Critical Habitats for Migrating Birds along the Gulf of Mexico

Project Summary

Each spring over 2 billion birds migrate north *en route* to breeding grounds across the U.S. and Canada and in autumn, this number roughly doubles with the addition of young-of-the-year, migrating south to tropical wintering grounds. Along the way, these birds congregate in habitats around the Gulf Coast where they rest and forage before and after the long flight across the Gulf of Mexico. In North America, over 80% of the terrestrial migratory bird species (i.e., songbirds and near songbirds with a terrestrial life history [doves, cuckoos, nightjars, hummingbirds, woodpeckers]) migrate at night. Many of these species are declining and Gulf Coast stopover sites are critical to their conservation. The bird habitat maps in this report are intended to inform where future conservation and restoration actions would be most beneficial for nocturnally migrating birds.

We leveraged a large-scale dataset that allowed us to generate distribution maps of nocturnally migrating birds in stopover habitat across the entire northern coast of the Gulf of Mexico, and all of Florida. Until recently, detection of nocturnally migrating birds was limited to site-specific studies characterizing local-scale migration patterns. While valuable, these studies cover a limited spatial scale and are unable to provide a regional picture of relative distributions during migration. We leveraged one of the largest, most-comprehensive and systematically collected biological datasets in existence, collected by the U.S. network of weather surveillance radars, to rigorously quantify bird distributions beyond the capabilities of site-specific studies. We processed data collected by 13 weather radars during 8 years (2008-2015) of spring and fall migration. The main migration seasons occur from March- May, with the peak in late April and early May, and from August- October, with a peak in late September and early October. We used machine-learning models to interpolate the distribution of bird densities in a 1km^2 grid.

We found and mapped locally consistent coastal stopover habitat, i.e., "hotspots", within each state that support high densities of migrating birds. Regionally, we found that the pulse of migration shifts from west to east between spring and fall with a larger proportion of birds in the eastern states (Florida, in particular) during fall migration and a larger proportion of migrants in the western states (Texas and Louisiana primarily) during spring migration. The wooded habitat within the identified hotspots are strategic areas where conservation efforts including habitat acquisition or conservation easements, habitat restoration, habitat enhancement and/or active management, and removal of non-native predators are likely to have the greatest return on conservation investment for nocturnally migrating birds.

These are the first comprehensive maps of the distributions of migrating landbirds around the entire U.S. coast of the Gulf of Mexico, produced with support from a National Fish and Wildlife Foundation Gulf Coast Conservation grant. The fundamental information in the enclosed maps are critical to identify, characterize, and conserve priority sites and habitats for North America's migratory bird populations.

Why Stopover Habitat Is Important

Each spring, over 2 billion birds migrate north across the Gulf of Mexico on their way to breeding grounds throughout the U.S. and Canada. In autumn, that number more than doubles with the addition of young-of-the-year migrating south to tropical wintering grounds. Of the terrestrial breeding bird species in North America, approximately 70% are migratory, and of those, over 80% migrate at night. These species are largely songbirds (Passeriformes) and near songbirds with a terrestrial life history (doves, cuckoos, nightjars, hummingbirds, woodpeckers), often collectively referred to as landbird migrants. During their journeys, most of these species congregate in "stopover" habitats along the U.S. coast of the Gulf of Mexico, from southern Texas to the Florida Keys. Migratory periods of the annual cycle are when most annual mortality occurs and a lack of suitable stopover habitat can result in delays, poor condition, and susceptibility to predation. Thus, the success of migration depends on the availability and quality of stopover habitat. Gulf Coast habitats comprise some of the most important resting and refueling areas for North America's migratory birds. As most migratory bird species are declining, Gulf Coast stopover habitats are likely to be increasingly important for species conservation.

"We are seeing dramatic and rapid declines of North American birds, with a net loss of bird abundance across the entire avifauna. If current rates of avian declines continue without significant and urgent conservation action, additional endangered species listings will be triggered at tremendous financial and social cost, as once common species near extinction. Moreover, because birds provide countless benefits to ecosystems and society, these population reductions and possible extinctions will have severe direct and indirect consequences. Targeted research to identify population limiting factors must be coupled with effective policies and societal change to reduce threats and increase habitats. Birds will rebound once given a chance."

— Dr. Peter P. Marra
Smithsonian Migratory Bird Center

Migratory Bird Banding, Mad Island Marsh Preserve, Texas

Using Radar to Identify Priority Habitats

Direct observation of nocturnally migrating birds is difficult. Until recently, detection of nocturnally migrating birds has been limited to site-specific studies and to a handful of large-bodied species capable of wearing tracking devices characterizing local or individual migration patterns. While valuable, these studies typically cover a limited spatial and taxonomic scale and are unable to provide a regional picture of relative bird densities and associations with stopover habitat. However, recent advancements in information technology and data acquisition have created new research opportunities for using big data in ornithology. Specifically, weather surveillance radar is systematically collected across a broad scale and this has made it possible to rigorous quantify bird distributions beyond the capabilities of individual tracking data or surveys by human observers.

Radar emerged as a powerful tool for tracking migrating bird movements with the U.S. deployment of more than 150 weather surveillance radars (model WSR 88D) in the mid-1990s. These weather radars provide broad spatial coverage of the continental U.S. and continuously scan the atmosphere. This radar archive is one of the largest and most-comprehensive biological datasets in existence. Measures from weather radars can be used to quantify the relative density of birds leaving the ground from stopover habitats when sampled at the onset of migratory flights.

