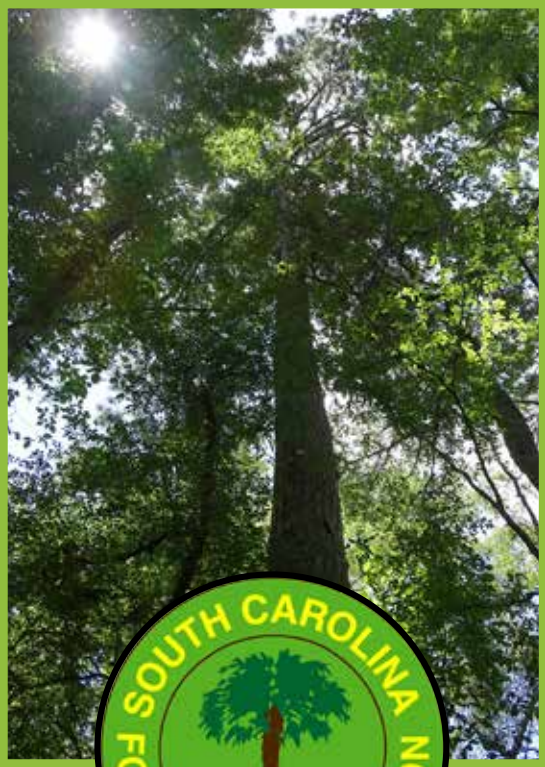
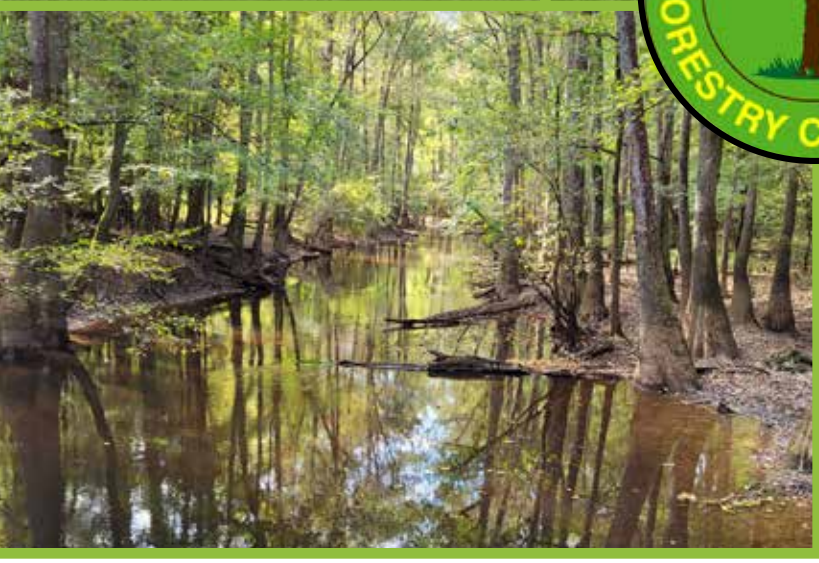
A Green Infrastructure Plan

to Restore, Connect, and Protect South Carolina's Habitats




SOUTH CAROLINA FORESTRY COMMISSION

March 2023

Green Infrastructure Center

Prepared for the state of South Carolina
by the Green Infrastructure Center

Acknowledgments

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All images, graphics and maps in this report are by the Green Infrastructure Center Inc. unless otherwise credited. Contributing authors to this report include the following Green Infrastructure Center staff: Lauren Doran, Matt Lee, and Karen Firehock;
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To obtain any materials presented in this report please contact:
GIC, 320 Valley St., Scottsville VA 24590-4996: Tel: 434-286-3119.
Or visit our website for resources at: www.gicinc.org

The maps and data presented in this report are also available on the HUB site created for this project:
https://scgiplan-gicinc.hub.arcgis.com/

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About the SC Urban and Community Forestry Program

The SC Urban and Community Forestry (SCU&CF) program fosters, supports, and enhances the long-term, sustainable, urban, and community forestry programs within communities. SCU&CF staff provide technical, educational and financial assistance, primarily to cities, towns, non-profit organizations, and state and county governments. Secondary assistance is offered to educational institutions, businesses and private landowners.

For more about the program, see: https://www.state.sc.us/forest/urban.htm
To learn more about the nonprofit Green Infrastructure Center Inc. visit www.gicinc.org

Stakeholder Acknowledgement

Special thanks to those state and local stakeholder committee members who provided expertise and collaboration on this project. GIC also thanks Esri for donating staff and data management support to allow for stakeholders to access all of the project's data, models and maps online.

Participants in the state agency stakeholder workshops included representatives from:

- Center for Heirs Property Preservation
- Open Space Institute
- SC Association of Conservation Districts
- SC Conservation Bank
- SC Department of Agriculture
- SC Department of Health and Environmental Control
- SC Department of Natural Resources
- SC Department of Transportation
- SC Farm Bureau
- SC Forestry Commission
- SC Office of Resilience
- SC ORS, Energy Office
- SC Parks, Recreation and Tourism
- SC Sea Grant Consortium
- Sustain SC
- Trees SC

Participants in the regional stakeholder workshops included representatives from:

- Appalachian Council of Governments
- Anderson County
- Greenville County
- Oconee County
- Pickens County
- City of Clemson
- City of Gaffney
- City of Greenville
- City of Travelers Rest
- City of Westminster
- Greenville County Soil & Water Conservation District
- Oconee County Soil & Water Conservation District
- Trees South Carolina
- TreesUpstate
- Upstate Forever
- Wildlands Network
- BCD Council of Governments
- Berkeley County
- Charleston County
- Dorchester County
- City of Charleston
- City of North Charleston
- City of Folly Beach
- Town of Awendaw
- Town of Hollywood
- Town of Summerville
- Town of Monk's Corner
- Town of Mt. Pleasant
- Lowcountry Land Trust
- Gullah Geechee Island Coalition
- Catawba Council of Governments
- York County
- Lancaster County
- Union County
- Chester County
- City of Rock Hill
- City of Lancaster
- Town of Fort Mill
- Town of Clover
- Carolina Thread Trail
- Katawba Valley Land Trust
- Nation Ford Land Trust
- Catawba Indian Nation
- Central Midlands Council of Governments
- Lexington County
- City of Columbia
- University of South Carolina
- Congaree Land Trust
- Congaree National Park
- The Nature Conservancy
- SC National Guard
- Lowcountry Council of Governments
- Beaufort County
- Colleton County
- City of Beaufort
- Town of Hilton Head
- Town of Bluffton
- Town of Hardeeville
- Beaufort Conservation District
- Port Royal Sound Foundation
- Lower Savannah Council of Governments
- Aiken County
- Barnwell County
- Calhoun County
- Orangeburg County
- City of Orangeburg
- City of North Augusta
- Town of Blackville
- Vorhees College
- Congaree Land Trust
- Central Savannah River Land Trust
- Savannah Riverkeeper
- Pee Dee Council of Governments
- Chesterfield County
- Darlington County
- Florence County
- Town of Cheraw
- Town of Lamar
- Town of Olanta
- Pee Dee Land Trust
- Francis Marion University
- US Fish and Wildlife Service
- Santee Lynches Council of Governments
- Kershaw County
- Lee County
- City of Sumter
- City of Camden
- Upper Savannah Council of Governments
- Greenwood County
- Laurens County
- Abbeville County
- McCormick County
- Vision Greenwood
- Upper Savannah Land Trust
- Waccamaw Council of Governments
- Georgetown County
- City of Myrtle Beach
- City of Georgetown
- City of Conway
- City of Loris
- Town of Andrews
- Coastal Carolina Association of Realtors
- Waccamaw National Wildlife Refuge
- Waccamaw Indian Tribe
- Waccamaw Riverkeeper
- Black-Sampit Riverkeeper
- Open Space Institute
- South Atlantic and Southeast Conservation Blueprint
- SC Forestry Commission
- SC Department of Health and Environmental Control
- SC Sea Grant Consortium
- SC Coastal Conservation League
- SC Department of Natural Resources
- SC Department of Transportation
- SC Office of Resilience
- Town of McClellanville

Participants in the Native Nation stakeholder discussions included representatives from:

- The Catawba Nation
- The Muscogee Nation

Land Acknowledgement

We acknowledge and honor that what we now refer to as "the State of South Carolina" is the traditional homeland of many indigenous peoples, both past and present. South Carolina is home today to one federally recognized tribe, The Catawba Nation, whose members continue cultural practices and care for land along the Catawba River as they have done for 6000 years in what is today York County. The Muscogee, Cherokee, Shawnee, and Chickasaw Nations are federally recognized tribes with ancestral homelands in South Carolina, but these tribes were relocated to Oklahoma with the 19th century Indian Removal Act, where they reside to this day. The Eastern Band of Cherokee are a federally recognized tribe descended from those Cherokee who avoided relocation and are currently located in North Carolina. Additionally, coastal South Carolina is part of the Gullah Geechee Cultural Heritage Corridor, a National Heritage Area established to recognize the unique culture and contributions of the Gullah Geechee people who are descendants of Africans enslaved on the rice, indigo, and cotton plantations of the lower Atlantic coast.

The State of South Carolina recognizes several tribes and groups in the state today including the Beaver Creek Indians, the Edisto Natchez-Kusso Tribe, the Pee Dee Indian Nation of Upper South Carolina, the Pee Dee Indian Tribe, the Piedmont American Indian Association, the Santee Indian Organization, the Sumter Tribe of Cheraw Indians, the Waccamaw Indian People, the Wassamasaw Tribe of Varnertown Indians, the Chaloklowa Chickasaw Indian People, the Eastern Cherokee, the Southern Iroquois and United Tribes of South Carolina, the Natchez Tribe, and the Pee Dee Indian Nation of Beaver Creek. Other indigenous people with possible ancestral ties to South Carolina who may have merged with other tribes or whose whereabouts are unknown include the Ashepoo, Bohicket, Cape Fear, Cheraw, Chicora, Combahee, Congaree, Edisto, Escamacu, Etiwan, Hoya, Kiawah, Kusso, Lumbee, Mayon, Pee Dee, Saluda, Sampa, Santee, Sewee, Stalame, Stono, Sugeree, Touppa, Waccamaw, Wando, Wateree, Waxhaw, Westo, Wimbee, Winyah, Witcheaugh, and Yamasee tribes.

Contents

Regional Strategies for Councils of Government Localities and Regions

To access the reports for each of the Councils of Government (listed below) visit the data hub at **https://scgiplan-gicinc.hub.arcgis.com/** or **www.gicinc.org**

- Appalachian
- Berkeley, Charleston, and Dorchester (BCD)
- Catawba
- Central Midlands
- Lowcountry
- Lower Savannah
- Pee Dee
- Santee Lynches
- Upper Savannah
- Waccamaw

Introduction

The South Carolina Forestry Commission (SCFC) and the nonprofit Green Infrastructure Center Inc. (GIC) collaborated with state, regional, and local governments, and federal and state agencies to create **a strategic green infrastructure network and plan for South Carolina.** The project was funded by a grant from the Southern Region of the USDA Forest Service. Green infrastructure includes all those natural landscapes that provide services to people and wildlife. They include forests, wetlands and bays, dunes, rivers, agricultural soils, and other natural landcovers. These landscapes provide such services as clean air and water, places to recreate, and sources of food and shelter. They are our natural or "green" infrastructure. The size and intactness of these features determines whether they can provide key functions, such as sustaining native populations of wildlife or adequate buffers against storms.

According to the USDA Forest Service, land conversion is the number one threat facing our forests and natural landscapes. To stem the loss of South Carolina's natural resources and to ensure that the landscape is resilient, the SCFC and GIC launched a statewide strategic planning effort to map key, large habitat areas known as core habitats and to identify and plan for their connectivity. The more connected the landscape is, the more resilient it is to disturbance, since areas damaged by storms or floods can repopulate more quickly if species can reach these areas through natural landscape corridors. The statewide planning work has resulted in this green infrastructure strategic plan, which provides new tools and planning strategies for use by state agencies and regional and local governments and conservation organizations to maximize landscape conservation and connectivity.

Green Infrastructure (GI) includes *all the interconnected natural systems in a landscape, such as intact forests, woodlands, dune systems, parks and rivers, or agricultural soils* that provide clean water, air quality, wildlife habitat, and food. These landscapes also provide critical habitat for wildlife, birds, and amphibians. Planning to conserve or restore GI ensures that communities can be vibrant, healthful, and resilient. Having clean air and water, nature-based recreation, scenic viewsheds, abundant local food and sustainable working landscapes requires that environmental assets are included as part of community planning.

Green Infrastructure (GI) Plans can inform land-use decision makers about natural assets within their counties or regions, identify threats and help inform strategies for strategic land conservation. ***GI plans can be used to focus development into patterns that maximize resource conservation and economic efficiency, while also preserving a healthy economy.*** They can also be used to identify places to conserve for future parks and conservation easements, or as buffers.

