MARCH 2022

Audubon

LOWER MISSISSIPPI RIVER CONSERVATION BLUEPRINT

Audubon's vision for healthy, resilient communities and birds

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The National Audubon Society protects birds and the places they need, today and tomorrow, throughout the Americas using science, advocacy, education, and on-the-ground conservation. Audubon's state programs, nature centers, chapters, and partners have an unparalleled wingspan that reaches millions of people each year to inform, inspire, and unite diverse communities in conservation action. Since 1905, Audubon's vision has been a world in which people and wildlife thrive.

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Cover: Prothonotary Warblers. Photo: Donald Wuori/Audubon Photography Awards
This page: Semipalmated Sandpipers and White-rumped Sandpipers. Photo: Chuck Wood/Audubon Photography Awards

Introduction

The Mississippi River is the fourth-largest river system in the world, with its basin encompassing 40 percent of the contiguous United States, stretching across 31 states and 2 Canadian provinces. This vast river system is one of the most important hydrologic, cultural, and economic corridors in North America. It is also a critical corridor for people, the economy, and migratory birds. More than 12 million people live along its banks, and the river contributes more than $400 billion annually to the U.S. economy.

The Lower Mississippi River and its watersheds provide vital habitats for birds to nest, forage, winter, and stop over during migration, highlighted by Audubon's network of Important Bird Areas. As the centerpiece of the Mississippi Flyway, the river connects birds from the Arctic to the southern tip of South America, and iconic areas in between, including the Gulf of Mexico, Central American highlands, Amazon River Basin, and southern South American grasslands. The wide diversity of habitats, including forested wetlands, prairies, coastal wetlands, and upland forests, support a dizzying array of birds.

However, this incredible national treasure is under threat. Human engineering, increasing pollution from nutrients and storm water, and climate threats like sea-level rise, increasing water temperatures, and heavier rainfall events are all affecting the health of the river and the communities and wildlife that rely on it. Of the more than 350 bird species in the region, the U.S. Fish and Wildlife Service lists over 20 percent as continental or regional Birds of Conservation Concern, emphasizing the stresses bird populations face in this region. Birds are important indicators of ecosystem health, and the decline of certain populations in the region tells us that we must conserve this ecosystem, for the birds and for human communities.

Audubon has created this conservation blueprint to focus on the Lower Mississippi River region, defined here as the section of the Mississippi River Basin and watersheds stretching from the confluence of the Missouri River at St. Louis to the Gulf of Mexico. We focused on 16 priority species in the region to represent our habitat conservation priorities, needs, and opportunities in the region. Audubon developed this blueprint to identify areas where we could deploy conservation initiatives, including natural infrastructure solutions that restore and enhance ecosystems like wetlands and floodplains, to futureproof the communities and ecosystems in this region against climate change. This blueprint identifies strategies and actions that Audubon will take to protect birds and people in the region through regional programming, centers, conservation science, or active engagement on policy matters. Audubon's vision is for a healthy and connected network of habitats in the Lower Mississippi River region that support sustainable bird populations and strengthen the resilience of human communities against human-made and natural threats such as subsidence, poor water quality, and more frequent and severe climate-driven disasters like flooding and sea-level rise.

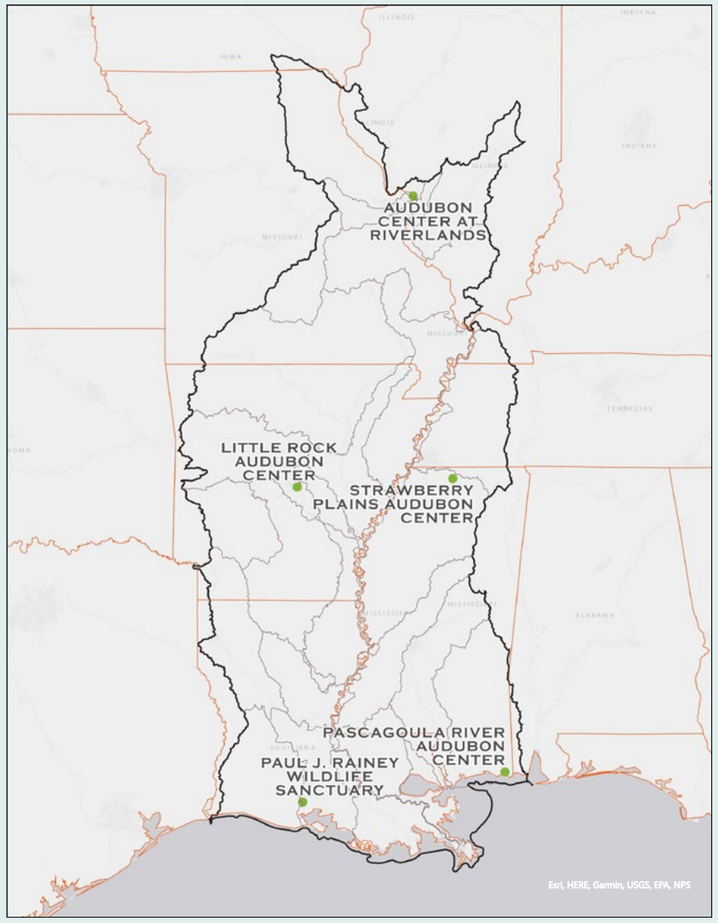
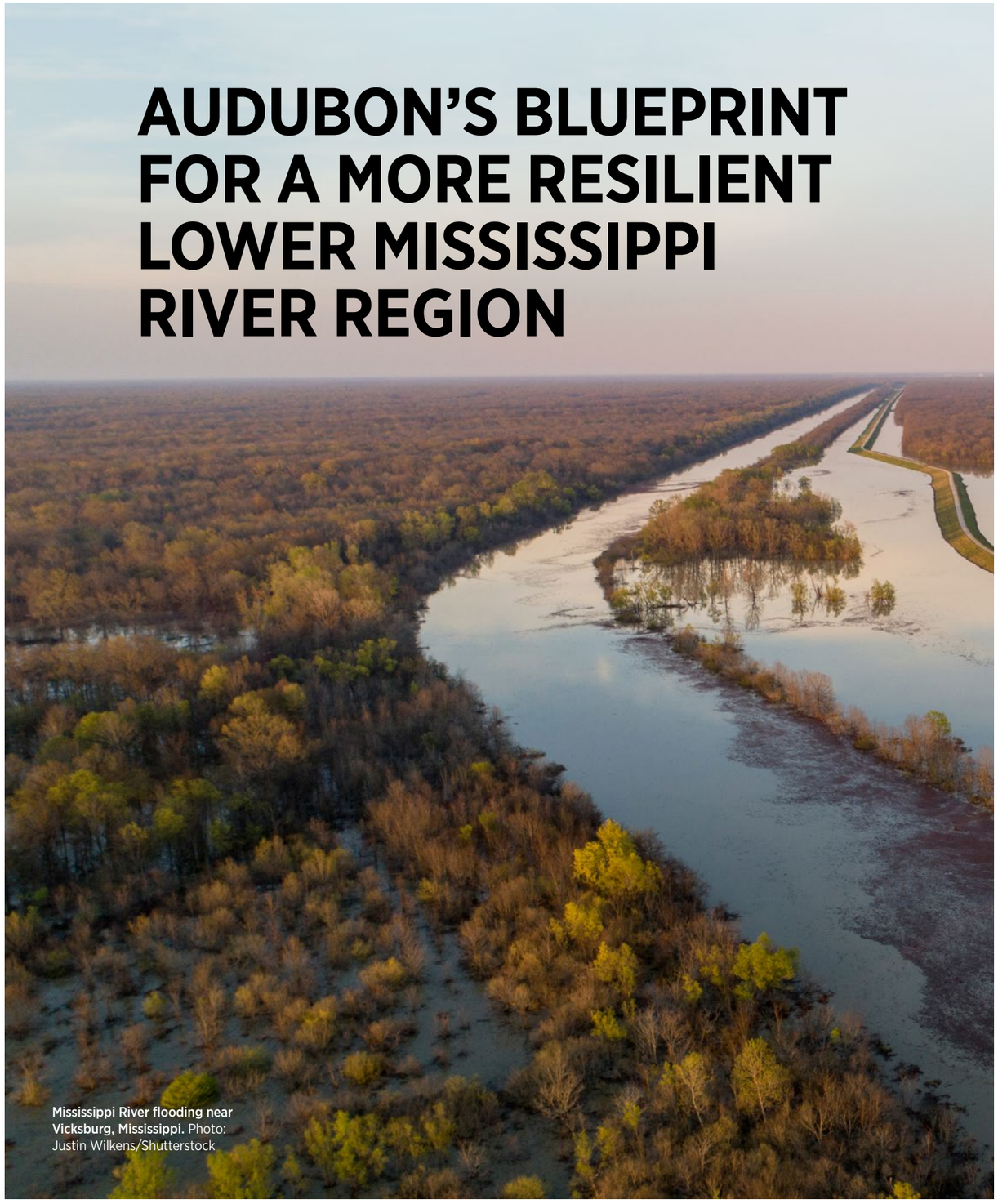