We used data collected by 13 weather radars to model of the distributions of migrating birds in stopover habitat around the entire U.S. coast of the Gulf of Mexico. These data were combined with measures of habitat, vegetation greenness, and weather in Boosted Regression Tree machine learning models to map spring and fall stopover bird density in a 1km^2 grid across the region. The radar-derived magnitude and daily flux in nocturnal migration traffic rates have been positively related to daily density of migrants within terrestrial stopover habitats. Radar cannot identify individual species per se, but rather provides unbiased and unmatched observations of the collective movements of birds at continental and regional scales. By observing the patterns of bird movement throughout a migration season, weather radars allow for a comprehensive assessment of the importance of stopover sites across large geographic areas at a relatively fine spatial resolution.

Results and Application

The pulse of migration shifts between spring and fall with a larger proportion of birds in the eastern states during fall migration (Florida, in particular) and a larger proportion of migrants in the western states during spring migration (Texas and Louisiana primarily). While the region-wide distribution of birds shifts between seasons, some sites are consistent hotspots during both spring and fall. Nevertheless, migratory birds rely on stopover habitats during both fall and spring before and after the flight across the Gulf of Mexico. The wooded habitat within the mapped hotspots are areas where conservation efforts are likely to have the most benefit for nocturnally migrating birds.

The enclosed maps can be used to make informed decisions on where to prioritize limited resources within states and across this vast region. For example, efforts should prioritize habitat in the central coastal portion of the Florida panhandle and habitat in the Northeast and Southeast regions of Florida, which are likely critical for populations of north and south-bound migratory species. In Texas, protection of both coastal and inland habitats will benefit migrating birds. These areas and others should be the focus of targeted conservation work with the aim of securing, restoring, and enhancing stopover habitat in the near- and long-term.

Future work is recommended to further quantify the habitat-abundance relationship for stopover habitat hotspots. Such efforts may include identifying the land ownership and protection status, assessing the availability and quality of resources (e.g., food, shelter) that hotspots provide for migrating birds, and identifying differential use of hotspots by individual species and their populations (migratory connectivity). Stopover habitat that is consistently used by a high density of birds may also support threatened or At-Risk species or populations. Further, effective use of limited conservation resources should include information about the current and projected vulnerabilities of identified hotspots to both land-use changes (including development) and potential effects of climate change.

Interpretation of Maps

The maps on the following pages characterize stopover habitat use during spring and fall from 2008 to 2015 across the entire region (Pages 10-13) and for each state (Pages 14-23). The colors on the maps represent the relative density of birds in stopover habitat, with hotspots having the highest densities identified in yellow, orange and red, and the low densities in gray. The high density hotspots are differentiated by daily variability within the season, red sites always have high densities of migrants, orange sites often have high densities, and yellow sites occasionally have high densities.

