Gulf Coast Joint Venture Landbird Conservation Plan
Bird Conservation Regions 25, 26, & 27
Gulf Coast Joint Venture Region

A Product of the Gulf Coast Joint Venture Monitoring, Evaluation, and Research Team's Landbird Working Group

Suggested Citation:
Vermillion, W. G., B. Eley, B. C. Wilson, S. A. Heath, and M. W. Parr. 2012. Gulf Coast Joint Venture Landbird Conservation Plan, Bird Conservation Regions 25, 26, & 27, Gulf Coast Joint Venture Region. 56 pp.

Acronyms and Abbreviations Used

ac - acre

BBS – Breeding Bird Survey

BCR – Bird Conservation Region

CBC – Christmas Bird Count

CCAP – Coastal Change Analysis Program

DDT - Dichlorodiphenyltrichlorethane

DST – Decision Support Tool

EGCPJV – East Gulf Coastal Plain Joint Venture

GCJV – Gulf Coast Joint Venture

ha - hectare

IA – Initiative Area

km - kilometer

LMVJV – Lower Mississippi Valley Joint Venture

mi - miles

NBCI – Northern Bobwhite Conservation Initiative

NBTC – National Bobwhite Technical Committee

NLCD – National Landcover Dataset

NWR – National Wildlife Refuge

OPJV – Oaks and Prairies Joint Venture

PIF – Partners in Flight

RMBO – Rocky Mountain Bird Observatory

USDA – United States Department of Agriculture

WGCPO – West Gulf Coastal Plain and Ozarks

Gulf Coast Joint Venture Landbird Conservation Plan
Bird Conservation Regions 25, 26, & 27
Gulf Coast Joint Venture Region

In 2008, the Gulf Coast Joint Venture (GCJV), in concert with the Gulf Coast Bird Observatory, produced a landbird conservation plan for Bird Conservation Region (BCR) 37, the Gulf Coastal Prairie. The plan (available at http://www.gcjv.org/docs/Coastal_Prairies_BCR37_Landbird_Plan.pdf) focused on 7 priority landbirds; Northern Bobwhite, Loggerhead Shrike, Seaside and Le Conte's sparrow, and a suite of warblers; Cerulean, Golden-winged, and Swainson's.

BCR 37 comprises the bulk of the GCJV region, however, 5 other BCRs intersect the GCJV boundary (Figure 1):

- BCR 21 - Oaks and Prairies
- BCR 25 – West Gulf Coastal Plain/Ouachitas
- BCR 26 – Mississippi Alluvial Valley
- BCR 27 – Southeastern Coastal Plain
- BCR 36 – Tamaulipan Brushlands.

The purpose of this document is to describe population and habitat objectives for the above priority landbird species in portions of the GCJV region intersected by BCRs 25, 26, and 27. The plan does not provide objectives for the portions of BCRs 21 and 36 in the GCJV region. The overwhelming majority of BCR 21 is located within the current administrative boundary of the Oaks and Prairies Joint Venture (OPJV), and OPJV's landbird planning is anticipated to address the entire BCR. Landbird conservation planning in BCR 36 (and in the Mexican portion of BCR 37) will be accomplished by the Rio Grande Joint Venture.

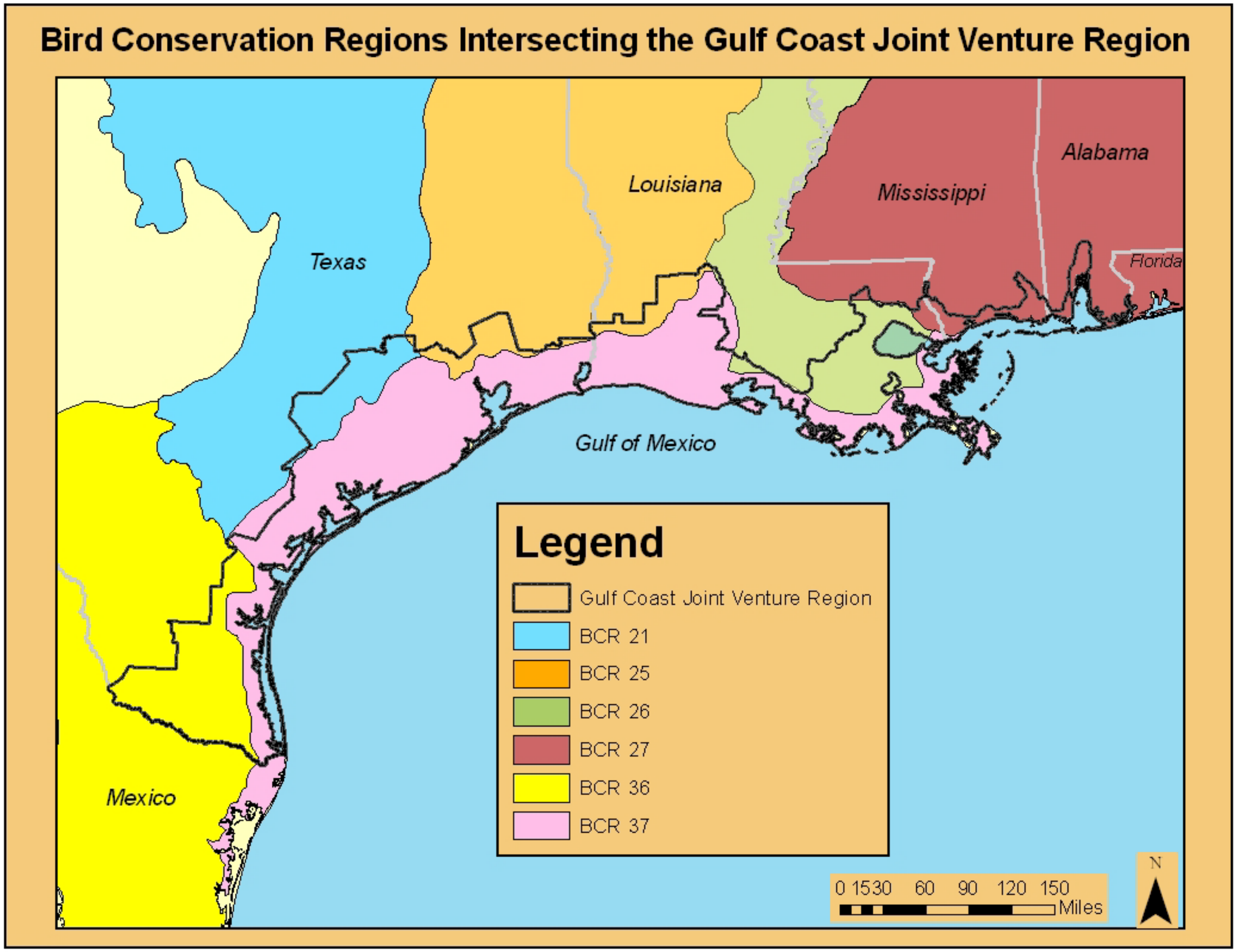
Some landbird planning has already taken place in the GCJV portions of BCR 25, 26, and 27. Lower Mississippi Valley Joint Venture (LMVJV) scientists and partners have analyzed forest cover for breeding landbirds in the BCR 25 and 26 portions of the GCJV region. East Gulf Coastal Plain Joint Venture (EGCPJV) scientists and partners are developing an open-pine decision support tool that will have applications for breeding and wintering landbirds within the historic range of longleaf pine, which intersects the GCJV region in BCRs 25, 26, and 27. The relevance of those planning processes and tools to this plan will be discussed below.

Priority Species Accounts

Seaside Sparrow

Seaside Sparrow *(Ammodramus maritimus)* is a permanent resident in salt and brackish marshes in the GCJV region. The population estimate for the GCJV region is approximately 74,000 individuals; 60,000 in Texas, BCR 37; 5,000 in Louisiana, BCR

Figure 1


Bird Conservation Regions Intersecting the Gulf Coast Joint Venture Region
Texas
Louisiana
Mississippi
Alabama
Florida
Gulf of Mexico
Mexico
Legend
Gulf Coast Joint Venture Region
BCR 21
BCR 25
BCR 26
BCR 27
BCR 36
BCR 37
0 15 30 60 90 120 150
Miles
N

37; 20 in Mississippi, BCR 37; and 9,000 in Alabama, BCR 27 [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 and brackish marsh by the Breeding Bird Survey (BBS) in Texas (Brent Ortego, pers. comm.). The lack of an RMBO Seaside Sparrow population estimate for the BCR 27 portion of Mississippi may also be due to BBS sampling issues. Partners in Flight (PIF) recommends maintaining current population levels (Rich et al. 2004). This species has been assigned a population trend score of 3, which indicates an uncertain trend due to highly variable data or small sample size. Because of the potential BBS-related sampling issues described above, the GCJV population objectives for this species are to maintain a population of 65,000 individuals in the Texas and Louisiana portions of the GCJV region, which includes BCR 37 in Texas, and BCRs 26 and 37 in Louisiana, and 9,000 individuals in the Mississippi and Alabama portions of the region, which includes BCRs 27 and 37 in Mississippi and BCR 27 in Alabama.

Seaside Sparrows occupy tidal marshes along the Gulf and Atlantic coasts. Key habitat components include nest sites in grasses above high tide levels, and openings in marsh vegetation, such as tidal pools or creeks, where birds can forage in exposed mud or around plant bases (Post and Greenlaw 2009). The Gulf populations of Seaside Sparrows are not migratory and northeastern U.S. migratory populations probably do not winter along the Gulf. Territory sizes vary across the species range (Post and Greenlaw 2009). In relatively unaltered marsh habitat, birds in the northern part of the species' range occupy smaller territories than southern birds (Post and Greenlaw 2009). Foraging may occur outside of nesting territories. Mean territory size is highly variable, from less than a quarter of an acre (ac) [0.1 hectares (ha)] to about 16 ac (~6 ha) (Post and Greenlaw 2009). Tidal marshes utilized by the species along the Gulf coast are often dominated by smooth cordgrass *(Spartina alterniflora)* and/or black needlerush *(Juncus roemarianus)*, but in southern coastal Texas, sea ox-eye daisy *(Borrichia frutescens)* is also an important nest substrate (Brent Ortego, 2008, pers. comm.).

Other landbird species of concern found in brackish and salt marsh habitat in the GCJV region include Nelson's Sparrow *(Ammodramus nelsoni)*, Short-eared Owl *(Asio flammeus)*, and Northern Harrier *(Circus cyaneus)*. All three are winter residents in the region. Interspecific aggression occurs regularly between Seaside and Nelson's Sparrows, with Seaside usually dominant. While Gulf Coast Seaside Sparrows likely maintain territories in the non-breeding season, Nelson's Sparrows form loose winter feeding flocks. It is not known to what extent, if any, these flocks interact with individual Seaside Sparrows. Management activities that increase suitable marsh habitat for Seaside Sparrows would increase habitat for wintering Nelson's Sparrow, especially in smooth cordgrass marshes (John Arvin, 2007, pers. comm.). While found in salt and brackish marshes, Northern Harriers and Short-eared Owls are more common in freshwater marshes and prairies, so management activities targeting Seaside Sparrow would likely only have marginally significant impacts on these raptors.

Post and Greenlaw (2009) opined that loss of coastal marsh habitat caused by human activities such as filling, ditching, and development-related pollution, as well as marsh loss due to natural processes, are a significant factor limiting Seaside Sparrow populations. Many of these natural processes, such as erosion and subsidence, have been exacerbated by development actions such as canal construction, increased marine vessel traffic, and extraction of petroleum and natural gas. Additionally, climate-induced sea level rise and expansion of black mangrove *(Avicennia germinans)* into emergent marsh areas may eliminate significant amounts of Seaside Sparrow habitat (Titus and Richman 2001, Doyle et al. 2010, Krauss et al. 2011, Comeaux et al. 2012).

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 this species should provide large areas of medium height smooth cordgrass or black needlerush, interspersed with numerous ponds, tidal creeks, and bare ground areas (Post and Greenlaw 2009). In instances of beneficial use of dredged material, creation of marsh elevation islands with some shallow waterbodies, vegetated with emergent marsh vegetation and scattered shrubs may encourage colonization by Seaside Sparrows if extant populations are nearby (Post and Greenlaw 2009). Post and Greenlaw (1994) also cited control of mammalian predators as a measure to increase or sustain Seaside Sparrow populations.

Gabrey and Afton (2000) studied the abundance of Seaside 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 recommended 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 2 growing seasons before re-burning a marsh. This fire frequency recommendation from *Spartina*-dominated marshes may or may not translate to marshes dominated by rushes *(Juncus)*, as in parts of coastal Mississippi, where historical fire return frequency may have been longer (i.e., about every 7 years) (Mark Woodrey, 2008, pers. comm.).

Using published species habitat requirements and PIF population estimates, a population habitat model was developed to estimate habitat needs for Seaside Sparrow in the GCJV region. 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 the marsh, the feeding areas required are less specific than nesting areas.

Seaside Sparrow 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 GCJV region breeding population is approximately 74,000 birds; 65,000 in Texas and Louisiana, and 9,000 in Mississippi and Alabama
- Assume 1:1 male-to-female population ration (Post and Greenlaw 1982), so GCJV region population contains approximately 37,000 males; 32,500 in Texas and Louisiana, and 4,500 in Mississippi and Alabama
- 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 (4,046 ha) of suitable salt/brackish habitat is required to support a viable population of Seaside Sparrow (Twedt et al. 1999)
- Approximately 740,000 ac (299,467 ha) of habitat in block sizes of at least 10,000 ac are needed to maintain current Seaside Sparrow populations in the GCJV region; 650,000 ac in Texas and Louisiana, and 90,000 ac in Mississippi and Alabama
- A portion of each habitat block should be burned every 3 years

2001 National Oceanic and Atmospheric Administration Coastal Change Analysis Program (CCAP) data was analyzed to ascertain the availability of ≥10,000 ac blocks of suitable Seaside Sparrow habitat. CCAP's estuarine emergent marsh land cover class represents potential Seaside Sparrow habitat. Using Leica Geosystems Geospatial Imaging ERDAS Imagine software, CCAP land cover classes for the GCJV region were clumped, then sieved based upon the minimum 10,000 ac size. That process identified 42 patches of estuarine emergent marsh ≥10,000 ac in the GCJV region (see Figures 2 – 6 below). Overlaying those patches with polygons depicting federal, state, and non-profit conservation organization lands (i.e., National Wildlife Refuges (NWR), State Wildlife Management Areas and Parks, The Nature Conservancy and National Audubon Society Preserves, etc.) indicates the possibility of achieving a significant portion of Seaside Sparrow population and habitat goals on extant conservation lands in the GCJV region. 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 habitat interspersion, and the positive habitat and species response recorded from 3-year frequency marsh burns, information on the frequency of burning, and other habitat disturbance, on public and private marshlands in the GCJV is needed. Given the prevalence of winter burning for marsh management in the GCJV region, more information regarding the effects of winter versus growing season burns would aid determination of the most desirable fire regime for Seaside Sparrow and other high-priority marsh species. The GCJV Landbird Working Group assumes that a combination of growing season and dormant season fires would be optimal for priority marsh birds in the region. Because there is some evidence of direct mortality for certain marsh birds during prescribed burning (Legare et al. 1998), studies comparing the impacts of different prescribed burn ignition strategies on priority marsh species would be useful.

Seaside Sparrow Research and Monitoring Needs:

- Assess suitability of habitat patches identified by CCAP analysis and accuracy of PIF population estimates for Seaside Sparrow in the GCJV region, possibly using a multi-species survey design according to the Conway marshbird monitoring protocol (Conway and Nadeau 2006)
- Determine territory size in the GCJV region
- 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 in the GCJV region
- 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

Le Conte's Sparrow

Le Conte's Sparrow *(Ammodramus leconteii)* is a wintering species in the GCJV region. Its primary habitat needs in this season are periodically (approximately every three years) disturbed grasslands, preferably consisting largely of native bunchgrasses 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. Limiting factors include habitat fragmentation, overgrazing, fire suppression and invasive exotic plant species.

The species is found in grassy old fields and prairies with dense cover, often dominated by *Andropogon* and *Schizachyrium* grass species. While moist habitats are not required for breeding (Cooper 1984), those habitats seem to be preferred in winter (Lowther 2005). 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 Sparrows is not known, but Winter et al. (2005) found no recognizable influences of patch size and percent shrub cover on the species' densities during breeding season in Minnesota and South Dakota. The 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).

