0
Developed, Low Intensity	1
Developed, Open Space	50
Cultivated Crops	10
Pasture/Hay	100
Grassland/Herbaceous	100
Deciduous Forest	5
Evergreen Forest	5
Mixed Forest	5
Scrub/Shrub	50
Palustrine Forested Wetland	5
Palustrine Scrub/Shrub Wetland	50
Palustrine Emergent Wetland	5
Estuarine Scrub/Shrub Wetland	50
Estuarine Emergent Wetland	5
Unconsolidated Shore	0
Bare Land	0
Open Water	0
Palustrine Aquatic Bed	0

Using those assumed percentages, the potential Loggerhead Shrike habitat by state in BCR 37 are as follows:

- TX BCR 37 – 4,115,216 ac (1,665,369 ha)
- LA BCR 37 – 810,559 ac (328,021 ha)
- MS BCR 37 – 1,666 ac (674 ha)

Comparing BCR 37 Loggerhead Shrike Population and Habitat Objectives with potentially available habitat yields the following:

Table 8: Comparison of Loggerhead Shrike Population and Habitat Objectives with Potentially Available Habitat

Area	Loggerhead Shrike Population Objective	Habitat Required	Potential Habitat Available	Habitat Surplus or Deficit
TX BCR 37	318,732	2,693,650 ac	4,115,216 ac	1,421,566 ac
LA BCR 37	489,420	3,847,090 ac	810,559 ac	-3,036,531 ac
MS BCR 37	1,626	14,130 ac	1,666 ac	-12,464 ac

It is evident from the table above that, assuming a territory size of 20 ac for resident pairs and 5 ac for migrants, neither the Louisiana nor Mississippi portion of BCR 37 can support Loggerhead Shrike population objectives as defined by PIF. In fact, the estimated extant resident population in Louisiana (85,000 pairs) and Mississippi (300 pairs) could not be supported by potentially available habitat in those states. It seems likely that the error lies in the PIF resident Loggerhead Shrike population estimate for Mississippi and Louisiana, unless Loggerhead Shrike territory sizes are for some reason significantly smaller than any observed in prior studies.

Until the BCR 37 Loggerhead Shrike population estimate can be improved, we recommend using the estimate for the Texas portion of the BCR shown above, adopting the larger of the grassland habitat goals calculated for Northern Bobwhite and Le Conte's Sparrow in Louisiana and Mississippi:

- TX BCR 37 - 2,693,650 ac (1,090,081 ha) (see Table 5)
- LA BCR 37 - 86,800 ac (35,126 ha) [Le Conte's Sparrow habitat goal 78% (67,382 ac) in the LA Chenier Plain IA; 22% (19,418 ac) in the MS River Coatal Wetlands IA]
- MS BCR 37 – 240 ac (98 ha) (Northern Bobwhite habitat goal, assuming 1 covey per 12 ac suitable habitat = 20 coveys or 240 birds)

Loggerhead Shrike Research and Monitoring Needs

- Improve estimates of resident and migratory population sizes
- Assess territory shape, size, and habitat requirements in BCR 37
- Determine general productivity and vital rate data for resident birds in various habitats (i.e., agriculture, range, conservation managed lands)
- Compare habitat use and territory size of resident versus migratory shrikes
- Identify important factor(s) leading to reduced winter survival
- Conduct stable isotope studies to determine proportion of migrant vs. resident shrikes in winter
- Assess suitability of habitat in residential areas
- Quantify significance of fire ants as limiting factor to breeding or wintering individuals
- Simulate the impacts of predictions for cultivation of native grasses for ethanol production on Loggerhead Shrike and other priority grassland birds
- Explore the value of conspecific attraction theory to attract individuals to unoccupied habitat

Integration of Grassland Habitat Objectives

The three priority grassland bird species treated above have similar, but not overlapping, habitat requirements. If the species with the largest habitat objective is the most habitat specific, that acreage could be sufficient to account for all three. Ideally, habitat components needed by all three (and other) species could be provided in a habitat matrix. For example, to the extent that Northern Bobwhite habitat also has perches and nest substrates available for Loggerhead Shrike, then it could be assumed to meet the needs of all three species. If Le Conte's Sparrow habitat possesses shrubs and trees that provide perches and nest substrates for Loggerhead Shrike, and those woody species are configured in such a fashion to serve Northern Bobwhite cover requirements, then it could be assumed to meet the needs of all three species. If Loggerhead Shrike habitat is subject to periodic disturbance that enables ground level movement of birds, but with some overhead screening cover, and additional patches of woody cover for Northern Bobwhite needs, then it could be assumed to serve all three species. Based upon current knowledge, it appears that Le Conte's Sparrow has the least exacting requirements of the three species.

Coastal Forests

Coastal forests in BCR 37 include chenier woods; several bottomland hardwood and cypress-tupelo forest areas that are associated with large river systems that empty into the Gulf of Mexico such as the Pearl River basin, the Atchafalaya River basin, and the Columbia Bottomlands; and the live oak mottes of south Texas. Each of these forest systems are potentially critical stopover areas for nearctic-neotropical migrants (Barrow et al. 2000). The cheniers are primarily oak and hackberry wooded areas on relic beach ridges paralleling the coast of Louisiana and extreme southeastern Texas. Although the diversity of plant species in cheniers and other maritime forests is somewhat limited, they provide emergency cover and food for migrants that cross the Gulf and are forced to land because of inclement weather (Moore 1999). These coastal woodlands also receive significant use by southbound migrants, as they make their way along the Gulf of Mexico rim en route to Central and South American wintering areas. In fall, many migrants are choosing to use these habitats, rather than being forced by circumstances. BCR 37's riverine bottomland hardwood forests are key migration corridors due to their generally rich avian food resources and proximity to the Gulf (see Figure 4, Appendix A).

Nearctic-neotropical migrants use these habitats opportunistically, depending on weather and fitness. Most migrants pass over the coast and land inland during periods of southerly winds (Lowery 1974). With strong southerly tail winds to facilitate migration, the migrants have some choice about habitat selection and probably gravitate to their favored foraging habitat. When forced into cheniers or other near-shore forest types, limited resources due to competition and lack of stratification force migrants to be more plastic in their selection of habitat (Moore and Aborn 2000). However, Buler et al. (2007) showed that, at least in coastal Mississippi, migrant landbirds preferentially selected nearshore habitats, rather than being forced to utilize them due to inclement weather. The same nearshore habitat selection may be at work in south Texas, where migration routes parallel the coast (W. Barrow 2008, personal communication). From the limited information available regarding habitat selection by migrant landbirds, it appears that birds probably settle in response to gross habitat features such as vegetation density or stratification and then search for resources based on other factors (Moore and Aborn 2000).

Cerulean, Golden-winged, and Swainson's Warbler ("Migrant Suite")

The selection of three warbler species is intended to cover the stratification of coastal landbird migration habitat by including a canopy species (Cerulean), a mid-story species (Golden-winged), and an understory species (Swainson's). Each of these species is found on the Watch List of continental concern by Partners in Flight (Rich et al. 2004).

Cerulean, Golden-winged, and Swainson's Warblers are all known to be trans-Gulf migrants. Swainson's Warbler breeds in BCR 37 in the floodplain deciduous forests of the coastal plain (Graves 2002). All three species are fairly regular transients in BCR 37 in spring and fall, from early March to mid-May and from mid-August to mid-October.

Cerulean Warblers are canopy-dwellers during breeding, winter (Robbins et al. 1989), and during early spring migration in Central America (Parker 1994). Cerulean Warblers breed in scattered locations in the Ohio and Mississippi River Valleys in mature and older deciduous forests with broken canopies (Hamel 2000). The birds winter in the mountains of northern South America, primarily on the east slope of the Andes at elevations of 1,968-4,593 ft (600-1,400 m) (Parker 1994). Habitat preferences of Ceruleans on the Gulf Coast are unknown. They probably occupy canopy in bottomland forests inland, but, like other species, will utilize any portion of a chenier or other emergency stopover point when they are forced to stop there (B. Eley 2007, personal observation). Robbins et al. (1989) showed that nearctic-neotropical migrants often use habitats in winter that are at least superficially similar to their breeding habitats, so the same may apply in migration in situations where Ceruleans are in coastal bottomland forest along the coast.

Photo by Michael L. Gray

Cerulean Warbler

Golden-winged Warblers breed in the upper Mississippi and Ohio valleys, into the northeastern U.S. and around the Great Lakes of Canada in patches of shrubs along forest edge (Confer 1992). In winter in Central and northern South America, the birds are found in open forest, forest edge, and sometimes in the canopy (Ridgely and

Photo by Wayne Nicholad

Golden-winged Warbler

Tudor 1989). Again, no literature exists on habitat use by this species in migration, but anecdotal observations suggest woodland edge and mid-story in bottomland hardwoods and cheniers where the species often forages in suspended dead-leaf clumps and at flowers. (B. Eley 2007, W. Barrow 2008, personal observation).