Spring Stopover Habitat
March - May

Gulf of

LEGEND
RELATIVE BIRD DENSITY

- LOW
- MODERATE
- HIGH (HIGH VARIABILITY)
- HIGH (MED VARIABILITY)
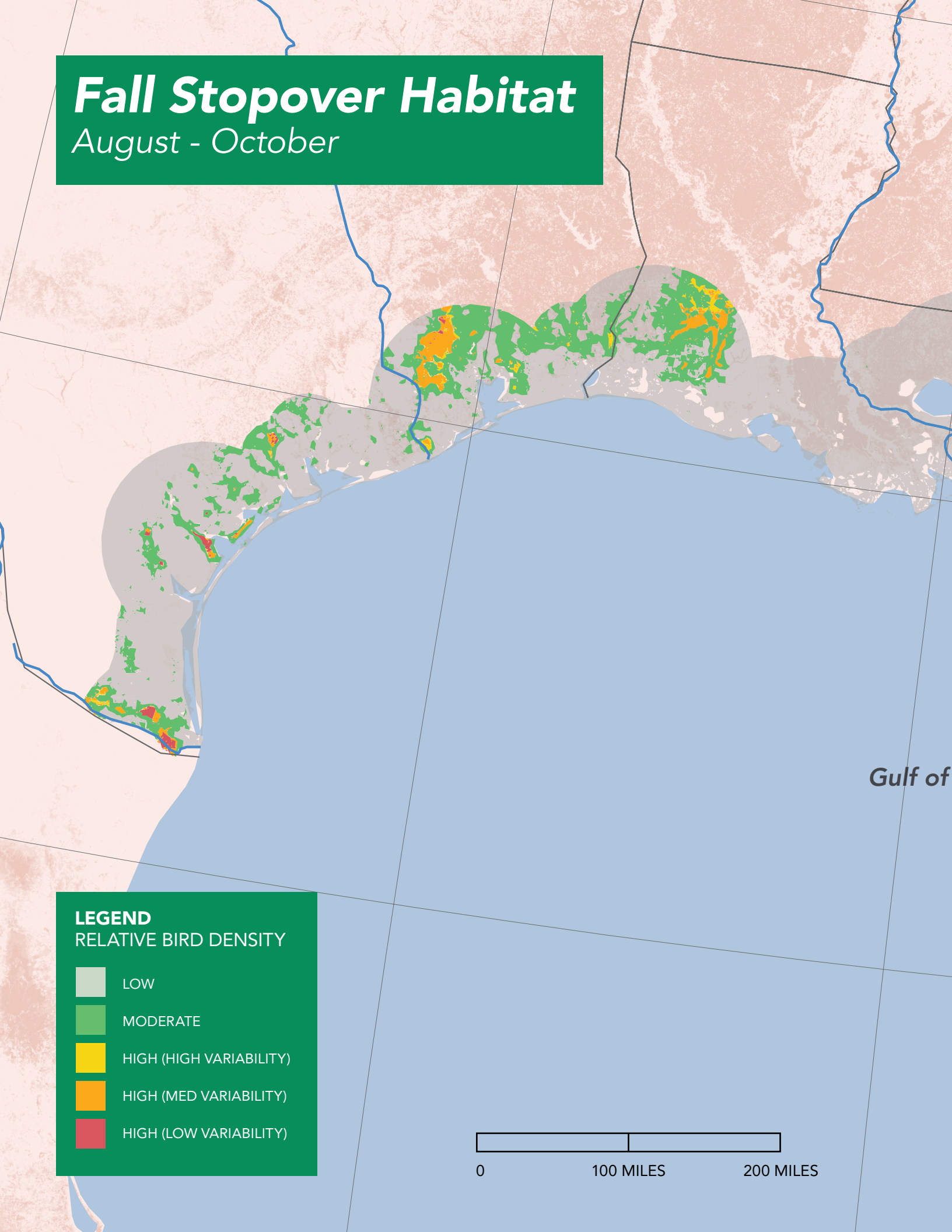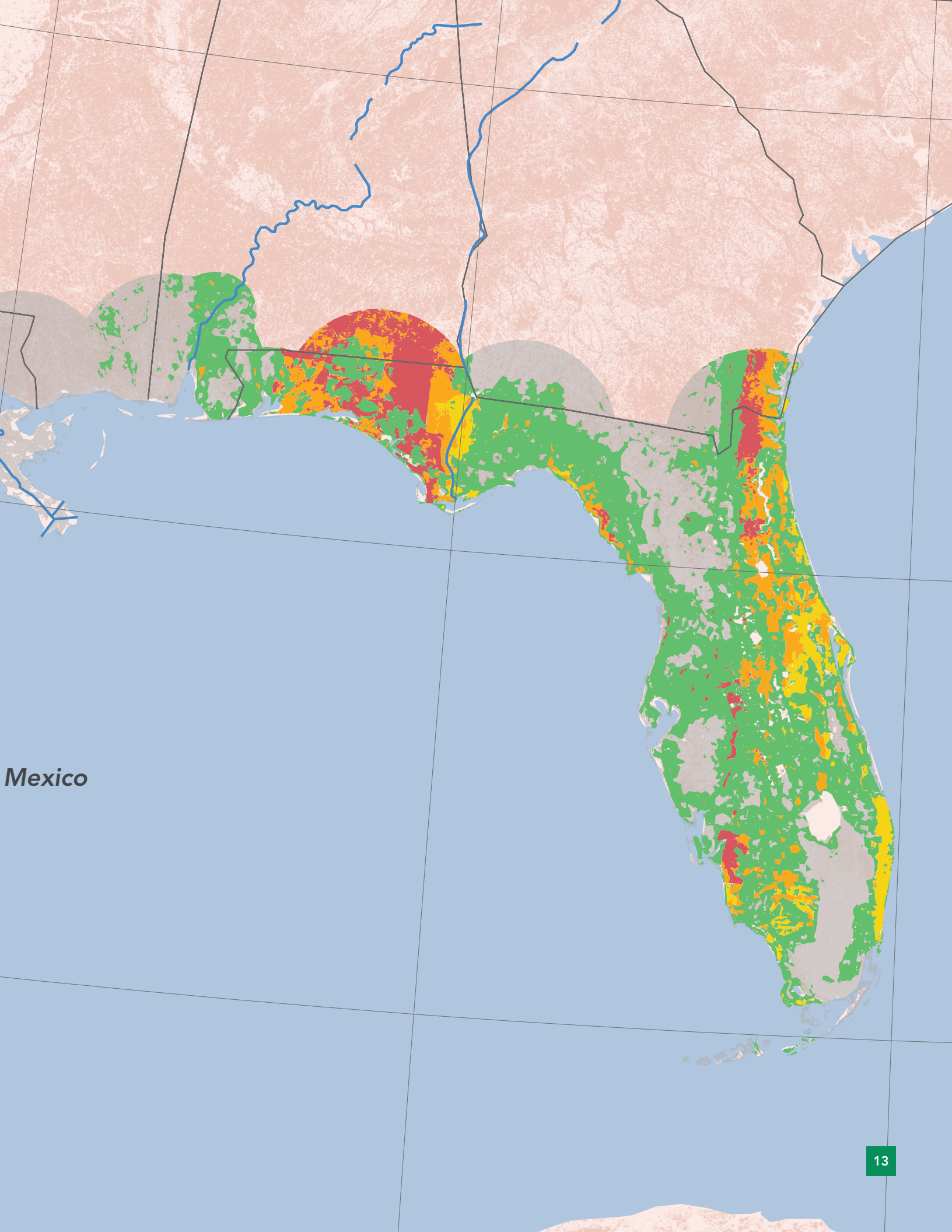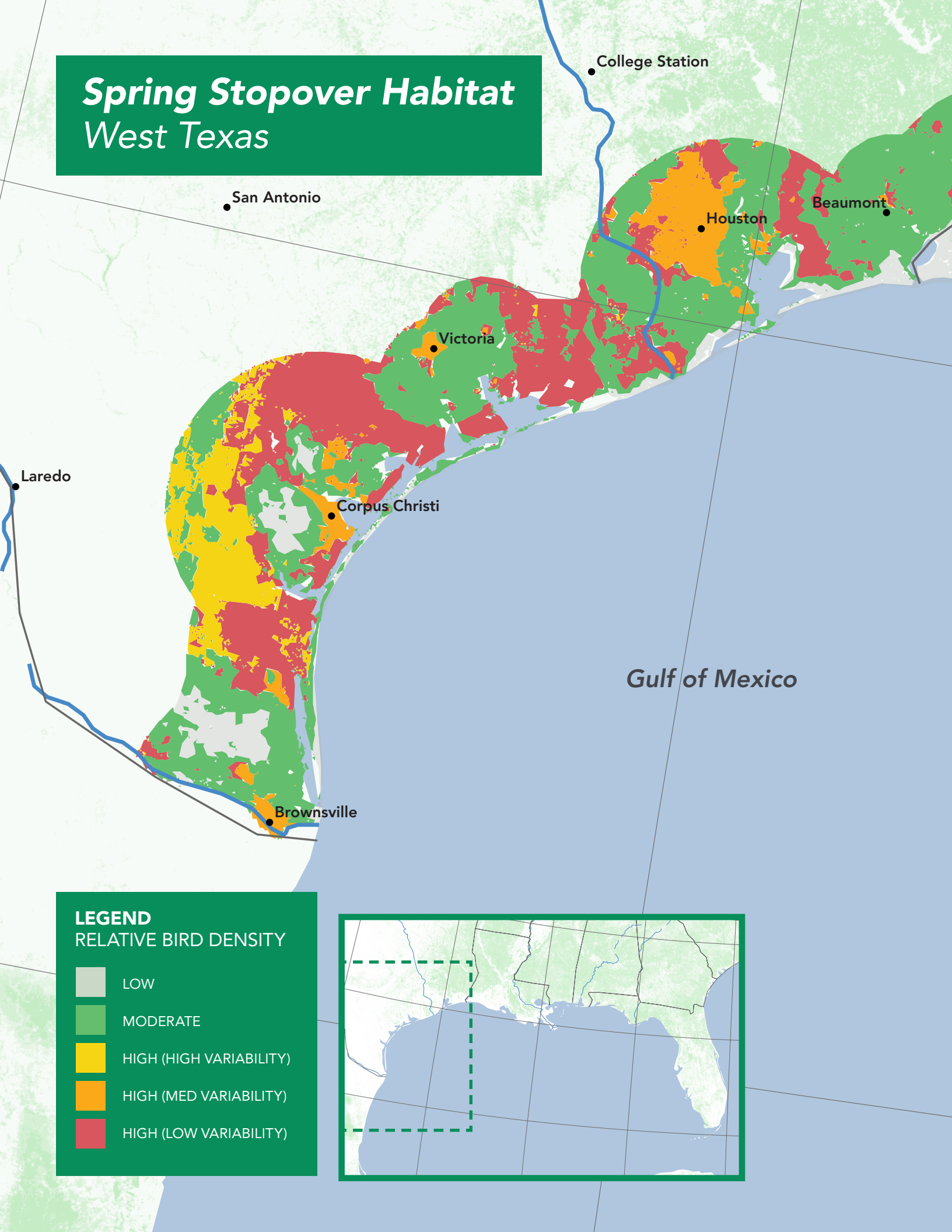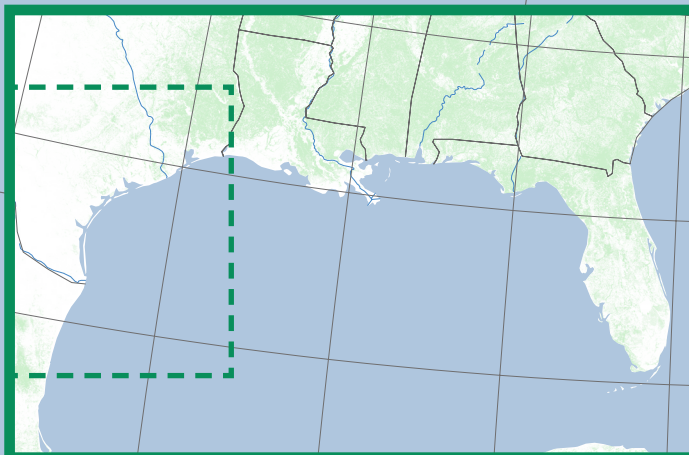- HIGH (LOW VARIABILITY)