Le Conte's Sparrow is one of many declining grassland bird species that share Gulf Coast grassland habitats, including Northern Bobwhite *(Colinus virginianus)*, Eastern Meadowlark *(Sturnella magna)*, Northern Harrier, Attwater's Greater Prairie-Chicken *(Tympanuchus cupido)*, and Loggerhead Shrike *(Lanius ludovicianus)*. While

Figure 2

Estuarine Emergent Marsh Patches 10,000 Acres or Larger
Gulf Coast Joint Venture Region

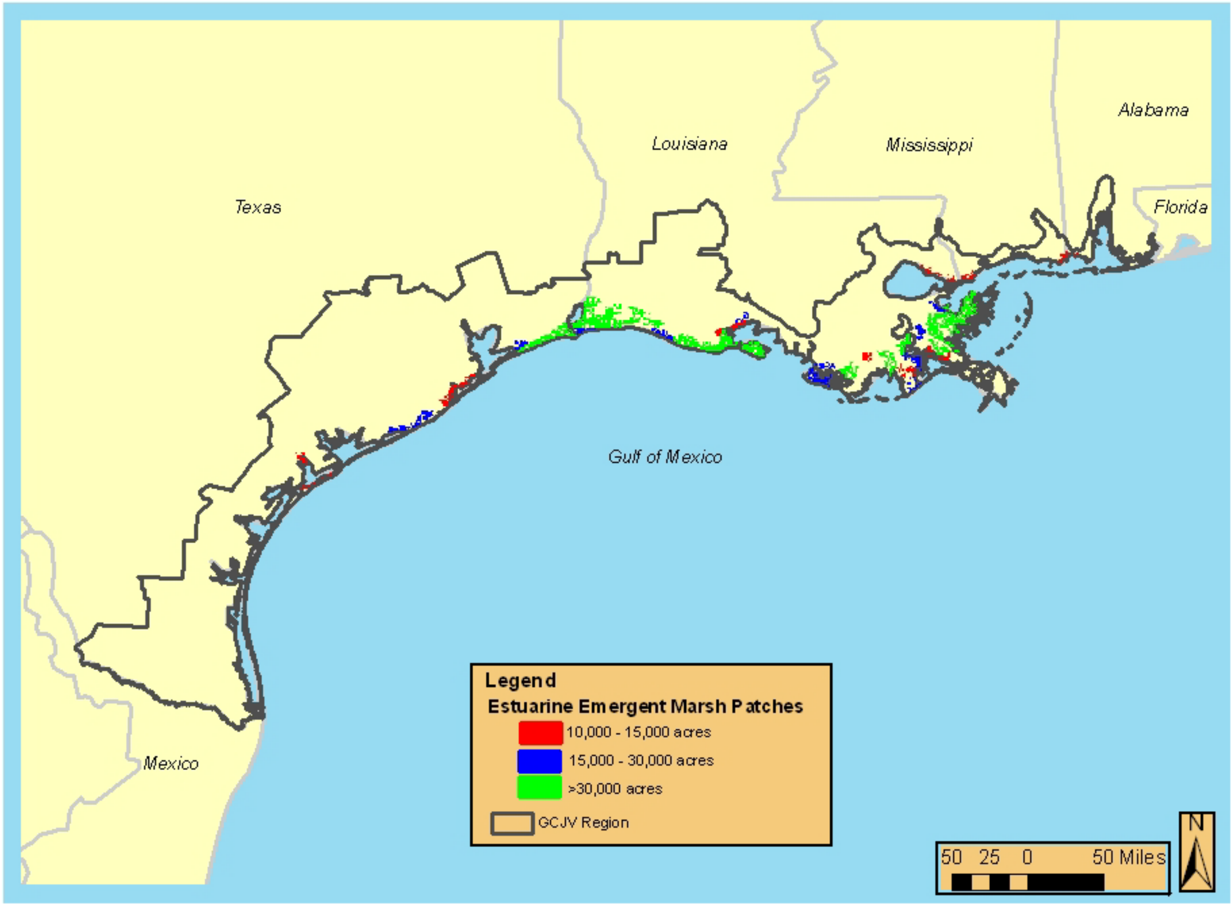


Figure 3
Estuarine Emergent Marsh Patches 10,000 Acres or Larger
BCR 26, Louisiana Chenier Plain Initiative Area

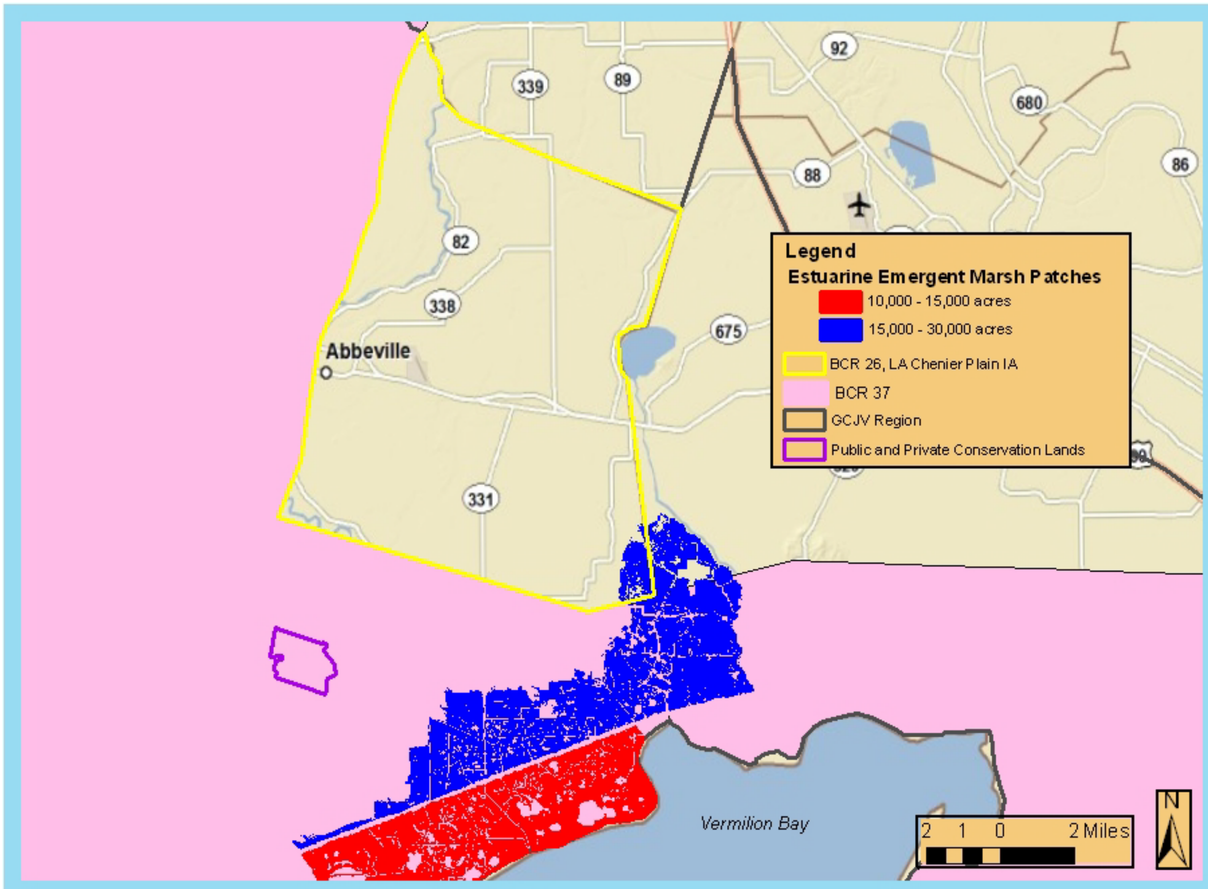


Figure 4

Estuarine Emergent Marsh Patches 10,000 Acres or Larger
BCR 26, Mississippi River Coastal Wetlands Initiative Area

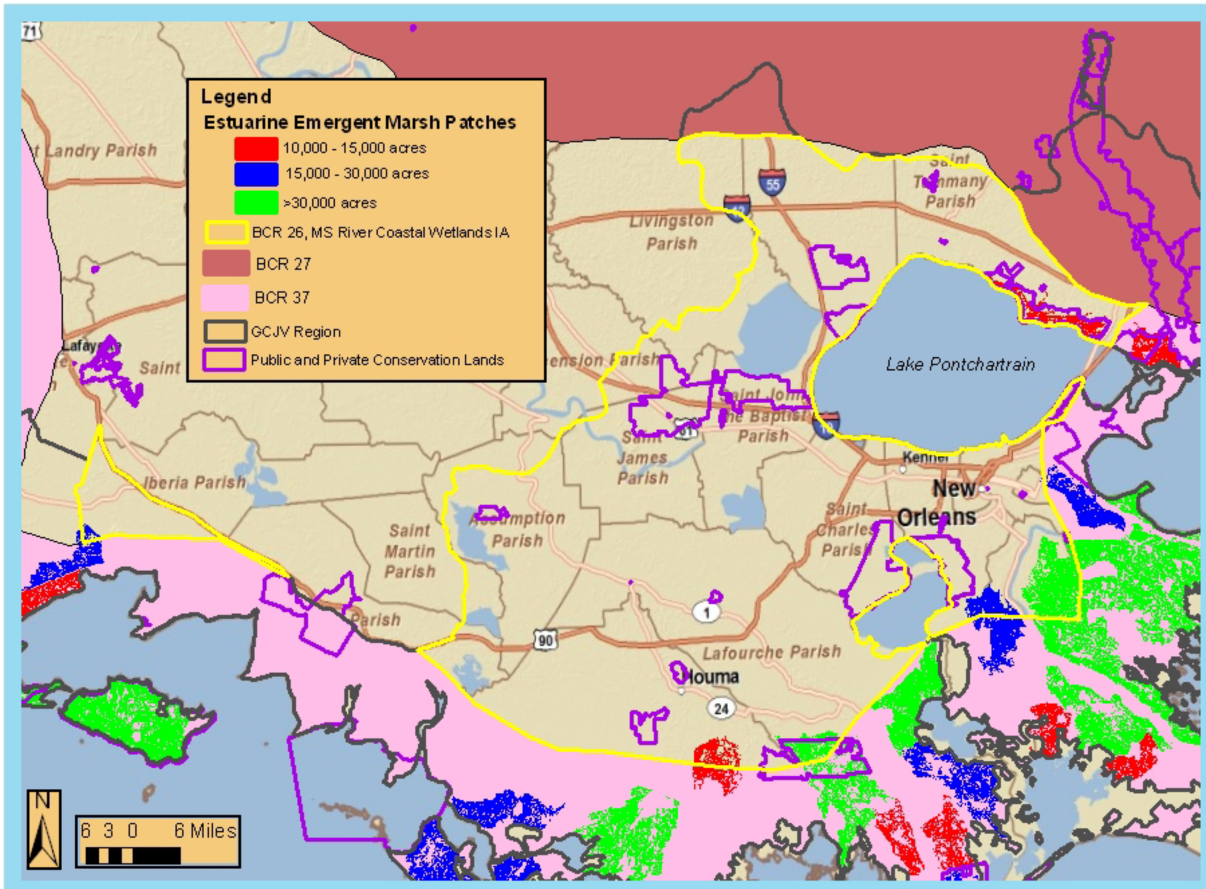


Figure 5

Estuarine Emergent Marsh Patches 10,000 Acres or Larger
BCR 27, Mississippi, Mississippi - Alabama Coastal Wetlands Initiative Area

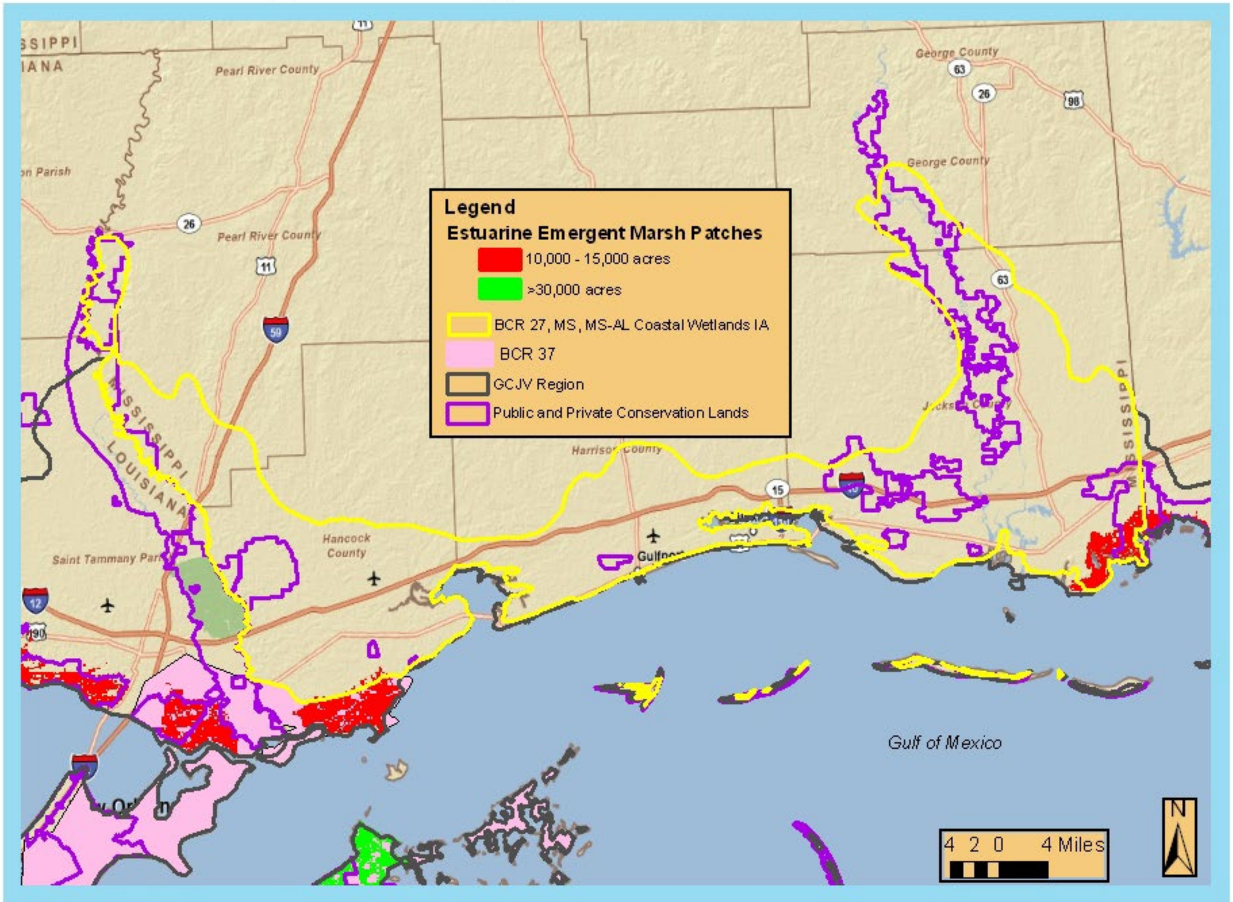
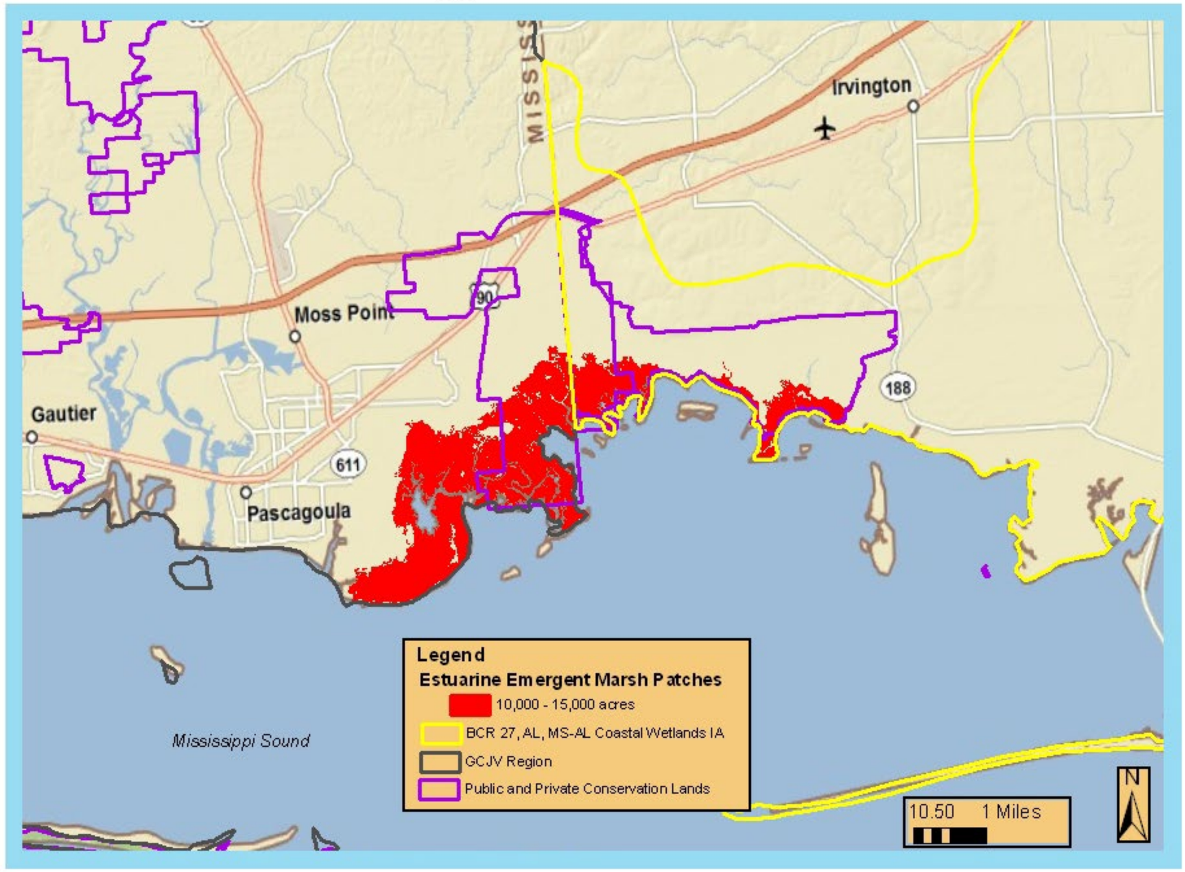


Figure 6

Estuarine Emergent Marsh Patches 10,000 Acres or Larger
BCR 27, Alabama, Mississippi - Alabama Coastal Wetlands Initiative Area



microhabitat requirements differ among these species, management for these grassland birds will benefit Le Conte's Sparrows.