Swainson's Warbler nests in two distinct habitats—bottomland hardwood forests with dense understory in the southeastern U.S. and forest in the Appalachian Mountains with moderately dense undergrowth and moderate ground cover. The species winters in the Caribbean, portions of Central America, and the Yucatan of Mexico. Again, little has been published on habitat use during migration (Brown and Dickson 1994), but the birds are most often observed in the understory of coastal woods (G. Graves 2007, personal communication).

Photo by Michael L. Gray

Swainson's Warbler

Migration Habitat

It is unclear to what extent en-route habitat is a limiting factor to nearctic-neotropical migrant populations. Current evidence suggests that the success of an individual migrant is dependent on several factors, primarily the energetic state of the migrant and the abundance and spatial configuration of stopover habitat (Moore and Simons 1992). Moore et al. (1995) concluded that spring migrants on the northern Gulf of Mexico coast preferentially select structurally diverse stopover sites which consist of forested areas with mixed shrub layers, and that maintenance of plant species and structural diversity should be a goal at migratory landbird stopover sites. Much of what is known about migrant use of stopover habitat is summarized below:

- Many migrants are known to be more plastic in their selection of stopover habitat than breeding or wintering habitat (Petit 2000).
- Some migrants select different stopover habitat based on age and sex (Marra and Holmes 2001, Woodrey 2000).
- Birds often use different habitat in spring and fall (Petit 2000).

- Migrants do not always use the same routes each season – there is much variability due to weather, barriers, and timing (Duncan et al. 2002). However, long-term patterns of migrant use along the Gulf of Mexico Coast indicate that the vicinity of Longitude 95 degrees West receives consistent, high use annually (Barrow et al. 2005, Gauthreaux et al. 2006).
- While birds make macro-decisions just prior to landfall (Buler et al. 2007), micro-decisions appear to be made after the bird has arrived at a site, and depend on food availability, competition, and presence of predators (Moore and Simons 1992).
- Species often select different habitat types at different locations along the migration route, but species do not randomly choose habitats (i.e., species are not distributed equitably across major habitat types during migration). Migrating birds exhibit selective use of some habitats over others (Petit 2000).
- Habitat selected in migration may or may not be similar to breeding or wintering habitat (Petit 2000).
- As intuitively expected, more complex habitats support increased bird species richness in migration (Moore et al. 1990).
- Habitat fragmentation is probably not as great an issue for migrants as it is for breeding birds, though habitat corridors from less suitable woods to rich bottomland hardwoods would be valuable (Petit 2000).
- Importance of mortality during migration to the overall survival rate of a migrant species is unknown (Szep and Moller 2005) though it may be substantial for some species (Sillett and Holmes 2002).

Development of a population-habitat model for non-breeding birds, especially nearctic-neotropical migrants, is challenging because of diurnal and seasonal variability in bird abundance, complications of weather and other factors. A detailed theoretical model was described by Simons et al. (2000) in an attempt to quantify and describe how structurally diverse habitats may be used by migrants and how these habitats contribute to the fitness and survival of migrants when they reach the coast. The model is superimposed on five 296,526 ac (120,000 ha) areas of the Gulf coast with increasingly rich habitat to measure and predict habitat use. The model measures a migrant's change in energy level as suitable and non-suitable habitats are encountered. The premise is that migrants arrive along the Gulf coast and are presented with habitats of varying suitability for foraging. The abundance and pattern of this habitat will likely affect the probability of a successful migration. A bird's energy state (amount of remaining fat) upon arrival will determine whether a bird can find and utilize quality habitat, or whether the bird must use suboptimal habitat (and lower the chances of regaining fat stores). The interplay of the bird's energetic state and the abundance and spatial configuration of habitat will determine the success of migration.

Moore et al. (2005) also provided some general considerations for conservation planning of stopover habitat. A landscape-wide approach should consider the size of suitable habitat patches and the distance between those patches. An important consideration is the orientation of the habitat patch (Barrow et al. 2005). Forest perpendicular to migrant flight paths is preferable because it increases the likelihood of detection by the migrant. Mapping of dispersion areas is important. However, landscape contexts are critical to consider. Concentrations of birds may only indicate that habitat was available, not that the habitat is of high quality.

Available information strongly points to the importance of stratified forest habitat containing a diversity of food-bearing plant species for landbird migrants. Protecting, enhancing, and restoring this habitat along the coast should be a high priority. It is also important to consider that most nightly spring migration flights, in good weather with southerly winds, do not stop on the coast, but continue inland (up to several hundred miles) (Lowery 1945). This implies that the expanse of forest from east Texas eastward through the southeastern coastal states is also critical to the survival of arriving migrants. The use of composite radar images highlights habitat used by capturing departing migrants on a series of Doppler radar images and constructing a composite image based on pixel values. This technique is being significantly refined (W. Barrow and R. Diehl 2007, personal communication) and will be a valuable tool for future habitat planning efforts. Figure 9, Appendix A depicts a composite image derived from radar illustrating departure points over a period of time in the fall on the coasts of Mississippi and Alabama indicating the potential importance of north-south linear-forests along the northern Gulf Coast. This type of image can suggest areas important to migrants. South-bound birds will likely select optimum habitat, typically non-flooded riverine and bottomland hardwoods, since the birds often have to wait for favorable winds before either crossing the Gulf or continuing around its perimeter. (Able 1972, Buler et al. 2007).

A conceptual framework for considering stopover habitat was developed at a workshop on Protecting Stopover Sites at Moss Point, Mississippi, in May of 2001 (Duncan et al. 2002). The framework focused on prioritizing stopover habitat based on usage by migrants and generated the simple definitions described below:

- **"Fire Escape":** Like fire escapes in human habitations, these stopover sites are infrequently used, but are utterly vital when they are. Habitat quality may be too low to allow birds to gain significant mass, but at least they will survive, can take shelter, and may be able to get fresh water. Fire escape sites are typically adjacent to significant barriers such as deserts or large bodies of water.

- **"Convenience Store":** Forested patches, such as small parks or woodlots, in a non-forested matrix and located along migratory routes. These sites offer a place where birds can briefly rest and gain some mass easily, perhaps between short flights to higher quality sites, or when migrants' fuel stores are moderate. A given Convenience Store may be better able to serve the needs of some species than others.

- **"Full-service Hotel":** Forested sites in a forested landscape. Full-service Hotels are places where all needed resources (food, water and shelter) are relatively abundant and available. These places serve many individuals of many species. Bottomland hardwood forests are a good example.

In an effort to quantify the amount and type of migratory landbird stopover habitat available in BCR 37, we assigned parameters to the categories above to enable spatial analysis of 2001 NLCD data. "Full-service Hotel" habitat was defined as forested habitat patches at least 10,000 ac in size. This patch size is the size believed to be required to support a viable breeding population of Swainson's Warbler (Twedt et al. 1999), and we opined that this size should provide ample resources for transient landbirds. Based on Buler et al.'s (2007) work with landbird migrants in Mississippi, we classified all forested habitat, patches less then 10,000 ac in size, within 6 mi (10 km) of the Gulf of Mexico shore and shorelines of other significant coastal water bodies (i.e., bays, the Laguna Madre, Lake Pontchartrain) as "Fire Escape" habitat. We defined "Convenience Store" habitat as being greater than 6 mi (10 km) from coasts, and less than 10,000 acres in size. The preliminary results of this landcover analysis are depicted in Appendix A, Figures 5 - 8. Testing the validity of and subsequently refining this stopover habitat classification is a high priority for the GCJV partnership. Whereas we cannot currently estimate how much of each type of habitat is needed to sustain or increase migrant landbird populations, the relationships and distances between the different types are likely to be important parameters in future planning efforts (Mark Woodrey 2007, personal communication).

GCJV partners are currently proposing to develop a landscape-scale approach to the development of migratory landbird forest habitat objectives using empirical data derived from archived radar imagery. Data collected from 2005 – 2007 at four radar stations (Lake Charles, LA, Houston, TX, Corpus Christi, TX, and Brownsville, TX) would be analyzed. Each radar area would be subdivided into hexagonal sampling sites, where migrant landbird density and coefficient of variation among sampling sites will be calculated. Landbird migrant density and coefficient of variation would be modeled against parameters of geographic position, degree of human development, and habitat composition. Based on that information, a model would be constructed for each radar area describing those relationships between birds and the environment. Those individual models would lend themselves toward development of a landscape-scale (i.e., the entire GCJV region) model to inform landbird habitat objective setting. This work is among the highest priorities for the GCJV staff and partners. Future model iterations could be used to predict effects of habitat gains or losses on the landscape on distribution and density of migrant landbirds, and thus inform spatial prioritization of habitat conservation actions.