0   100 MILES   200 MILES

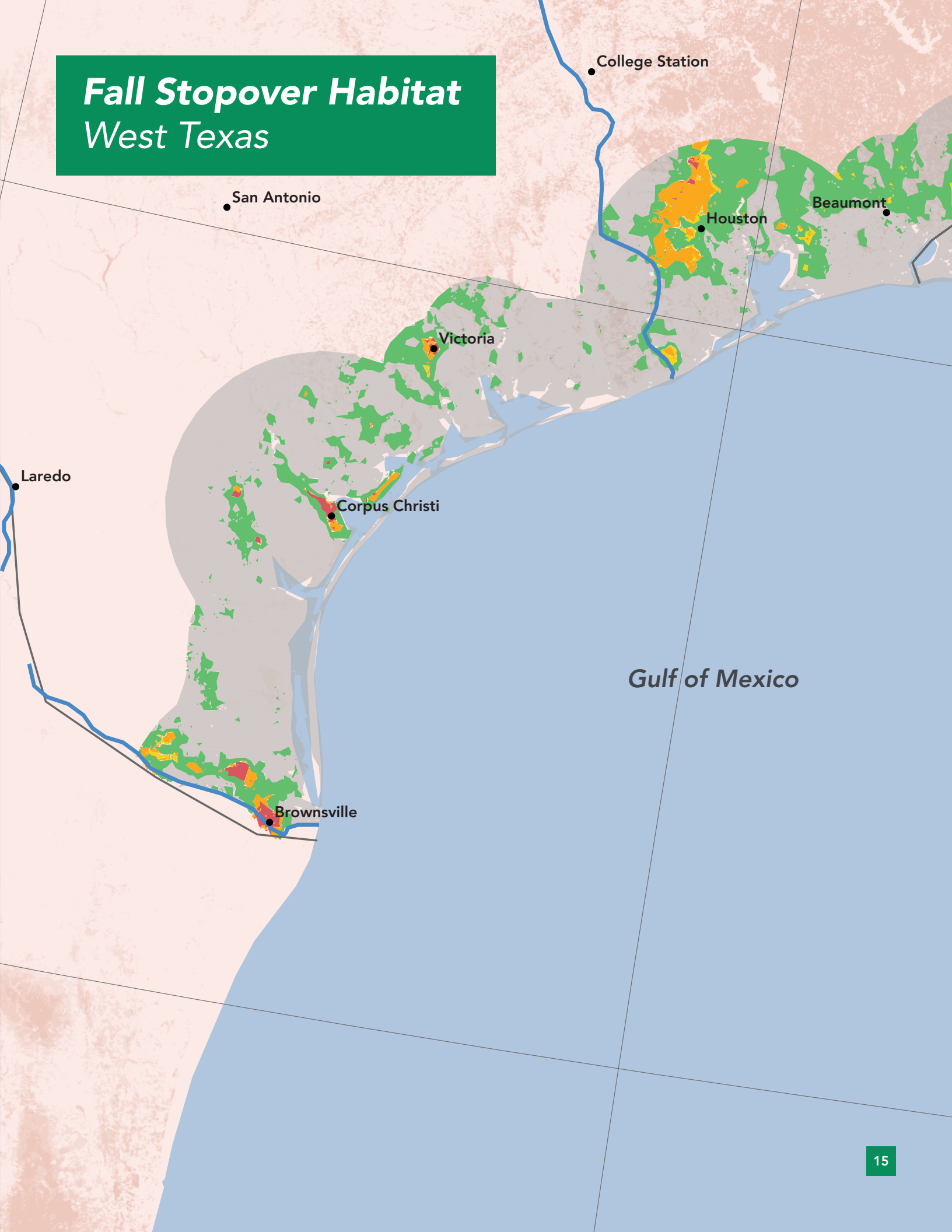Mexico

11

Fall Stopover Habitat
August - October

LEGEND
RELATIVE BIRD DENSITY

- LOW
- MODERATE
- HIGH (HIGH VARIABILITY)
- HIGH (MED VARIABILITY)
- HIGH (LOW VARIABILITY)