The global population of Le Conte's Sparrow is estimated at 3,000,000 individuals (RMBO 2007), however, PIF has not derived population estimates for birds overwintering in states comprising the GCJV region. Winter population estimates at several lightly grazed refuges in Texas ranged 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) on Brazoria NWR, Texas. Estimating populations accurately during the non-breeding season is difficult because the species is not detected easily. 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.

Le Conte's Sparrow abundance and distribution in the GCJV is believed to fluctuate greatly from year to year, 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, grazing, or other disturbance is critical (Dechant et al. 1999, Baldwin 2005). Birds will avoid fields that have been burned within a year, as well as fields that have not been burned for many years. 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 and other grassland birds in Texas coastal prairie habitat. Haying or mowing may negatively impact habitat usage by Le Conte's Sparrow (Dechant et al. 1999), but the effects of grazing are unclear.

PIF's population objective for Le Conte's Sparrow is to maintain current global levels. To derive an estimate of the number of Le Conte's Sparrow wintering in the GCJV region, we apportioned PIF's global population estimate 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 where the species overwintered. For each state, we averaged data across years and across CBC circles to arrive at an average relative Le Conte's Sparrow density by state. We multiplied the state's relative bird density by its area 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; Louisiana hosts approximately 9.14% of the population (~ 274,132 individuals); Mississippi hosts approximately 3.82% of the population (~114,467 individuals), and Alabama hosts approximately 0.94% of the population or approximately 28,186 individuals. To step those state population estimates down to the GCJV region level, we further analyzed 1985/86 – 2005/06 bird per party-hour data from CBC circles at the

BCR – state intersect level, using the methods for entire states previously employed. Once estimates by state and BCR were derived, we stepped those down another level to reflect the intersection of the GCJV region, BCR, and state. Where available, CBC data collected inside the GCJV region was used to derive estimates; if not, we compared BCR area within-state to BCR area within-state-within-GCJV region and derived a proportional estimate using the BCR-state estimate obtained in the prior step. These estimates serve as population objectives for Le Conte's Sparrow in the GCJV region (see Table 1 below).

Table 1. Le Conte's Sparrow Population Objectives by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area (IA)

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	5,781	12,068	8,813	-*	-	-
26	-	-	479	12,852	-	-
27	-	-	-	393	2,548	216

*BCR does not extend into Initiative Area

Le Conte's Sparrow 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. Information on Le Conte's Sparrow food energy values for various grassland habitat types, (i.e., old fields, native prairie, improved pastures, etc.) in the GCJV region, however, is lacking. Based on information from the breeding grounds, and upon GCJV-regional 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 for Le Conte's Sparrow in the region. At Welder Wildlife Refuge, Texas, Grzybowski (1982) recorded densities of 1.1 and 7.6 Le Conte's Sparrow per acre (2.6 and 18.8 birds per hectare) at 2 moderately grazed grassland sites, and a density of 1.0 birds per acre (2.4 birds per hectare) at a lightly grazed grassland site. Baldwin (2005) recorded densities of 2.0 bird per acre (4.9 birds per hectare) at Brazoria NWR, Texas. Both Grzybowski's and Baldwin's study areas were on wildlife management areas. Since the majority of the GCJV region's grasslands are privately owned and not primarily managed for wildlife, we chose the most conservative density estimate (1.0 Le Conte's Sparrow per acre) for habitat objective calculations. Thus, habitat objectives for Le Conte's Sparrow in the GCJV region mirror population objectives (see Table 2 below).

CBC data and Lockwood and Freeman (2004) indicate that Le Conte's Sparrow becomes increasingly uncommon south of the Texas Mid-Coast. We therefore recommend that the majority of habitat provisioning for this species in the Laguna Madre Initiative Area (IA) of Texas be concentrated in the northern part of the IA (roughly from Kingsville north to Corpus Christi).

The Natural Resources Conservation Service Wildlife Habitat Management Institute recommends that grassland patches managed for an array of nesting birds should be 500 ac (~202 ha) or greater in size [United States Department of Agriculture (USDA) 1999a]. 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. An examination of Project Prairie Birds data (Texas Parks and Wildlife Department 2007) and other grassland bird data, combined with landcover

Table 2. Le Conte's Sparrow Habitat Objectives (ac) by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	5,781 ac (2,339 ha)	12,068 ac (4,883 ha)	8,813 ac (3,566 ha)	-*	-	-
26	-	-	479 ac (193 ha)	12,852 ac (5,201 ha)	-	-
27	-	-	-	393 ac (159 ha)	2,548 ac (1,031 ha)	216 ac (87 ha)

*BCR does not extend into Initiative Area

data, may help to address minimum block size and habitat interspersion questions for this species. We opine that a properly managed native grassland site of 500 ac in the GCJV region should support Le Conte's Sparrow densities in the range observed by Grzybowski (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 on a staggered rotation, so that some habitat would be available to birds every winter. Le Conte's Sparrow will not typically 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. If possible, 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. Gryzbowski (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 Landbird Working Group 2006, pers. comm.). As with the 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 bird objectives.

Le Conte's Sparrow Research and Monitoring Needs

- Acquire and analyze Project Prairie Birds and other data to determine suitable grassland patch size, species composition, structure, and landscape habitat matrix needed to support wintering birds
- Assess accuracy of PIF-derived population estimates for Le Conte's Sparrow in the GCJV region
- Determine the ideal mix of growing season and dormant season burns
- Assess effects of haying and grazing and the timing of these 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

Northern Bobwhite

Northern Bobwhite *(Colinus virginianus)* is a permanent (i.e., non-migratory) resident species in the GCJV region. The species' population has declined 3% per year on average range-wide since the advent of the BBS in 1966 [The National Bobwhite Technical Committee (NBTC) 2011]. For the physiographic regions comprising BCRs 25, 26, and 27, the decline as measured by the BBS has been steeper; 5.2%, 4.7%, and 4.9% per year, respectively (Sauer et al. 2011). These BBS derived population declines have been corroborated through other monitoring methodologies, including Christmas Bird Counts and upland game bird surveys conducted by state wildlife agencies (Brennan 1999). 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. 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).

Maintenance of 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 (2011) described an optimal bunchgrass density of 600 – 700 basketball-sized clumps per acre for nesting bobwhites. Adequate cover to escape predators is another 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 feet 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 feet in diameter (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) (NBTC 2011), Brennan et al. (2005), and numerous other sources including many of the references in this section

Numerous factors have negatively impacted northern bobwhite habitat, and thus populations, in the GCJV portions of BCR 25, 26 and 27. Some of the more significant of these factors include: conversion of open pine and mixed oak-pine-hickory forests into densely stocked pine plantations; alteration of historic fire frequencies in pine and mixed pine forests, leading to canopy closure and loss of herbaceous groundcover; replacement of native warm season grasses with non-native cool season sod-forming grasses; and intensive agricultural practices that have eliminated shrubby cover and quail food plants (NBTC 2011).

Other factors potentially affecting quail populations include rainfall and temperature (Sands 2010), fire ants (Perez 2007), hunting pressure (Burger et al. 1995, Sands 2010), and mammalian predators during the nesting season (Brennan et al. 2005).

Northern Bobwhite Habitat Model

The first version of the NBCI (Dimmick et al. 2002) aimed to restore current bobwhite densities to levels seen in 1980, largely through actions taken to improve agricultural, pastoral and forest habitats. Potential improvable acres were calculated for BCRs and states using the Natural Resources Conservation Service 1982 Natural Resources Inventory. State quail experts estimated the proportion of improvable acres, and the necessary management actions required to restore bobwhite to 1980's densities. The 2011

NBCI revision employed a different methodology to set population and habitat objectives. State wildlife biologists were asked to rank their states (on a scale of Low to High), first at the level of county, and then at the level of individual 6,400 ac grid cells, according to the likelihood that bobwhite populations would respond to proposed management actions, and the likelihood that those actions would render enough habitat to maintain viable bobwhite populations. Only areas ranked as "High" or "Medium" were considered to have potential for management of bobwhite on a landscape scale. Areas ranked "Low" were considered highly unlikely to be bobwhite habitat (except perhaps in isolated patches) for reasons such as unsuitable land cover types, small habitat patches, impediments to use of prescribed fire, or other constraints. Additionally, urban areas received a rank of "None." Biologists also identified habitat recommendations and constraints for ranked areas.

State quail biologists then assigned estimated and potential bobwhite densities by habitat type. For example, Mississippi biologists opined that the estimated density of "High" ranked row crop habitat in BCR 27 as approximately 1 bird/16 ac. Under recommended management, the density could be increased to 1 bird/2 ac. Potential coveys (12 birds = 1 covey) added under recommended management scenarios can be calculated by state, BCR, BCRs within-states, or other subdivisions, such as subsets of the GCJV region, as can acres of potential improvable "High" and "Medium" ranked habitat. Tables 3 - 6 below show the potential improvable acres and potential coveys added in BCRs 25, 26, and 27, by state and GCJV Initiative Areas.

Table 3. Potential Improvable Acres for Northern Bobwhite and Coveys Added, Alabama, by BCR and Gulf Coast Joint Venture Initiative Area

Alabama BCR	**Gulf Coast Joint Venture Initiative Area**			
	Coastal Mississippi – Alabama Wetlands			
	High Management Potential	**Potential Coveys Added**	**Med. Management Potential**	**Potential Coveys Added**
27	0 ac	0	2,036 ac (823 ha)	25

Table 4. Potential Improvable Acres for Northern Bobwhite and Coveys Added, Mississippi, by BCR and Gulf Coast Joint Venture Initiative Area

Mississippi BCR	**Gulf Coast Joint Venture Initiative Area**			
	Coastal Mississippi – Alabama Wetlands			
	High Management Potential	**Potential Coveys Added**	**Med. Management Potential**	**Potential Coveys Added**
27	0 ac	0	2,675 ac (1,082 ha)	68

Table 5. Potential Improvable Acres for Northern Bobwhite and Coveys Added, Louisiana, by BCR and Gulf Coast Joint Venture Initiative Area

Louisiana BCR	Gulf Coast Joint Venture Initiative Area							
	Chenier Plain				MS River Coastal Wetlands			
	High Management Potential	Potential Coveys Added	Med. Management Potential	Potential Coveys Added	High Management Potential	Potential Coveys Added	Med. Management Potential	Potential Coveys Added
25	323,410 ac (130,879 ha)	2,357	107,624 ac (43,553 ha)	991	-*	-	-	-
26	0 ac	0	56,976 ac (23,057 ha)	643	0 ac	0	271,628 ac (109,924 ha)	2,756
27	-	-	-	-	0 ac	0	96,414 ac (39,017 ha)	825

*BCR does not extend into Initiative Area

Table 6. Potential Improvable Acres for Northern Bobwhite and Coveys Added, Texas, by BCR and Gulf Coast Joint Venture Initiative Area

Texas BCR	Gulf Coast Joint Venture Initiative Area							
	Chenier Plain				Texas Mid-Coast			
	High Management Potential	Potential Coveys Added	Med. Management Potential	Potential Coveys Added	High Management Potential	Potential Coveys Added	Med. Management Potential	Potential Coveys Added
25	0 ac	0	2,838 ac (1,148 ha)	2	0 ac	0	26,171 ac (10,591 ha)	35

In the NBCI (NBTC 2011), state biologists identified the following opportunities for restoration of quail habitats and populations in BCR 25, 26, and 27:

- Use of prescribed fire on forests and fallow fields,
- Conversion of exotic pasture grasses to native warm season grasses,
- Restoration of pine and oak savannahs,
- Improved management on existing public conservation lands, such as wildlife management areas and national forests,
- Improved management of agricultural fields and field borders,
- Conversion of off-site pine species to native longleaf pine, with corresponding management,
- Extant northern bobwhite populations.

Conversely, those biologists listed the following constraints to achieving desired northern bobwhite habitat and populations goals (NBTC 2011):

- Use of sod-forming grasses for pasture and hay,
- Limited, or no monetary incentives for landowners to employ bobwhite-friendly practices,
- Low adoption of existing landowner incentives for use of wildlife conservation practices, such as prescribed burning or field border management,
- Impediments to the use of prescribed fire,
- Intensive agricultural practices,

- Industrial forest ownership,
- Average acreage of privately-owned farms and forests too small for significant conservation impacts to result from management implementation,
- Low northern bobwhite populations,
- Future urbanization.

Northern Bobwhite research and monitoring needs relevant to GCJV planning efforts are listed below. Additional research and monitoring considerations are presented in Brennan (1999) and the NBCI (NBTC 2011).

The EGCPJV drafted a decision support tool (DST) to guide conservation of open pine habitat in the EGCPJV region (Grand et al. 2008). This tool has potential applicability throughout the historic range of longleaf pine, which includes portions of the GCJV region in BCRs 25 and 27. The plan incorporates key habitat needs of a set of eight umbrella bird species that utilize open pine habitats, along with attributes related to existing open pine forest cover, and restoration possibilities. One of the umbrella species used in developing the DST is Northern Bobwhite, and others, such as Henslow's Sparrow *(Ammodramus henslowii)* and Bachman's Sparrow *(Peucaea aestivalis)* have habitat requirements very similar to Le Conte's Sparrow. As the EGCPJV's boundary abuts the GCJV's boundary in southeastern Louisiana, Mississippi, and Alabama, the DST may be useful in prioritizing areas for restoration of open pine habitat in the GCJV region to benefit Northern Bobwhite and Le Conte's Sparrow. Similarly, LMVJV staff and partners developed an open pine landbird plan for the West Gulf Coastal Plain and Ouachitas (WGCPO) that uses a methodology similar to that of Grand et al (2008) (LMVJV WGCPO Landbird Working Group 2011). Northern Bobwhite was chosen for an umbrella species in that effort as well, but was ultimately not considered in construction of the LMVJV's open pine DST due to unresolved parameter issues. However, the LMVJV open pine plan outlines ideal open pine forest attributes for Northern Bobwhite, and the DST has value to identify priority areas for open pine (and thus Northern Bobwhite) management in the BCR 25 portion of the GCJV region in Texas and Louisiana.

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 and management response assumptions used in developing improvable acre and added covey estimates
- Simulate impacts of the predicted cultivation of native and exotic grasses for ethanol production on Northern Bobwhite and other priority grassland birds

Loggerhead Shrike

The GCJV's Loggerhead Shrike *(Lanius ludovicianus)* population comprises both permanent residents and overwintering migrant individuals. Resident breeding Gulf Coast populations are joined in winter by birds the 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 despite this relatively robust population size, those authors also indicate 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 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. Changes in agricultural practices, loss of hayfields, and elimination of hedgerows have decreased shrike habitat on the landscape. 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 Landbird Working Group tentatively recommended 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 *(Ammodramus savannarum)* 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 was 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 (Bill Eley 2007, pers. obs.), 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 (John Arvin 2007, pers. comm.). While breeding success in urban habitats in the GCJV region is not known, Boal et al. (2003) found that nesting success in Tuscon, Arizona, was high in comparison to studies in other habitats, and fledging success was within the range reported from most of those studies.