Widgeon Point Preserve (left) protects 162 acres of mixed pine-hardwood forest, maritime forest, and salt marsh along the Broad River providing habitat for many species including the great egret (right).

Landsford Canal State Park along the Catawba River provides wildlife habitat, clean water and air, and recreation opportunities such as hiking and kayaking. The park protects the world's largest population of the rare Rocky Shoals Spider Lily.

Project Background

The GIC created a statewide map of large forest and wetland habitats in 2015, as well as a guide *Evaluating and Conserving Green Infrastructure Across the Landscape: A Practitioner's Guide*[1], which describes the importance of habitat cores and how to plan for their conservation. This report does not replace that guide. Those who wish to learn more about GI planning can obtain the free guide at the link below. This project is an update to the original map and a strategic plan for actions and strategies that South Carolina can employ to conserve its highest value landscapes for **both wildlife and people.**

Since 2015, the landscape of South Carolina has changed as intact forested land cover has declined. In addition, more species are now at risk. For example, the U.S. Forest Service listed the Northern Long Eared bat as an endangered species in November 2022. This bat has mostly disappeared from the upstate but has been found in Charleston and Berkeley Counties, both of which are experiencing tremendous growth pressures, putting the bats at greater risk. To prioritize the landscapes to conserve for the future, GIC has created an updated statewide map of large habitat cores and connecting corridors and worked with local governments to select priority connections to ensure that abundant and diverse native species can be sustained in South Carolina. Mapping intact habitat cores and their connecting corridors has many practical applications beyond providing habitat for birds, amphibians and wildlife. Corridors also facilitate recreation networks, such as greenways and blueways. Corridor planning can also meet goals for highway safety by identifying areas where there can be conflicts and devising other strategies, such as wildlife tunnels or bridges, and other tactics to reduce road/wildlife conflicts. Water quality is also protected, as key riparian corridors can be identified and either conserved or restored through tree planting and conservation projects. Also key to forestland conservation is the protection of those working landscapes that support the state's timber industry, a network of forestry projects providing $23.2 billion to the state's economy and the greatest number of jobs by sector.

To ensure that South Carolina's natural landscape is resilient and that species can, not just survive, but thrive, we need to understand the quality, extent, and connectivity of that landscape. Many species depend on large intact habitats to survive and thrive. Without those intact landscapes, species lack enough area to support breeding populations. And habitat loss has repercussions for people's health and safety too. South Carolinians need access to open, undeveloped land for their physical and mental well-being.

[1]This guide is available free https://www.scfc.gov/wp-content/uploads/2021/03/sc-green-infrastructure-guide.pdf

Project Partners and Process

This effort to map the highest value landscapes in South Carolina was ***built from the ground up, region by region*** to result in a statewide priority network of vital conservation lands and corridors.

GIC and SCFC worked with South Carolina's ten Councils of Government (COGs) to set regional priorities. Each COG serves as the regional coordinating body for its member counties and cities to plan for transportation or trails, such as the East Coast Blueway or the Palmetto Trail. COGs can serve a similar role in planning for a connected green infrastructure network to foster a healthier forest landscape for both wildlife and people. The GI map can also inform comprehensive plans for local governments. Maps can be used to identify areas for landscape conservation and conversely for where growth is preferred. The maps and data can also be used to engage with large landowners and other key stakeholders who want to ensure that their landscape is healthy and resilient.

Greenways such as the Swamp Rabbit Trail in Traveler's Rest provide SC residents opportunities for outdoor recreation.

How do regional councils or local conservation groups benefit from the GI plan? Each region now has:

- A land cover map of highest value habitats and connecting corridors.
- A strategic plan for the region that links to local and state priorities for conservation.
- A tool to inform plans for transportation, growth areas, water supply, zoning, park and open space networks, regional trails, economic development, and more.
- Great public relations for being a progressive green community to attract families and businesses.

> The State of South Carolina is rich in its diversity of natural landscapes that support a multitude of both common and rare, threatened or endangered species.

How do state agencies or conservation groups benefit? The statewide map and plan can be used to:

- Site future roads (avoiding the highest valued landscapes).
- Mitigate impacts (areas to protect or restore for mitigation projects).
- Site future parks and design greenways (maps show major connections and high-value habitats).
- Plan for resiliency (identify those landscapes that provide benefits for people and wildlife).
- Reduce flooding and protect healthy rivers and bays (protecting high-value landscapes that can also provide storm buffers or better water infiltration).
- Support state wildlife action plans and forest action plans (by protecting habitats that support RTE species and addressing issues such as fragmentation and parcelization).
- Inform local plans (comprehensive plans, regional transportation, growth, and development).
- Promote geo- or heritage tourism (many intact landscapes protect historic and archaeological sites).
- Promote healthy communities (identify recreation and outdoor sites that are highly valuable.)

Key Findings

A variety of interesting statistics are derived from state GI data. These data can be "clipped" or sorted to generate similar statistics for any geography in the state (e.g. by watershed or by county).

What did we find? First of all, the State of South Carolina is rich in its diversity of natural landscapes that support a multitude of both common and rare, threatened or endangered species. This network of natural landscape habitats also provides many opportunities for new recreation options, such as a new park or greenway. Knowing the location of key cores

Study Area GI DATA

19,802,880 acres– total area (30,942 mi²)

10,794,240 acres– of habitat cores (16,866 mi²)

55% of land area of South Carolina that is habitat cores

2,656,000 acres– of protected cores (4,150 mi²)

25% of habitat cores are protected cores

2,748,800 acres–area of protected land (cores and other) (4,295 mi²2)

14% of total area are protected land

952,320 acres–area of public park land (1,488 mi²)

5% of total area is public parkland

6,470,400 acres– area of habitat cores with known cultural/archaeological resources (10,110 mi²)

3,830,400 acres– area of habitat cores with highest value ranking (top 5th) (5,985 mi²)

3,284,480 acres– area of habitat cores that intersect a groundwater protection zone (5,132 mi²)

3,667,200 acres– area of prime agricultural soils on open land (5,730 mi²)

661,120 acres of wetlands (1,033 mi²)

15,543 mi of 20,470 mi (76%)– miles of streams that flow within a habitat core

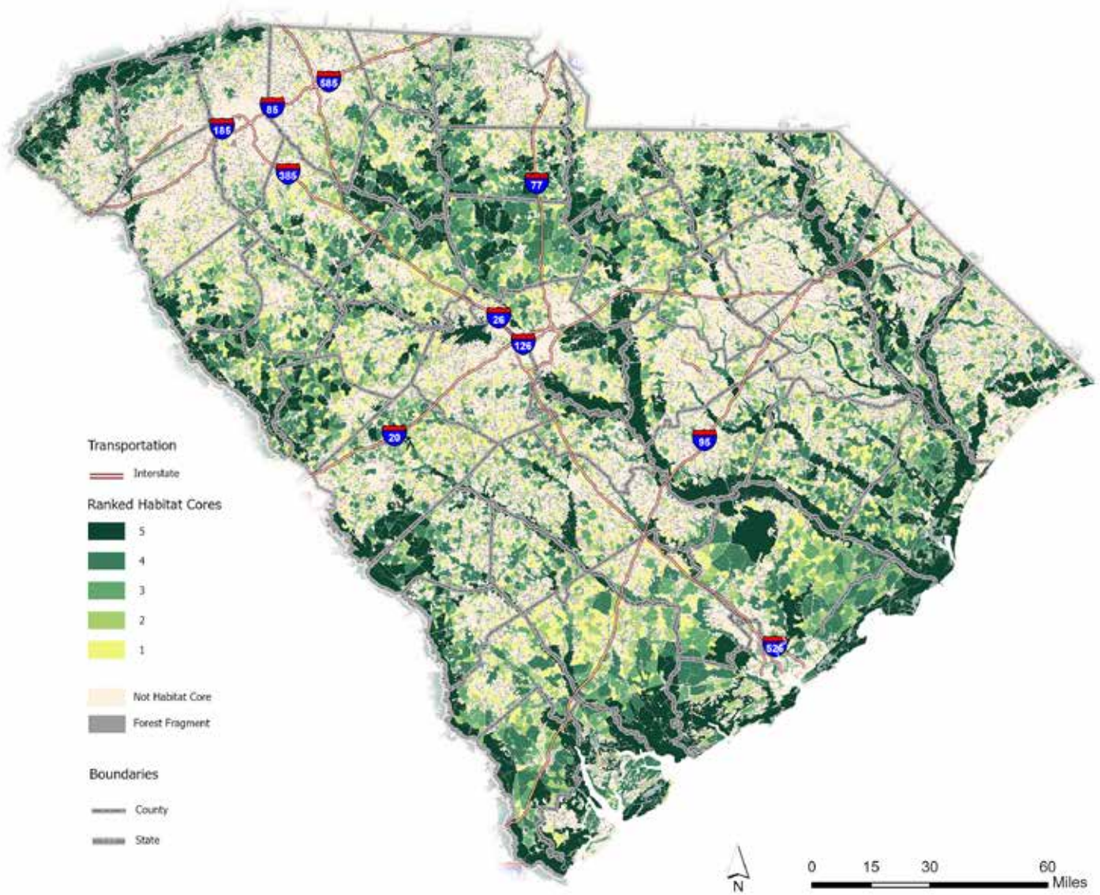
2,943 of 8,946 (33%)– of habitat cores support cultural or recreational assets

989 of 8,946 (11%)– habitat cores that support known rare, threatened, or endangered species

and corridors can also inform many of the functions that local and regional governments undertake. For example, the state DOT often needs to mitigate impacts from highway projects. These maps can be used to show where key lands can be restored by DOT to mitigate road projects while maximizing benefits for native wildlife. Similarly, an area of roadway with high collision rates between vehicles and wildlife might be a key place to add a wildlife tunnel to improve safety, while also providing a safe corridor between two high-value habitat cores. Protecting large native landscapes also adds to the scenic qualities appreciated by locals and heritage tourists alike.

In Section 5 of this report *(Implementation Strategies, pages 32-41)*, we provide strategies for specific state agencies. Strategy reports and maps for each of the ten Regional Council's of Government are available on the project's data hubsite (see link below). The database that supports this report, also available through the hubsite: https://scgiplan-gicinc.hub.arcgis.com/ can inform both daily and long-range planning decisions.

South Carolina Statewide Ranked Habitat Cores Map



Habitat cores are intact natural landscapes large enough to support interior forest or marsh or wetland dwelling species. This map depicts the state's habitat cores ranked based on ecological metrics, with dark green representing the highest quality habitat cores and yellow representing the lowest quality habitat cores.

Methods and Maps

Stakeholder Engagement

This Green Infrastructure Plan comprises a set of maps and strategies for conserving and restoring a connected landscape in South Carolina. GIC led local stakeholders in each of the ten regional Councils of Governments through GIC's Six-Step Green Infrastructure Planning Process with a series of four workshops per COG (40 workshops total) from 2021-22. This process involved mapping habitat cores and corridors, as well as natural and cultural assets, followed by risk analysis to inform strategies for action. With these data, local stakeholders determined priority areas for conservation in the region, as well as strategies to ensure a connected landscape into the future.

GIC reviews maps with stakeholders in a workshop with the Lowcountry COG.

In the first COG workshops, GIC presented an overview of the project and shared maps of the regions' ranked habitat cores. Feedback on the accuracy of the map and areas of development were noted and incorporated. In the second workshop, GIC presented themed overlay maps that showed the regions' agricultural soils, water resources, recreation, and cultural assets, and workshop attendees added their local input for additional assets, such as regional greenways or cultural corridors. The final COG asset maps and dataset were updated to add these new data. In the third workshop, GIC presented maps depicting risks to habitat cores, including sea-level rise (for coastal areas), storm surge, development, utility-scale solar development, and impaired waters. Stakeholder feedback about these risks was used to update and finalize the risk maps. In the fourth and final workshop, GIC shared a strategy map depicting ranked habitat cores, protected lands, and regional corridors. Stakeholders then considered priority habitats and risks to those assets and recommended strategies to reduce or prevent such impacts.

GIC followed regional-level workshops with planners and stakeholders at the COG, county, and city level with state-level stakeholder engagement. In December 2022 and January 2023 representatives from 16 state agencies and non-profit organizations gathered to focus on state-level strategies for protecting and restoring green infrastructure.