While we are not able to formulate specific habitat objectives for priority migrant landbirds at this time, we have sufficient information to suggest priorities for habitat protection (through acquisition, conservation easement, or sustainable management agreement) and restoration. Available empirical and anecdotal evidence points to the importance of large, mesic bottomland hardwood forest patches in BCR 37 during both spring and fall landbird migration, especially those in the vicinity of Longitude 95 degrees West (Barrow et al. 2005, Gauthreaux et al. 2006, Buler et al. 2007). Buler et al.'s (2007) research in Mississippi also indicated regular use of forest habitats within 10 km of the coast. Barrow et al. (2005) used available information and expert opinion to characterize landbird migrant use in Gulf of Mexico coastal forests. They described six levels of landbird migrant use:

1. Consistent abundant—area used by large numbers of migrants each year and season
2. Consistent common—area used by a moderate number of migrants each year and season
3. Sporadic common-abundant—prevailing winds determine if area is used by moderate to large numbers of migrants
4. Sporadic common—prevailing winds determine if area is used by a moderate number of migrants
5. Light use—area used by a few migrants every year or season
6. Unknown

The entirety of BCR 37's coastal forests fall within one of the first three classifications listed above (Figures 5 - 8). The region stretching from the Colorado River mouth in Texas to approximately Point Au Fer, Louisiana is used by large numbers of migrants each year and season (Consistent abundant). The region from Baffin Bay, Texas, south to about the northern edge of Laguna Madre de Tamaulipas, Mexico, is used by a moderate number of migrants each year and season (Consistent common). The area of Texas between Baffin Bay and the Colorado River mouth is used by a moderate to large number of migrants, dependent on prevailing winds (Sporadic common-abundant). The eastern portion of BCR 37, from approximately Point Au Fer, Louisiana, to southwestern Hancock County, Mississippi, also receives use from a moderate to large number of migrants, depending on prevailing winds (Sporadic common-abundant).

We classified the Consistent abundant area of BCR 37 as Priority 1, the Consistent common area as Priority 2, and the two Sporadic common-abundant areas as Priority 3 (Figures 5 - 8). Using those designations, our interpretation of Duncan et al.'s (2002) stopover habitat types, and the research of Barrow et al. (2005), Gauthreaux et al. (2006), and Buler et al. (2007), we have developed the following coarse, draft, prioritization scheme for transient landbird habitat protection and reforestation in BCR 37 (and throughout the entire GCJV region).

Protection (meaning acquisition, conservation easement, or sustainable management agreement) priorities:

1. Large (≥10,000 ac) forest patches within 6 mi (10 km) of Gulf of Mexico/bay shoreline
2. Large (≥10,000 ac) forest patches further than 6 mi (10 km) from Gulf of Mexico/bay shoreline
3. Forest patches ‹10,000 ac in size within 6 mi (10 km) of Gulf of Mexico/bay shoreline, with larger patches a higher priority than smaller patches
4. Forest patches ‹ 10,000 ac in size further than 6 mi (10 km) from Gulf of Mexico/bay shoreline; with larger patches a higher priority than smaller patches.

Reforestation priorities:

1. Additions of forested habitat within 6 mi (10 km) of Gulf of Mexico/bay shoreline that would increase an extant forested patch to ≥10,000 ac
2. Additions of forested habitat further than 6 mi (10 km) from Gulf of Mexico/bay shoreline that would increase an extant forested patch to ≥10,000 ac
2. Additions that would fill a void of forested habitat within 6 mi (10 km) of Gulf of Mexico/bay shoreline.

It is important to note that the ideal size and juxtaposition of habitat patches for migrant forest landbirds, and what constitutes a habitat void, is not well understood at this time. For this reason, the protection and reforestation priorities above should be viewed tentatively.

Migrant Suite Research and Monitoring Needs

- Identify the habitat components of an ideal migration stopover habitat
- Develop a better understanding of habitat selection in the three priority trans-gulf migrant species during migration
- Evaluate the criteria, such as distance from coast, patch size, and geographic position, used to categorize stopover habitat
- Assess the value of establishing forested corridors between stopover habitat patches
- Determine the ideal amounts and relationships needed between the three classes of stopover habitat
- Ascertain the importance of migration mortality to overall population dynamics of migrant species
- Continue the development and assessment of radar as a tool to provide information on habitat conservation for migrants

Conclusions

This plan addresses the three major habitat types in BCR 37 of importance to priority landbirds; forests, grasslands, and emergent wetlands. Tentative habitat goals are contained herein for grasslands and emergent wetlands. Development of goals for forest habitat is pending. Further analysis of weather radar (described above) and/or other spatial data will inform the forest habitat objective-setting process. This is intended, however, to be a living document. Any stated habitat goals in this document are subject to revision, as warranted by the results of identified research and monitoring needs, and/or through refinement of population estimates and objectives.

While initial habitat modeling indicates the possibility that sufficient habitat currently exists to support Seaside Sparrow population objectives, those assumptions require affirmation through targeted measurement of species density and/or abundance in identified habitat patches. Seaside Sparrow habitat needs and goals are anticipated to address those of other priority landbirds using brackish to saline emergent wetlands, such as Nelson's Sharp-tailed Sparrow, Northern Harrier, Short-eared Owl, and Sedge Wren. The degree to which management recommended for Seaside Sparrow coincides with the needs of those other species is unknown and should be determined. Similarly, the possibility of tweaking existing management schemes for waterfowl so as to increase benefits to priority landbirds should be investigated. The habitat suitability model described in this document does not currently consider possible changes to habitat resulting from sea-level rise, human development, and other factors. Those factors should be included in future model iterations to aid with habitat conservation and restoration prioritization.

Significant available habitat appears to be currently under management by the U.S. Department of Interior, GCJV region states, and non-governmental conservation agencies to support Seaside Sparrow population objectives. This remains to be validated. If habitat on those public and private conservation lands is insufficient to achieve Seaside Sparrow population and habitat goals (and to support associated priority bird species), other possible avenues for habitat provision include the USFWS Partners for Fish and Wildlife/Coastal Program; North American Wetlands Conservation Act grants; Coastal Wetlands Planning, Protection, and Restoration Act projects; Louisiana Waterfowl Project – South and Texas Prairie Wetland Project; and National Fish and Wildlife Foundation grants aimed at protection and restoration of coastal emergent wetlands.

Prairie grasslands historically covered more than half of BCR 37. Today, native prairie occupies a miniscule amount of its former range in the BCR. The majority has been converted to row crop agriculture, pasture, and hay. Urban development has claimed former prairie habitat as well, especially near Houston, TX. Due to the predominance of agriculture, probably the best hope for provision of suitable grassland habitat is through U.S. Department of Agriculture Farm Bill conservation programs such as WHIP and CRP. The USFWS Partners for Fish and Wildlife Program can also be a potential impetus for prairie restoration in the region. Potential for prairie restoration exists on public lands in BCR 37, as well as many of those properties occupy portions of historic prairie range. On these lands, grassland restoration could be targeted in the vicinity of shallow-water wetlands to achieve twin goals of providing habitat for grassland passerines and nesting Mottled Duck. Prairie plant ecotypes adapted for Gulf Coast growing conditions are in short supply, however, and seed increase programs are needed to support Gulf Coastal prairie restoration efforts.

Potential exists for significant acreage of agricultural and pastoral lands to be planted into corn or switchgrass for use in ethanol production. While the impacts of increased corn acreage for ethanol production can be assumed to be largely negative to priority grassland bird species, the impacts of increased switchgrass acreage are unknown and should be examined.

We need further work to establish and validate population estimates and objectives for the three priority grassland bird species, especially Loggerhead Shrike. The three priority grassland birds discussed in this plan have similar, but not identical, habitat needs. The optimal habitat matrix and management regime for these birds and other high-priority grassland birds is yet to be determined. Ideally, grassland patches should be 500 acres or greater in size, but smaller patches can be of value, especially to wintering birds if situated within a matrix of agricultural, pastoral, and low-density residential lands. A regular schedule of disturbance is needed to prevent encroachment by shrubs and trees, with prescribed fire being the preferred management tool. A three-year fire frequency is recommended for Le Conte's Sparrow, and ideally, season of fire should vary between dormant season and growing season.

A significant portion of the populations of nearctic-neotropical migratory birds that breed in the forests of the eastern United States transit through BCR 37 in spring, fall, or both seasons. BCR 37's forested habitats are, therefore, vital to sustaining or increasing populations of priority forest-breeding migrant birds. The GCJV LWG chose a suite of migrant landbirds with the goal of representing critical components of landbird migration habitat. Efforts at qualifying and quantifying migrant landbird stopover habitat have been few. We have made some preliminary efforts to assign prioritization parameters to types of landbird migration habitat available in BCR 37. Much promise exists in the area of describing migrant landbird habitat use via weather radar analysis. The GCJV partnership hopes to use this technology to identify and rank the factors that determine habitat use and to use that information to prioritize areas for protection, restoration, or habitat creation. Ultimately, models based upon analysis of radar data may be linked with finer-scale energetic-based or other models to develop habitat objectives for priority migrant landbirds across the GCJV region.