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. Discourage the conversion of prairie and pasture to cropland.
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 (Muller et al. 1997, Ward and Schlossberg 2004, Ahlering and Faaborg 2006). 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.

Loggerhead Shrike Habitat Model

PIF estimates the global Loggerhead Shrike population at 4,200,000 individuals [Rocky Mountain Bird Observatory (RMBO) 2007]. PIF also provides resident Loggerhead Shrike population estimates by state and BCR. PIF's goal is to double the population of Loggerhead Shrike (Rosenberg 2004a, 2004b, 2004c, 2004d). Resident shrike estimates for BCR 25, 26, and 27 in the states which intersect the Gulf Coast Joint Venture region are listed below:

- Alabama
  - BCR 27 – 50,000
- Louisiana
  - BCR 25 – 12,000
  - BCR 26 – 100,000
  - BCR 27 – 3,000
- Mississippi
  - BCR 27 – 50,000
- Texas
  - BCR 25 – 12,000

To step down PIF's state- and BCR-level resident Loggerhead Shrike population estimates to the level of GCJV IAs, we reviewed data collected from BBS routes inside or intersecting the GCJV region, and grouped them by BCR and IA. Only routes with ≥10 years of data were considered. The BBS provides data on average number of species-per-route. For each BCR-IA subdivision (i.e., the BCR 25 portion of the Texas Mid-Coast Initiative Area), we multiplied its relative bird density by its area to arrive at relative bird abundance. These BCR/IA-specific relative bird abundances were then expressed as percentages of the sum of all relative bird abundances within the specific BCR and across IAs. Multiplying these percentages by the state/BCR-level population estimate yields a resident population estimate for each IA within a given BCR (see Table 7 below).

Table 7. Resident Loggerhead Shrike Population Estimates by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area (IA)

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	**642**	**2,304**	**4,362**	**-***	**-**	**-**
26	**-**	**-**	**3,020**	**15,802**	**-**	**-**
27	**-**	**-**	**-**	**452**	**1,168**	**850**

*BCR does not extend into Initiative Area

To derive an estimate of the number of migratory Loggerhead Shrike over-wintering in the GCJV region, we used the map and written description of the species' range from the Birds of North America account (Yosef 1996), along with several 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 same process described above for Le Conte's Sparrow, we analyzed CBC data to generate average relative shrike densities and abundances for regions in the species' eastern winter range, then expressed these regional abundances as percentages of the sum of all relative bird abundances across the shrike's eastern wintering range. Multiplying these percentages by the eastern migratory shrike population estimate generated by RMBO (1,081,400) yields a winter population estimate for each region in the species' eastern winter range.

This process suggests that approximately 3.89% or 42,063 Loggerhead Shrike overwintered in Alabama, approximately 11.35% or 122,709 overwintered in Louisiana, approximately 6.56% or 70,912 overwintered in Mississippi, and approximately 48.95% or 529,386 overwintered in Texas.

As with Le Conte's Sparrow, these state-specific estimates were further stepped down to the level of BCR and IA within the GCJV region, yielding the following migratory shrike population estimates (Table 8):

Table 8. Migratory Loggerhead Shrike Winter Population Estimates by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area (IA)

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	536	1,119	2,857	-*	-	-
26	-	-	285	7,645	-	-
27	-	-	-	537	1,453	535

*BCR does not extend into Initiative Area

The PIF population objective for Loggerhead Shrike is to double the existing population. Doing so yields the following objectives for the BCR 25, 26, and 27 resident and migratory populations (Tables 9 – 10 below):

Table 9. Resident Loggerhead Shrike Population Objectives by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area (IA)

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	1,284	4,608	8,724	-*	-	-
26	-	-	6,040	31,604	-	-
27	-	-	-	904	2,336	1,700

*BCR does not extend into Initiative Area

Table 10. Migratory Loggerhead Shrike Winter Population Objectives by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area (IA)

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	1,072	2,238	5,714	-*	-	-
26	-	-	570	15,308	-	-
27	-	-	-	1,074	2,906	1,070

*BCR does not extend into Initiative Area

Loggerhead Shrike Habitat Model

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 the GCJV region. 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), 61.78 ac (25 ha)

Based on these reported territory sizes, 20 ac (8 ha) was chosen as the average resident Loggerhead Shrike territory size in the GCJV region. We also assumed that migratory Loggerhead Shrike have territory sizes of approximately 5 ac (2 ha) per bird in the GCJV region, which roughly represents half the territory size of an individual resident Loggerhead Shrike. We used those territory sizes to generate habitat objectives for resident and migrant Loggerhead Shrike in the GCJV region, and then estimated potential habitat availability through analysis of the 2001 National Landcover Dataset (NLCD). That analysis showed that some portions of the GCJV region could not support Loggerhead Shrike objectives at the assumed territory sizes of 20 ac per resident pair and

5 ac per migrant wintering bird. In fact, in some portions of the GCJV region, the estimated extant resident population could not be supported by potentially available habitat. It seems likely that the error lies in the PIF resident Loggerhead Shrike population estimates, unless GCJV region territory sizes are for some reason significantly smaller than any observed in prior studies.

Until Loggerhead Shrike population estimates can be improved, we recommend adopting the larger of either the grassland habitat goals calculated for Le Conte's Sparrow, or estimated improvable acres for Northern Bobwhite (NBTC 2011) in the portions of the region showing habitat deficits (see Table 11 below).

Table 11. Loggerhead Shrike Habitat Objectives by Bird Conservation Region and Gulf Coast Joint Venture Initiative Area (IA)

BCR	Texas Mid-Coast IA	Chenier Plain IA		MS River Coastal Wetlands IA	Coastal MS-AL Wetlands IA	
		TX	LA		MS	AL
25	18,170 ac (7,353 ha)	57,210 ac (23,152 ha)	114,930 ac (46,510 ha)	-*	-	-
26	-	-	56,976 ac[1] (23,057 ha)	271,628 ac[1] (109,923 ha)	-	-
27	-	-	-	14,240 ac (7,858 ha)	37,940 ac (15,353 ha)	22,350 ac (9,044 ha)

*BCR does not extend into Initiative Area
[1]Northern Bobwhite Improvable Acres

Loggerhead Shrike Research and Monitoring Needs

- Improve estimates of resident and migratory population sizes
- Assess territory shape, size, and habitat requirements in the GCJV region
- 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 Le Conte's Sparrow, Northern Bobwhite, and Loggerhead Shrike 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.

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

The selection of these three warbler species is intended to cover the stratification of coastal forest landbird migration habitat by including a canopy species [Cerulean Warbler, *(Setophaga cerulean)*], a mid-story species [Golden-winged Warbler *(Vermivora chrysoptera)*], and an understory species [Swainson's Warbler *(Limnothlypis swainsonii)*]. 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 is an uncommon breeder in the GCJV portions of BCRs 25, 26, and 27 (Wiedenfeld and Swan 2000, Sauer et al. 2011), using deciduous and mixed deciduous-evergreen forests. All three species are fairly regular transients in the GCJV region 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 emergency stopover habitat when they are forced to stop there (B. Eley 2007, pers. obs.). 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.

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 Tudor 1989). During migration in the coastal hardwood forests of the Texas and Louisiana Chenier Plain, the species often forages in suspended dead-leaf clumps and at flowers (Barrow et al. 2000).

The majority of the breeding range of Swainson's Warbler is in the southeastern U.S., where it typically uses bottomland hardwood forests with dense understory, and Appalachian Mountain forests with moderately dense undergrowth and moderate ground cover. The species has also been found to nest in pine plantations under certain conditions (Carrie 1996, Basset-Touchell and Stouffer 2006). 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 (Anich et al. 2010), but the birds are most often observed in the understory of coastal woods (G. Graves 2007, pers. comm.).

Forest habitats used by migrant landbirds in the GCJV portion of BCRs 25, 26, and 27 include maritime forests in coastal Mississippi and Alabama as well as larger bottomland hardwood forest systems associated with the region's rivers, such as the Pascagoula, Mobile-Tensaw, Neches, and Calcasieu.

Selection and use of forested habitat by nearctic-neotropical migrants is influenced by weather and body condition. Both Lowery (1945) and Gauthreaux (1971) described the "coastal hiatus" wherein migrants typically landed 25 – 80 miles (mi) [40 – 125 kilometers (km)] inland of the Louisiana coastline after crossing the Gulf of Mexico during spring. However, Buler et al. (2007a, 2007b) and Buler and Moore (2011) showed that migrant landbirds preferentially selected habitat proximal [i.e., within approximately 11 mi (18 km)] to the Mississippi coastline during spring migration. Similarly, Buler et al. (2007b) stated that while migrant birds consistently used areas dominated by extensive tracts of hardwood forests in the southeastern U.S., they also concentrated in coastal areas dominated by relatively low-quality stopover habitats such as urban development. They surmised that a portion of spring migrants are physiologically constrained to land at the first available habitat upon reaching the shoreline. However, near shore forests are utilized by large numbers of fat, fit spring migrant birds as well, especially during inclement weather (Leberg et al. 1996). Conversely, in autumn, Buler and Moore (2011) found that migrant densities along the Gulf Coast from southeastern Louisiana to Alabama peaked at about 22 mi (35 km) from the coast, with birds concentrating in extensive bottomland hardwood corridors. Additionally, it has been observed that migrant birds will also engage in reverse, inland movements at coastal sites; this is theorized to be an adaptive behavior employed by birds to access better foraging areas in order to fatten prior to crossing large expanses of water or other unsuitable habitat (Able 1977, Alerstam 1978, Richardson 1978, 1982, Lindström and Alerstam 1986, Wiedner et al. 1992, Åkesson et al. 1996, Åkesson 1999, Yaukey 2010).

It is unclear to what extent en-route habitat is a limiting factor to nearctic-neotropical migrant bird 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). 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 (Woodrey 2000, Marra and Holmes 2001).
- Birds often use different habitat in spring and fall (Petit 2000, Buler et al. 2007a. 2007b, Buler and Moore 2011).
- 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. 2007a), 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, Barrow et al. 2000).
- 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, Newton 2004, 2006).

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. Available information strongly points to the importance of stratified, hardwood-dominated 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.

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. Extensive bottomland hardwood forests are a good example.

In an effort to quantify the amount and type of migratory landbird stopover habitat available in the GCJV region, parameters were assigned to the categories above to enable spatial analysis of 2001 NLCD data. NLCD classes analyzed included deciduous forest, evergreen forest, mixed forest, and palustrine forested wetland. "Full-service Hotel" habitat was defined as forested habitat patches at least 10,000 ac (4,046 ha) in size. This patch size is the size believed to be required to support a viable breeding population of Swainson's Warbler in BCR 26 (Twedt et al. 1999), and it is likely that this size should provide ample resources for transient landbirds. Based on Buler et al.'s (2007a) work with landbird migrants in Mississippi, we classified all forested habitat patches < 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 ac in size. The preliminary results of this landcover analysis are depicted in Figures 7 – 19 below. 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, pers. comm.).

U.S. Geological Survey scientists are currently working to develop a landscape-scale approach to the development of migratory landbird forest habitat objectives in the GCJV region, using empirical data derived from archived radar imagery. Data collected from

2002 – 2010 at four radar stations (Lake Charles, LA, Houston, TX, Corpus Christi, TX, and Brownsville, TX) are being analyzed. Migrant landbird density will be calculated for sampling sites in each radar area, along with coefficient of variation among sites. Landbird migrant density and coefficient of variation will be modeled against parameters of geographic position, degree of human development, and habitat composition. Based on that information, a model will be constructed for each radar area describing those relationships between birds and the environment. Those individual models will 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 information points to the importance of large, mesic bottomland hardwood forest patches in the GCJV region 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 2007a, 2007b). Additionally, in Mississippi and Alabama, Buler et al. (2007a, 2007b) showed regular use of forest habitat within approximately 11 mi (18 km) of the coastline.

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 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 majority of GCJV forests in BCR 25, 26, and 27 fall within either the Consistent-abundant or Sporadic common-abundant classification (Figures 7-11 below). The region stretching from the Colorado River mouth in Texas to approximately Point Au Fer, Louisiana to approximately 60 mi (100 km) inland is used by large numbers of migrants each year and season (Consistent abundant). The eastern portion of the GCJV region, from approximately Point Au Fer, Louisiana, to the Alabama-Florida state line, receives use from a moderate to large number of migrants, depending on prevailing winds

Figure 7

Gulf Coast Joint Venture Forest Habitat within Landbird Priority Zones, NLCD 2001