6-Step Green Infrastructure Planning Process:

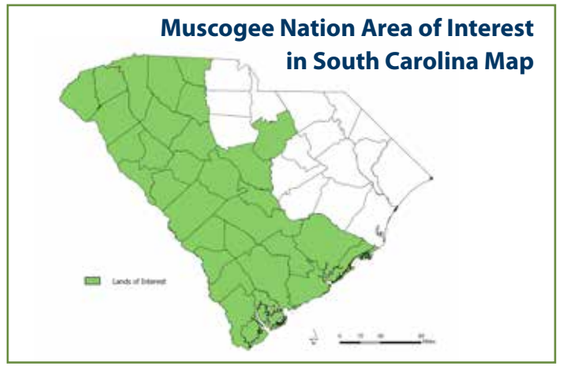
1. **Set Your Goals –** What does your community value?
2. **Review Data –** What do we know or need to know, to map identified values? Combine the state modeled data with local data.
3. **Map Your Community's Ecological and Cultural Assets –** Based on the goals established in Step 1 and data from Step 2.
4. **Assess Risk –** What assets are most at risk and what could be lost, if no action was taken?
5. **Rank Assets and Determine Opportunities –** Based on those assets and risks you have identified, which ones should be restored or improved?
6. **Implement Opportunities –** Include natural asset maps in both daily and long-range planning (park planning, comp plans, zoning, tourism and economic development, seeking easements etc.)

The Catawba Nation is located in York County. The Catawba Nation Long House Government Center (left) overlooks the Catawba River where the Catawba Nation Greenway (right) connects to the Carolina Thread Trail network.

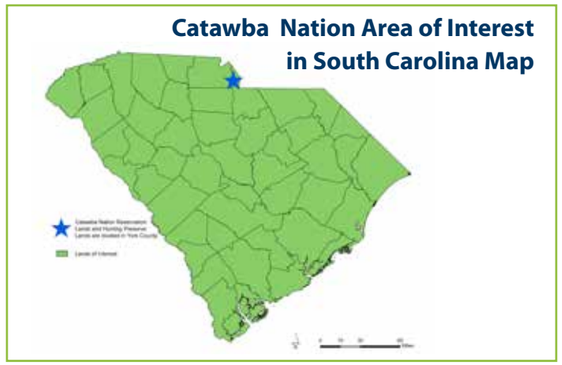
In the first workshop, GIC shared statewide maps, statistics, and methods, examples of COG priorities and applications for using the data and maps. Additionally, GIC facilitated a discussion of related agency initiatives and ways the GI Plan could inform such work. Participants provided feedback on the maps, data, and process, and brainstormed how to use the data to further their agencies' missions. In the second workshop, GIC shared the final statewide maps and data layers and facilitated cross-agency collaboration. The workshop culminated with the creation of a collective list of agency strategies for action and partnerships to achieve them. Those agency strategies are described in the Implementation Strategies section of this plan on page 32.

GIC reached out to Native American Nations in SC as well as those with ancestral lands in SC and met individually with the Muscogee Nation and Catawba Nation to discuss the Green Infrastructure Plan and its relevance to these Nations. The Muscogee Nation ancestral homelands include an area of interest comprised of the land of 30 counties in SC. These lands include known and unknown cultural resources and archaeological sites of importance to the Muscogee. The Catawba Nation's Reservation and hunting preserve are located in York County and the Nation's area of interest covers the entire state of SC. Land across the state contains known and unknown cultural resources and archaeological sites of importance to the Catawba.
Both Nations emphasized the importance of land conservation for the protection of Native American cultural assets. Additionally, they pointed out that any list or spatial dataset of cultural assets is not an exhaustive list as many native cultural assets have not been discovered while others will never be listed on a map as this places assets at risk for looting.

The resulting statewide plan includes state priorities informed by regional priorities. The COG, state agency, and Catawba Nation strategies will help to protect and restore green infrastructure at local, regional, and statewide levels to ensure a resilient and connected natural landscape in South Carolina.



The Muscogee Nation's area of interest in SC comprises the 30 counties shown on this map. These lands include known and unknown cultural resources and archaeological sites of importance to the Muscogee.



The Catawba Nation has reservation and hunting land in York County today. Their area of interest in SC encompasses the entire state. These lands include known and unknown cultural resources and archaeological sites of importance to the Catawba.

Habitat Cores

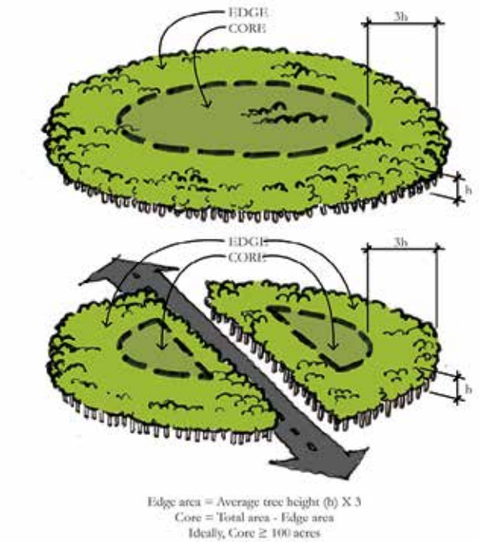
GIC created the habitat cores model using the National Land Cover Database (NLCD) 2019 land cover data (the most recent land cover available when this project began). The NLCD provides nationwide data on land cover and land cover change at the Landsat Thematic Mapper (TM) 30-meter resolution (30 x 30 meter pixels of analysis) and is appropriate for mapping rural landscapes.

To be considered a habitat core, the natural landscape must encompass more than 100 acres of intact area. This acreage standard is based on studies evaluating the minimum acreage for terrestrial species to survive and thrive. For example, interior forest dwelling birds such as cerulean warblers need 100 acres of interior forest habitat for adequate foraging and nesting habitats. Large, intact forest cores are less impacted by disturbances and can better support area-sensitive and extinction-prone species because they retain larger populations, and their habitat is less likely to degrade through time (Ewers et al 2006).

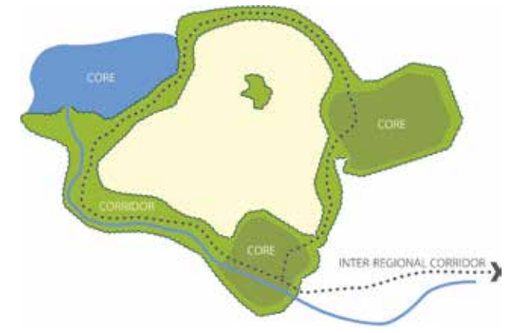
Forest fragments or woodlands less than 100 acres (known as patches) were also mapped to aid in identification of corridors or pathways for species to migrate across the landscape. These fragments, while not ideal habitat for larger species, can provide quality refugia for some species. Fragments can act also act as stepping stones, allowing species to move across the landscape while minimizing their exposure to predators and other disturbances.

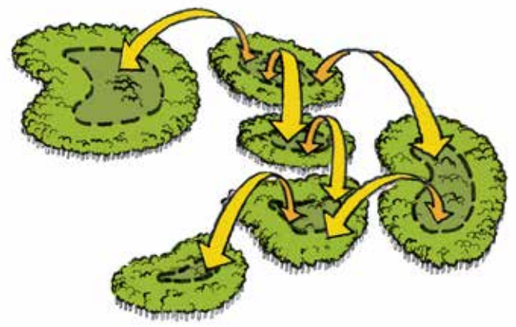
Such 2019 NLCD landcover types as forests and wetlands were then evaluated to determine their intactness by identifying features that fragment them, such as roads, buildings, transmission corridors, large rivers, and so on. These features bisect the landscape into smaller units (see diagram above right). If an area is bisected too often, it does not contain a large enough habitat area to support interior nesting species and thus is too small to function as a habitat core.

To ensure that there is enough interior habitat, GIC's analysts first subtract (clip out) the outer edge for a distance of 300 feet to ensure that potentially disturbed area is not counted as interior habitat. Edge areas are more likely to contain invasive species, suffer from wind impacts leading to dryness and blowdowns, and opportunistic predators such as domestic cats and dogs. In the final map of intact habitats, this edge area is added back in, but does not count towards the 100-acre minimum core size.



Large, intact habitat cores are less impacted by disturbances and can better support area-sensitive and extinction-prone species. When roads bisect habitats, the remaining areas may be too small to be considered a core.





Forest fragments provide stepping stones allowing wildlife movement across the landscape.

Additional Ranking Factors for Habitat Cores

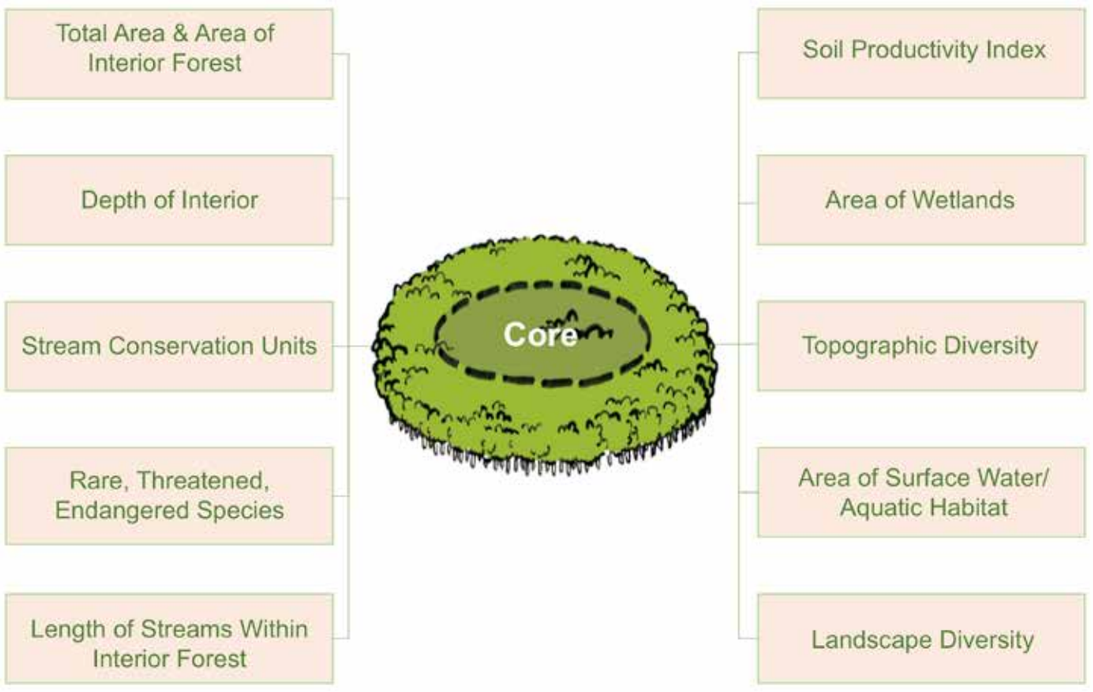
The next step in the process is to divide the acreage into quintiles or "natural breaks." This sorts the cores by size, which is the most important element for contributing to species abundance – bigger landscapes can generally support more species. However, there are other landscape factors that contribute to species abundance such as surface waters. Thus, in addition to geometry and extent, habitat cores are ranked based on additional environmental attributes. Assigning attributes to each core allows for the identification and prioritization of specific high-quality and high-value habitat during strategy development. Not all habitats will be protected and resources for management or conservation are usually limited. Ranking habitat cores by their quality allows land-use planners, agency officials, and landowners or site managers to prioritize specific landscapes that provide the highest value for species.

The rankings use landscape-based environmental and ecological attributes. Examples of environmental attribute data used to rank cores include the number of wetlands found within a core; the presence of rare, threatened or endangered species; species richness; soil diversity; the length of stream miles; and topography. These factors all influence the diversity of plants, insects, animals and other biota within a forest or even a wetland core. For more on how cores are ranked see the technical appendix to this plan.