FIGURE 1 | Spatial extent of Audubon's Lower Mississippi River Conservation Blueprint and location of Audubon centers and sanctuaries. Map: Lotem Taylor/Audubon.

This blueprint is intended to complement rather than replace other existing conservation plans in the region, including well-established documents like those created by the Lower Mississippi Valley Joint Venture. This blueprint utilizes those existing tools and prioritizations, and adds climate-based models developed by Audubon scientists as well as other priorities identified by our team. This plan also considers multiple lowland and upland habitat types in order to draw inferences about where to grow and refine Audubon's work in the region. We recognize that there are many conservation organizations in the region already doing important work, and this blueprint is intended to build upon Audubon's expertise in the region to provide support and leadership to advance established and emerging conservation initiatives through a collaborative, multidisciplinary approach.

LOWER MISSISSIPPI RIVER CONSERVATION BLUEPRINT

AUDUBON'S BLUEPRINT FOR A MORE RESILIENT LOWER MISSISSIPPI RIVER REGION



Mississippi River flooding near Vicksburg, Mississippi. Photo: Justin Wilkens/Shutterstock

Birds and Habitats at Risk

As one of the most important navigation and commerce corridors in the country, the Lower Mississippi River has been highly modified by humans. Many birds in the region are at risk due to habitat loss, fragmentation and degradation. Modifying the landscape to support human infrastructure and economic growth has led to decreased water and soil quality through erosion and runoff, the proliferation of invasive species, and altered hydrological regimes through leveeing, dams, and pumps. Climate-driven weather extremes are stressing this infrastructure, simultaneously putting bird habitat and human communities at greater risk. As climate threats grow and human development has expanded in urban and suburban areas throughout the watershed, there is an urgent need to increase landscape connectivity and improve management on protected lands.

The Lower Mississippi River Alluvial Valley has lost over 80 percent of its bottomland forested wetlands over the last century, yet extensive tracts remain in the Atchafalaya Basin and Three-River Delta in Louisiana, the White River Basin in Arkansas, and Mississippi's South Delta. Reconnecting these habitats is critical for reducing invasive species, improving water quality, and providing a network of high-quality stopover habitats for migratory birds. Similarly, connecting migratory shorebird foraging habitat between the Gulf Coast and interior wetlands up the flyway through strategic water management activities is critical to address alarming declines among the majority of shorebird species. Sea- and shorebird populations have declined 70 percent in recent decades due in part to climate impacts like sea-level rise and more intense storms. As climate change alters rainfall patterns and increases the likelihood of extreme droughts and floods, addressing water management challenges for agriculture, communities, and birds will become increasingly urgent.

As important indicators of ecosystem health, birds tell us that the time to act is now. About 30 percent of all of the birds in the U.S. and Canada have disappeared over the last 50 years because of the loss of habitat quality and quantity. In addition, Audubon's own Survival by Degrees report shows that two-thirds of the bird species here are at risk of extinction from climate change in the coming century. Without immediate and intentional action, these birds and the habitats on which they depend face a bleak future.