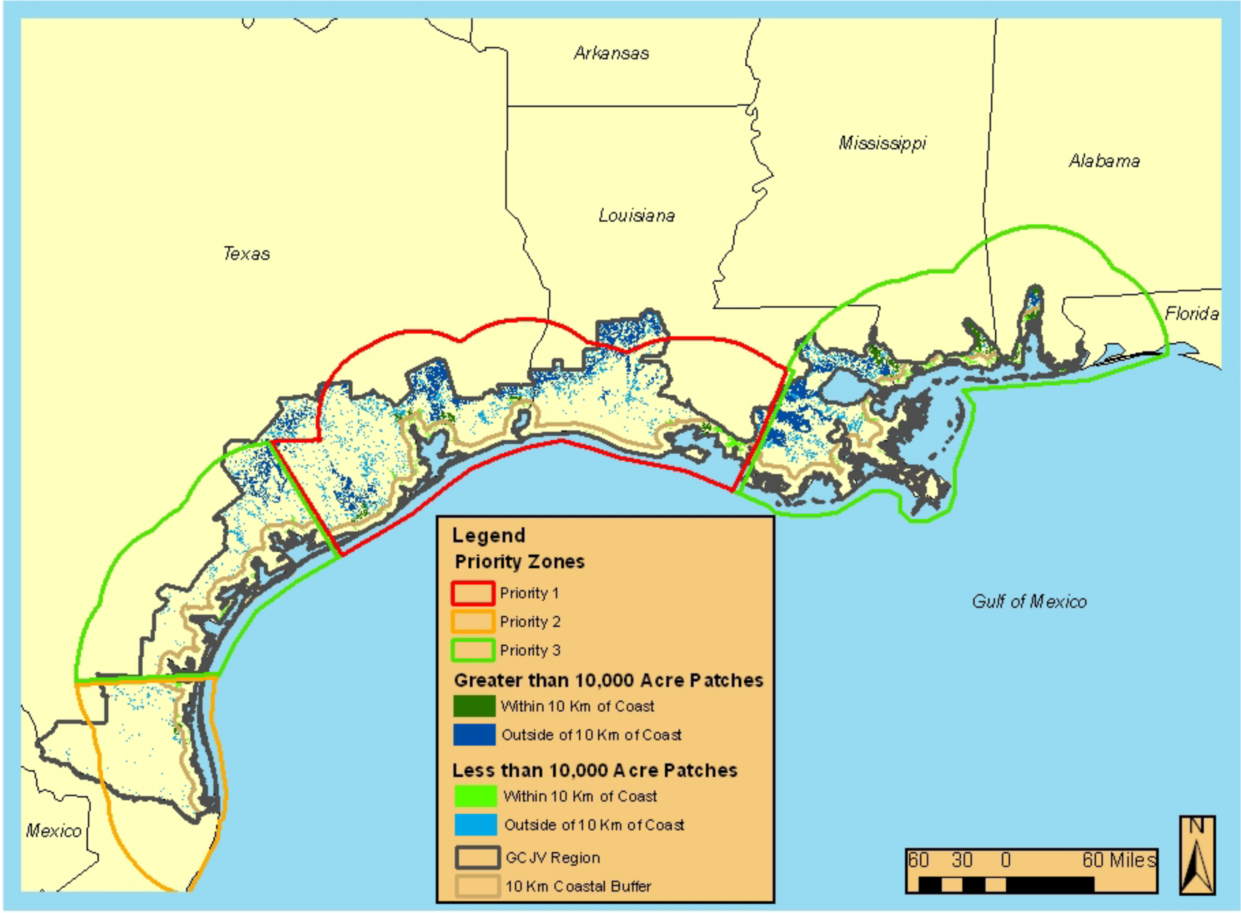


Figure 8

Gulf Coast Joint Venture Forest Habitat within Landbird Priority Zone 1

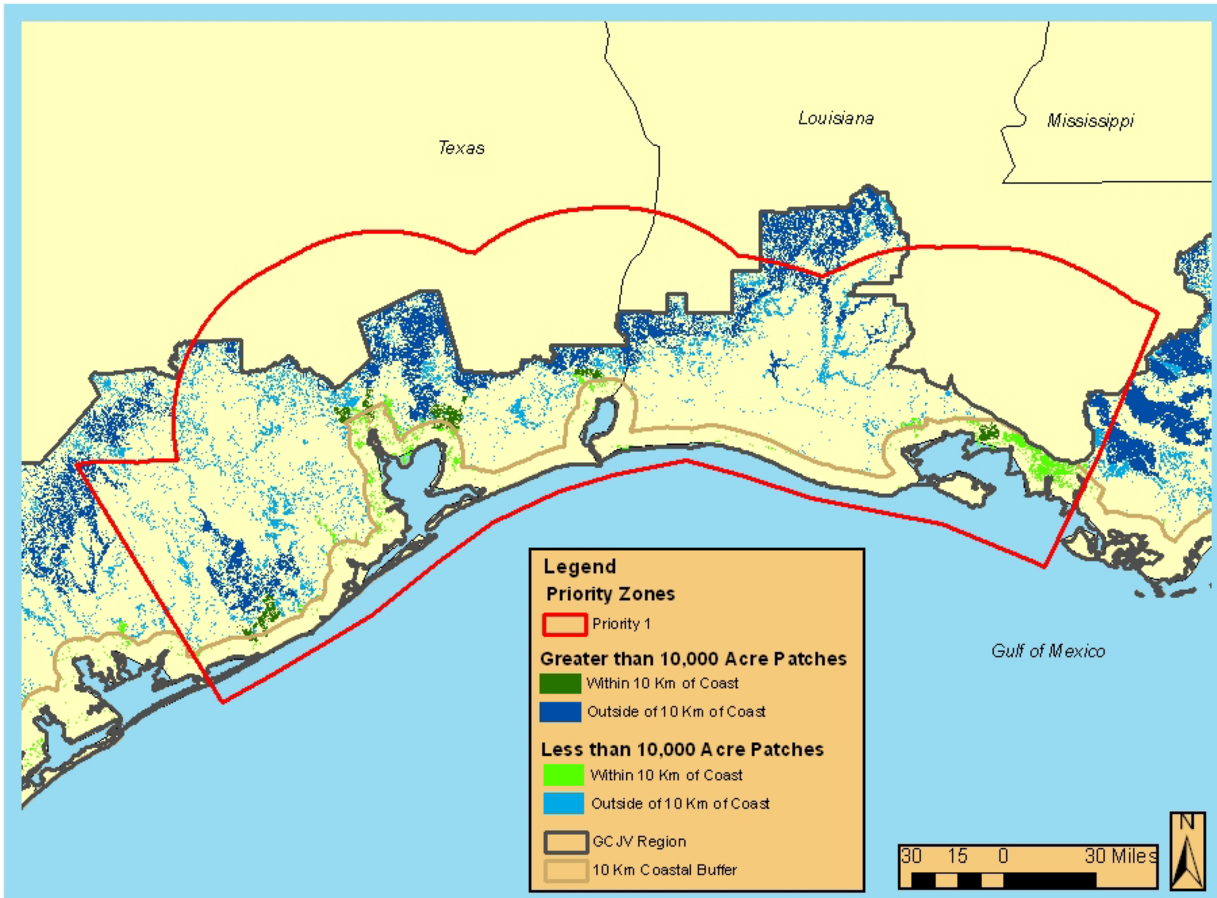


Figure 9

Gulf Coast Joint Venture Forest Habitat within Landbird Priority Zone 2

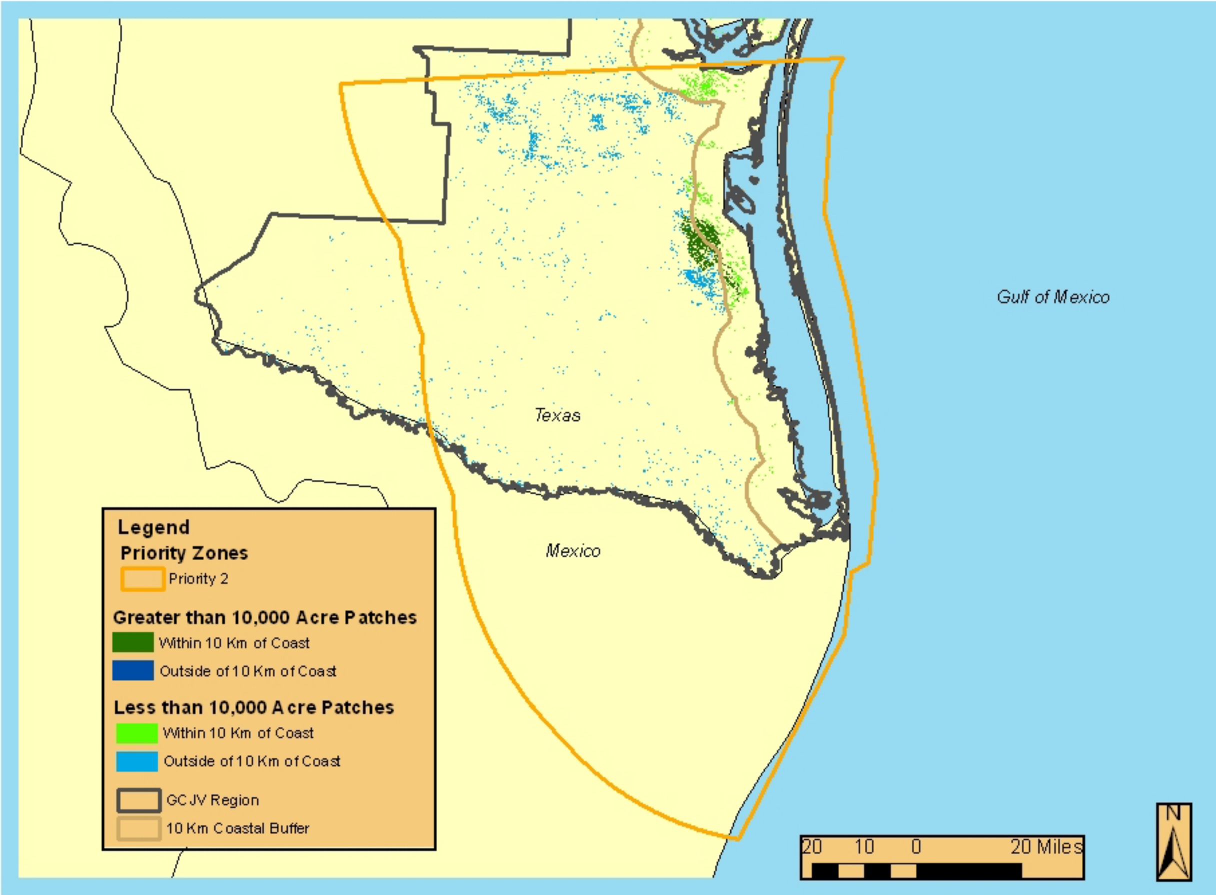


Figure 10

Gulf Coast Joint Venture Forest Habitat within Landbird Priority Zone 3, West

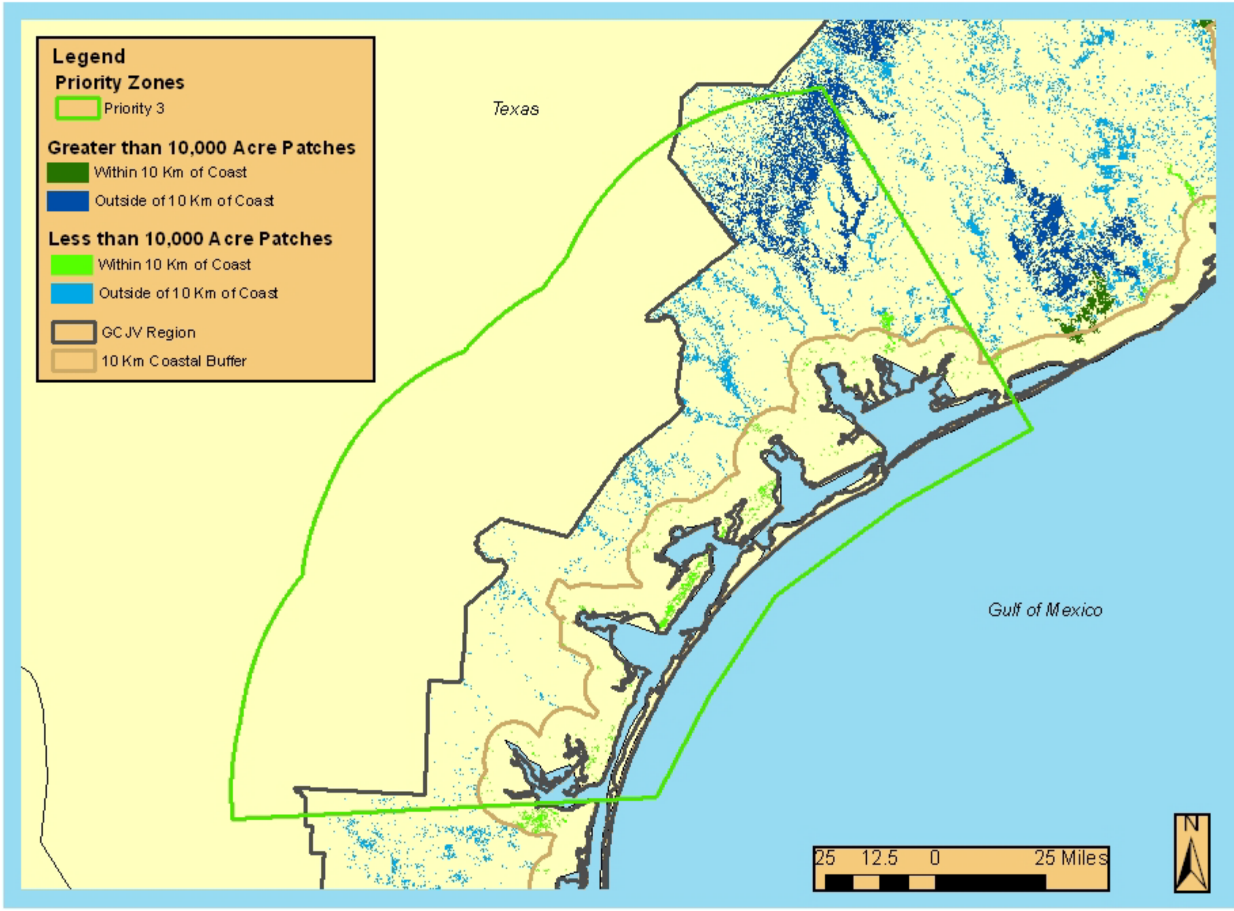


Figure 11

Gulf Coast Joint Venture Forest Habitat within Landbird Priority Zone 3, East

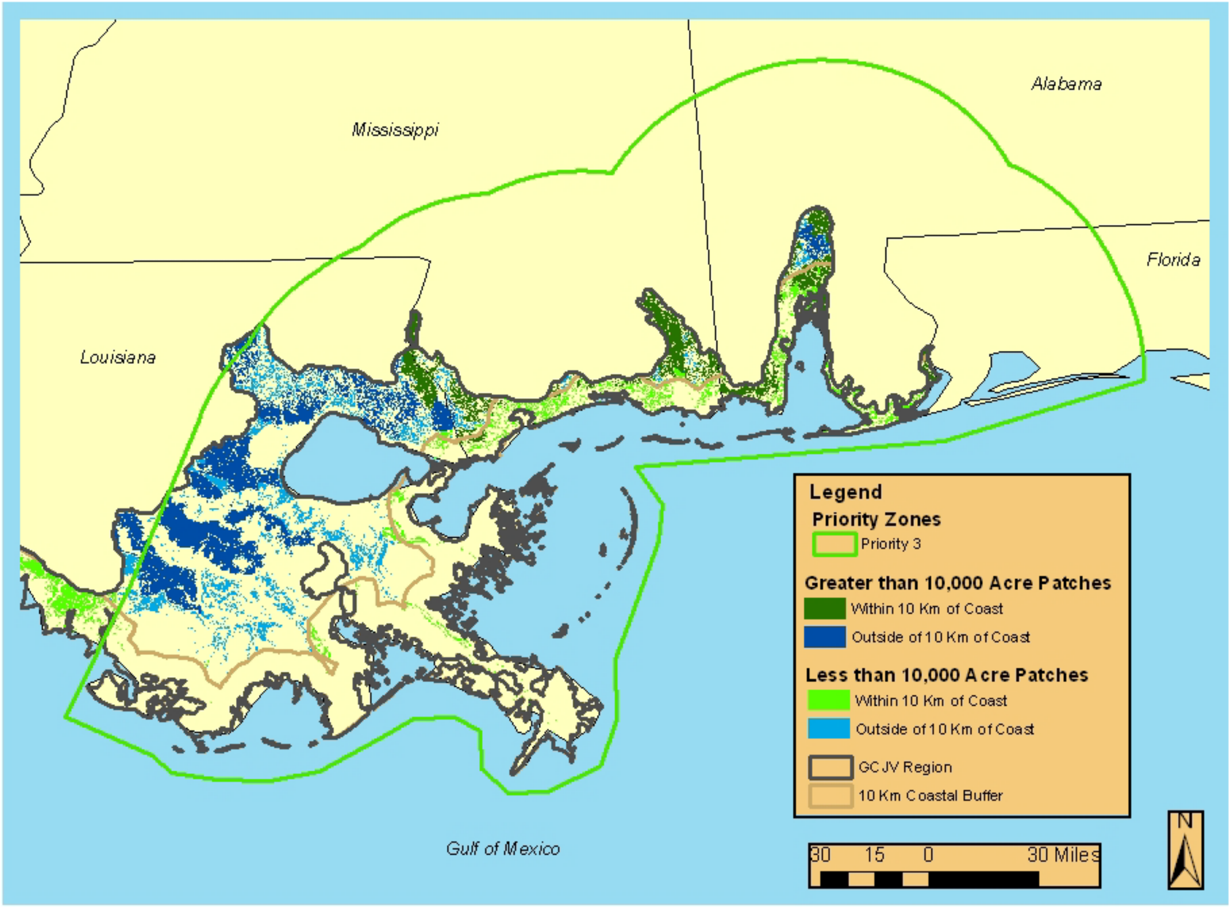


Figure 12

Forest Habitat, BCR 25, Gulf Coast Joint Venture, Texas Mid-Coast Initiative Area

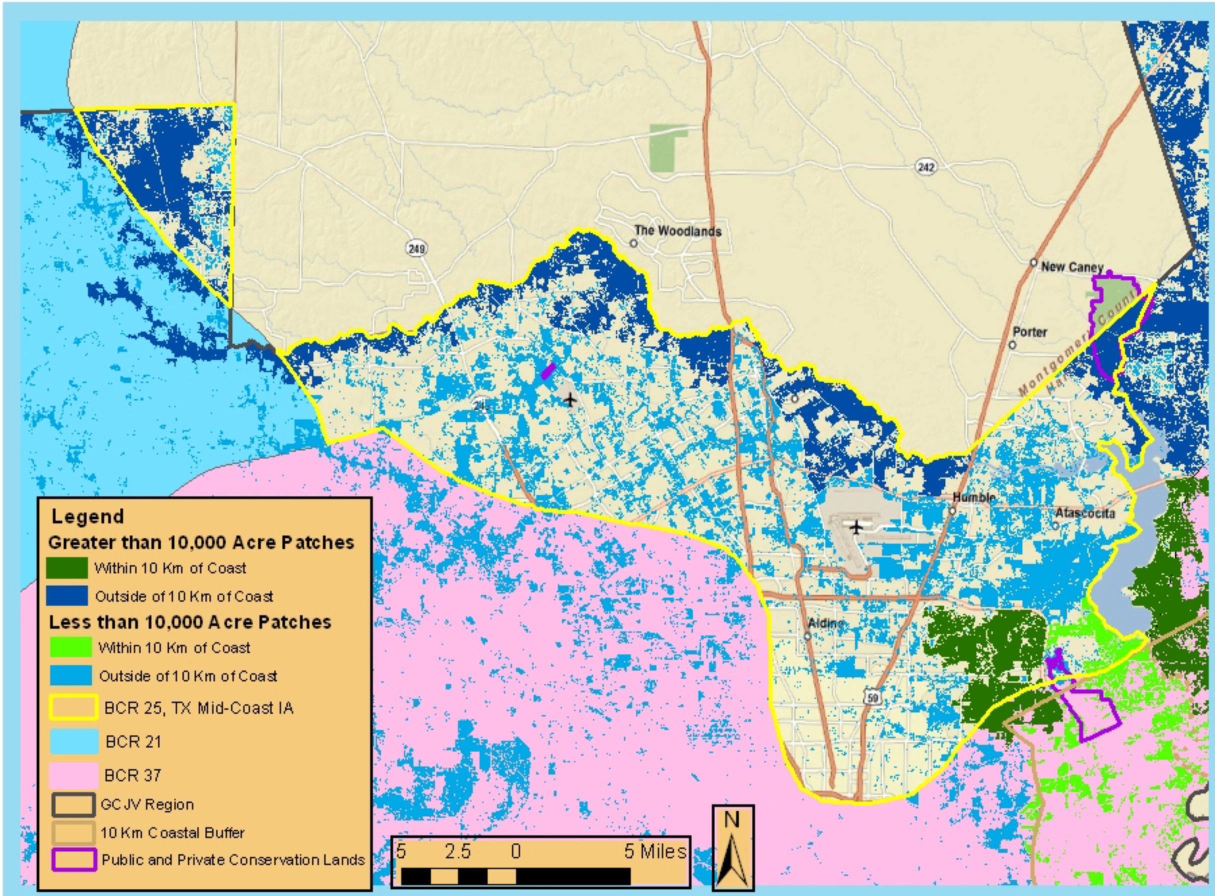


Figure 13

Forest Habitat, BCR 25, Gulf Coast Joint Venture, Texas Chenier Plain Initiative Area