Connectivity is Key

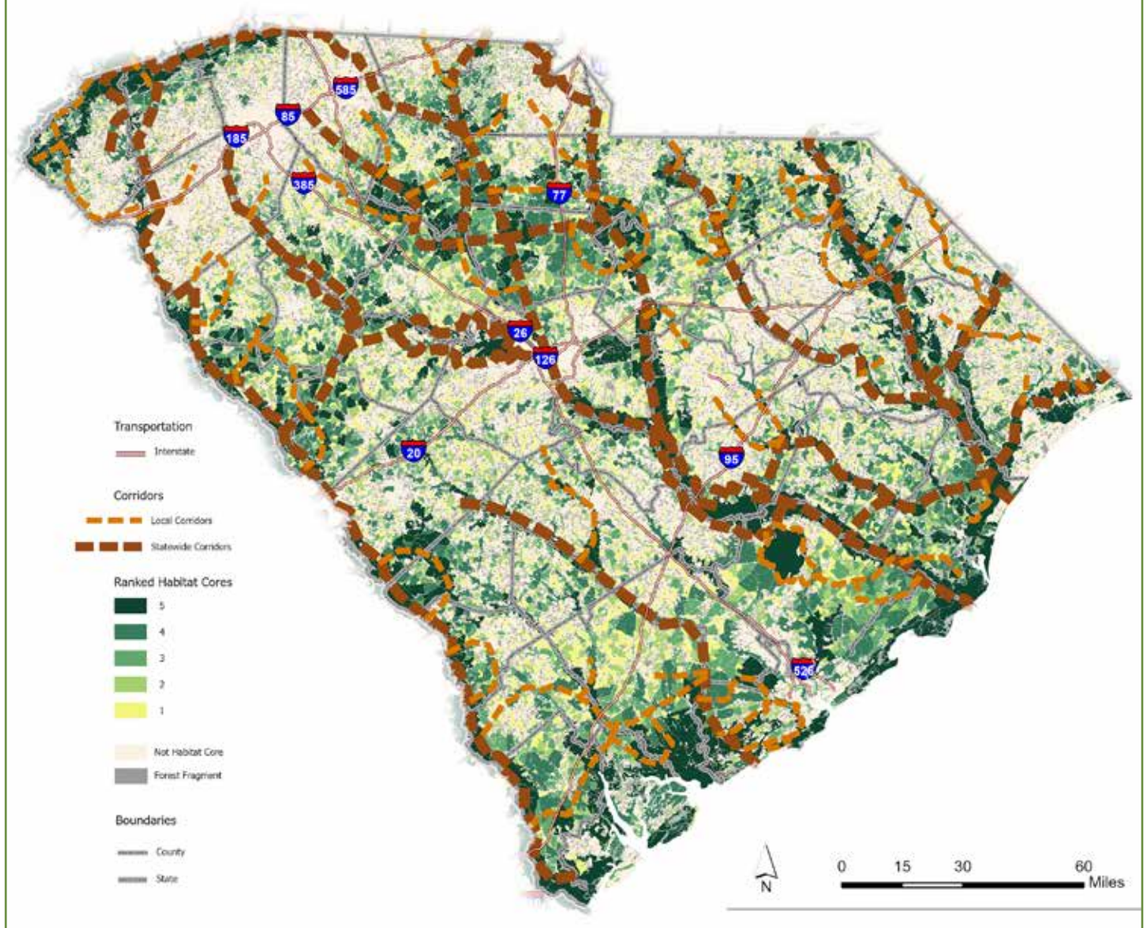
Maintaining and enhancing connectivity across a landscape is key component of green infrastructure planning. To turn habitat cores into a network requires connectivity provided by interspersed tracts of habitat that facilitate the movement of animals, plants and pollinators between cores and prevent species within them from becoming isolated.

Types Of Data Used To Score The Environmental Ranks For Habitat Cores



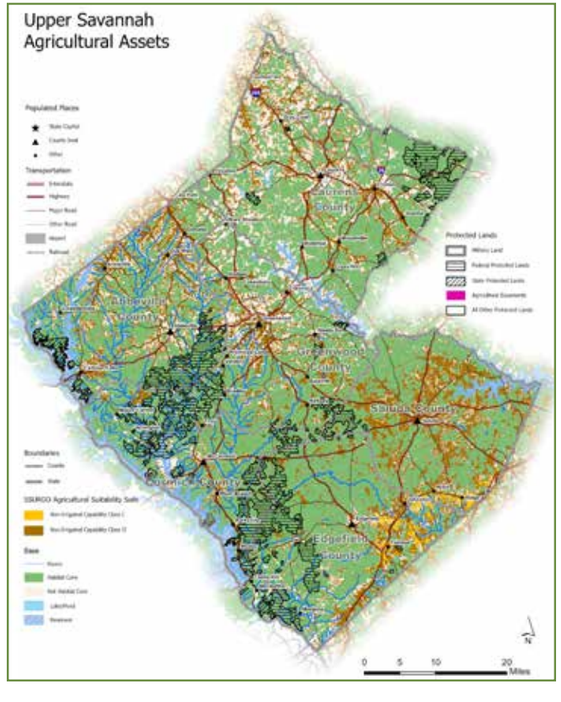
Wider corridors are correlated with greater species abundance and diversity (Lindenmayer 2002). How wide is wide enough? The answer will depend on the ecosystem and the species, but generally wider is better. Ideally, interior habitat needs to be present for it to be a corridor. In forested landscapes, it is recommended that these connections are at least 300 yards wide. That includes a central 100-foot pathway width of interior habitat, with a 100-foot wide edge on either side to protect safe passage and buffer against human intrusion and invasive species – approximately 300 feet wide overall. Streams are natural corridors and the width of the vegetative corridor on either side should reflect the stream order (i.e. larger streams need wider forested buffers). The larger and more complex a network of interconnected corridors and cores happens to be, the more likely it is that overall species diversity and functioning ecosystems can be maintained amidst a changing landscape. This is due, in part, to the resiliency offered by multiple pathways. Should one pathway be blocked or removed, other pathways can be utilized, thereby allowing for species migration, and greater access to food and shelter.

South Carolina Habitat Cores and Corridors Map



Themed Overlays and Other Assets

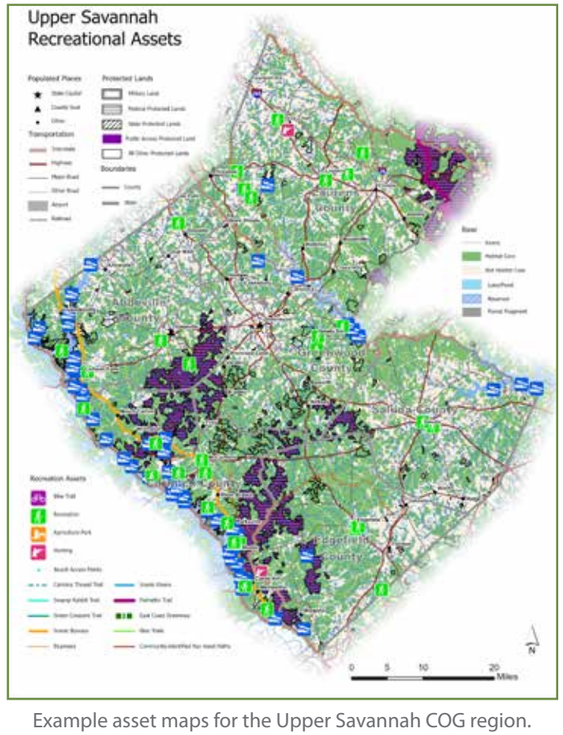
Habitat cores also support other cultural priorities on the landscape. A historic plantation home or a slave cemetery are both supported by the surrounding landscape which provides the context for those sites. A native habitat core also supports historic artifacts that sit within or adjacent to it. Agricultural uses of the landscape, such as farming, depend on high-value crop soils, while drinking water uses depend on clean rivers, which intact habitat cores also support. This project mapped additional natural assets, such as agricultural soils and water resources, as well as cultural overlays, such as historic assets and recreational uses. The uses of the landscape by people, whether for outdoor sports, such as fishing or hiking, or for historic preservation and interpretation, also lend value to protecting larger intact habitat cores and corridors. Following is a list of those themed maps. To view these themed maps, see the COG map for each region at the end of this report or view them on the HUB site https://scgiplan-gicinc.hub.arcgis.com/ if you wish to zoom in and see finer grained details.



Cultural (human values) Data Layers

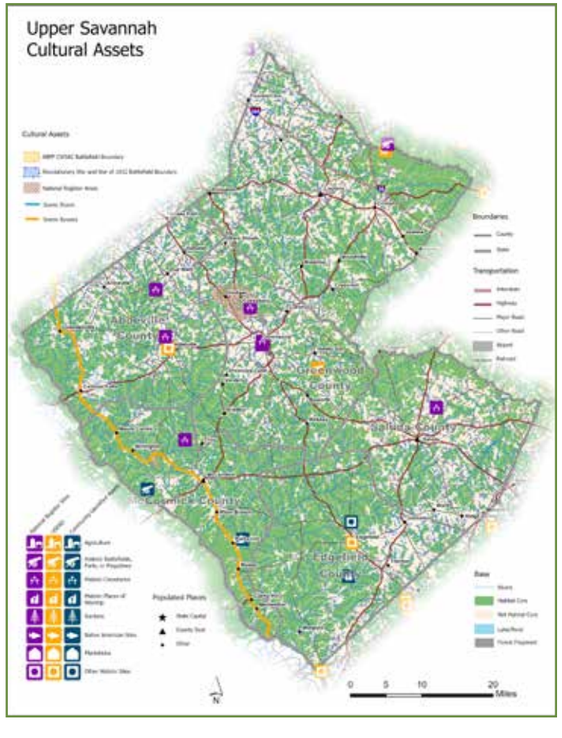
Agricultural Soils: This map overlay theme shows the location of important row crop agricultural soils from the USDA SSURGO database. High-value soils are important to protect from disturbance (e.g. development) for the health of the soils, as well as to ensure a continued agricultural economy in South Carolina. These map layers were provided to the COGs and participating counties to ensure that they are aware of the location and extent of these soils.

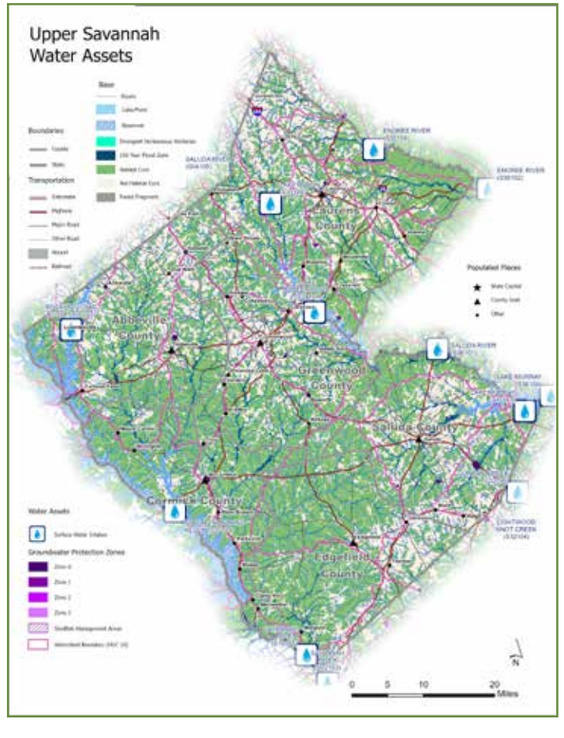
Water: A water overlay map includes rivers, streams, lakes and wetlands, as well as 100 and 500 year floodplains, known community wells, reservoirs and other significant water features, such as DHEC identified groundwater protection areas. Intact habitats help to protect these areas. Since older forests act as natural sponges, capturing, filtering and slowly releasing the water to subsurface aquifers below, protecting natural landcover such as forests helps to both protect and recharge groundwater.



Example asset maps for the Upper Savannah COG region. Full paged maps for each COG are included in the COG chapters in the appendix of this report.

Examples of natural and cultural assets across the state: an agricultural field in Chester County *(top left)*, Lake Marion *(bottom left)*, Sheldon Church Ruins *(top right)*, and a hiking trail in Table Rock State Park *(bottom right)*.

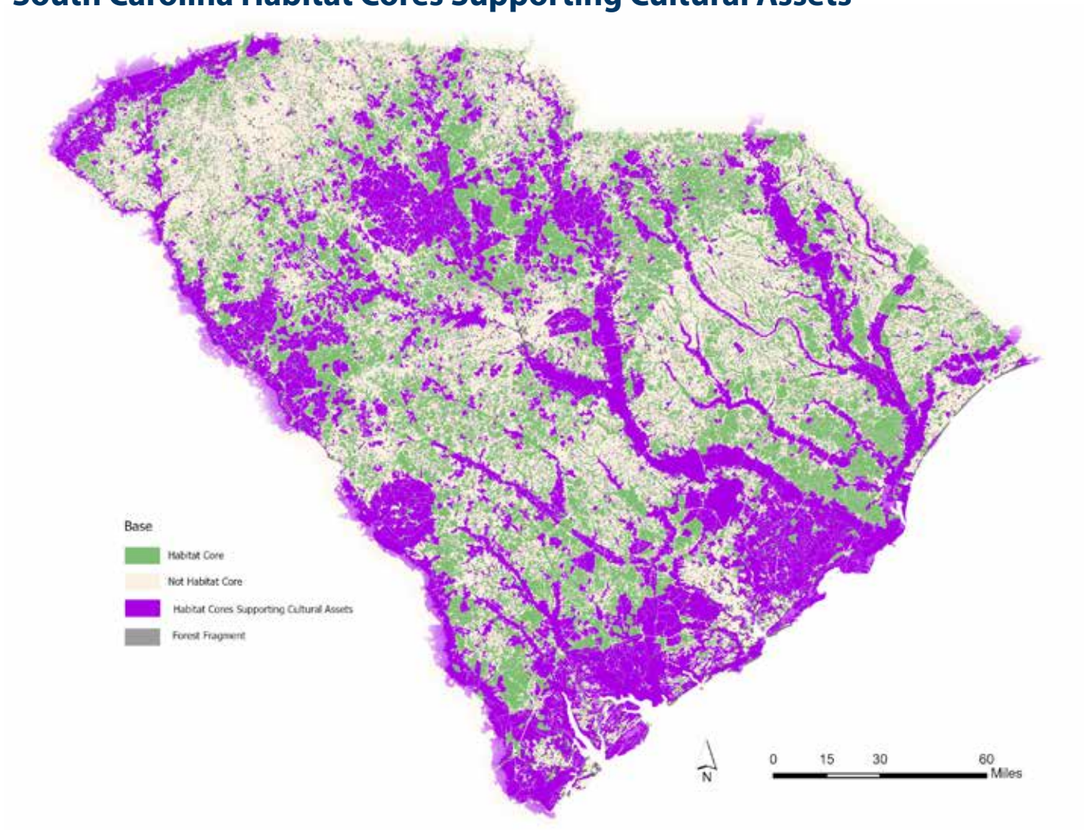




Culture and History: This map covers historic and cultural sites. These sites are from known data sources, such as the National Register of Historic Places, but also include locally identified historic sites, such as an old mill that is not yet nominated or indicated as an historic site but is likely historic and important to the community. GIC has classed the data as Community-identified assets for those sites that were requested for inclusion at the COG meetings. Archeologically significant areas were also added from the state's dataset SC ArchSite http://www.scarchsite.org (but locations are masked to avoid release of sensitive information). Additional sites of archaeological importance, such as shell middens or significant slave cemeteries were also added, based on local knowledge.