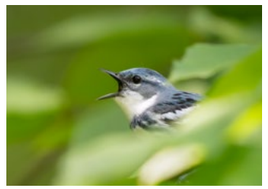
Osprey nest, Pascagoula River, Mississippi.
Photo: Whit Andrews/ Flickr (CC BY 2.0)

The Lower Mississippi River Alluvial Valley has lost over 80 percent of its bottomland forested wetlands over the last century.

Priority Bird Species and Habitats

Photos clockwise from top left: Gary Robinette/Audubon Photography Awards; Jesse Gordon/Audubon Photography Awards; Andy Morffew/Flickr (CC BY 2.0); Steve Byland/Shutterstock; Andy Morffew/Flickr (CC BY 2.0); Matthew Filosa/Audubon Photography Awards; Agnieszka Bacal/Shutterstock; Paul Reeves Photography/ Shutterstock; Peter Brannon/Audubon Photography Awards; Walker Golder; Melissa James/Audubon Photography Awards; Robert Gundy/Audubon Photography Awards; Andy Wraithmell/FFW/Flickr (CC BY NC ND 2.0); Robert Bunch/Audubon Photography Awards; Matt Tillet/Flickr (CC BY 2.0); Tom Benson/Flickr (CC BY NC ND 2.0)

Prothonotary Warbler
BOTTOMLAND HARDWOOD



Cerulean Warbler
BOTTOMLAND HARDWOOD

Swallow-tailed Kite
BOTTOMLAND HARDWOOD

Worm-eating Warbler
EASTERN FORESTS

King Rail
WETLANDS

Semipalmated Sandpiper
WETLANDS

Mallard
WETLANDS

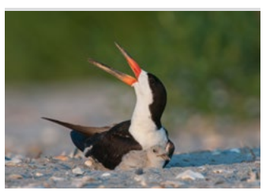
Northern Bobwhite
PRAIRIE

Eastern Meadowlark
PRAIRIE

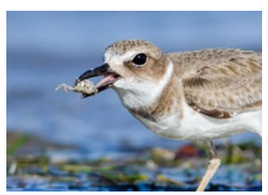
Grasshopper Sparrow
PRAIRIE

Brown-headed Nuthatch
PINE WOODS

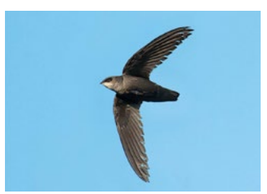
Least Tern
BEACH/DUNE



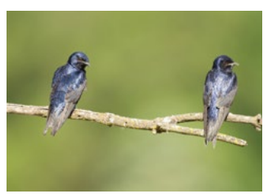
Black Skimmer
BEACH/DUNE



Wilson's Plover
BEACH/DUNE



Chimney Swift
URBAN/SUBURBAN



Purple Martin
URBAN/SUBURBAN

Communities at Risk

The Lower Mississippi River region is home to a wide range of communities, from metropolitan centers like Memphis, St. Louis, and New Orleans, to smaller, primarily rural agricultural regions like the Mississippi Delta. From the birthplace of jazz, through the cradle of the blues, and northward to the breadbasket of America, the Mississippi River supports this storied geographic region.

As a powerful economic engine and vital resource for the people and wildlife, the Mighty Mississippi serves as a key national corridor for shipping goods and services, a source of drinking and irrigation water, a recreational center, and a catalyst for critical bird and wildlife habitat. Its annual spring floods once nourished crops throughout the region, but they also brought tragedy and great hardship.

In 1927, the Mississippi River flooded more than 23,000 square miles and displaced hundreds of thousands of people. To prevent similar disasters in the future, the federal government began managing the river through a complex system of levees and floodgates. This attempt to control the river and prevent future floods dramatically changed the way that people and wildlife interacted with the river, its tributaries, and adjacent communities. While some communities along the river saw reduced flooding, the wetlands and floodplains that relied on the river's land-creating sediments eroded or were lost to agricultural expansion and development. Today, seasonal flooding and water quality and quantity impairments continue to plague the region as climate change brings more frequent and intense extreme weather events.

The impacts from climate-driven disasters are already dramatically affecting the region's communities, economies, and wildlife and their habitats, bringing greater challenges to how we manage our water and natural resources. More intense and frequent rain events, as well as changing seasonal snow and rainfall patterns, in the Upper Basin are exacerbating flooding for communities throughout the Lower Mississippi River region. Riverine flood risk across the entire Mississippi Basin is expected to threaten $4.2 billion in GDP annually, an increase of $831 million from 2010. Coastal communities also face the threat of rising sea levels in addition to river flooding. Across coastal regions of Louisiana and Mississippi, more than $9.3 billion in today's property value is at risk of increased flooding with 6 feet of sea-level rise, and 70 to 80 percent of people living in those at-risk properties are considered medium- to highly vulnerable based on their socioeconomic status.

These disasters disproportionately affect lower-income communities, communities of color, and Tribal Nations and Indigenous communities. A legacy of racist policies like redlining and forced relocation have constrained these communities to more flood-prone areas and near polluting facilities, while starving them of needed investments to reduce risks, which exacerbates harms when disasters strike. Key partnerships between community-based organizations in the Mississippi Delta and the Greater New Orleans area have helped Audubon engage thoughtfully in work to help strengthen the resilience of these communities.

Yazoo River floodwaters near Satartia, Mississippi.
Photo: Lance Cheung/ USDA

Working with Nature

Audubon's conservation strategy focuses on advancing nature-based solutions and partnering with communities to identify ways to enhance resilience to these climate threats and other stressors. Resilient, healthy river ecosystems must be part of the solution—they provide habitat for birds and protection for communities facing stronger storms, more frequent flooding, and sea-level rise.

Despite complex challenges affecting the health and resilience of the Lower Mississippi River region, we know that conservation and restoration works. Restored habitats along the river and its tributaries not only help recover bird populations, but also improve water quality and provide important natural flood buffers for communities. The blueprint targets conservation and restoration in the region's hundreds of thousands of acres of state- and federally managed conservation areas, but also acknowledges that the majority of lands in this region are privately owned. This blueprint identifies where private and public lands can be connected and restored to establish large-scale parcels of well-managed habitat. It also will help us increase enrollment in private lands programs like Wetland Reserve Easements and Conservation Reserve Programs. By engaging both public and private landowners, Audubon will expand the availability of wetland, forested, and grassland habitat for birds in ways that will reduce flooding, erosion, and water pollution affecting the river.