Available empirical and anecdotal evidence points to the importance of large alluvial floodplain forest patches in BCR 37 during both spring and fall landbird migration. Buler et al. (2007) indicated regular use of forest habitats in Mississippi within 6 mi (10 km) of the coast. Barrow et al. (2005) characterized the Gulf of Mexico's coastal forests based on long-term patterns of migrant landbird uses: Coastal Forests in BCR 37 fall within three prioritization tiers based upon migrant use. These observations lend themselves to the following coarse, draft, prioritization scheme for transient landbird habitat protection and reforestation in BCR 37:

Protection (meaning acquisition, conservation easement, or sustainable management agreement) priorities:

1. Large (≥10,000 ac) forest patches within 6 mi of Gulf of Mexico/bay shoreline
2. Large (≥10,000 ac) forest patches further than 6 mi from Gulf of Mexico/bay shoreline
3. Forest patches <10,000 ac in size within 6 mi of Gulf of Mexico/bay shoreline, with larger patches a higher priority than smaller patches
4. Forest patches < 10,000 ac in size further than 6 mi from Gulf of Mexico/bay shoreline; with larger patches a higher priority than smaller patches.

Reforestation priorities:

1. Additions of forested habitat within 6 mi of Gulf of Mexico/bay shoreline that would increase an extant forested patch to ≥10,000 ac
2. Additions of forested habitat further than 6 mi from Gulf of Mexico/bay shoreline that would increase an extant forested patch to ≥10,000 ac
3. Additions that would fill a void of forested habitat within 6 mi of Gulf of Mexico/bay shoreline.

Acknowledgements

WE WOULD LIKE TO ESPECIALLY THANK the members of the Gulf Coast Joint Venture Landbird Committee: Cliff Shackelford, Wylie Barrow, Dave Krueper, and Mark Woodrey for their input and participation in preparation of this plan. We also thank Cecilia Riley, Gary Graves, and John Arvin for discussions and edits. Thanks to Robert Perez and Fred Kimmel for Northern Bobwhite information. This document was improved by comments and edits provided by Tim Anderson, Kevin Brunke, Marty Floyd, Wade Harrell, Bill Hohman, Brent Ortego, Michael Seymour and Ben Thatcher.

Funding for this document was provided by U.S. Fish and Wildlife Service, Gulf Coast Joint Venture, and the Gulf Coast Bird Observatory.

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Appendix A: Maps of BCR 37 Habitats