Natural landscapes support these resources by protecting them against disturbance. They may also provide the setting and landscape context for these historic sites, such as a slave cemetery that was originally within a forest or even a battlefield for which the forest or marsh provided a scenic backdrop. Understanding a landscape's role in protecting these resources both physically and by context shows the importance of conserving the native landscapes of South Carolina.

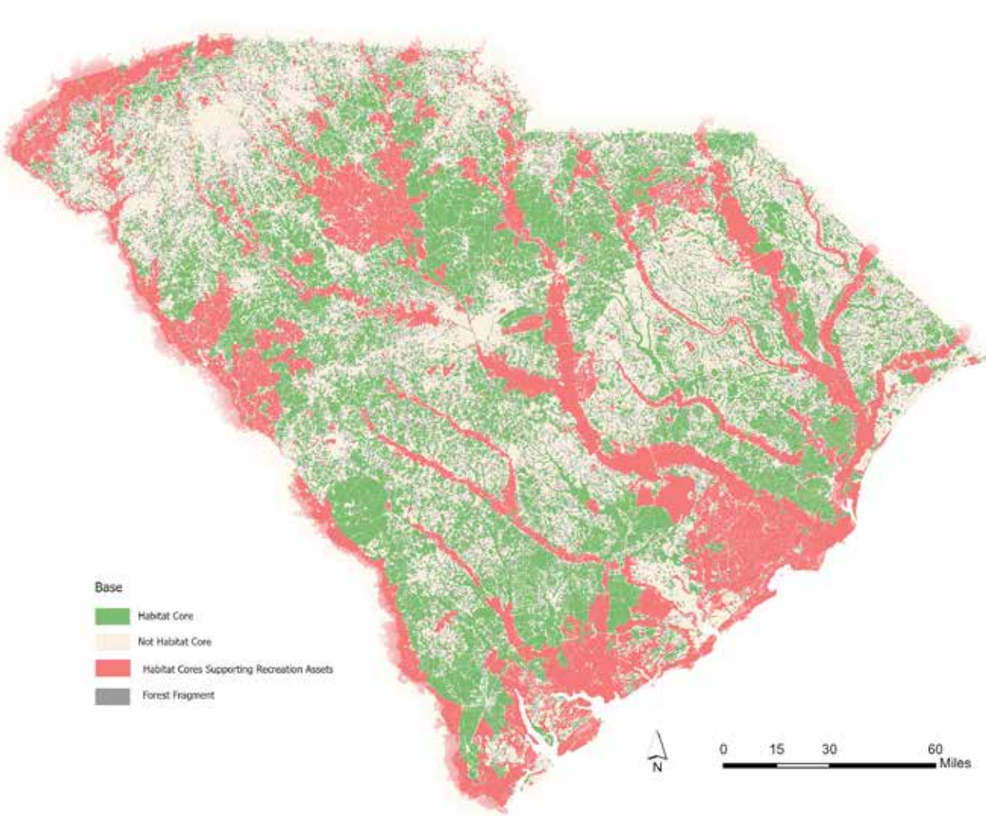
South Carolina Habitat Cores Supporting Cultural Assets



This map depicts all the cores across the state of SC that are known to support cultural assets or archaeological sites. Caveats: GIC used known datasets and stakeholder feedback to identify cultural assets. Areas that were well represented at stakeholder meetings are more likely to see additional assets on the maps. Any list or spatial dataset of cultural assets is not an exhaustive list as many native cultural assets have not been discovered while others will never be listed on a map as this places assets at risk for looting.

Recreation: A recreation overlay map was created for nature-based recreation. This is recreation that depends upon native landscapes and, as such, does not include manicured golf courses, smaller urban parks of ten acres or less, or sports fields. It does include significant recreational sites and parks; regional greenways and trails or bikeways; and water trails, public hunting and fishing, boat ramps or other related features. These sites are important public uses of natural landscapes and are further reasons why these landscapes should be protected. In addition, many outdoor activities, such as hunting, cross country horseback riding or paddle sports, depend upon a connected and unobstructed landscape to allow species to remain abundant and for people to enjoy them.

South Carolina Habitat Cores Supporting Recreation Assets



This map depicts all the cores across the state of SC that are known to support recreation assets. Caveat: GIC used known datasets and stakeholder feedback to identify recreation assets. Areas with representation at stakeholder meetings are more likely to see additional assets on the maps.

Mitigating Risks

Threats and Risks

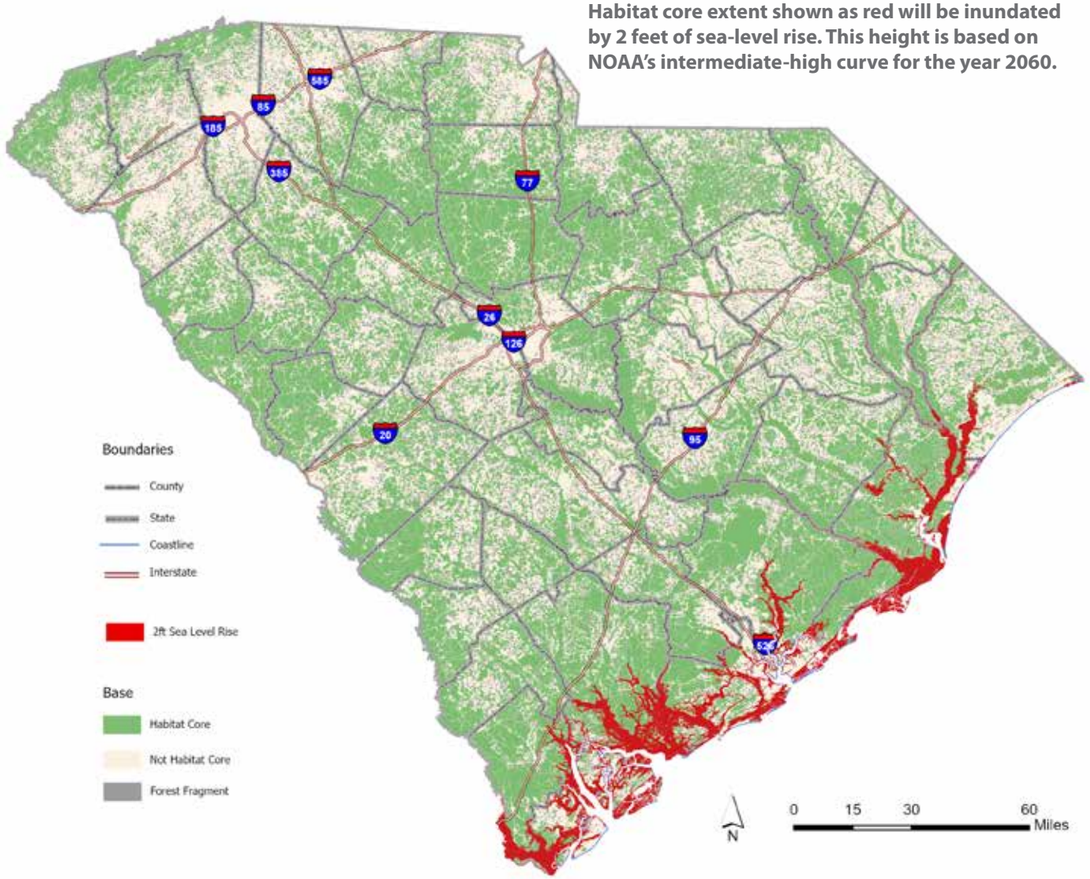
Since some threats increase in severity over time, and mitigation programs often take decades to implement, threats were modeled for each of the ten Councils of Government looking approximately 40 years into the future, to the year 2060. The key take-away was that many threats can be mitigated or prevented if we are aware of them and take necessary actions today, such as adopting zoning or planting more trees to buffer our coastal landscapes against storm impacts.

SEA-LEVEL RISE

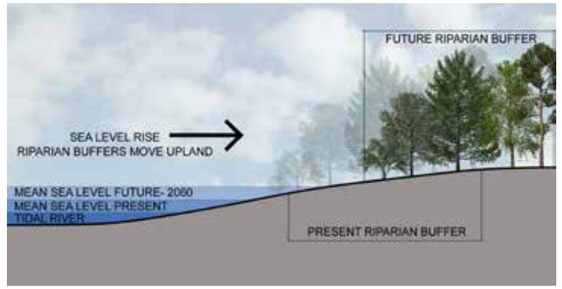
257 habitat cores (3%)
in South Carolina are at HIGH RISK from 2-ft sea-level rise.

Sea-level Rise Risk Map – South Carolina's habitat cores at risk of sea-level rise

Habitat core extent shown as red will be inundated by 2 feet of sea-level rise. This height is based on NOAA's intermediate-high curve for the year 2060.



Rising seas are killing coastal forests.



As sea levels rise marshes and forests will migrate upland.

In South Carolina, the coastal land surface is sinking, so the observed rate of sea-level rise relative to the land is greater than the global average rise. As the oceans and atmosphere continue to warm, sea level is likely to rise one-to-four feet in the next century along the coast of South Carolina (EPA 2016). In addition, the rate of sea-level rise appears to be accelerating (NOAA 2022 Sea-Level Rise Technical Report). For a recent project on forest resiliency, GIC studied a multitude of coastal forest risks. More information can be found in our report.[2]

> The saltwater intrusion into these forests and the subsequent death of the trees results in "ghost forests" of dead trees.

For this assessment, NOAA's (2017 data) intermediate projected value of 2 feet of sea-level rise by the year 2060, was obtained from data at the Springmaid Pier Gauge. Habitat core extent shown as red will be inundated by 2 feet of sea-level rise. This height is based on NOAA's intermediate-high curve for the year 2060.

Permanent saltwater inundation into coastal forests results in death of the trees.

[2] For coastal forest threats see: https://www.scfc.gov/wp-content/uploads/2022/07/SC_ResilientCoastalForests.pdf

Saltwater intrusion into coastal forests and the subsequent death of the trees results in a problem of "ghost forests," where dead skeletal trees bleached from the sun give them a ghostly appearance. To ensure healthy forest habitat cores of the future, upland forests will need to be identified, protected, and perhaps expanded, in order to ensure that these landscapes are conserved into the future. In coastal areas, forestry staff should also use sea-level rise maps to ensure landowner plans for forest management or harvest are viable into the future so that forests intended for harvest or other uses will not have been killed by inundation.

GIC Recommendations

- Increase forest buffer widths along shorelines and along riparian areas to account for landward migration of water.
- Plant new forest buffers further upland to account for sea-level rise and marsh migration.
- Protect land upland of projected sea level rise to allow for future marsh migration and new upland forest buffers
- Use sea-level rise in resource management decisions. For example, shorten rotation periods in timber operations; select faster growing species; and consider alternative land uses, as wetter areas will be more difficult and potentially more destructive to future harvests.