Strategically protecting and restoring certain habitats now will make the region more resilient and will support birds as climate change shifts their suitable range and habitats. From wetlands to river floodplains to barrier islands, the Lower Mississippi River region's diverse habitats provide important protections that reduce climate-driven risks to communities and wildlife, while also delivering multiple co-benefits like improved air and water quality, nature-based recreational amenities, and high-paying restoration jobs.

Strategically protecting and restoring certain habitats now will make the region more resilient and will support birds as climate change shifts their suitable range and habitats.

Monarch butterflies at Strawberry Plains Audubon Center.
Photo: Mike Fernandez/ Audubon

Audubon's Wingspan in the Region

Audubon has a powerful network in this region, with 71,252 members and 30 chapters. For almost a century, Audubon has been active in the Lower Mississippi River region as a conservation advocate and landowner. Audubon centers and sanctuaries bookend the region to the north, south, east, and west, creating a unique opportunity to coordinate conservation across the landscape. Established in 1924, the Paul J. Rainey Wildlife Sanctuary in southwest Louisiana is Audubon's oldest and largest wildlife sanctuary. The Audubon Center at Riverlands, near St. Louis, anchors the region to the north and the Little Rock, Strawberry Plains, and Pascagoula River Audubon Centers help serve communities throughout the region through education, recreation, and advocacy.

Audubon is also a leader in supporting on-the-ground restoration and enacting resilience policies that benefit both birds and people. For example, Audubon was instrumental in passing legislation that ensured that Deepwater Horizon oil spill penalties were directed to Gulf Coast restoration. In Missouri, Audubon is a key partner in influencing restoration and management of 49,000 acres of bottomland forest along the Mississippi River, benefiting birds and water quality for the river and the communities that surround it. Along the Gulf of Mexico, Audubon is supporting projects to rebuild natural storm defenses like our coastal wetlands and barrier islands. The 220-acre Round Island project in Mississippi Sound used dredged sediments to re-establish the island that buffers nearby Pascagoula, while providing important bird habitat and recreational opportunities.

Audubon is a proven conservation leader in the region, spearheading the passage and legislative support of coastal and climate policy, establishing and maintaining long-term stewardship and monitoring programs for birds and habitats at risk, as well as engaging with private landowners and underserved communities to enhance habitat in the region. Audubon is well positioned to advance conservation and restoration work in the region that will improve river health, enhance community resilience, and support the recovery of birds and other wildlife.

LOWER MISSISSIPPI RIVER CONSERVATION BLUEPRINT

Black Skimmer.
Photo: Peter Brannon/ Audubon Photography Awards

Audubon has prioritized nearly 50 million acres of habitat like wetlands, pine woods, and prairies in need of futureproofing—areas to restore, maintain, or adapt to accommodate for climate change and other stressors.

Targeting Our Work for Greatest Impact

In order to develop a meaningful framework for future conservation in the Lower Mississippi River region, Audubon conducted a spatial analysis to prioritize landscapes in need of conservation action. We identified areas of high value for all 16 priority birds, their habitats, and co-benefits for human communities, both now and in 2050 (See appendix A for detailed methods). An interactive version of this map is available online for the conservation community to use as a decision-support tool.

The analysis identified 39 percent of the region, or 48,931,000 acres of habitat, as high-priority for both birds and people. Priority habitats are classified into three categories—those to maintain, restore, and adapt (Figure 2). "Priorities to maintain" are those areas predicted to be high value both now and in the future. These areas must be managed appropriately and protected from future development, degradation, fragmentation, and further loss of ecological function. "Priorities to restore" are those areas, whose present condition is impaired or not highly suitable for priority species or human communities, but are predicted to become increasingly valuable in the future, due in part to climate change, reforestation after agriculture, or predicted species shifts. Restoration needs can include improving habitat structure, hydrological regimes, or other ecological processes. "Priorities to adapt" are those areas with high values currently, but not in the future. The shift in suitability is due mostly to predicted climate stressors or future development. The goal in these areas is to develop "adaptation pathways," or conservation and management actions that help prepare natural habitats and human communities for future environmental conditions, and increase resilience.