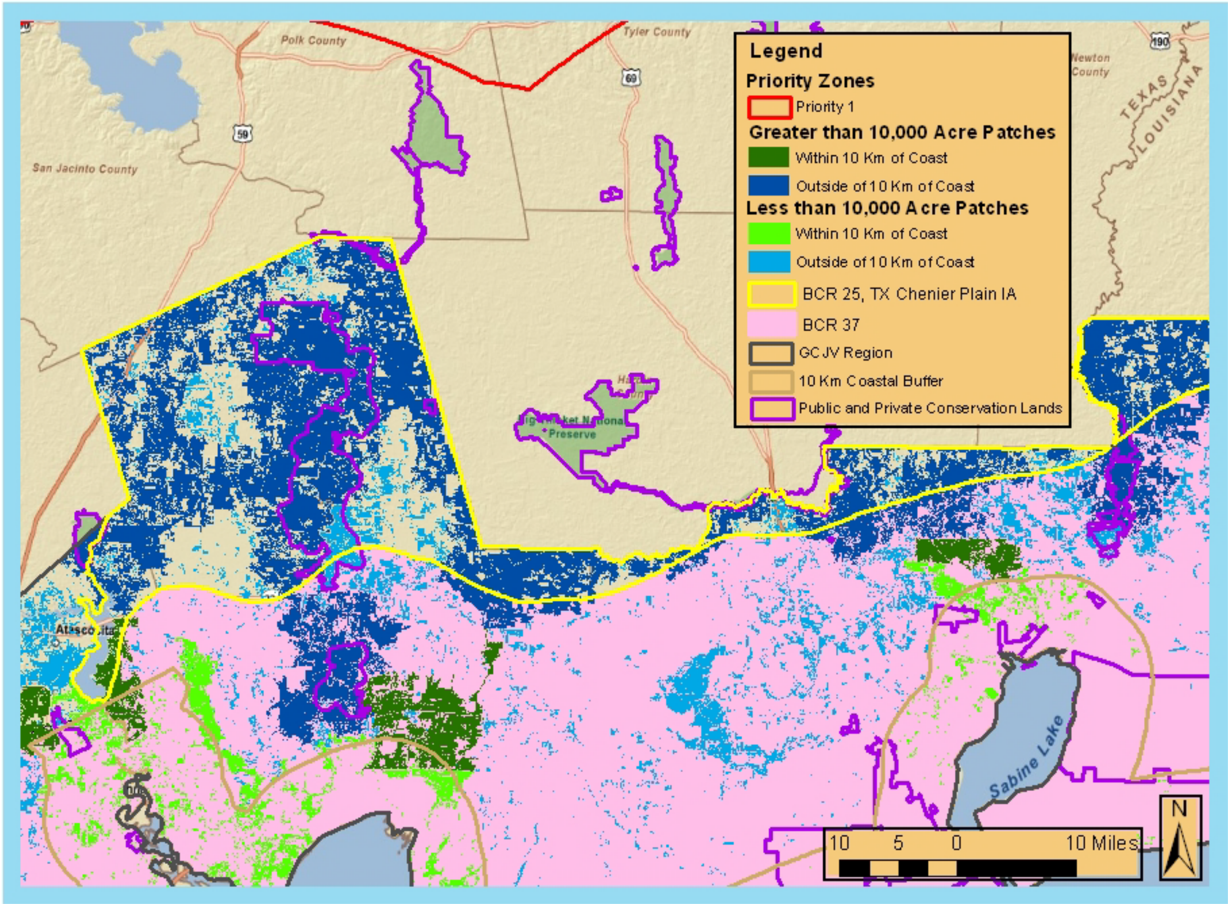


Figure 14

Forest Habitat, BCR 25, Gulf Coast Joint Venture, Louisiana Chenier Plain Initiative Area

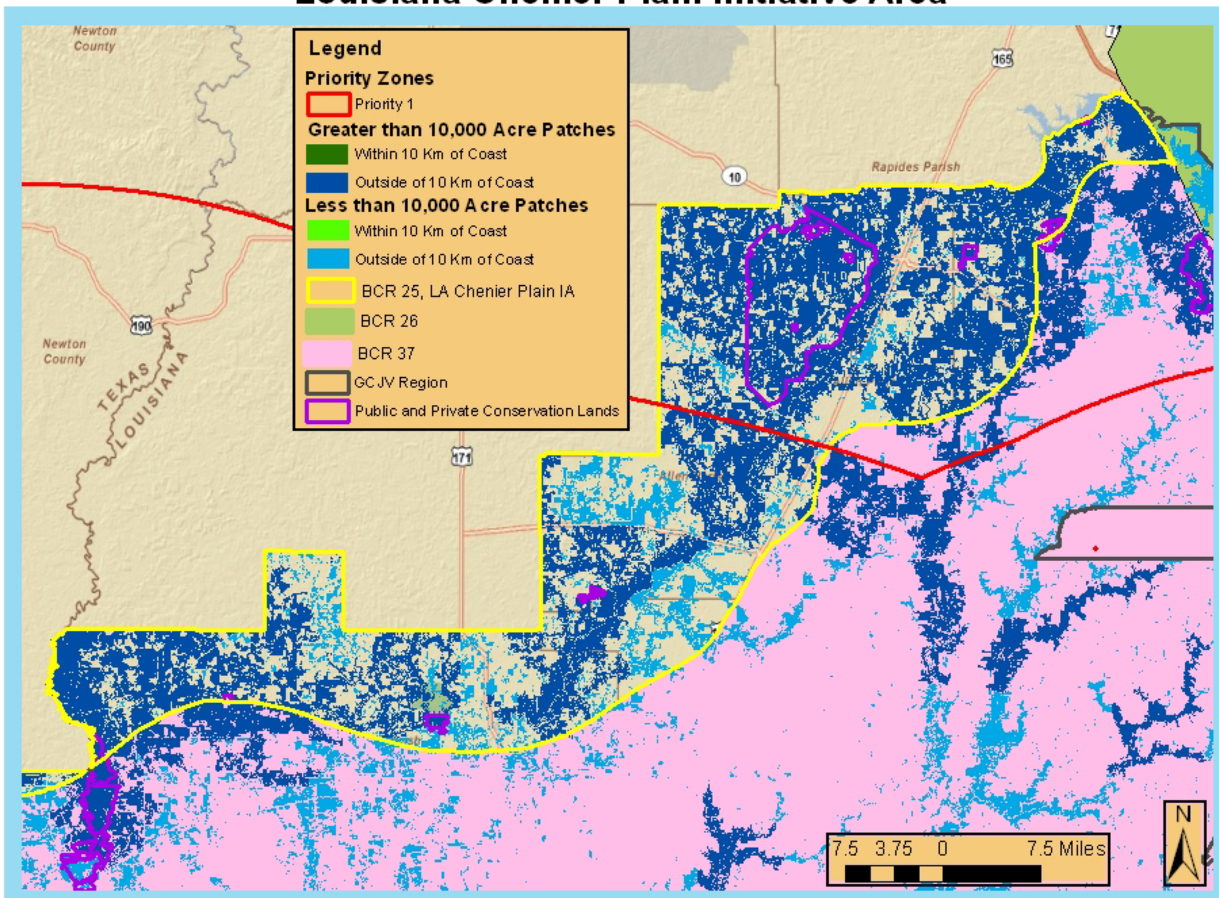


Figure 15

Forest Habitat, BCR 26, Gulf Coast Joint Venture
Louisiana Chenier Plain Initiative Area

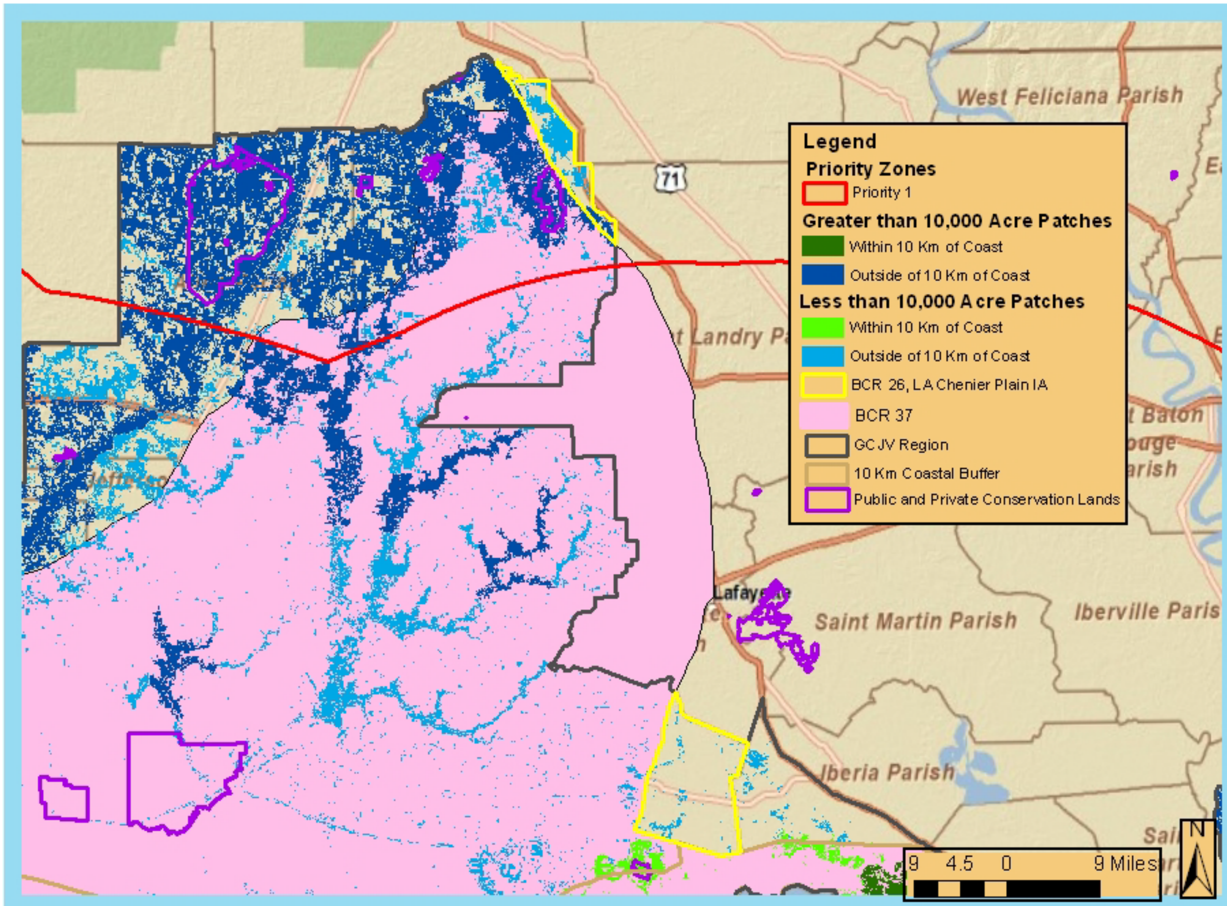


Figure 16

Forest Habitat, BCR 26, Gulf Coast Joint Venture
Mississippi River Coastal Wetlands Initiative Area

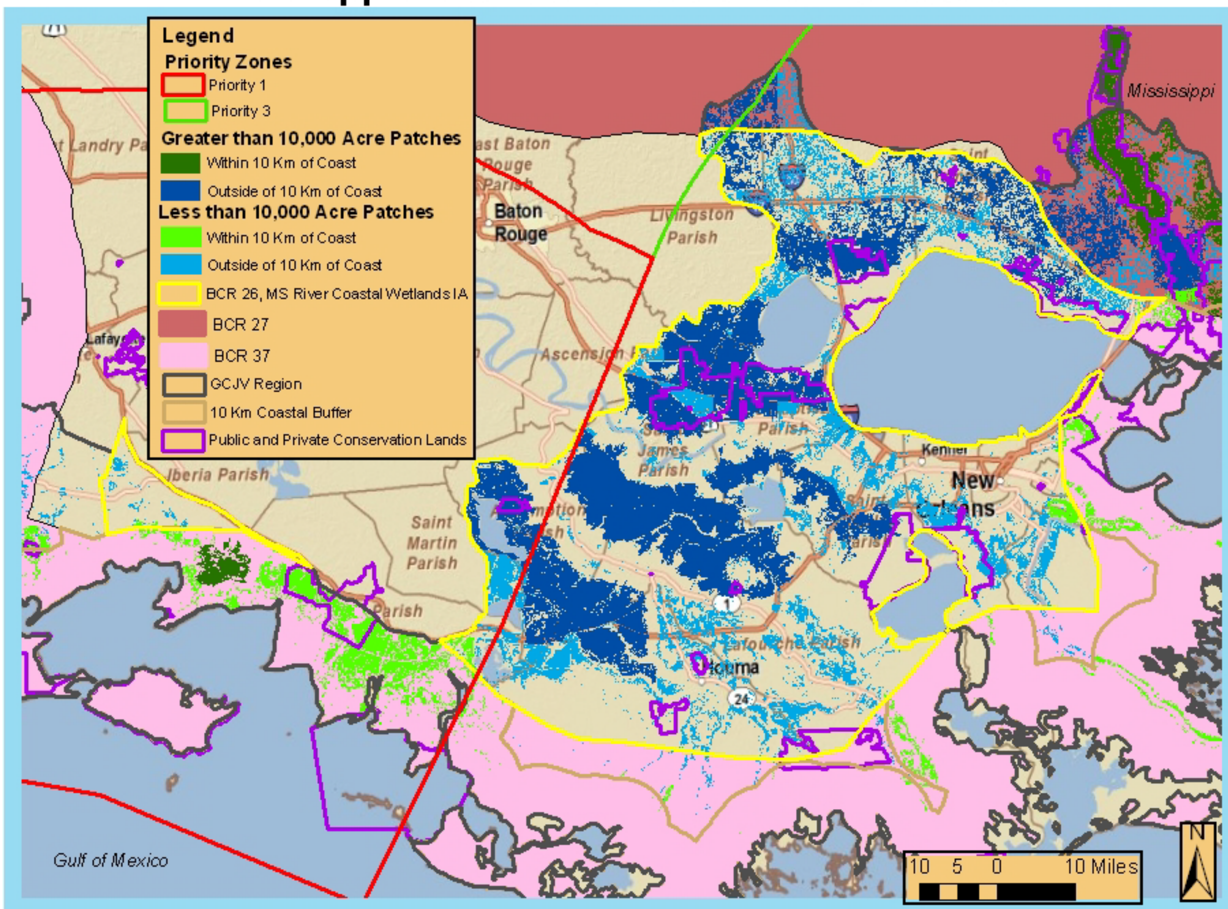


Figure 17

Forest Habitat, BCR 27, Gulf Coast Joint Venture
Mississippi River Coastal Wetlands Initiative Area