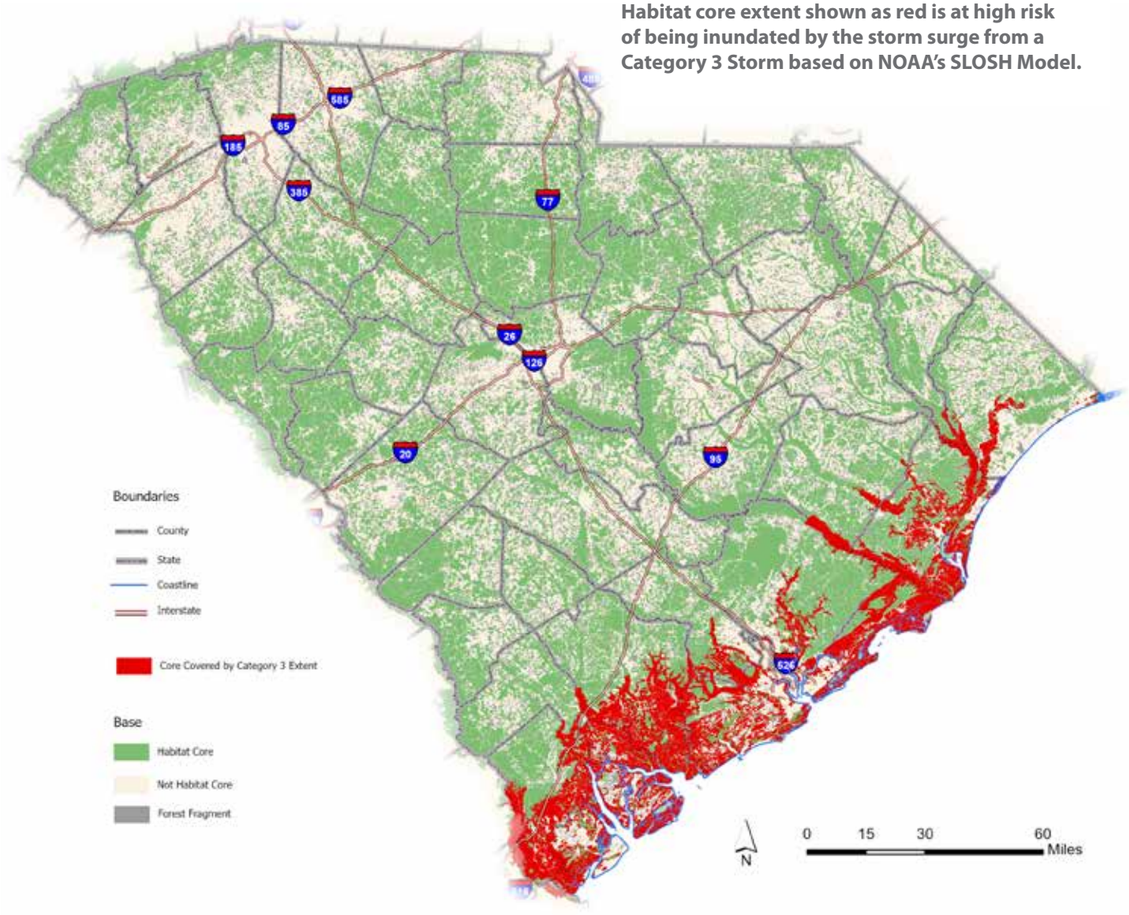
STORMS

552 habitat cores (6%)
in South Carolina are at HIGH RISK from storm surge.

The International Panel on Climate Change's Working Group 1 released a report "Climate change: the physical science basis" that indicated that storm intensity globally will likely increase by 1-10% and global rainfall rates would likely increase 10-15% within about 60 miles of the storm under a 3°F warming scenario (IPCC 2007). Factoring in evidence that hurricanes are slowing down upon reaching landfall implies an increase in the destructive potential per storm, assuming no reduction in storm size (Kossin 2019).

Storm Surge Rise Risk Map –
South Carolina's habitat cores at risk of storm surge.

Habitat core extent shown as red is at high risk of being inundated by the storm surge from a Category 3 Storm based on NOAA's SLOSH Model.



Storm surge models from the National Oceanic Atmospheric Administration (NOAA) show that in some coastal areas of South Carolina, saltwater surges are reaching up to 35 miles inland, flooding coastal forest swamps. The resultant surge creates toxic soil conditions that kill the trees and leave standing dead or downed debris. Salt spray can further stress trees, making them more susceptible to pests and disease and increasing overall mortality. Increased precipitation from storms also increases the likelihood of downstream flooding and higher levels of erosion and sediment deposition into the estuary.

Studies show that storm intensity is increasing making storms more damaging and new data suggest that storm frequency is also increasing.

GIC Recommendations

- Preserve natural land cover in the 100-year floodplains along waterways and bays.
- Localities can adopt landscape-scale green infrastructure plans, and when rare species protection is included as a goal can be used to lower their Community Rating System score, thus saving on insurance rate costs.
- Communities with urban forests should include them in emergency plans – preparation, cleanup and restoration – especially as it relates to storm readiness, response and long-term recovery. They should also have pre-contracting in place for debris cleanup to ensure that damaged trees are properly removed and communities can receive reimbursement from FEMA for such services.
- Increase the number of living shoreline projects to improve coastal marsh habitats and to buffer communities from storm surges.
- Increase the width and extent of shoreline forest buffers.
- Plant more salt-tolerant species in urban settings. (See Appendix for a list of salt spray and saline soil tolerant species.)

DEVELOPMENT

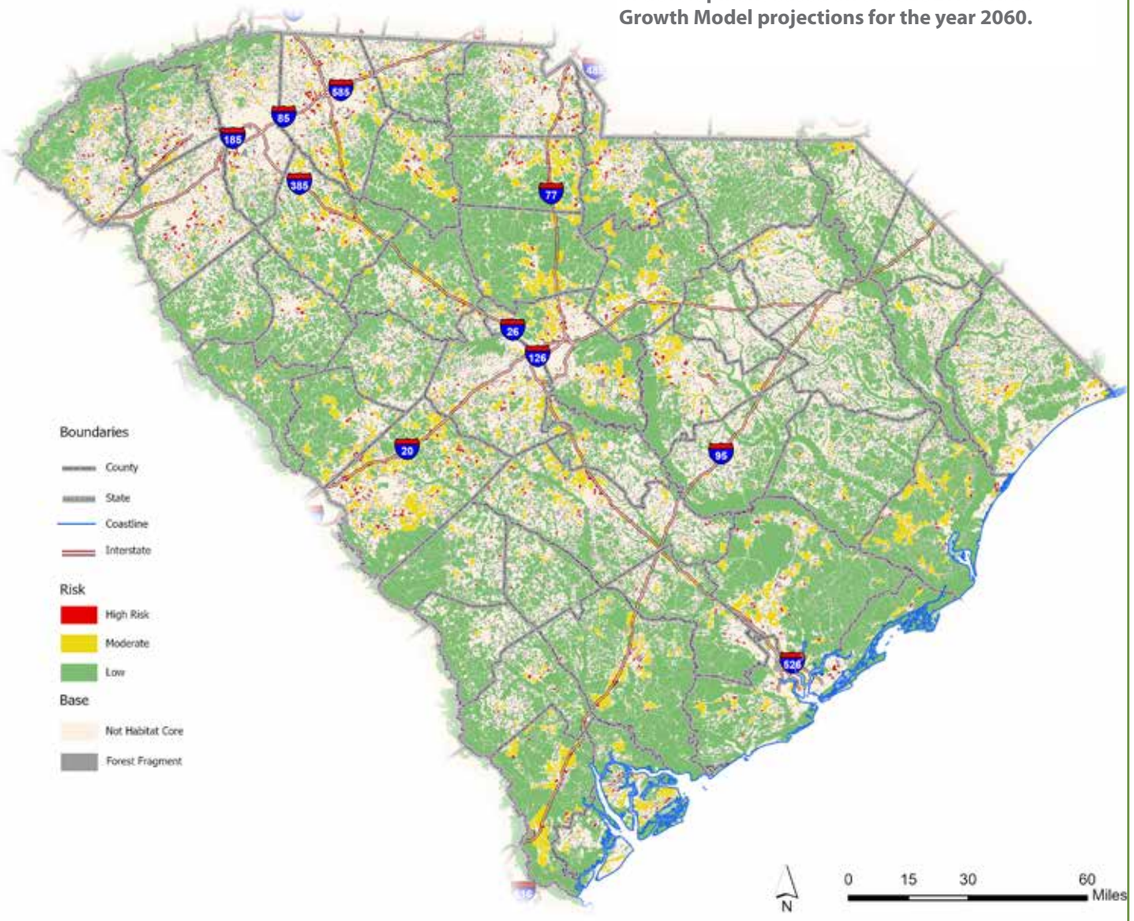
2,567 habitat cores (29%)
in South Carolina are at MODERATE TO HIGH RISK from encroaching development.

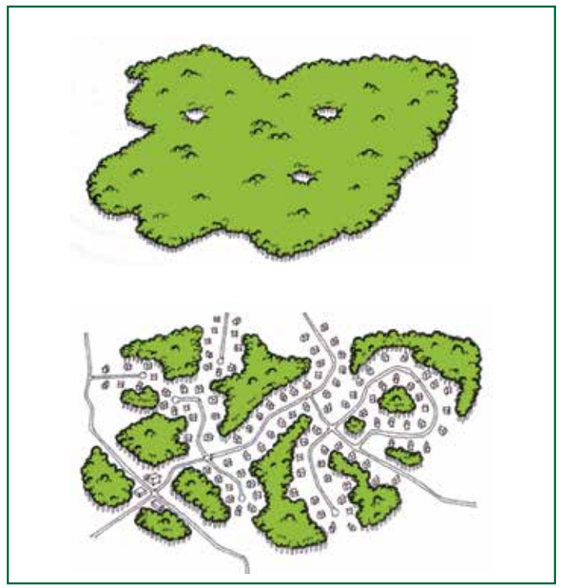
Development is a major threat to habitat cores because it represents permanent conversion of the natural land cover to hardscape and lawns. The Southern Forest Resource Assessment predicted that suburban residential and commercial development would convert 19 million acres of southern forests into urban hardscape between 2020 and 2040, and at the same time increase forest fragmentation (Wear 2002). To learn more about these challenges for South Carolina's coastal areas see GIC's report *Resilient Coastal Forests of South Carolina*.

Development represents permanent conversion of the natural land cover to hardscape and lawns.

Development Risk Map – South Carolina's habitat cores at risk of development.

Habitat cores at high and moderate risk of development based on the SLUETH Urban Growth Model projections for the year 2060.





When development occurs within forested landscapes, it can fragment the forest, leaving patches that are too small for forest wildlife to thrive and inappropriate for harvest.

GIC Recommendations

- Establish appropriate zoning to protect habitat cores, such as Rural or Conservation zoning. Many rural areas of South Carolina remain unzoned.
- Land trusts should use the habitat cores maps and overlay data to prioritize places for possible conservation easements.
- Local governments experiencing high growth should consider establishing Purchase of Development (PDR) programs to compensate landowners for keeping habitat cores intact and avoiding growth in areas that are not served adequately by infrastructure or schools.

Rock Hill and other parts of South Carolina are facing increasing rates of development.

Conservation Subdivision (Cluster Development) Ordinances to Protect Habitat Cores

If conservation is a key objective, then at least 50% of the site should be conserved as open space. Some communities set low thresholds of 20-30%, which do not provide the necessary habitat and connectivity needed on the landscape. The ordinance should also include provisions that limit the percentage of regulated lands or primary areas (wetlands, floodplains, steep slopes, etc.), to be calculated as part of the required open space. This allows for more upland forest habitat to be included as part of the conserved open space, which provides greater habitat diversity for wildlife and can mitigate potential impacts from long-term future threats (sea-level rise, more severe floods, etc.).

The cluster ordinance should also limit the percentage, or exclude altogether, stormwater best management practices (BMPs), such as dry ponds,

South Carolina is growing, with new development being built.

from the open space calculation and limit the amount of developed open space, such as tennis courts, golf courses and athletic fields.