Lower Mississippi River Spatial Prioritization

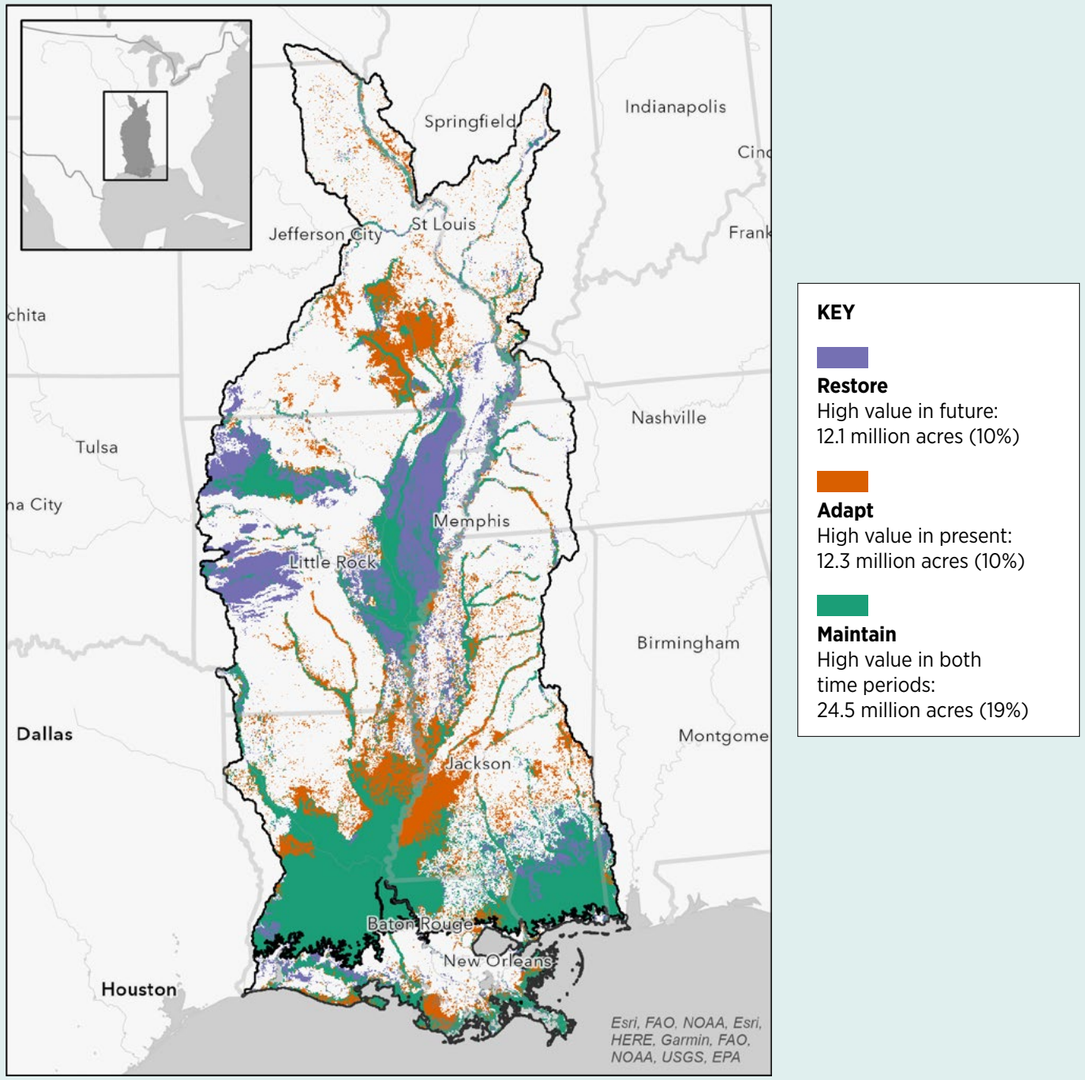


FIGURE 2 | Results of the Lower Mississippi River spatial prioritization, identifying areas of high value for priority birds, their habitats, and co-benefits for human communities within the region, both now and in the future (2050). Management recommendations are based on whether areas are predicted to be high value in the future but not in the present (priorities to restore, purple), high value in the present but not in the future (priorities to adapt, orange), or high value in both time periods (priorities to maintain, green). Coastal and inland landscapes were modeled and prioritized separately, demarcated by the black line across south Louisiana and Mississippi (see appendix A for more detail). Map: Lotem Taylor/Audubon

CONSERVATION IMPACT PLAN

A Yellow-breasted Chat after being banded at Strawberry Plains Audubon Center in Mississippi. Photo: Mike Fernandez/Audubon

CONSERVATION IMPACT PLAN

Strategy 1:

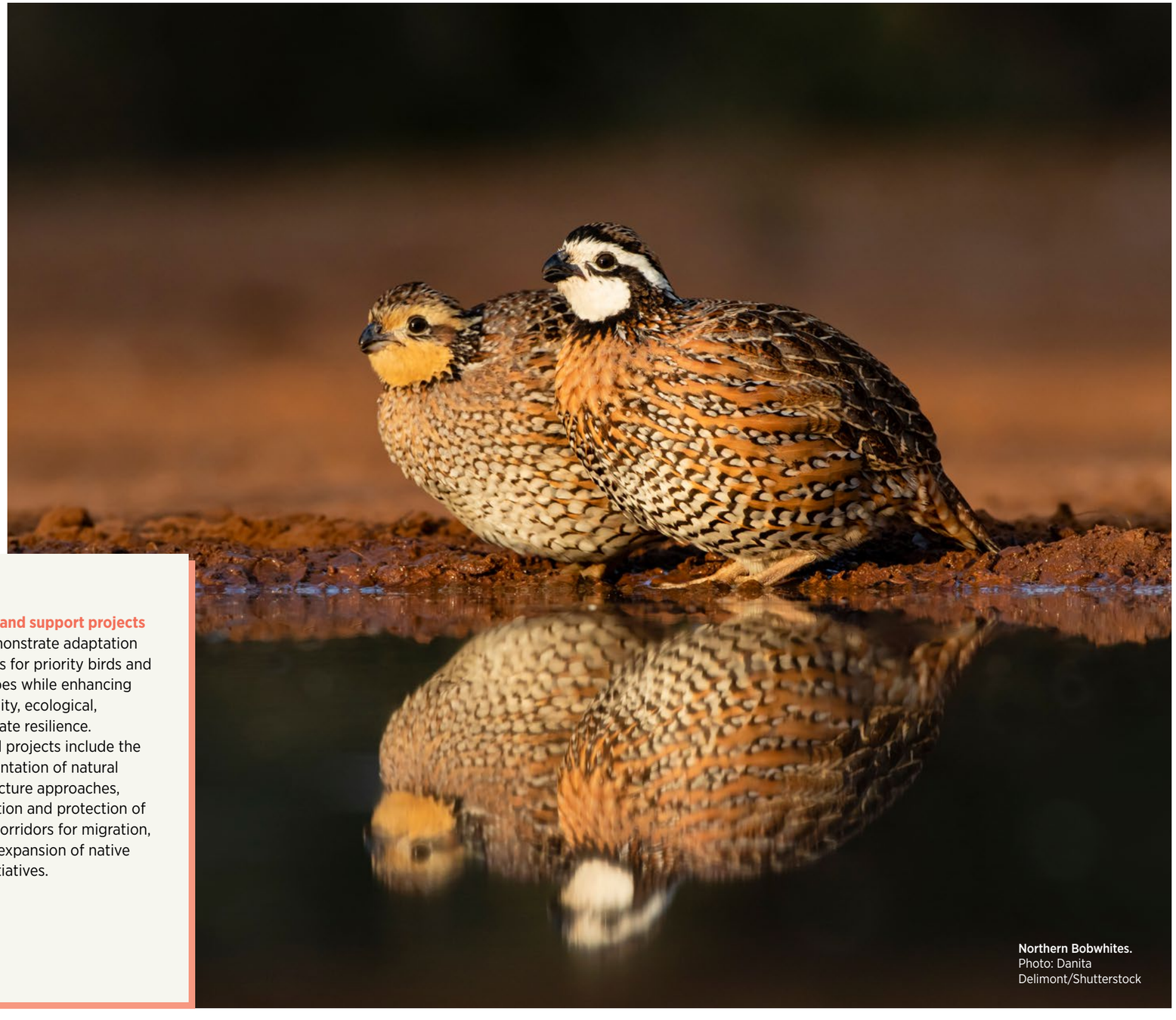
Fill critical science gaps and develop implementation strategies that ensure adequate protection, adaptation pathways, and restoration for priority landscapes and species within the Lower Mississippi River region while also building community resilience and enhancing watershed health.