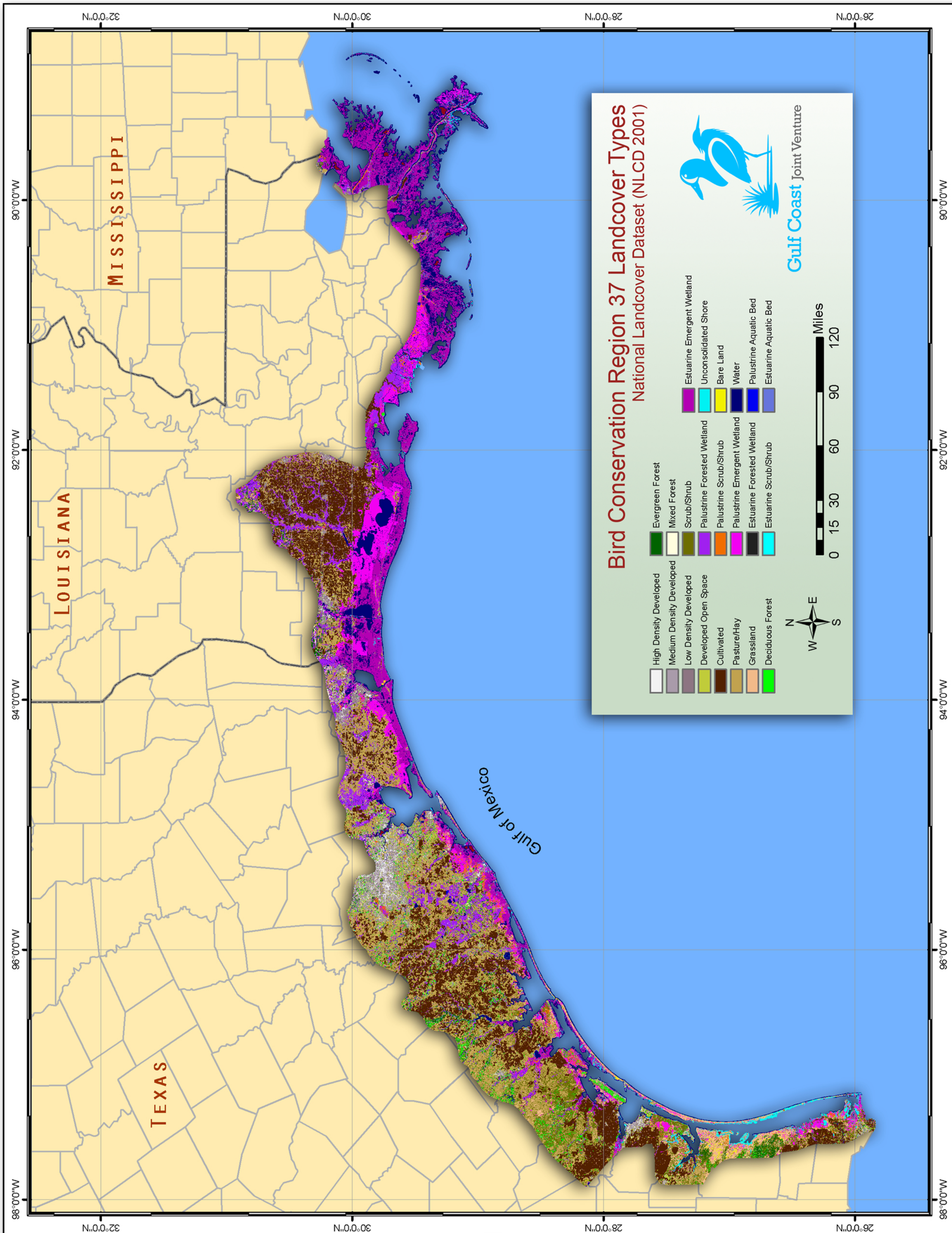


Figure 1: BCR 37 Landcover Types, NLCD 2001

Figure 2: BCR 37 Estuarine Emergent Wetlands, NLCD 2001

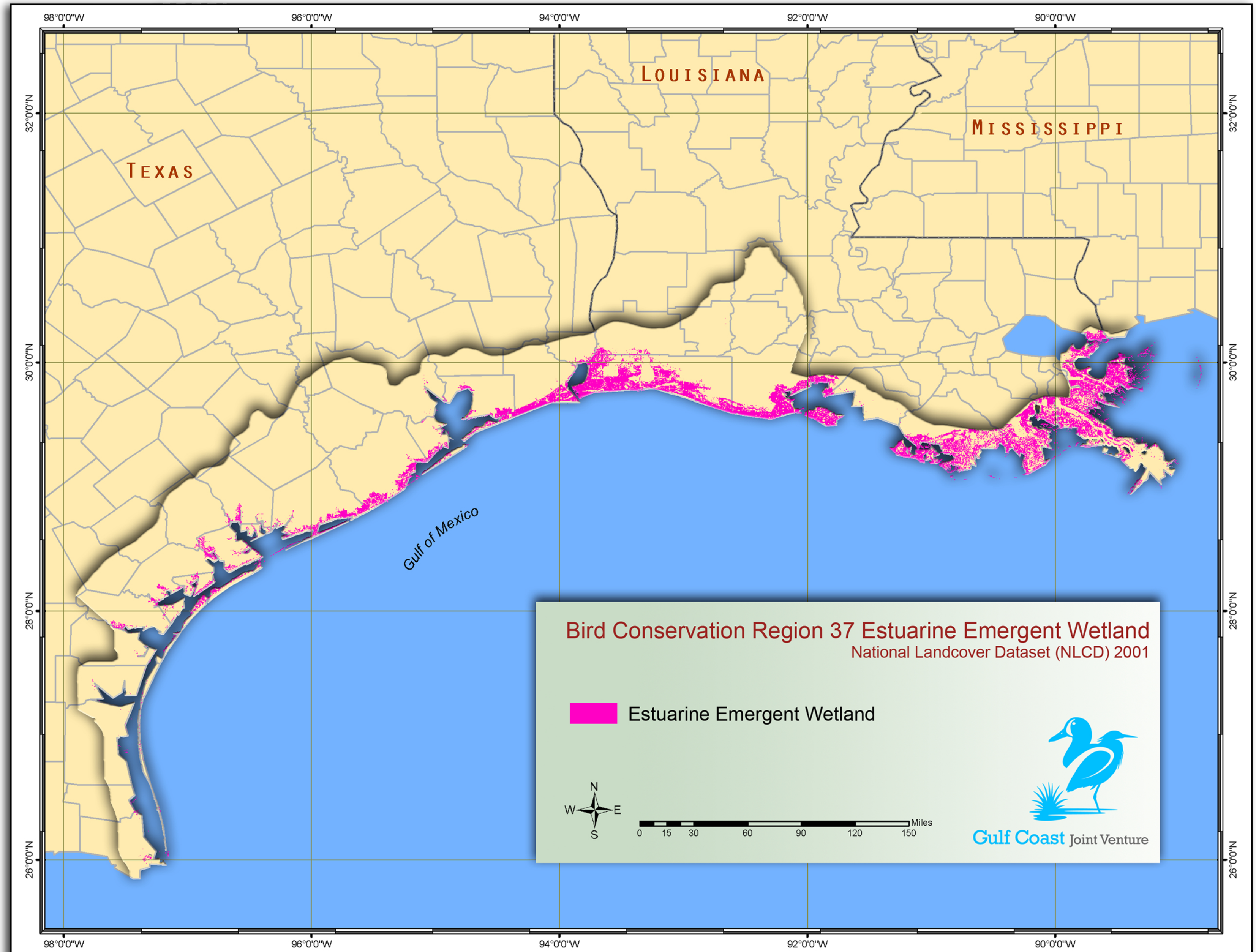


Figure 3: BCR 37 Grasslands and Pasture/Hay, NLCD 2001