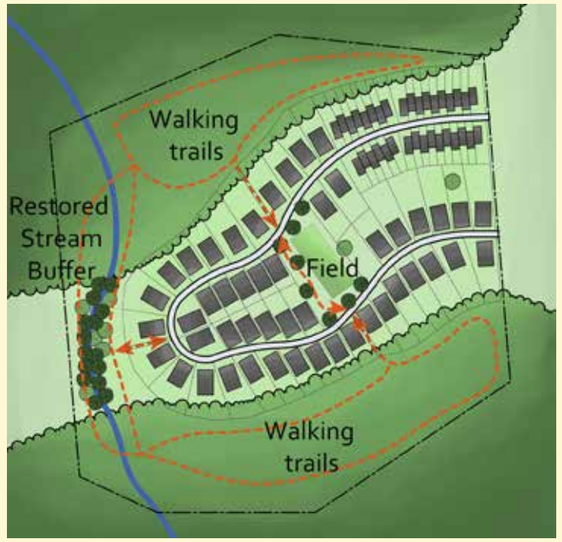
To learn more about how to design a conservation subdivision and best practices for planning them see GIC's guide *Forest Conservation in the Developing Landscape: A Design Guide for Conservation Developments* at: https://www.scfc.gov/wp-content/uploads/2021/06/urbconnectguide.pdf

A few example standards used by Oconee County and Dorchester County in their conservation subdivision ordinance include:

- A minimum of 50 percent of the gross area shall be preserved as green space. (Oconee County).
- At least half of the lots shall directly abut conservation land or face conservation lands from across the street. (Oconee County)
- Areas used for stormwater management ponds are not considered common open space and shall not count toward minimum requirement or be used for bonus density. (Dorchester County)
- Pedestrians shall have easy access to common open space. (Dorchester County)
- Covenants and restrictions governing the preservation of green space, wetlands and other sensitive lands shall be recorded with the final subdivision plat prior to any sales. A statement assigning the homeowners association responsibility for maintaining the conservation land shall be clearly placed on the final subdivision plat. (Oconee County)
- All conservation lands shall be contiguous, to provide for integrated open space throughout the subdivision, excluding thoroughfares. Long, thin strips of conservation land (less than 150 feet in width) shall be prohibited. (Oconee County)

A development site in its larger context shows habitat cores and potential for increasing connectivity.

In this example, the cluster development protects some of the habitat cores but traps most of the open space in a central green and pocket park while piping the site's stream



In this example, the cluster development protects the habitat cores and restores connectivity between cores through the stream corridor while allowing the same number of houses. Most of the open space consists of extensive walking trails through connected habitat creating space for people and wildlife. Developments that include natural areas sell faster and for higher profit margins than developments without community green space.

Nearby walking trails are a desirable feature to homebuyers.

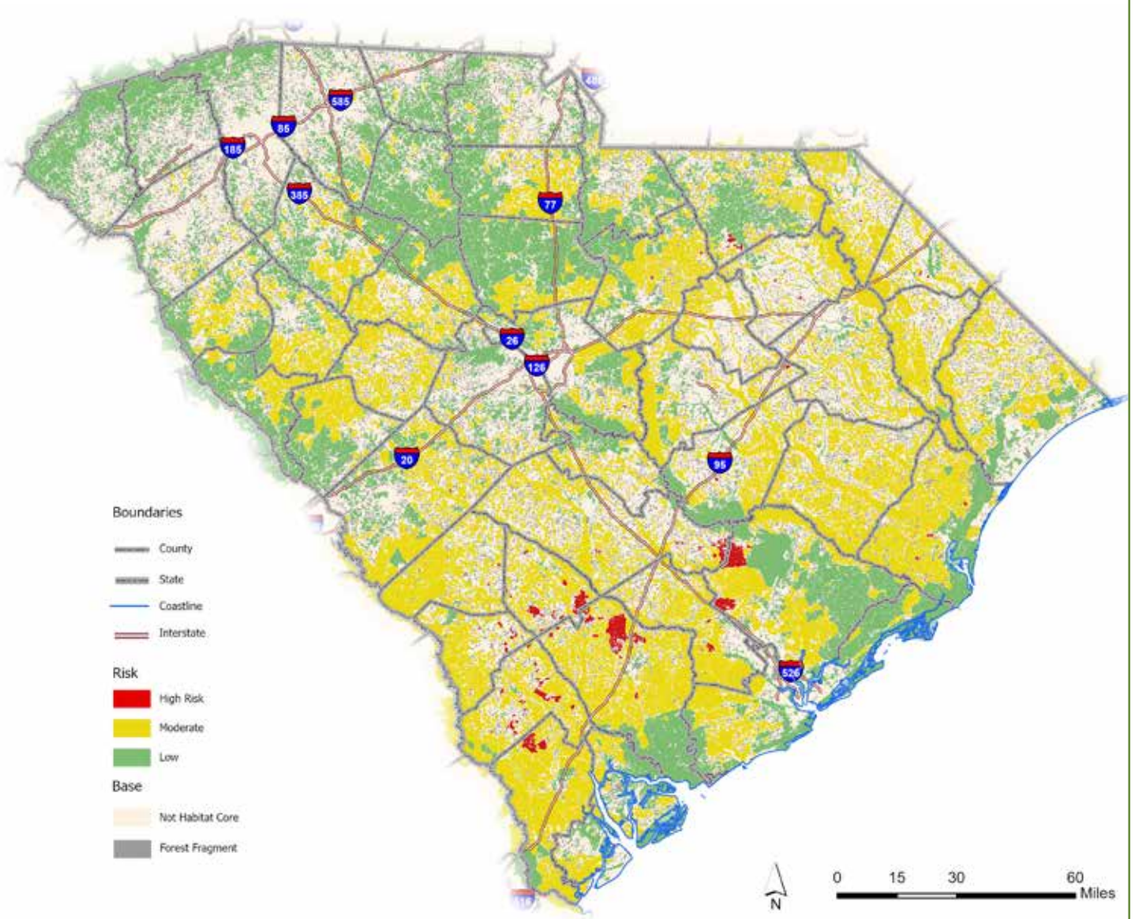
UTILITY-SCALE SOLAR

6,575 habitat cores (73%)
in South Carolina are at MODERATE TO HIGH RISK from utility-scale solar development.

Utility-Scale Solar Development Risk Map —

South Carolina's habitat cores at risk of utility-scale solar development.

Habitat cores a moderate to high risk for solar development based on Argonne Lab's Solar Site Suitability Analysis.



Solar development is surging across the southern United States and South Carolina is no exception. While solar power development is a key strategy to move away from polluting energy sources, many applications for utility-scale solar include clearcutting forests or draining wetlands or Carolina Bays to make room for the installation of panels, with some applicants proposing clearance of hundreds or thousands of acres of forest. While solar energy development is critical to reducing U.S. dependence on fossil fuels, forests provide important carbon sequestration and storage functions necessary to mitigate the earth's existing atmospheric carbon dioxide levels. Carbon stored in the forest is also released if cleared trees are burned. South Carolina has developed advice for habitat conservation around solar sites, but localities need to do more to determine their own development requirements for solar applicants. South Carolina's Department of Natural Resources offers a solar habitat guide for anyone who wants to protect or enhance habitat at solar sites https://www.dnr.sc.gov/solar/

The transition to greater sources of clean energy is resulting in forestland and agricultural land conversion to utility-scale solar. Forests and prime agricultural soils lost to solar farms will likely accelerate into the future unless policies are adopted to discourage large solar arrays on these lands.

Low Impact Utility-Scale Solar Design to Protect Habitat Cores

The location and design of utility-scale solar farms affects their impact on the environment. Low impact design considerations include:

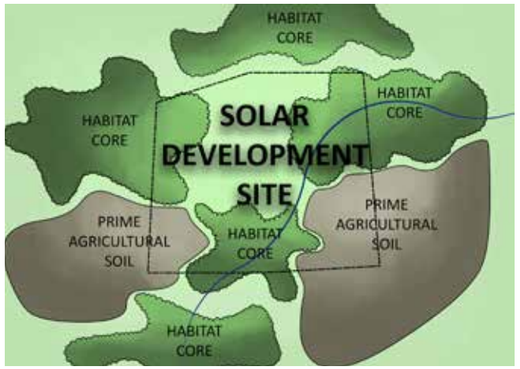
Site locations

- Avoid environmentally sensitive and valuable areas- wetlands, endangered species habitat, high value habitat cores, riparian buffers etc. Avoid floodplains and sensitive features such as Carolina Bays.
- Identify sites of cultural significance to avoid through community engagement.
- Consider current and previous land use before choosing a site- reuse of developed, industrial, brownfield or landfill sites will have lowest impact.
- Avoid prime agricultural soils.
- Avoid steep slopes.
- Discourage utility-scale solar on forested land.

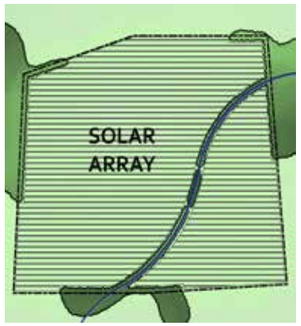
Site design

- Retain existing soil.
- Configure the solar arrays with the land's natural contours to minimize grading.
- Utilize small footprint foundations for panel support structures- e.g. driven piles.
- Plant or maintain vegetation that supports habitat- e.g., pollinator species.
- Minimize maintenance- this could involve livestock grazing.
- Consider wildlife-permeable fencing with openings to allow passage for smaller mammals or foraging birds, such as quail.
- Avoid breaking up and disconnecting the remaining trees in surrounding forests.
- Consider agrivoltaics- combining solar panels with agriculture where appropriate.

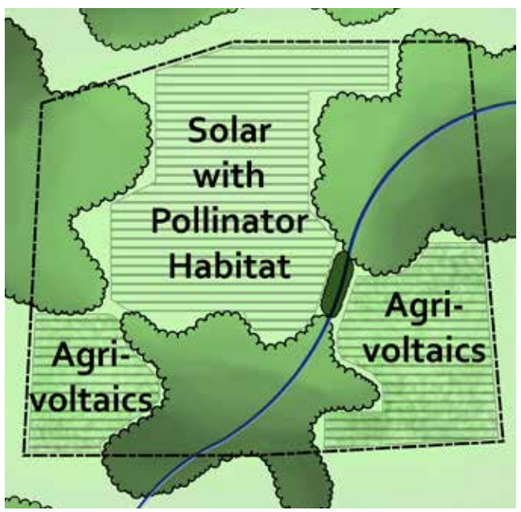
UTILITY-SCALE SOLAR DEVELOPMENT



A development site in its larger context shows habitat cores, stream corridors, prime agricultural soils, and potential for increasing connectivity.



In this example, a standard solar development design locates the solar array on the entire site regardless of habitat cores or agricultural soils. If the local ordinances require it, a minimum stream buffer is left intact and new trees planted to fill in the gap in the buffer.



GIC Recommendations

- Zoning ordinance or solar overlay for utility-scale solar.
  - — Require a stormwater management plan for the site that factors in contribution to impervious area from the panels themselves.
  - — Require pollinator-attracting seed mixes.
  - — Buffer open waterways by 100 feet with native vegetation.
  - — Require 100-foot vegetated screening buffers around the site.
  - — Discourage utility-scale solar on forested land, steep slopes, and prime agricultural soils.
- Require mitigation of forest site impacts by requiring that new trees be planted offsite.
- Establish a clause that preemptive forest clearing under the guise of forestry will result in a three-year delay in permits for solar facilities.
- Analyze site suitability for utility scale solar farms at a regional scale.
- Develop a strategy for utility scale solar farms that minimizes impacts to natural resources.
- Incentivize solar development on marginal or other non-greenfield lands.
- Include solar locations (appropriate/inappropriate designations) in the Comprehensive Plan.
- Develop guidance for solar developers to create better habitat around solar panel sites. For examples, see South Carolina's *Technical Guidance for the Development of Wildlife and Pollinator Habitat at Solar Farms*, link: https://www.dnr.sc.gov/solar/assets/pdf/solarHabitatGuide.pdf

In this example, the solar array is located to protect habitat cores on the site and restore connectivity through a newly planted portion of stream buffer. The solar array over prime agricultural soils is combined with plantings such as blueberries or other crops well suited to agrivoltaics. The remainder of the solar array is underplanted with a pollinator plant mix. The soil on the site is left intact and driven piles are used to support the arrays. The fencing around the site is permeable to allow small mammals to move across the site.

INVASIVE SPECIES, PESTS AND DISEASE

According to a 2007 International Union for Conservation of Nature (IUCN) Red List Fact Sheet (available at https://www.iucn.org/sites/dev/files/import/downloads/species_extinction_05_2007.pdf), invasive species are a leading cause in the loss of biodiversity and extinction of species globally. Invasive plants and animals alter ecosystems by displacing or replacing native species through competition of resources, such as light, water and space. Invasive species can degrade the quality of habitat cores and make them less hospitable to native species.

Many invasive plants support fewer species of insects than native plants. Other species have allelopathic properties – they exude chemicals into the soil that inhibit other plants from germinating or getting established. They can also proliferate to the degree that they choke or smother other plants or trees, causing them to die prematurely. To learn more about how to spot invasive species and to implement improved habitat management to reduce or remove them visit https://www.scfc.gov/protection/forest-health/

GIC Recommendations

- Disallow or remove invasive species from landscape ordinances. It is OK to have non-native, non-invasive species of trees included in allowed tree lists.
- Encourage landowners to remove invasive tree species, such as Bradford pear, from their properties. (See Clemson's Bradford Pear Bounty program: https://www.clemson.edu/extension/bradford-pear/index.html
- Place signage discouraging outside sources of firewood in managed campgrounds. Example: Don't Move Firewood Campaigns. For any program or signage, clarify from how far away (e.g., a mile).