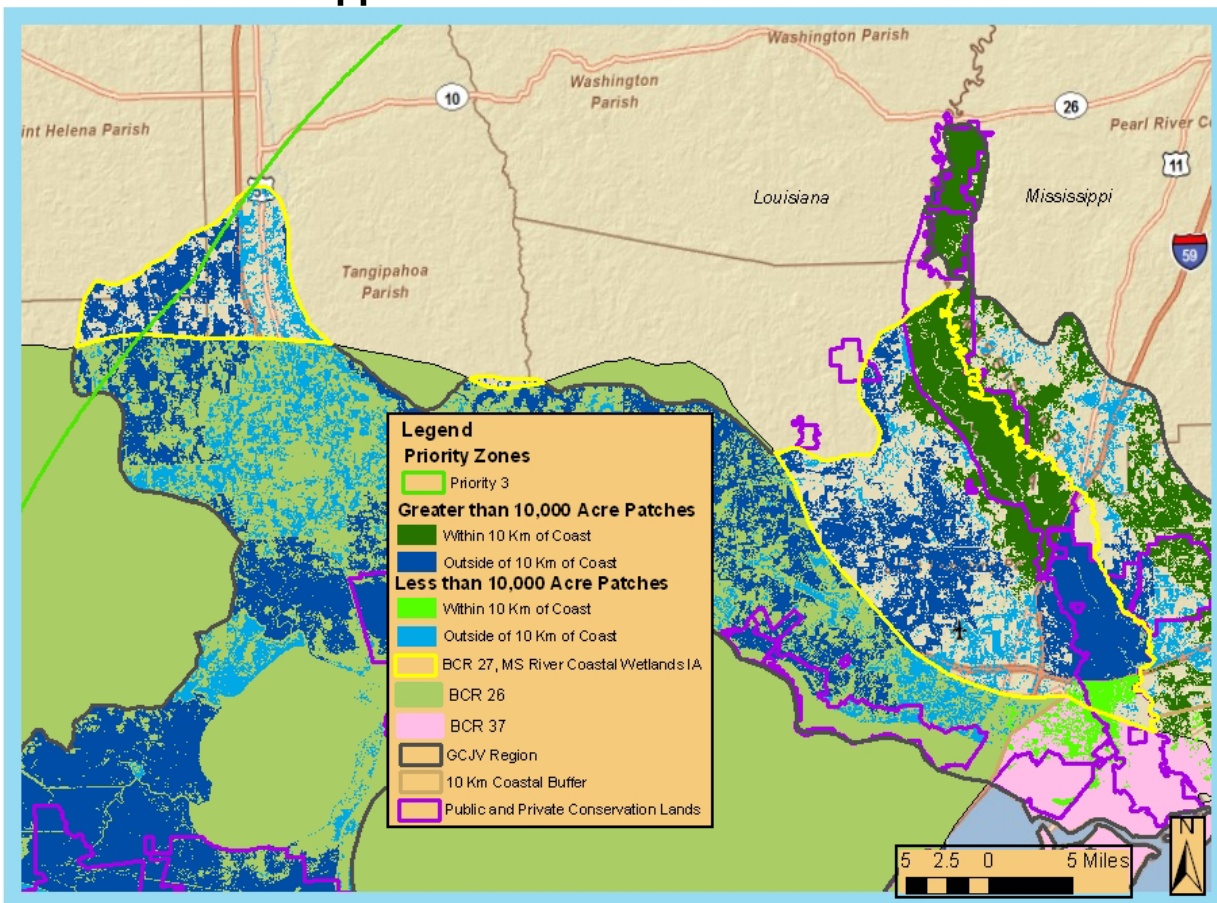


Figure 18

Forest Habitat, BCR 27, Gulf Coast Joint Venture, Mississippi
Mississippi - Alabama Coastal Wetlands Initiative Area

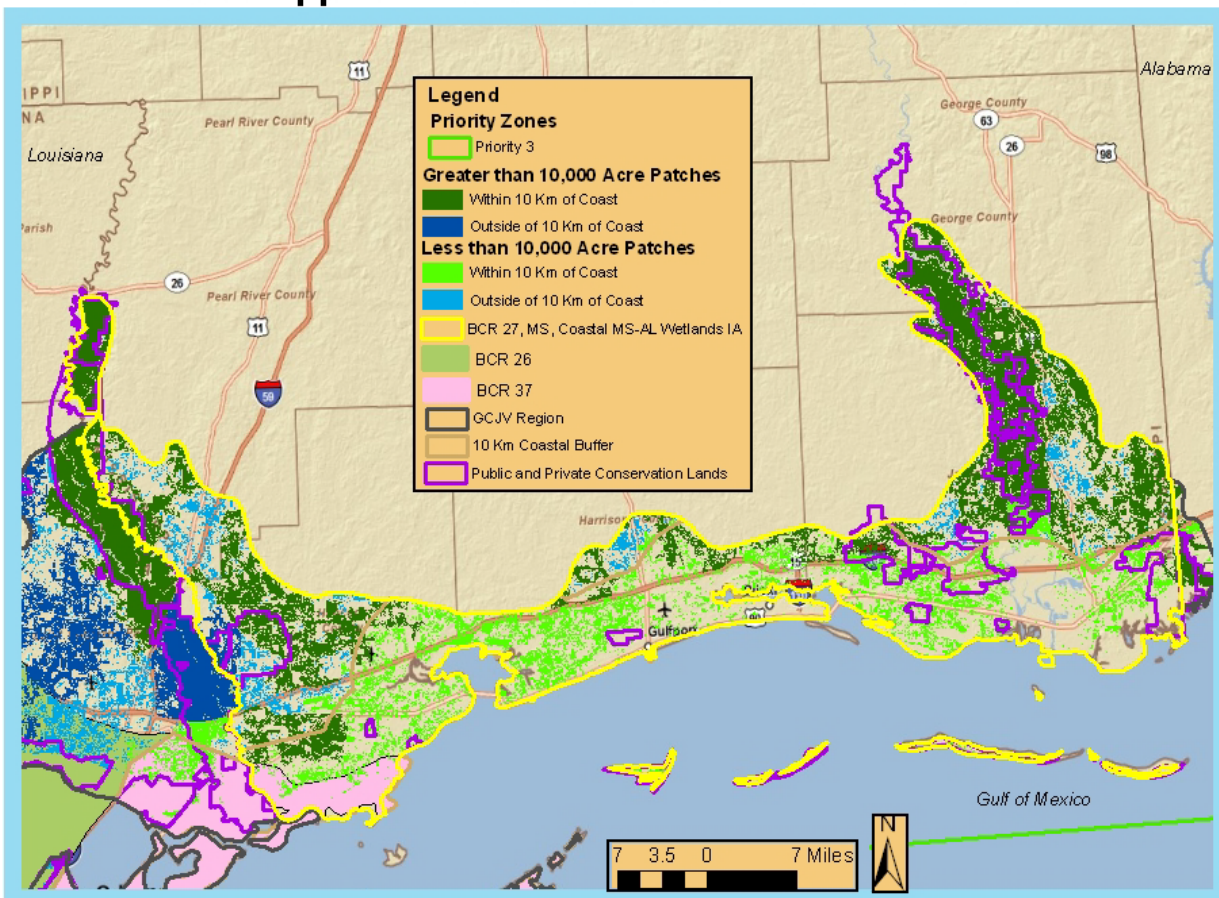
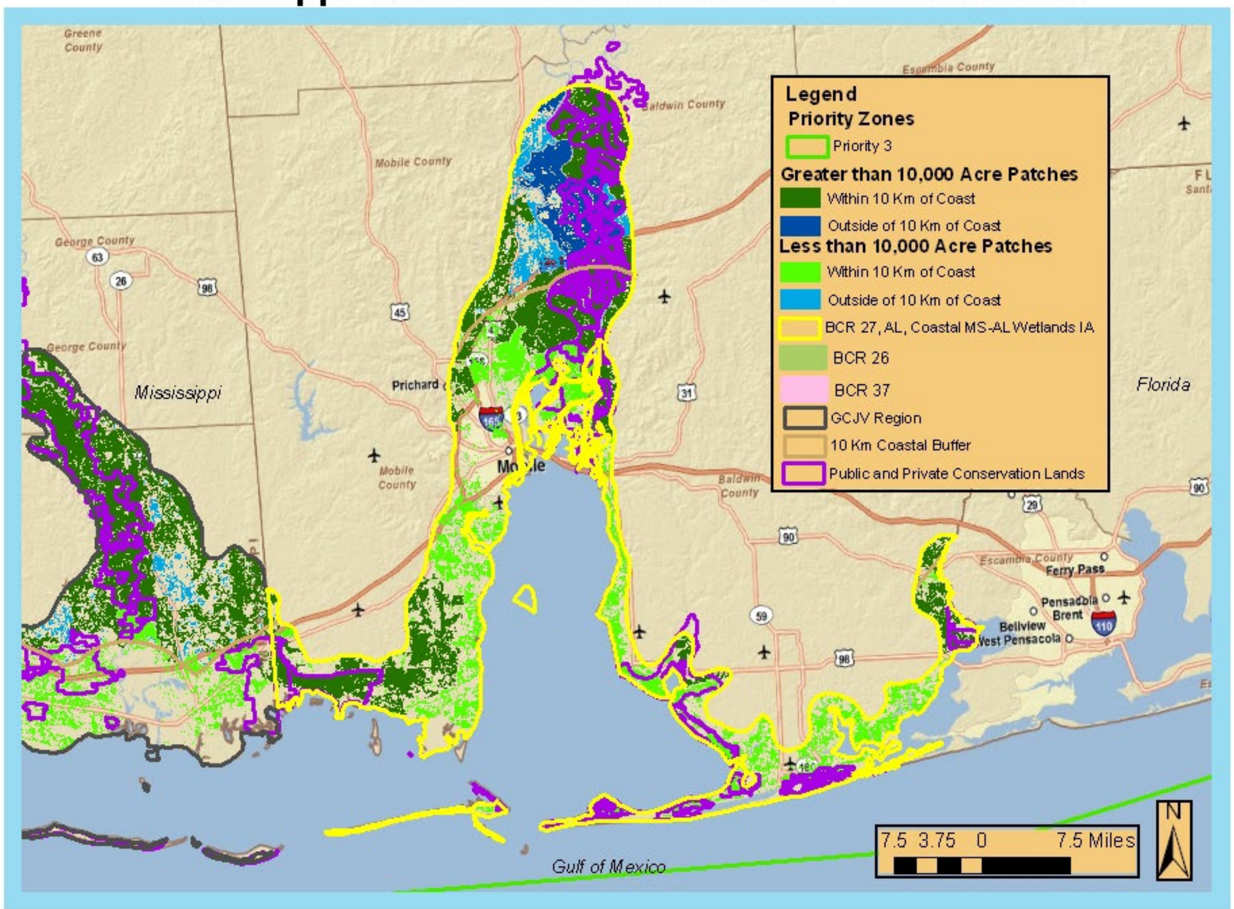


Figure 19

Forest Habitat, BCR 27, Gulf Coast Joint Venture, Alabama Mississippi - Alabama Coastal Wetlands Initiative Area



(Sporadic common-abundant). An additional portion of the GCJV region that comprises portions of BCR 36 and 37 is classified as a Consistent common area for migrants. The Consistent abundant area of the GCJV region was classified as Priority 1, the Consistent common area as Priority 2, and the Sporadic common-abundant area as Priority 3. Using those designations, the 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. (2007a, 2007b), we have developed the following coarse, draft, prioritization scheme for transient landbird habitat protection and reforestation the GCJV region.

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

1. Large (≥10,000 ac) forest patches within 10 km of Gulf of Mexico/ bay shoreline
2. Large (≥10,000 ac) forest patches further than 10 km from Gulf of Mexico/bay shoreline
3. Forest patches <10,000 ac in size within 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 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 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 10 km 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 10 km of Gulf of Mexico/bay shoreline.

Twedt et al. (2006) developed a forest breeding bird restoration decision support model for the Mississippi Alluvial Valley that identified and prioritized areas for restoration. The model focal area included the BCR 26 portion of the GCJV region (Figures 15 – 16 above). Though Twedt et al.'s breeding bird patch size and configuration objectives were different from those described for the migrant suite of warblers above, a similar approach could prove useful for planning forest restoration for migrant birds in this and other parts of the GCJV region.

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 conservation of priority landbirds in the portions of BCRs 25, 26, and 27 comprising the GCJV region. Tentative habitat goals are contained herein for grasslands and emergent wetlands. Development of goals for forest habitat is pending. Further analysis of weather radar data (described above) and/or other spatial data and models 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.

Acknowledgements

We would like to especially thank the members of the Gulf Coast Joint Venture Monitoring, Evaluation, and Research Team Landbird Working Group: Wylie Barrow, Dave Krueper, Michael Seymour, Cliff Shackleford, and Mark Woodrey for their input and participation in preparation of this plan. We thank John Arvin, Mike Baldwin, Gary Graves, Lori Randall, and Cecilia Riley for discussions and edits. Thanks to Robert Perez, Texas Parks and Wildlife Department, and Fred Kimmel, Louisiana Department of Wildlife and Fisheries, 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 and Ben Thatcher.

Bibliography

Able, K. P. 1972. Fall migration in coastal Louisiana and the evolution of migration patterns in the Gulf region. Wilson Bulletin 84: 231-242.

Ahlering, M. A. and J. Faaborg. 2006. Avian habitat management meets conspecific attraction: if you build it, will they come? Auk 123(2):301-312.

Ǻkesson, S. 1999. Do passerines captured at an inland ringing site perform reverse migration in autumn? Ardea 87:129-138.

Ǻkesson, S., L. Karlsson, G. Walinder, and T. Alerstam. 1996. Bimodal orientation and the occurrence of temporary reverse bird migration during autumn in south Scandinavia. Behav Ecol Sociobiol 38:293-302.

Alerstam, T. 1978. Reoriented bird migration in coastal area: dispersal to suitable resting grounds? Oikos 30:405-408.

Allen, C. R., R.S. Lutz, T. Lockley, S.A. Phillips, Jr., and S. Demarais. 2001. The non-indigenous ant, *Solenopsis invicta*, reduces Loggerhead Shrike and native insect abundance. Journal of Agricultural and Urban Entomology 18 (4): 249 -250.

Anderson, W.C. and R.E. Duzan. 1978. DDE residues and eggshell thinning in Loggerhead Shrikes. Wilson Bulletin 90:215-220.

Annich, N. M., T. J. Bensen, J. D. Brown, C. Roa, J. C. Bednarz, R. E. Brown, and J. G. Dickson. 2010. Swainson's warbler *(Limnothylpis swainsonii)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/126d0i:10.2173/bna.126

Baldwin, H. Q. 2005. Effects of fire on home range size, site fidelity and habitat associations of grassland birds overwintering in southeast Texas. M.S. Thesis, Louisiana State University. 69 pp.

Barrow, W. C., C. Chen, R. B. Hamilton, K. Ouchley, and T. J. Spengler. 2000. Disruption and restoration of *en route* habitat, a case study: the chenier plain. Studies in Avian Biology 20: 70-87.

Barrow, W. C., L. A. Johnson-Randall, M. S. Woodrey, J. Cox, E. Ruelas I., C. M. Riley, R. B. Hamilton, and C. Eberly. 2005. Coastal forests of the Gulf of Mexico: a description and thoughts on their conservation. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, C. J. Ralph and T. D. Rich, editors, pp. 450-464.

Bassett-Touchell, C. A., and P. C. Stouffer. 2006. Habitat selection by Swainson's warblers breeding in loblolly pine plantations in southeastern Louisiana. Journal of Wildlife Management 70(4):1013-1019.

Boal, C. W., T. S. Estabrook, and A. E. Duerr. 2003. Productivity and breeding habitat of loggerhead shrikes in a southwestern urban environment. The Southwestern Naturalist 48(4): 557-562.

Brennan, L. A. 1999. Northern Bobwhite (*Colinus virginianus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/397

Brennan, L. A. 2011. A biological basis for the National Bobwhite Conservation Initiative: northern bobwhite habitat and population. Pages 7 – 26 in Palmer, W. E., T. M. Terhune, and D. F. McKenzie, eds. The National Bobwhite Conservation Initiative: a range wide plan for recovering bobwhites. National Bobwhite Technical Committee Technical Publication, ver. 2.0., Knoxville, TN. 212 pp.

Brennan, L., S. DeMaso, F. Guthery, J. Hardin, C. Kowaleski, S. Lerich, R. Perez, M. Porter, D. Rollins, M. Sams, T. Trail, and D. Wilhelm. 2005. Where have all the quail gone? The Texas quail conservation initiative: a proactive approach to restoring quail populations by improving wildlife habitat. Texas Parks and Wildlife Publication PWD RP W7000-1025.

Brooks, B. L. 1988. The breeding distribution, population dynamics and habitat availability and suitability of an upper Midwest loggerhead shrike population. M.S. Thesis. University of Wisconsin, Madison, Wisconsin.

Brooks, B. L. and S. A. Temple. 1990. Dynamics of a Loggerhead Shrike population in Minnesota. Wilson Bulletin 102:441-450.

Buler, J. J. and F. R. Moore. 2011. Migrant-habitat relationships during stopover along an ecological barrier: extrinsic constraints and conservation implications. J Ornithol 152(1): 101-112.

Buler, J. J., F. R. Moore, and S. Woltmann. 2007a. A multi-scale examination of stopover habitat use by birds. Ecology 88(7): 1789-1802.

Buler, J. J., F. R. Moore, and R. H. Diehl. 2007b. Mapping migratory bird stopover areas in the south. Unpublished report prepared for the National Fish and Wildlife Foundation. Department of Biological Sciences, the University of Southern Mississippi, Hattiesburg, MS. 41 pp.