Much is known in the region about the relationships between birds and their habitats during the nesting season, but there remain gaps in our understanding of how habitat change and management actions affect bird species that migrate through or overwinter in the region. Identifying and filling in these gaps will aid in developing implementation strategies that ensure adequate protection for species, year-round. In addition, projected changes in climate and future land-use patterns require us to develop new solutions for recovering bird populations and restoring habitats that can adapt to changing environmental conditions.

We also recognize that the health of watersheds within the Lower Mississippi River region is inextricably linked to the resilience of birds and people. This connection must direct all habitat protection, climate adaptation, and restoration actions taken.

ACTIONS:

- **Collaborate with partners to identify and fill critical science gaps** and verify conservation implementation outcomes on birds and bird habitat.
- **Work with natural resource agencies, academic institutions, other conservation organizations, and public and private landowners** to ensure that "high priority to maintain" habitats, as identified by our spatial prioritization process, are enhanced through science-based best management practices or have adequate protections in place.
- **Develop habitat- and regionally specific restoration recommendations** that classify and rank "high priority to restore" areas according to their specific restoration needs, their potential benefits to species and local communities, and their potential to sequester carbon.
- **Inform private landowners about best practices** for bird-friendly land management and connect landowners with programs that support these practices.
- **Identify and support projects** that demonstrate adaptation pathways for priority birds and landscapes while enhancing community, ecological, and climate resilience. Potential projects include the implementation of natural infrastructure approaches, the creation and protection of natural corridors for migration, and the expansion of native plant initiatives.



Northern Bobwhites. Photo: Danita Delimont/Shutterstock

LOWER MISSISSIPPI RIVER CONSERVATION BLUEPRINT

Audubon Arkansas and project partners Arkansas Natural Heritage Commission and Roundstone Native Seed Company are assisting farmers with establishing production plots of pollinator-friendly forbs.
Photo: Audubon Arkansas

CONSERVATION IMPACT PLAN

Strategy 2:

Advance policies in the region that promote a healthy and resilient environment for priority bird species and human communities.

To advance a regional suite of goals and metrics focused on long-term resilience for the Lower Mississippi River region, greater engagement and advocacy will be necessary at the local, state, and federal level. Advocacy and engagement with policy-makers must be grounded in best available science and the needs of birds, while aligning with the long-term resilience and equity concerns of the people who call this region home.

ACTIONS

- **Build a diverse coalition of partners and develop a common policy agenda** at all levels of government that promotes natural infrastructure solutions for building more climate-resilient Lower Mississippi River communities and ecosystems (e.g., disaster recovery and hazard mitigation programs, U.S. Army Corps of Engineers civil works projects), as well as natural climate solutions for sequestering carbon pollution.
- **Support the development, funding, and implementation of new conservation programs in the region** to best leverage effective on-the-ground conservation, management, and restoration.
- **Secure funding and target the implementation of agricultural conservation programs** at the federal, state, and local level to achieve maximum benefits for bird habitat and climate resilience.
- **Defend against projects or policies** that further degrade bird habitat and reduce the climate resilience of communities in the region.
- **Engage Audubon's volunteer and student chapter network in** meetings with congressional offices in the region on Audubon's natural infrastructure policy priorities to educate legislators about the benefits of these types of approaches and to demonstrate grassroots support.
- **Leverage Audubon centers t**o build out and connect the conservation and policy work to the community through outreach and engagement programs. Centers and sanctuaries in the Lower Mississippi River region will provide on-the-ground examples of best management practices and showcase the implementation of projects and policies for which Audubon advocates.

The Little Creek Summer Camp is a partnership of the Ferguson-Florissant School District and the Audubon Center at Riverlands in Missouri.
Photo: Michelle Wiegand

LOWER MISSISSIPPI RIVER CONSERVATION BLUEPRINT

CONSERVATION IMPACT PLAN

Strategy 3:

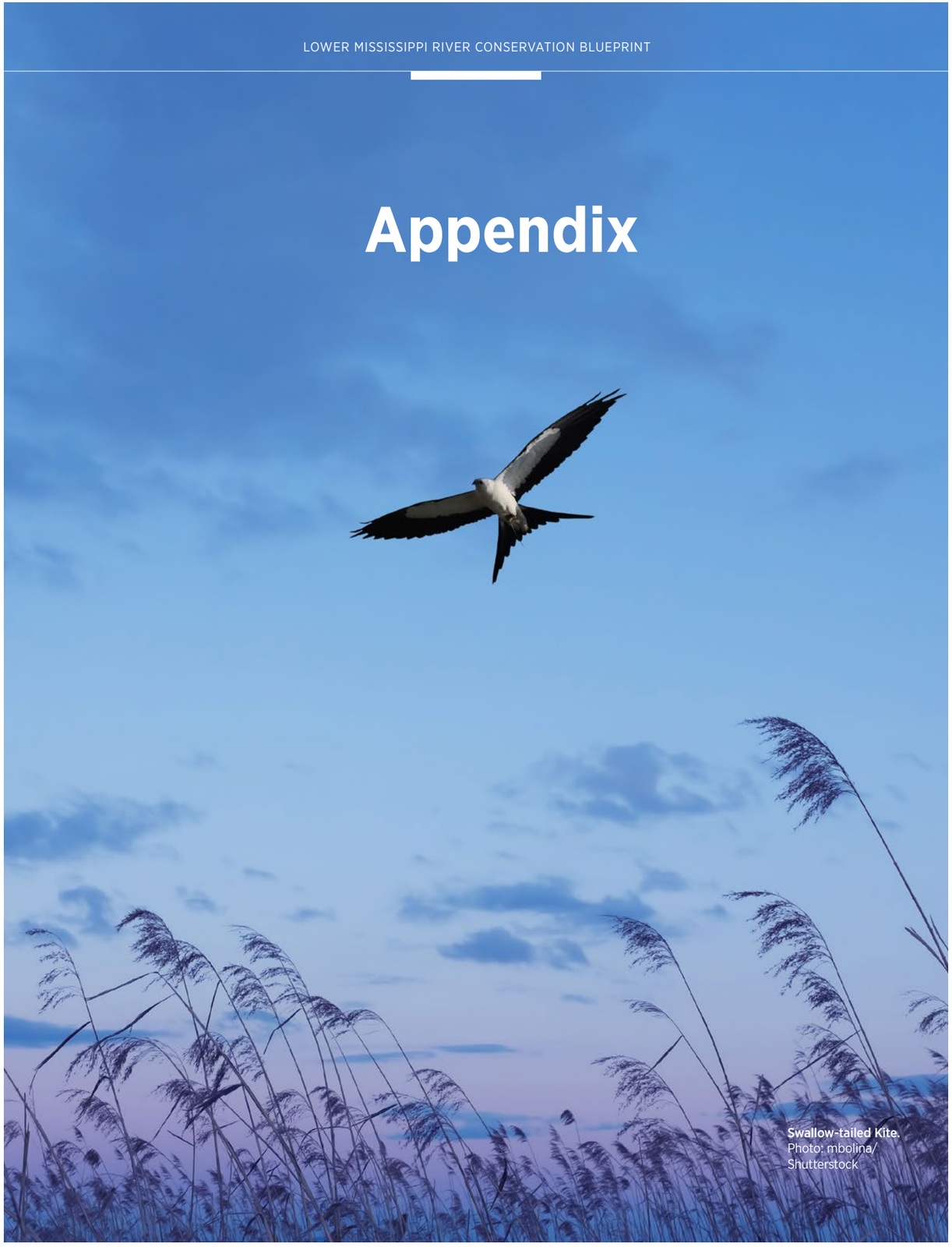
Engage and uplift the voices of underrepresented communities through conservation-based programming, environmental stewardship, and advocacy.

As Audubon works to ensure a sustainable and resilient home for birds, we have a duty to ensure that our work is informed by and beneficial to communities throughout the region, particularly those most threatened by climate-driven disasters. For the region's residents to prosper, restoration strategies must be rooted in the needs of local communities, and communities must have a voice in decision-making for the places in which they live and work. Audubon will work to build an informed, engaged, diverse, and inclusive network of community partners across the region to help uplift community voices to influence decision-making at the state, regional, and national levels. To that end, Audubon will engage community-based organizations, schools, and other local partners through our programming, properties, and chapters by strengthening existing and developing new partnerships that support opportunities for education, collaboration, equity, and funding.

ACTIONS

- **Work with local chapters, partners, and frontline communities** to identify, fund, and implement projects to restore and conserve priority habitats and to deploy natural infrastructure demonstration projects.
- **Engage partners and local chapters in advocating** for the use and funding of effective land management programs that are informed by and benefit underserved communities and communities of color, such as Audubon's native plant work or the Department of Agriculture's conservation programs
- **Work with partners in community-based organizations to identify the barriers** frontline communities face in accessing funding programs promoting resilience and nature-based solutions, and co-develop joint advocacy strategy for removing or reducing barriers.
- **Expand the network of Audubon campus chapters engaging on policy** and restoration opportunities in the region, with an emphasis on new partnerships with Historically Black Colleges and Universities.
- **Build a diverse corps of volunteer stewards** that actively advance local projects and policies to benefit coastal bird stewardship activities, with an emphasis on engaging youth and organizations located in underrepresented communities.
- **Launch a regional bird-friendly community program that engages underserved communities** and youth in locally based, climate-resilient native plant projects.

Appendix



Swallow-tailed Kite.
Photo: mbolina/
Shutterstock

LOWER MISSISSIPPI RIVER CONSERVATION BLUEPRINT

APPENDIX A: LOWER MISSISSIPPI RIVER SPATIAL PRIORITIZATION DETAILED METHODS

SUMMARY

The Lower Mississippi River spatial prioritization was designed to guide the development of a conservation blueprint for the region. It was co-developed by Audubon Delta and National Audubon Science and uses a systematic conservation planning approach to identify priority sites to maintain, restore, and adapt in the region. We used existing spatial datasets as inputs to an optimization designed to prioritize the landscape for conservation action, through the lens of Audubon Delta's strategic priorities. Results are available in a web app and can be used for site-specific decision support. The prioritization focuses on the following components:

- *Priority birds* – a parsimonious suite of species that represent all priority habitats in the region
- *Priority habitats* – bottomland hardwood forest, agricultural land, wetlands (coastal and interior), grasslands/prairie, pine woods, beaches/dunes, and barrier islands
- *Ecological resilience* – current coastal and terrestrial resilience and future marsh migration space
- *Social vulnerability* – communities with high exposure and vulnerability to natural and anthropogenic disasters
- *Carbon* – overlap with climate-change mitigation opportunities (i.e., carbon storage and sequestration)
- *Threats to ecological integrity* – human modification, invasive species, future urbanization, and sea-level rise