Gulf of

0   100 MILES   200 MILES

Mexico

Spring Stopover Habitat
West Texas

College Station

San Antonio

Houston

Beaumont

Victoria

Laredo

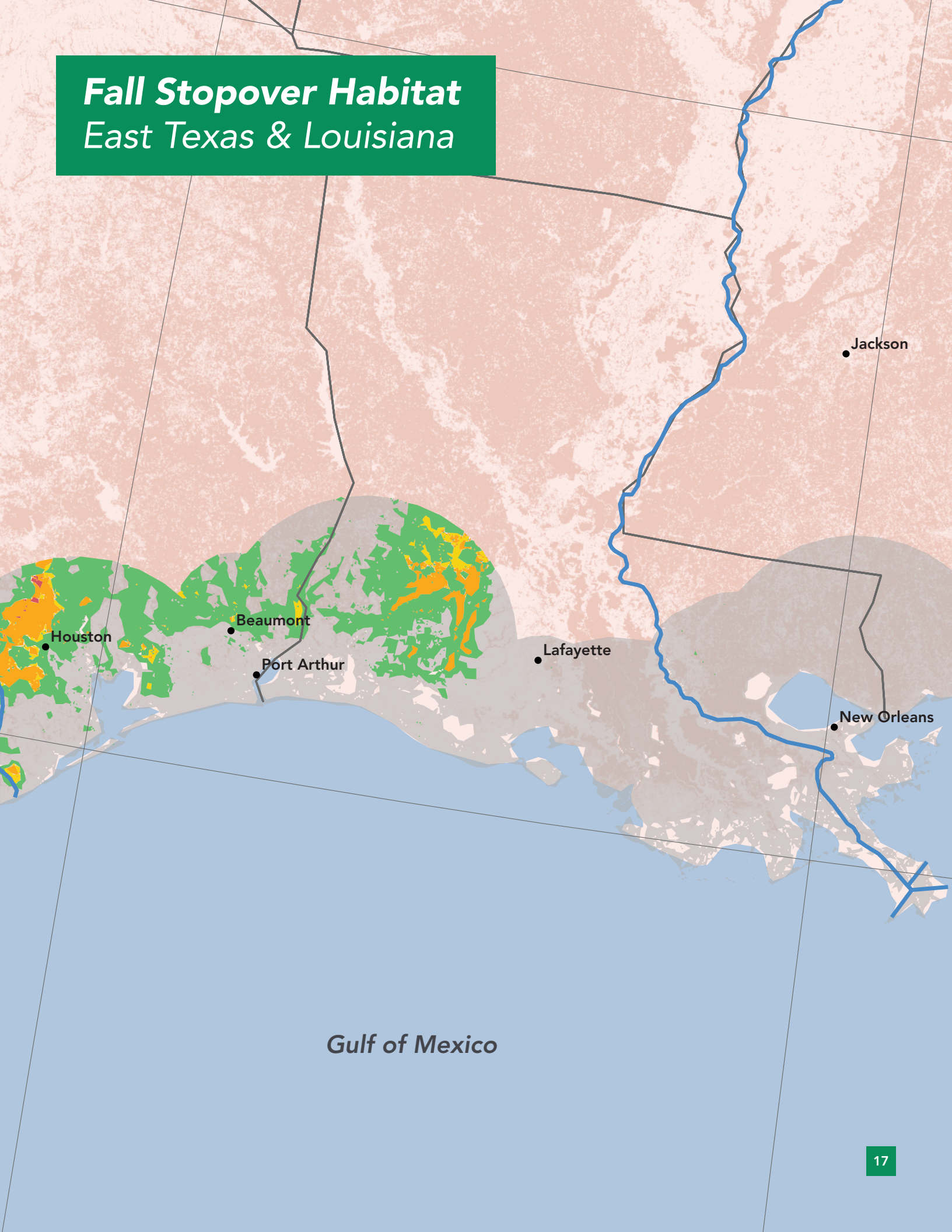**Corpus Christi**

Gulf of Mexico

Brownsville

LEGEND
RELATIVE BIRD DENSITY

LOW

MODERATE

HIGH (HIGH VARIABILITY)

HIGH (MED VARIABILITY)

HIGH (LOW VARIABILITY)

Fall Stopover Habitat
West Texas

College Station

San Antonio

Beaumont

Houston

Victoria

Laredo

Corpus Christi

Brownsville

Gulf of Mexico

Spring Stopover Habitat
East Texas & Louisiana

Jackson

Houston

Beaumont

Port Arthur

Lafayette

New Orleans

LEGEND
RELATIVE BIRD DENSITY

LOW

MODERATE

HIGH (HIGH VARIABILITY)

HIGH (MED VARIABILITY)

HIGH (LOW VARIABILITY)

Fall Stopover Habitat
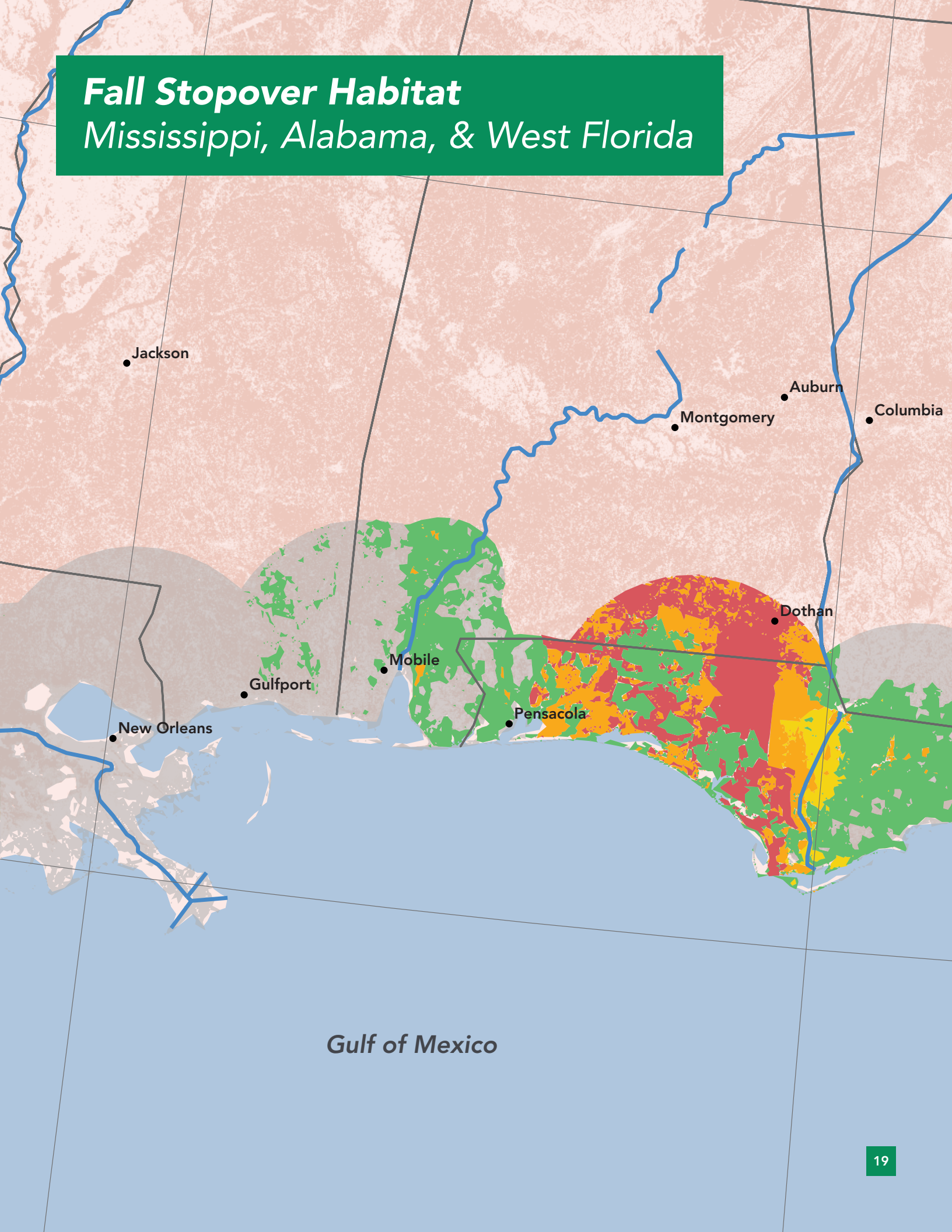## East Texas & Louisiana