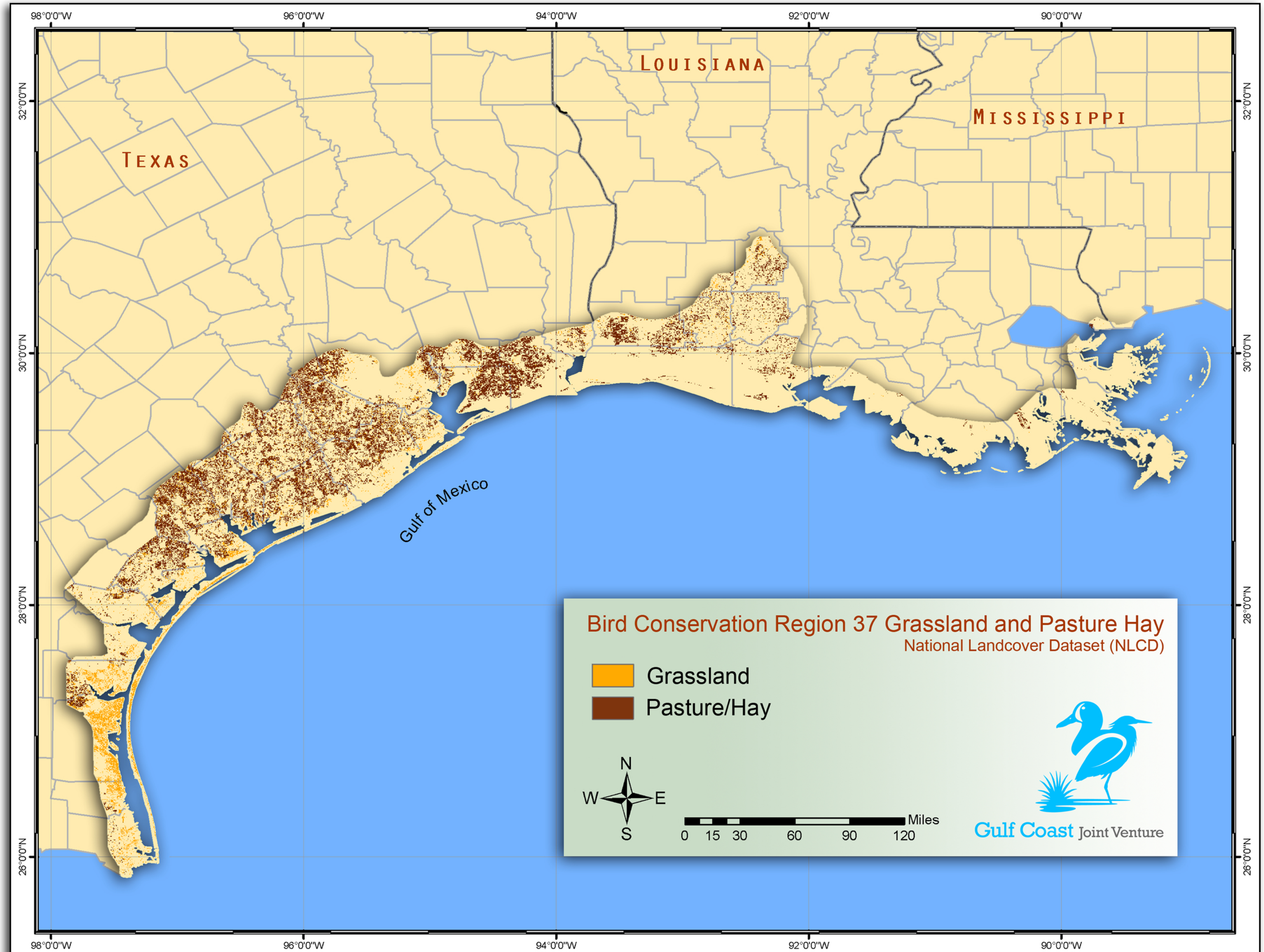


Figure 4: BCR 37 Forest, NLCD 2001

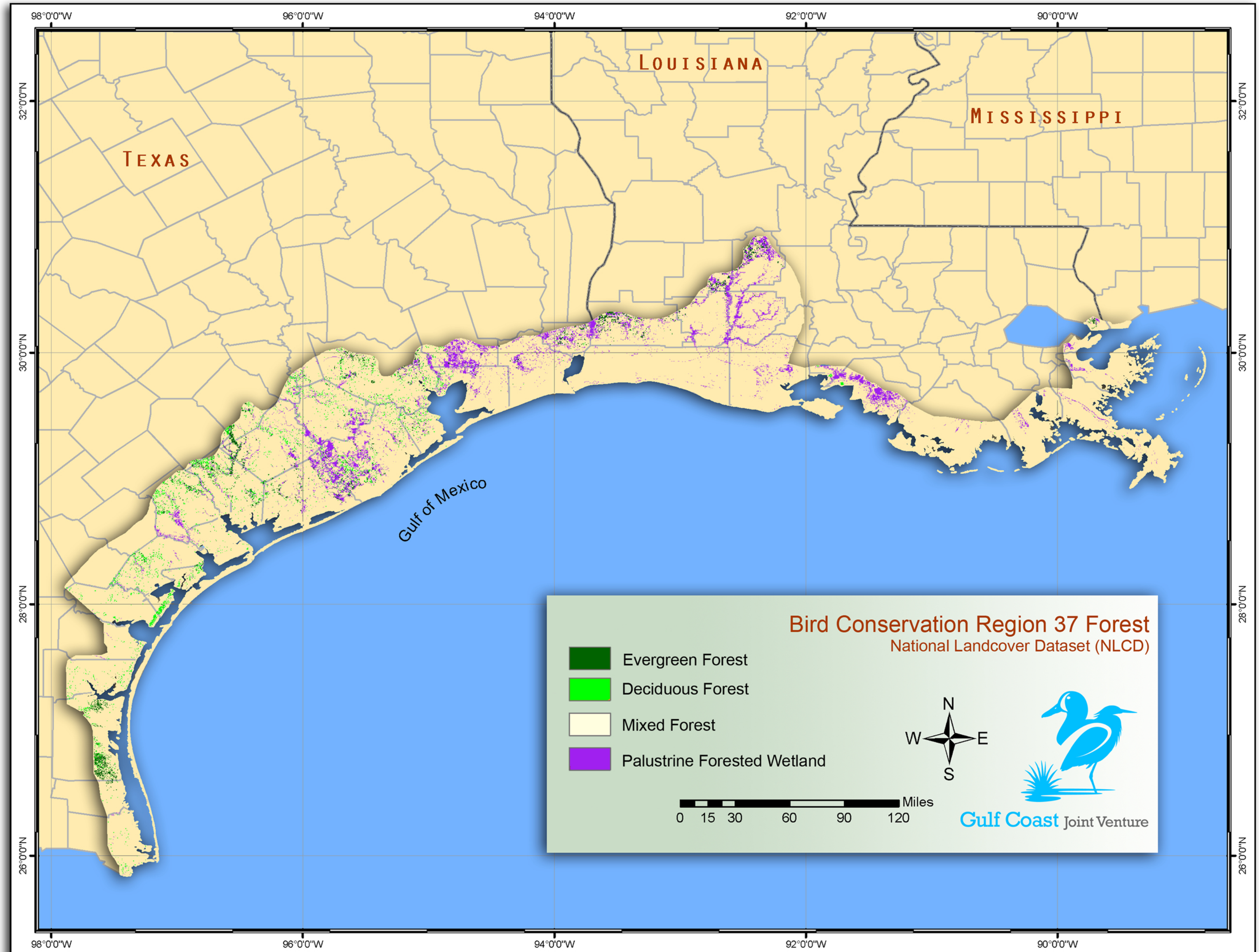


Figure 5: BCR 37 Forest Habitat within Landbird Priority Zones, NLCD 2001

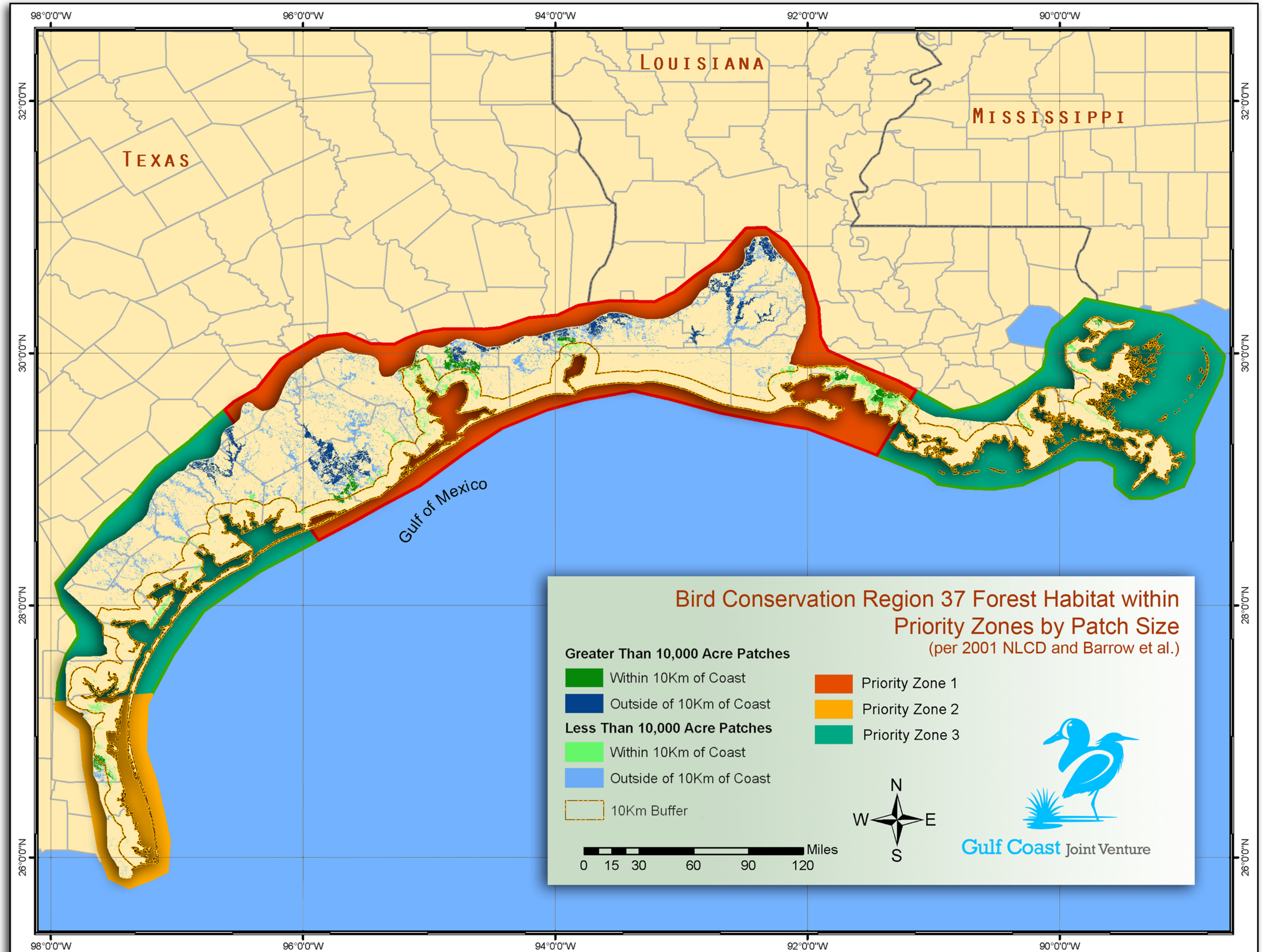
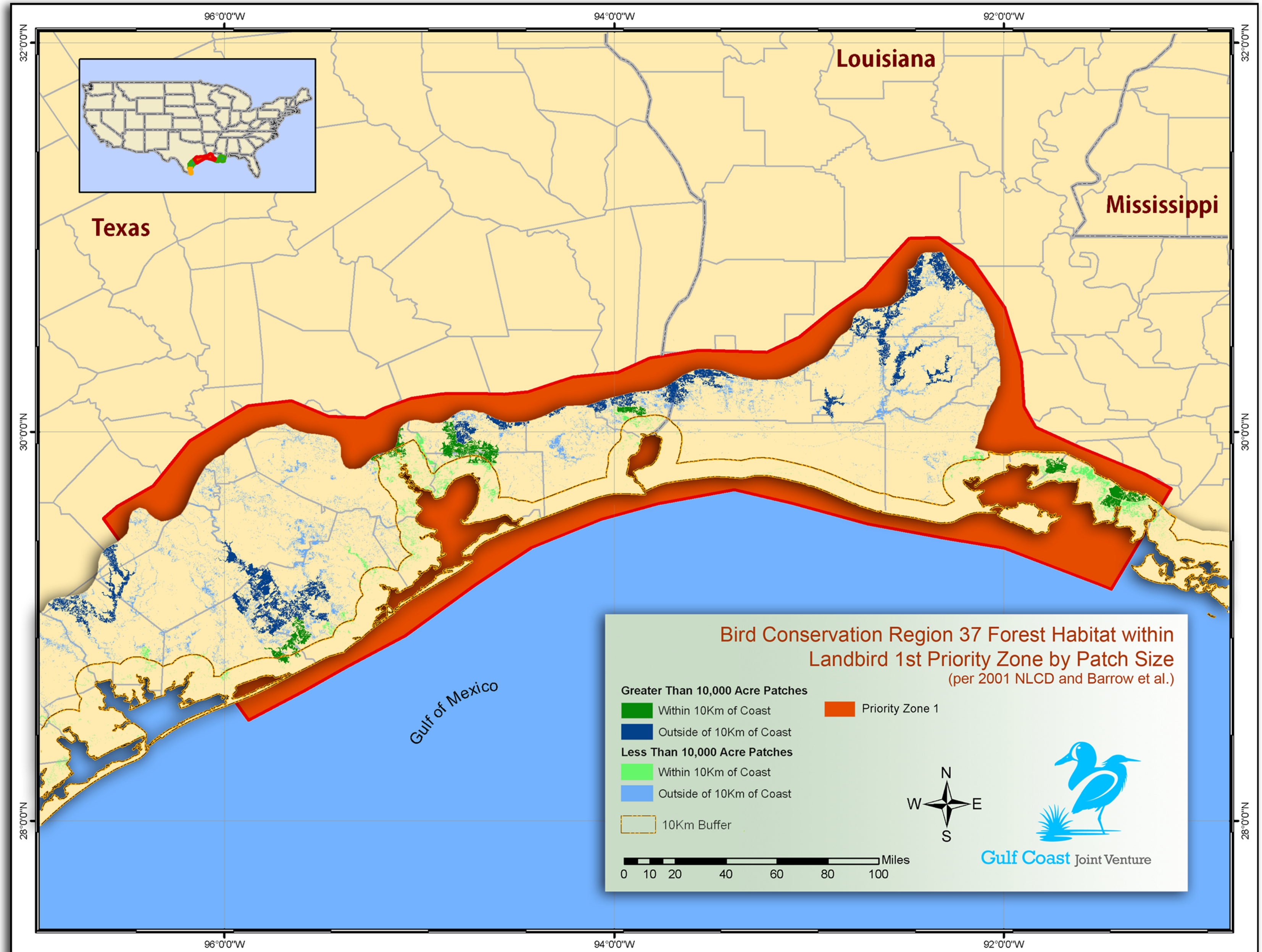