ANALYTICAL APPROACH

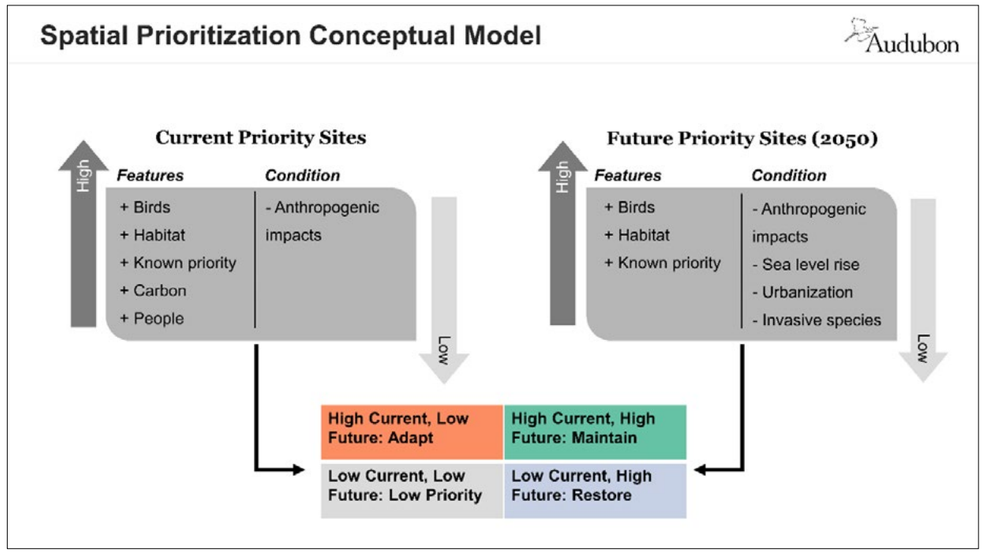


FIGURE 3 | Conceptual model outlining the process for identifying key sites for conservation action in the Lower Mississippi River region.

We conducted two spatial prioritizations using Zonation Conservation Planning software: one for the current landscape and one for the projected mid-century landscape. We then integrated the two prioritizations into a single classified raster with four management classes (Figure 3). The analysis extent included all HUC6 watersheds in which Audubon currently works in the lower and mid-Mississippi River Basin, as well as several watersheds contiguous with these areas (Figure 1). Because the area of interest covered a wide region extending from the Gulf Coast to northern Missouri, we stratified the prioritizations by coastal and inland regions, using the upland extent of predicted marsh migration space to delimit the boundary. We used the Additive Benefit Function (ABF) as our model optimization algorithm, which prioritizes locations with multiple high value input features. Birds were weighted twice as high as other inputs, and each species was weighted equally, regardless of seasonal or year-round presence.

MODEL INPUTS

Priority Bird Species and Habitats

We used Audubon's Survival by Degrees climate models to represent the current and future distributions of all priority birds and their habitats (Table 1) based on a 'business-as-usual' climate scenario (RCP 8.5). These models were developed across North America at a 1-km resolution for both the breeding and non-breeding seasons, based on a suite of climate and habitat variables. We included all seasons in which priority species were modeled to occur in the region, in both the current and future time periods. Two species did not have future projections available: Semipalmated Sandpiper, which uses the area only during the migration season (see below for surrogate data used to represent this species), and Cerulean Warbler, which currently breeds in the region but was projected to shift its distribution out of the region by mid-century.

TABLE 1 | Focal Habitat and Species List

HABITAT	SPECIES
Bottomland Hardwood	Prothonotary Warbler
	Cerulean Warbler
	Swallow-tailed Kite
Eastern Forests	Worm-eating Warbler
Wetlands	King Rail
	Semipalmated Sandpiper
	Mallard
Prairie	Northern Bobwhite
	Eastern Meadowlark
	Grasshopper Sparrow
Pine Woods	Brown-headed Nuthatch
Beach/Dune	Least Tern
	Black Skimmer
	Wilson's Plover
Urban/Suburban	Chimney Swift
	Purple Martin

ADDITIONAL ASSESSMENT FEATURES

- Shorebird migratory stopover habitat: Audubon's Survival by Degrees models represent bird distributions during the stationary breeding and non-breeding season only. Since Semipalmated Sandpiper occur in this region only during migration, we relied on USGS land cover projections of current and future croplands as a proxy for habitat use. These projections align closely with the eBird Status & Trends migration season models for Semipalmated Sandpiper. However, they likely overestimate potential migratory stopover habitat as crop types are not differentiated and only some are suitable for shallow flooding (such as rice and aquaculture). We did not include eBird Status & Trends data in the model because we lacked permission and future projections were not available.
- **Habitat features:** We included habitat features of particular interest that were not adequately represented by species distributions, including major rivers and streams, and bottomland forest (both from USGS).
- **Ecological resilience:** We used TNC's Resilient Sites coastal and inland resilience scores to represent present ecological resilience and predicted mid-century migration space as an indicator of future coastal resilience.
- **Co-benefits:** To prioritize areas that offer co-benefits for human communities, we included: (1) the CDC's Social Vulnerability Index to represent areas where people are most vulnerable to climate change and other environmental hazards, and (2) the distribution of high value carbon stores (high total ecosystem carbon) and sinks (positive net biome productivity) from Audubon's Natural Climate Solutions Report.
- **Existing priority areas:** We included Important Bird Areas to represent additional high priority bird habitat in the region, as well as an index of proximity to current priority sites (Audubon sites and protected areas) to leverage current conservation investments when planning where to work in the region.
- **Threats to ecological integrity:** We used several threat layers to estimate present and future landscape condition or ecological integrity. These included: (1) TNC's Human Modification Index, an aggregation of 14 terrestrial anthropogenic stressors, such as roads, to represent present-day threats; (2) NFWF's Coastal Resilience Evaluation and Siting Tool (CREST) flooding threat index, an aggregation of flood-related datasets including potential future storm surge, sea-level rise, and landscape characteristics that exacerbate flooding potential; (3) the EPA's Integrated Climate and Land Use Scenarios (ICLUS) urban growth model, to provide a measure of future development threats; and (4) the USFS's percent tree basal area loss due to all pests or percent basal area loss of ash species, to represent future Emerald Ash Borer invasion risk. Since cropland provides bird habitat in the region, we decreased the Human Modification Index in croplands to reflect its benefits to shorebirds.
- **Overlays:** We included several supplementary overlays in the web app rather than integrating them into the analysis to inform decision making without influencing priority ranks. These included: (1) NFWF's Coastal Resilience Evaluation and Siting Tool (CREST) resilience hubs representing areas of open space where restoration projects may have the greatest potential to benefit both human community resilience and fish and wildlife, and (2) a bottomland forest prioritization developed by the Lower Mississippi Valley Joint Venture.

RESULTS

Data available in the web app include:

- **Current prioritization raster:** wall-to-wall ranking of landscape from 0-1 for the current time period
- **Future prioritization raster:** wall-to-wall ranking of landscape from 0-1 for the future time period
- **Management classification raster:** top 30% classified as shown in Figure 3
- **Priority blocks shapefile:** attributes summarized across large polygons
- **Input rasters**
- **Overlays**

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