Jackson

Houston

Beaumont

Port Arthur

Lafayette

New Orleans

Gulf of Mexico

Spring Stopover Habitat
Mississippi, Alabama, & West Florida

Jackson

Auburn

Columbia

Montgomery

Dothan

Mobile

Gulfport

Pensacola

New Orleans

LEGEND
RELATIVE BIRD DENSITY

LOW

MODERATE

HIGH (HIGH VARIABILITY)
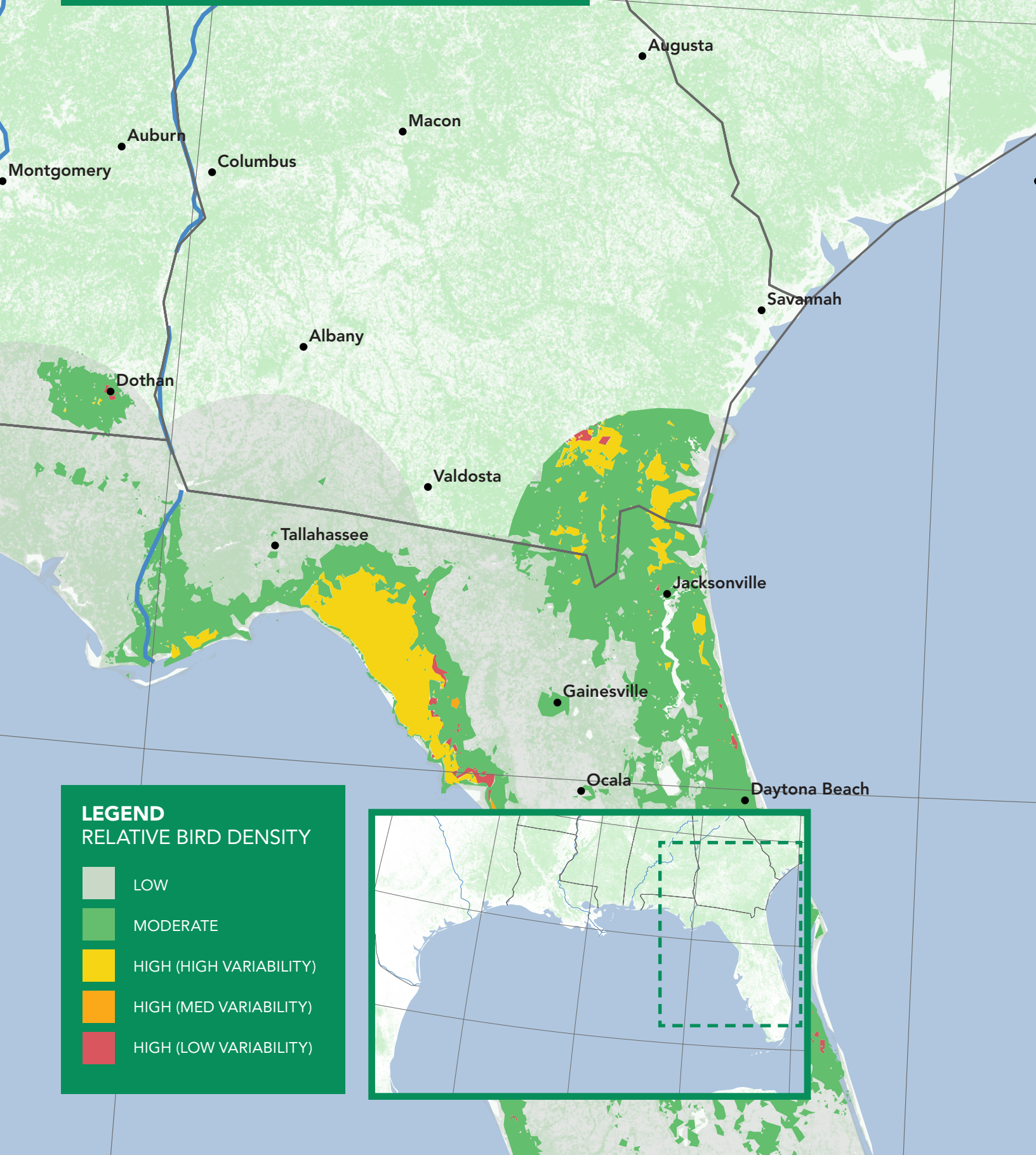
HIGH (MED VARIABILITY)

HIGH (LOW VARIABILITY)