Figure 6: BCR 37 Forest Habitat, Landbird Priority Zone 1



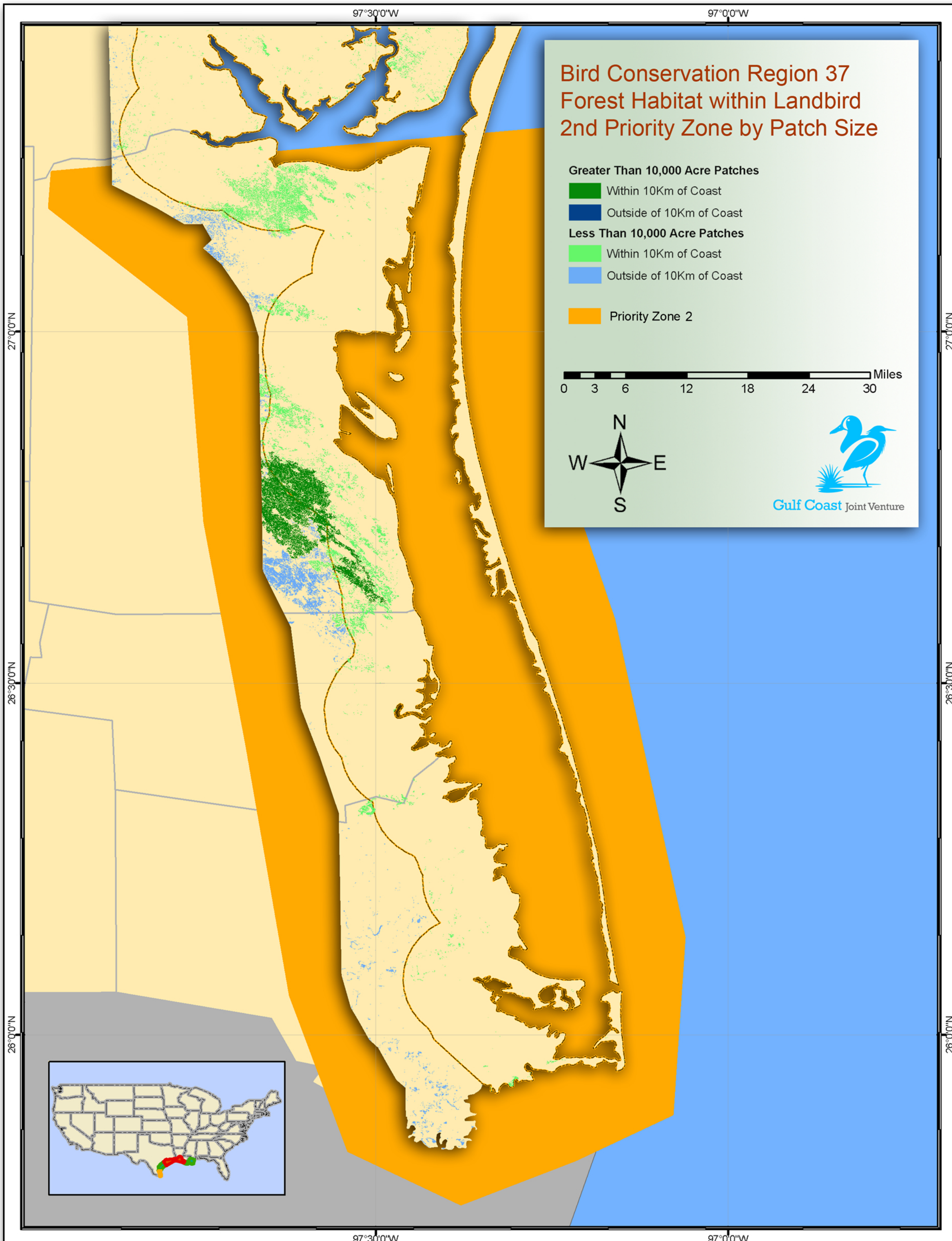


Figure 7: Forest Habitat, Landbird Priority Zone 2

FIGURE 8: FOREST HABITAT, LANDBIRD PRIORITY ZONES 3

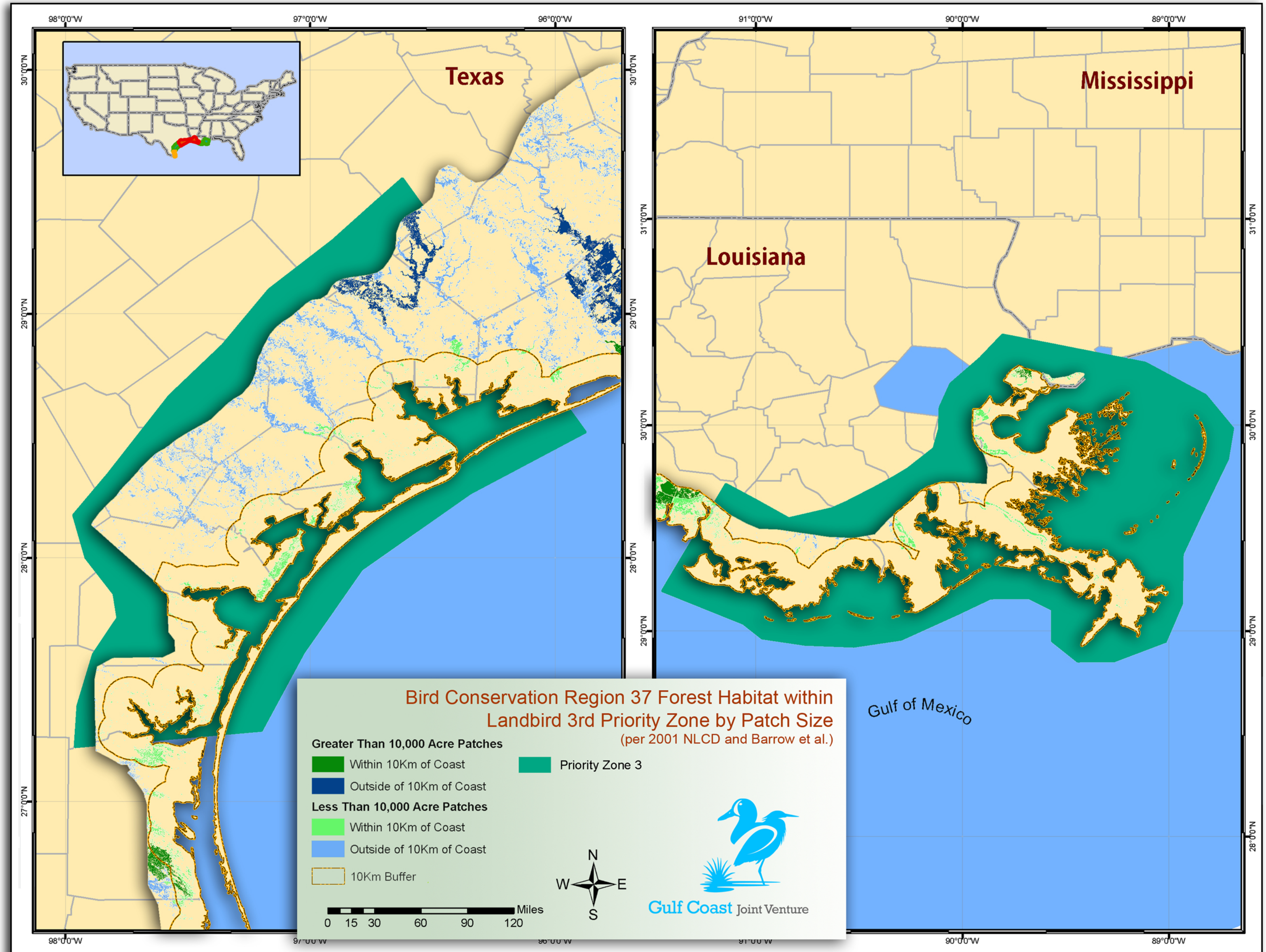


Figure 9: Data From Composite Radar Image Of Migratory Bird Exodus, Ms/Al

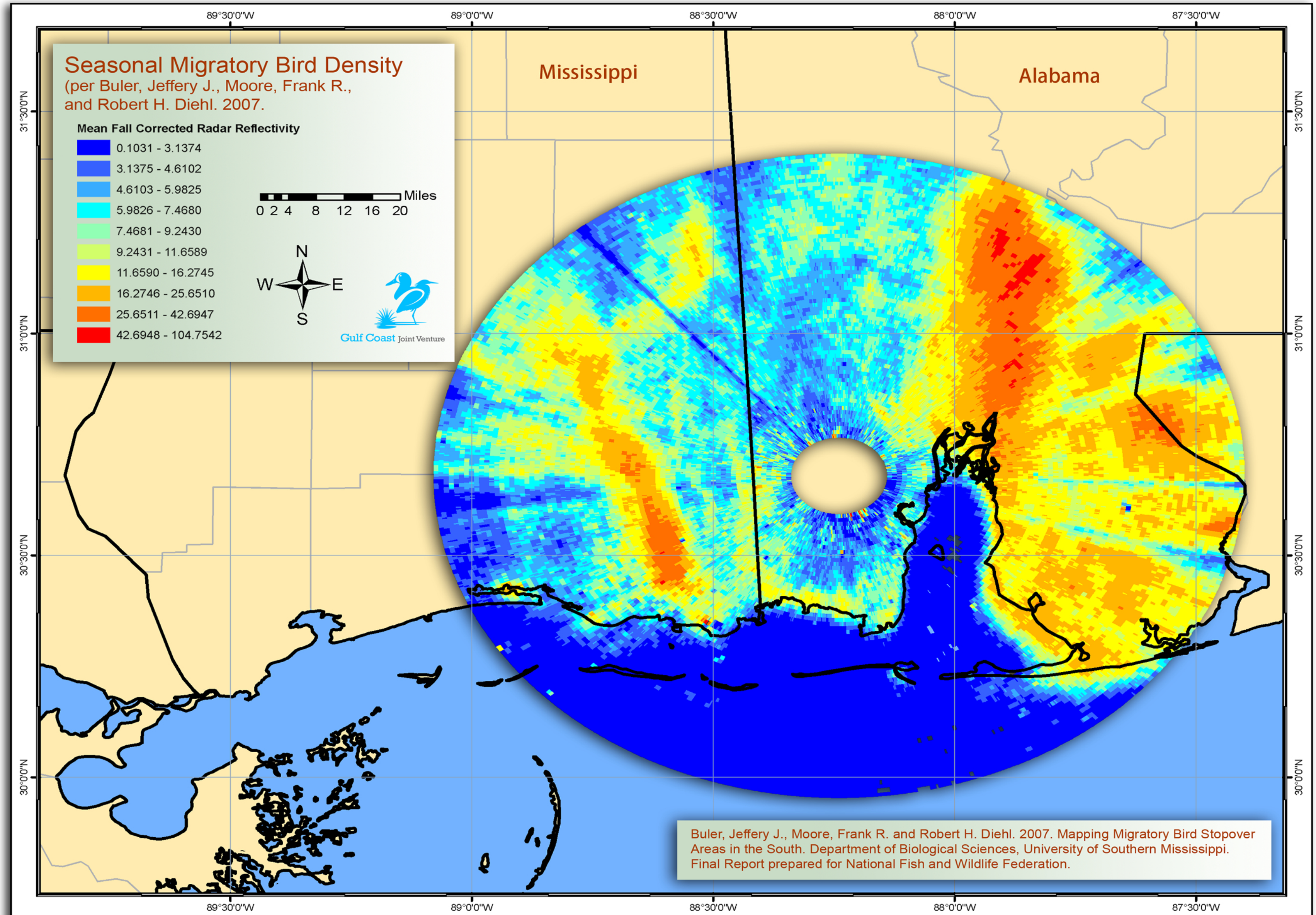
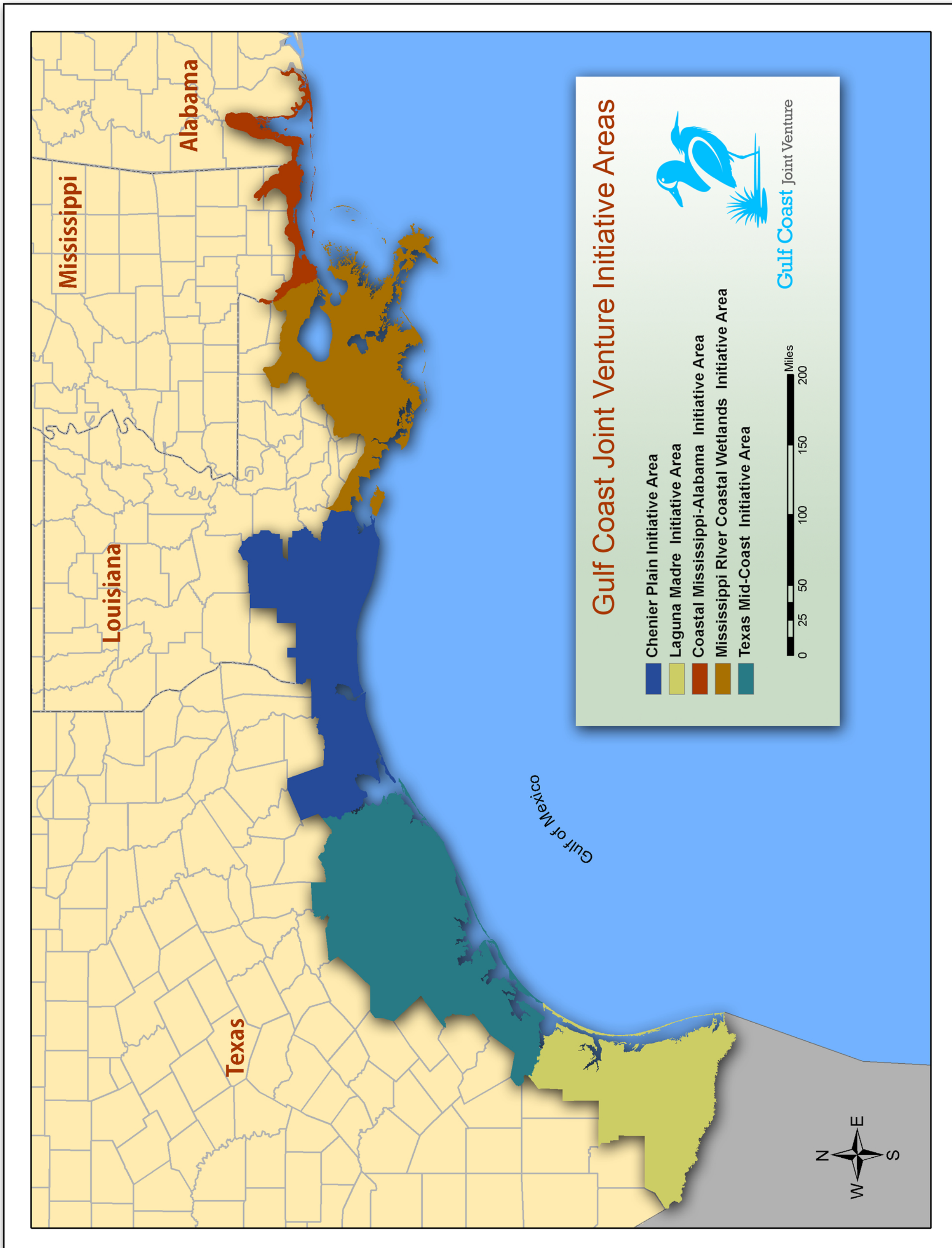


Figure 10: Gulf Coast Joint Venture Initiative Areas



Appendix B: Additional Tables

Table 9: Species of Regional Concern

See column definitions below.

Common_Name	PS-g	BD-g	TB-r	PT-r	RD-b	Pct_POP	RCS-b	CC	RC	CS	RS	Act
Greater Prairie-Chicken	3	5	5	5	2	0	20	Y	Y	-	-	CR
Henslow's Sparrow	4	3	5	5	2	0	19	Y	Y	-	-	CR
Seaside Sparrow	4	3	3	5	58	19	Y	-	Y	Y	PR	
Audubon's Oriole	4	5	4	3	3	1	19	Y	Y	-	-	MA
Botteri's Sparrow	3	4	4	3	5	1	19	-	Y	-	-	MA
Swallow-tailed Kite	4	3	5	5	2	0	19	Y	Y	-	-	CR
Painted Bunting	3	4	4	4	3	3	18	Y	Y	-	-	MA
Loggerhead Shrike	3	1	4	5	5	7	18	-	Y	-	Y	IM
Scaled Quail	3	3	5	5	2	0	18	Y	Y	-	-	CR
Bell's Vireo	3	3	5	5	2	0	18	Y	Y	-	-	CR
Prothonotary Warbler	3	3	4	3	4	4	17	Y	Y	-	-	MA
Swainson's Warbler	4	4	4	3	2	0	17	Y	Y	-	-	MA
Aplomado Falcon	4	1	5	5	2	0	17	-	Y	-	-	CR
Northern Beardless-Tyrannulet	3	3	4	3	4	1	17	-	Y	-	-	MA
Plain Chachalaca	3	4	4	3	2	1	16	-	Y	-	-	MA
Northern Bobwhite	2	2	3	5	4	2	16	-	Y	-	-	MA
Bald Eagle	4	2	4	3	3	0	16	-	Y	-	-	MA