Burger, L. W. 2001. Quail management: issues, concerns, and solutions for public and private lands – a southeastern perspective. Pages 20-34 in S. J. DeMaso, W. P. Kuvlesky

Jr., F. Hernandez, and M. E. Berger, eds. Quail V: Proceedings of the Fifth National Quail Symposium, Texas Parks and Wildlife Department, Austin, TX.

Burger, L. W., T. V. Daily, E. W. Kurzejeski, and M. R. Ryan. 1995. Survival and cause-specific mortality of northern bobwhite in Missouri. Journal Wildlife Management 59(2):401-410.

Busbee, E. L. 1977. The effects of dieldrin on the behavior of young Loggerhead Shrikes. Auk 94:28-35.

Carrie, N. R. 1996. Swainson's warbler nesting in early seral pine forests in east Texas. Wilson Bulletin 108:802-804.

Comeaux, R. S., M.A. Allison, and T. S. Bianchi. 2012. Mangrove expansion in the Gulf of Mexico with climate change: implications for wetland health and resistance to rising sea levels. Estuarine, Coastal, and Shelf Science 96: 81-95.

Confer, J. L., P. Hartman, and A. Roth 2011. Golden-winged Warbler (*Vermivora chrysoptera*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/020

Conway, C.J., and C.P. Nadeau. 2006. Development and field testing of survey methods for a continental marsh bird monitoring program in North America. Wildlife Research Report #2005-11. USGS Arizona Cooperative Fish and Wildlife Research Unit, Tuscon, AZ.

Cooper, S. 1984. Habitat and size of the Le Conte's Sparrow's territory. Loon 56:162–165.

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, A. Zimmerman, and B. R. Euliss. 1998. Effects of management practices on grassland birds: Le Conte's Sparrow. Northern Prairie Wildlife Research Center, Jamestown, ND. Northern Prairie Wildlife Research Center.

Dimmick, R.W., M.J. Gudlin, and D.F. McKenzie. 2002. The northern bobwhite conservation initiative. Miscellaneous publication of the Southeastern Association of Fish and Wildlife Agencies, South Carolina. 96 pp.

Doyle, T. W., K. W. Krauss, W. H. Conner, and A. S. From. 2010. Predicting the retreat and migration of tidal forests along the northern Gulf of Mexico under sea-level rise. Forest Ecology and Management 259(4): 770-777.

Duncan. C., B. Abel, D. Ewert, M. L. Ford, S. Mabey, D. Mehlman, P. Patterson, R. Sutter and M. Woodrey. 2002. Protecting stopover sites for forest-dwelling migratory landbirds. Unpublished report. The Nature Conservancy, Arlington, Va.

Dunn, E. H., B. L. Altman, J. Bart, J. Beardmore, H. Berlanga, P. J. Blancher, G. S. Butcher, D. W. Demarest, R. Dettmers, W. C. Hunter, E. E. Iñigo-Elias, A. O. Panjabi, D. N. Pashley, C. J. Ralph, T. D. Rich, K. V. Rosenberg, C. M. Rustay, J. M. Ruth, and T. C. Will. 2005. High priority needs for range-wide monitoring of North American landbirds. Partners in Flight Technical Series No. 2. Partners in Flight website: http://www.partnersinflight.org/pubs/ts/02-MonitoringNeeds.pdf

Gabrey, S. W. and A. D. Afton. 2000. Effects of winter marsh burning on abundance and nesting activity of Louisiana Seaside Sparrows in the Gulf coast chenier plain. Wilson Bulletin 112 (3):365-372.

Gauthreaux, S. A., Jr. 1971. A radar and direct visual study of passerine spring migration in southern Louisiana. Auk 88: 343-365.

Gauthreaux, S. A., Jr., C. G. Belser, and C. M. Welch. 2006. Atmospheric trajectories and spring bird migration across the Gulf of Mexico. J Ornithol 147(2):317-325.

Grand, J. B., A. L. Vogt, and K. J. Kleiner. 2008. A decision support tool for longleaf conservation in the east Gulf coastal plain. Unpublished manuscript (6 May 2008 draft). USGS Alabama Cooperative Wildlife Research Unit, Auburn University, Alabama. 59 pp.

Grzybowski, J. A. 1982. Population structure in grassland bird communities during winter. Condor 84(2): 137-152.

Grzybowski, J. A. 1983. Patterns of space use in grassland bird communities during winter. Wilson Bull. 95: 591–602.

Hands H. M., R. D. Drobney, M. R. Ryan. 1989. Status of the Loggerhead Shrike in the northcentral United States. U.S. Fish Wildl. Serv., Missouri Coop. Fish Wildl. Res. Unit, Univ. of Missouri, Columbia.

Jackson, A. S., C. Holt, and D. Lay. 1990. Bobwhite Quail in Texas. Texas Parks and Wildlife Publication PWD-BK-W7000-0037-12/90.

Kridelbaugh, A. L. 1983. Nesting ecology of the Loggerhead Shrike in central Missouri. Wilson Bulletin 95:303-308.

Krauss, K. W., A. S. From, T. W. Doyle, and M. J. Barry. 2011. Sea-level rise and landscape change influence mangrove encroachment onto marsh in the Ten Thousand Islands region of Florida. Journal of Coastal Conservation 15(4): 629-638.

Leberg, P. L., T. J. Spengler, and W. C. Barrow, Jr. 1996. Lipid and water depletion in migrating passerines following passage over the Gulf of Mexico. Oecologia 106(1): 1-7.

Legare, M. L., H. Hill, R. Farinetti, and F. T. Cole. 1998. Marsh bird response during two prescribed fires at the St. Johns National Wildlife Refuge, Brevard County, Florida. Abstract. T. L. Pruden and L. A. Brennan, eds. 20th Proceedings of the Tall Timbers Fire Ecology Conference: Fire in Ecosytem Management.

Lindström, Ǻ, and T. Alerstam. 1986. The adaptive significance of reoriented migration of chaffinches, *Fringilla coelebs*, and bramblings, *F. montifringilla*, during autumn in southern Sweden. Behav Ecol Sociobiol 19:417-424.

Lockwood, M. W., and B. Freeman. 2004. The Texas Ornithological Society handbook of Texas birds. Texas A & M University Press, College Station, TX. 261 pp.

Lofgren, C. S. 1985. The economic importance and control of imported fire ants in the United States. Pp. 227-256. *In* Economic Impact and Control of Social Insects (S. B. Vinson, ed.). Praeger Publishers, New York.

Lower Mississippi Valley Joint Venture West Gulf Coastal Plain and Ouachitas Landbird Working Group. 2011. West Gulf Coastal Plains/Ouachitas Open Pine Landbird Plan. Unpublished report available at: http://www.lmvjv.org/library/WGCPO_Landbird_Open_Pine_Plan_Oct_2011.pdf

Lowery, G. 1974. Louisiana birds. LSU Press, Baton Rouge, LA. 651 pp.

Lowther, P. E. 2005. Le Conte's Sparrow (*Ammodramus leconteii*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/224

Lymn, N. and S. Temple. 1991. Land-use changes in the Gulf Coast region: links to declines in Midwestern Loggerhead Shrike populations. Passenger Pigeon 53:315-325.

Marra, P. P. and R. T. Holmes. 2001. Consequences of dominance-mediated habitat segregation in American Redstarts during the nonbreeding season. Auk 118(1): 92-104.

Michaels, H.L. and J. F. Cully, Jr. 1998. Landscape and fine scale habitat associations of the Loggerhead Shrike. Wilson Bulletin 110 (4): 474-482.

Moore, F.R., and T. R. Simons. 1992. Habitat suitability and stopover ecology of neotropical landbird migrants. Pp. 345-355 *In* Ecology and Conservation of Neotropical Migrant Landbirds. Edited by J. M. Hagan and D. Johnston. Smithsonian Institution Press.

Moore, F. R., P. Kerlinger, and T. R. Simons. 1990. Stopover on a Gulf coast barrier island by spring trans-Gulf migrants. Wilson Bulletin 102:487-500.

Muller, K. L., J. A. Stamps, W. Krishnan, and N. H. Willits. 1997. The effects of conspecific attraction and habitat quality on habitat selection in territorial birds (*Troglodytes aedon*). American Naturalist. 150(5):650-661.

Newton, I. 2004. Population limitations in migrants. Ibis 146:197-226.

Newton, I. 2006. Can conditions experienced during migration limit the population levels of birds? J Ornithol 147:146-166.

Panjabi, A. O., E. H. Dunn, P. J. Blancher, W. C. Hunter, B. Altman, J. Bart, C. J. Beardmore, H. Berlanga, G. S. Butcher, S. K. Davis, D. W. Demarest, R. Dettmers, W. Easton, H. Gomez de Silva Garza, E. E. Iñigo-Elias, D. N. Pashley, C. J. Ralph, T. D. Rich, K. V. Rosenberg, C. M. Rustay, J. M. Ruth, J. S. Wendt, and T. C. Will. 2005. The Partners in Flight handbook on species assessment. Version 2005. Partners in Flight Technical Series No. 3. Rocky Mountain Bird Observatory website: http://www.rmbo.org/pubs/downloads/Handbook2005.pdf

Parker, T. A. 1994. Habitat, behavior, and spring migration of Cerulean Warbler in Belize. American Birds 48:70-75.

Perez, R. M. 2007. Bobwhites on the gulf coastal prairies. Pages 260-272 in L. A. Brennan, ed. Ecology and management of Texas quails. Texas A&M University Press, College Station, TX. 491 pp.

Petit, D. R. 2000. Habitat use by landbirds along nearctic-neotropical migration routes: implications for conservation of stopover habitats. Studies in Avian Biology 20:15-33.

Post, W., and J. S. Greenlaw. 1982. Comparative costs of promiscuity and monogamy: a test of reproductive effort theory. Behav. Ecol. Sociobiol. 10: 101-107.

Post, W., and J. S. Greenlaw. 2009. Seaside Sparrow (*Ammodramus maritimus*). The Birds of North America Online (A. Poole Ed.). Ithaca: Cornell Lab of Ornithology; Retreived from the Birds of North America Online: http//bna.birds.cornell.edu/bna/species/127

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American landbird conservation plan. Cornell Lab of Ornithology. Ithaca, NY. 84 pp.

Richardson, W. J. 1978. Timing and amount of bird migration in relation to weather: a review. Oikos 30:224-272.

Richardson, W. J. 1982. Northeastward reverse migration of birds over Nova Scotia, Canada, in autumn: a radar study. Behav Ecol Sociobiol 10:193-206.

Ridgely, R. S., and G. Tudor. 1989. The birds of South America, Vol. 1. Univ. Texas Press, Austin. 596 pp.

Robbins, C. S., B. A. Dowell, D. K. Dawson, J. A. Colon, R. Estrada, A. Sutton, R. Sutton, and D. Weyer. 1989. Comparison of neotropical migrant landbird populations wintering in tropical forest, isolated forest fragments, and agricultural habitats. Pp. 207-220 *In* Ecology and Conservation of Neotropical Migrant Landbirds. Edited by J. M. Hagan and D. Johnston. Smithsonian Institution Press.

Rocky Mountain Bird Observatory. 2007. PIF Landbird Population Estimates Database. Available at: http://rmbo.org/pif_db/laped/

Rosenberg, K. V. 2004a. Partners in flight continental priorities and objectives defined at the state and bird conservation regions levels: Alabama. Available at http://www.fishwildlife.org/files/AL_PIF_OBJ_PRIO.pdf

Rosenberg, K. V. 2004b. Partners in flight continental priorities and objectives defined at the state and bird conservation regions levels: Louisiana. Available at http://www.fishwildlife.org/files/LA_PIF_OBJ_PRIO.pdf

Rosenberg, K. V. 2004c. Partners in flight continental priorities and objectives defined at the state and bird conservation regions levels: Mississippi. Available at http://www.fishwildlife.org/files/MS_PIF_OBJ_PRIO.pdf

Rosenberg, K. V. 2004d. Partners in flight continental priorities and objectives defined at the state and bird conservation regions levels: Texas. Available at http://www.fishwildlife.org/files/TX_PIF_OBJ_PRIO.pdf

Sample, D. W. 1989. Grassland birds in southern Wisconsin: habitat preference, population trends, and response to land use changes. M.S. Thesis, University of Wisconsin, Madison, Wisconsin. 588 pp.

Sands, J. P. 2010. Testing sustained-yield harvest theory to regulate northern bobwhite hunting. Ph. D. Dissertation. Texas A&M University – Kingsville. 190 pp.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardiek, D. J. Ziolkowski, Jr., and W. A. Link. 2011. The North American breeding bird survey, results and analysis 1966 – 2009. Version 2.23.2011, USGS Patuxent Wildlife Research Center, Laurel, MD.

Sillett, T.S., and R.T. Holmes. 2002. Variation in survivorship of a migratory songbird throughout its annual cycle. Journal of Animal Ecology 71: 296-308.

Szep, T., and A. P. Moller. 2005. Using remote sensing data to identify migration and wintering areas and to analyze effects of environmental conditions on migratory birds.

Pp. 390-400 *In* Birds of Two Worlds, The Ecology and Evolution of Migration. R. Greenberg and P. Marra, editors. Smithsonian Press.

Temple, S. A. 1988. What's behind long-term declines in some breeding bird populations? Passenger Pigeon 50:133-138.

Texas Parks and Wildlife Department. 2007. Project prairie birds. Available at http://www.tpwd.state.tx.us/huntwild/wild/birding/project_prairie_birds/

The National Bobwhite Technical Committee. 2011. Palmer, W. E., T. M. Terhune, and D. F. McKenzie (eds). The National Bobwhite Conservation Initiative: A range-wide plan for recovering bobwhites. National Bobwhite Technical Committee Technical Publication, ver. 2.0, Knoxville, TN. 212 pp.

Titus, J. G., and C. Richman. 2001. Maps of lands vulnerable to sea level rise: modeled elevations along the US Atlantic and Gulf coasts. Climate Research. Vol. 18: 205-228.

Twedt, D., D. Pashley, C. Hunter, A. Mueller, C. Brown, and B. Ford. 1999. Partners in Flight conservation plan for the Mississippi Alluvial Valley. Available at http://www.blm.gov/wildlife/plan/MAV_plan.html#_1_36

Twedt, D. J., W. B. Uihlein III, and A. B. Elliott. 2006. A spatially explicit decision support model for restoration of forest bird habitat. Conservation Biology Vol. 20, No. 1: 100-110.

U. S. Department of Agriculture. 1999a. Grassland birds. Natural Resources Conservation Service, Wildlife Habitat Management Institute. Fish and Wildlife Habitat Management Leaflet Number 8. October 1999. 12 pp.

U. S. Department of Agriculture. 1999b. Northern Bobwhite. Natural Resources Conservation Service, Wildlife Habitat Management Institute. Fish and Wildlife Habitat Management Leaflet Number 9. September 1999. 12 pp.

Vance, D. R. 1976. Changes in land use and wildlife populations in southeastern Illinois. Wildlife Society Bulletin 4:11-15.

Ward, M. P. and S. Schlossberg. 2004. Conspecific attraction and the conservation of territorial songbirds. Conservation Biology 18(2):519-524.

Werner, H. W. and G. E. Woolfenden. 1983. The Cape Sable Sparrow, its habitat, habits, and history. Pp. 55-75 *in* The Seaside Sparrow, its biology and management (T. L. Quay, J. B. Funderburg, Jr., D. S. Lee, E. F. Potter, and C. S. Robbins, eds.). Occas. Pap. North Carolina Biol. Surv., Raleigh, NC.

Wiedenfeld, D. A., and M. M. Swan. 2000. Louisiana breeding bird atlas. Louisiana Sea Grant College Program, Louisiana State University, Baton Rouge. 78 pp.

Wiedner, D. S., P. Kerlinger, D. A. Sibley, P. Holt, J. Hough, and R. Crossley. 1992. Visible morning flights of neotropical landbird migrants at Cape May, New Jersey. Auk 109:500-510.

Winter, M., J.A. Shaffer, D.H. Johnson, T.M. Donovan, W.D. Svedarsky, P.W. Jones, and B.R. Euliss. 2005. Habitat and nesting of Le Conte's Sparrow in the northern tallgrass prairie. Journal of Field Ornithology 76 (1): 61-71.

Woodrey, M. S. 2000. Age-dependent aspects of stopover biology of passerine migrants. Studies in Avian Biology 20:43-52.

Yaukey, P. H. 2010. Concentrated migratory morning flight at Lake Pontchartrain, Louisiana, USA. Wilson J. Ornithol 122:738-743.

Yosef, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/231

Yosef, R. 2001. Nesting ecology of resident Loggerhead Shrikes in southcentral Florida. Wilson Bulletin 113 (3): 279-284.

Yosef, R., and F.E. Lohrer. 1995. Loggerhead Shrikes, red fire ants and red herrings? The Condor 97: 1053-1056.