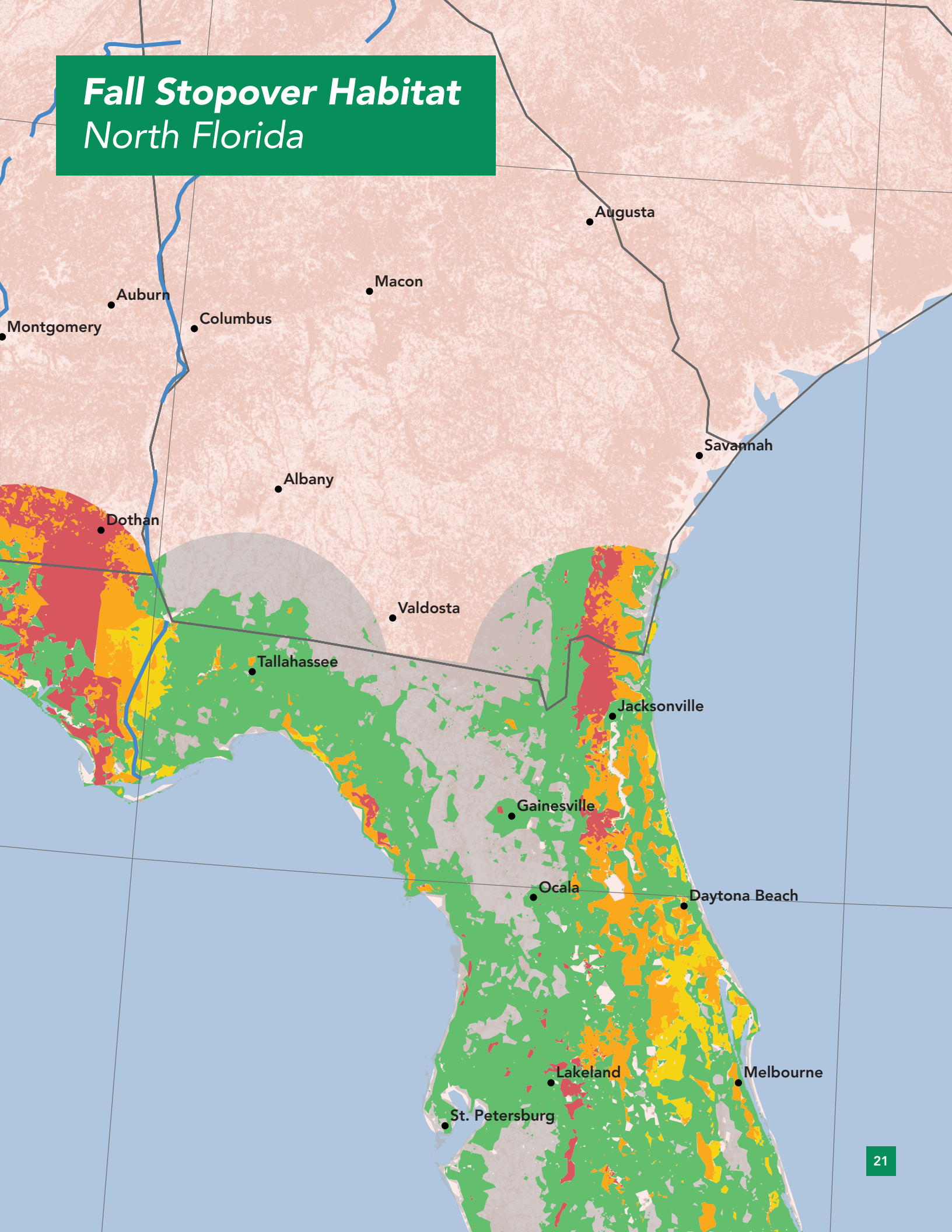# Fall Stopover Habitat
Mississippi, Alabama, & West Florida

Jackson

Auburn

Columbia

Montgomery

Dothan

Mobile

Gulfport

Pensacola

New Orleans

Gulf of Mexico

Spring Stopover Habitat
North Florida

Augusta

Macon

Auburn

Columbus

Montgomery

Albany

Dothan

Savannah

Valdosta

Tallahassee

Jacksonville

Gainesville

Ocala

Daytona Beach

LEGEND
RELATIVE BIRD DENSITY

LOW

MODERATE

HIGH (HIGH VARIABILITY)

HIGH (MED VARIABILITY)

HIGH (LOW VARIABILITY)

Montgomery

Auburn

Columbus

Macon

Augusta

Albany

Dothan

Savannah

Valdosta

Tallahassee

Jacksonville

Gainesville

Ocala

Daytona Beach

Lakeland

Melbourne

St. Petersburg

Spring Stopover Habitat
South Florida

Gulf of Mexico

nesville

Ocala

Daytona Beach

Lakeland

Melbourne

St. Petersburg

Fort Myers

West Palm Beach

Boca Raton

Miami

Homestead

Fall Stopover Habitat
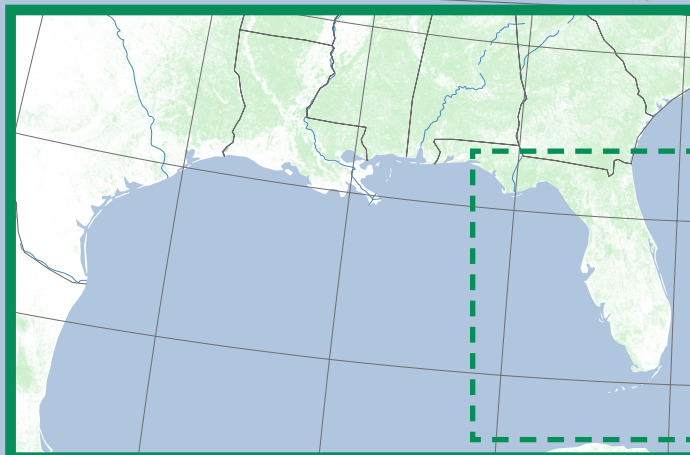## South Florida

Gainesville

Ocala

Daytona Beach

Gulf of Mexico

Lakeland

Melbourne

St. Petersburg

Fort Myers

West Palm Beach

Boca Raton

Miami

Homestead

Acknowledgements

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