White-tailed Hawk	3	1	4	3	5	0	16	-	Y	-	-	MA
Ferruginous Pygmy-Owl	2	1	4	4	5	0	16	-	Y	-	-	MA
Common Nighthawk	2	1	3	5	5	5	16	-	Y	-	-	MA
Eastern Meadowlark	2	1	3	5	5	3	16	-	Y	-	-	MA
Kentucky Warbler	3	3	4	3	2	0	15	Y	Y	-	-	MA
Dickcissel	2	2	4	3	4	2	15	Y	Y	-	-	MA
Yellow-green Vireo	3	3	4	3	2	0	15	-	Y	-	-	MA
Yellow-throated Warbler	3	3	4	3	2	0	15	-	Y	-	-	MA
Summer Tanager	3	2	4	3	3	1	15	-	Y	-	-	MA
Yellow-billed Cuckoo	2	1	3	4	4	2	14	-	Y	-	-	MA
Common Pauraque	2	1	4	3	4	0	14	-	Y	-	-	MA
Acadian Flycatcher	3	2	4	3	2	0	14	-	Y	-	-	MA
Yellow-throated Vireo	3	2	4	3	2	0	14	-	Y	-	-	MA
Bewick's Wren	2	2	5	3	2	0	14	-	Y	-	-	CR
Swainson's Hawk	4	2	3	3	2	0	14	Y	-	-	-	PR
Red-headed Woodpecker	3	2	4	3	2	0	14	Y	Y	-	-	MA

Table 9a: Column Definitions

PS-g Global population size score.
BD-g Global breeding distribution score.
TB-r Regional Threats to Breeding score.
PT-r Population trend score (regional, breeding).
RD-b Relative density score (regional, breeding).
Pct_Pop Percent of species' global breeding population in BCR.
RCS-b Regional Combined Score for the breeding season.
CC Species of continental concern?
RC Species of regional concern?
CS Continental Stewardship Species.
RS Regional stewardship?
Act Action code indicating the type of conservation action most needed for improving or maintaining current population status of each species

Notes

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