A variety of non-native, invasive species, such as kudzu (Pueraria montana) can alter the species composition and degrade the quality of habitats.

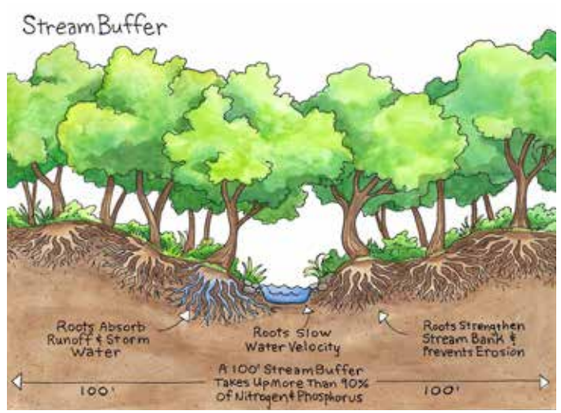
Rattlebox (*Sesbania punicea*) is a variety of non-native, invasive species that can alter the species composition and reduce the quality of forest habitat.

WATER QUALITY IMPAIRMENTS

Water quality impairments occur in water bodies across the state and pose risks to wildlife and human health. The various pollutants found in water have different sources and corrective actions. For example, low dissolved oxygen (DO) can be caused by algae blooms resulting from phosphorus contamination but also occurs naturally in some swamps in South Carolina while mercury is likely the result of coal combustion or industrial waste.

E. coli and fecal coliform impairments are an indication of sewage or animal waste contamination. The animal waste could be from cattle with access to the waterway or a high concentration of wildlife in a riparian corridor. Requiring riparian buffers and fencing of farm animals away from waterways in agriculture zones and wider riparian buffers along waterways serving as wildlife corridors could lessen some of these contaminant risks.

Increased impervious surfaces and stormwater runoff characteristic of development cause phosphorus, nitrogen, and sediment (or turbidity) impairments. Local codes and ordinances limiting parking requirements (parking maximums) or road widths for new development reduce impervious surfaces and the amount of runoff and pollutants entering waterways. Trees in riparian buffers absorb rainwater and stormwater runoff and their roots strengthen the stream bank preventing erosion and sedimentation. A 100' riparian buffer filters out more than 90% of the nitrogen and

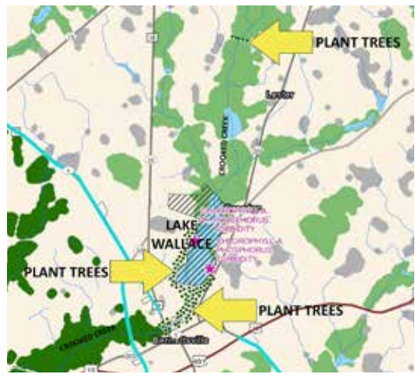


phosphorus from stormwater runoff. Protection and restoration of riparian buffers is a critical tool for improving water quality where nitrogen, phosphorus, low dissolved oxygen (DO) and turbidity are the impairments.

Water quality impairment maps were created with SC Department of Health and Environmental Control Water Quality Assessment data at the COG scale and can be used to determine areas to target for riparian plantings. These data will be available at the statewide scale on the HUB site https://scgiplan-gicinc.hub.arcgis.com/ but a statewide map of impairments is not included in this report as it would not be legible at this scale.

Lake Wallace and Crooked Creek Water Quality Impairments and Restoration Opportunities.

The water quality impairments around Lake Wallace and Crooked Creek in the Pee Dee COG region include phosphorus and turbidity in a lake and creek that lack sufficient riparian buffers. Restoration of 100' riparian buffers will improve water quality by absorbing runoff, preventing erosion, and taking up more than 90% of nitrogen and phosphorus.



WILDFIRES

Wildfire is a naturally occurring event in forests of the Southern U.S. Historically, forests periodically burned as a result of weather events, such as lightning strikes. These fires were typically low-to-moderate severity understory fires that removed some of the understory brush, making room for new species to grow, new seeds to germinate, the recycling of nutrients back into the soil, along with opening up new areas for animals to forage. Longleaf pine forests and savannas adapted to this frequent low-severity fire regime, resulting in a highly productive and biodiverse system. However, around the turn of the 20th century, forest managers across the United States started to suppress fire on the landscape for public safety, rather than allowing it to burn. This practice created an imbalance in ecosystems where a fire-climate dependent relationship had previously evolved. The result has been a buildup of vegetation or "fuel" that leads to hotter and more widespread fires that are harder for fire managers and firefighters to control. In addition, in coastal areas, the invasive tall reed species phragmites can provide ladder fuel – allowing wildfires to reach the crowns of trees, thus creating more destructive fires.

The buildup of vegetation or "fuel" leads to hotter and more widespread fires that are harder for fire managers and firefighters to control.

> **The risk for very large fires in the Southeastern U.S. will increase 300% by mid-century.**

Management tools such as prescribed fire are becoming increasingly difficult to implement because of shorter weather windows for safely controlling the operations. As development has spread farther into rural areas, fire managers have found it increasingly difficult to safely initiate prescribed burns to reduce forest fuels buildup. This creates a backlog of forest land to be burned, which in turn creates a buildup of fuel loads, thus increasing the risk of a more catastrophic fire. This can increase risks to human communities that occupy the wildland urban interface (WUI).

As the Southeast becomes hotter, fires also become more likely as climate change warms the planet. NOAA predicts that the risk for very large fires in the Southeastern U.S. will increase 300% by mid-century (2041-2070). These dangers can by mitigated by following landscaping and building standards from the National Firewise Program (See: https://www.scfc.gov/protection/fire-prevention/wildland-urban-interface/

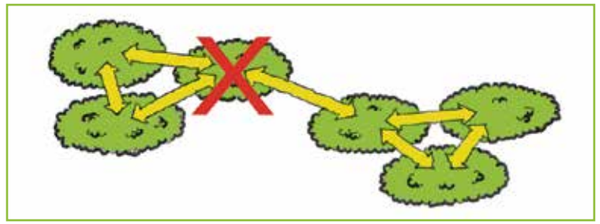
GIC Recommendations

- Utilize reverse 911 or apps to communicate when to burn or not to burn, or when prescribed burns are happening in the area, so people can tell the difference between planned fires and wildfires.
- Create co-ops for burning and logging with clusters of private, small forestland owners.
- Consider fire risk in comprehensive planning and discourage development in fire prone areas. Include fire risk maps in the Comprehensive Plan.
- Educate developers about Firewise design principles and provide talks to local realtors and builders.

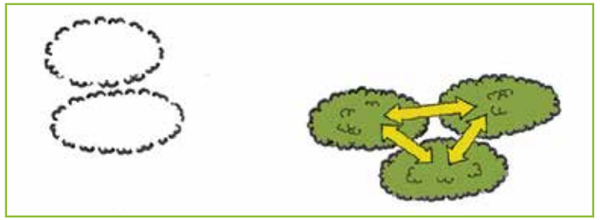
FRAGMENTATION

Fragmentation is one of the leading causes of habitat decline in Southern U.S., primarily as a result of development. Studies show that a more connected landscape is a more resilient landscape since species populations are not isolated by habitat fragmentation. E.O. Wilson was an early researcher of this phenomena in his Theory of Island Biogeography, in which he noted that isolated mangroves recovered far more slowly than those that were closer together (1967). If range expansion is restricted, populations may become more vulnerable to the effects of climate change and extreme weather events (Ewers, et al 2006).

Multiple, cumulative impacts arise from the variety of decisions humans make, from land use to built infrastructure. A prime example is road construction. Most of the state's roads have been built without regard to the impacts on the movement of species across the landscape. Roads are the biggest contributing factor to fragmenting forest habitat and are a significant factor in the mortality of species as they try to cross them. It is estimated that several million birds are killed annually in vehicle collisions on U.S. roads (Loss, et al 2014).



When habitat cores are destroyed, species are prevented from accessing other available forest habitats, causing those forest cores to decline.



Human infrastructure such as roads, transmission corridors and development fragment the forest into smaller pieces that provide less overall interior forest habitat. While we all need power lines and roads, they can be sited to avoid bisecting habitats and can be designed to allow for wildlife to move safely under them.

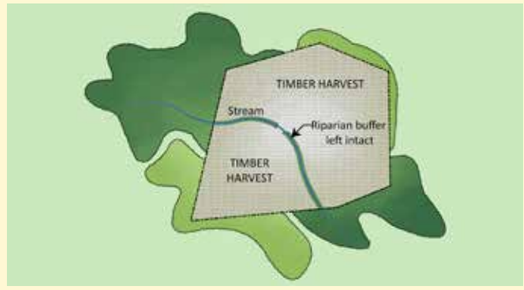
Risks were mapped for each of South Carolina's ten councils of government. Maps for the regions includes risks for sea level rise (coastal areas), storm surge, development, utility-scale solar and water quality impairments. As noted in this report, there are many more threats that can be mapped at a finer-level of detail, such as for a county scale plan. For more details on risks and specific strategies, see the individual sections for each Council of Government region at the end of this plan. Strategies for each state agency are found in the following section- Implementation Strategies, page 32.

GIC Recommendations

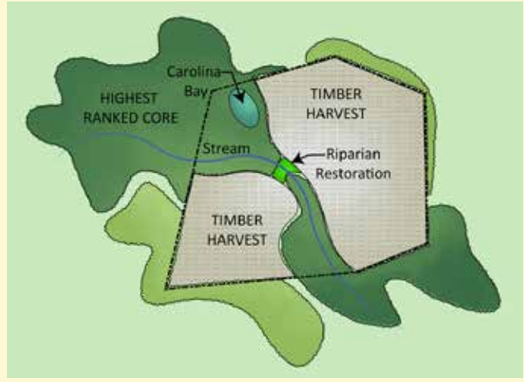
- Create more animal crossings/bridges/tunnels for safe passage of both people and wildlife. In areas with higher water tables along the coast, consider wildlife bridges.
- Localities should incorporate conservation overlays or large lot zoning to protect areas with high-value forests or important silvicultural areas.
- Prioritize land easements by considering corridors' data as a criterion for land to be protected.
- Site future roads to reroute around high-valued forest cores and habitats by considering habitat cores maps as part of long-range road planning (6-year plans).
- Identify key forest cores and corridors in comprehensive plans and regional plans.
- Include wildlife tunnels and bridges in future roads and add them to existing roads with high crash incidents. When replacing culverts or bridges across the state incorporate wildlife enhancements to improve connectivity.
- Land management practices such as timber harvesting should consider impacts on habitat cores and connectivity.

Sustainable Forestry Preserves Habitats and Connectivity

A forestry site in its larger context shows ranked habitat cores, stream corridors, and a Carolina bay.



In this example, a standard timber harvesting site encompasses the entire site regardless of habitat cores or Carolina bays. If the local ordinances require it, a minimum stream buffer is left intact.



In this example, timber harvest areas avoid the highest quality habitat cores on the site. The Carolina bay and stream are protected and connectivity is restored through a newly planted portion of stream buffer.

Implementation Strategies

The GIC led state agencies and COGs through a planning process culminating in agency specific and regional implementation strategies for protecting and restoring green infrastructure habitat cores and connecting corridors statewide. Additionally, each COG identified priority areas for protection in their region illustrated in the COG Priority Areas Map. Detailed reports were created for each of the ten Councils of Government and they can be downloaded at https://scgiplan-gicinc.hub.arcgis.com/. The following strategies were created by the agencies to describe how they plan to utilize the statewide habitat cores and corridors map to further agency missions. The GIC has made additional recommendations for the agencies to consider implementing.

South Carolina Department of Natural Resources Strategies: (DNR)

- **Action:** Utilize data to inform the acquisition of properties for Wildlife Management Areas or Heritage Trust Program's strategies to further the preservation of natural and cultural resources for current and future generations, species conservation, heritage tourism, and research. Use the risks and habitat data to inform how land is ranked for consideration by the Habitat Protection Committee.

  Partners: Tribal Nations, NGOs, local governments, community members, researchers, private firms.

- **Action:** Include GI habitat cores data as a reference layer for guidance with RTE species data, solar siting tools, and State Wildlife Action Plan (SWAP) priorities. Species data have sampling bias- habitat cores represent potential habitat for species and may guide more survey work. Habitat cores data could be included in web mapping apps and used by the agency's internal Habitat Protection Committee.

  Partners: SCDOT, SC Energy Office, NGOs, consultants, SCDHEC, SCFC, USFWS USFS, academia.

- **Action:** The SC SWAP identifies sensitive areas on the landscape. There is a need for connectivity for all species including currently common species. The maps and data should be used to locate and design sites to reduce impacts or severity of identified threats.

  Partners: Agency staff and landowners and increase landscape connectivity.

GIC Recommendations for DNR

- Utilize and promote guidance on designing solar sites for pollinator habitat.
- Continue to update the state's prohibitive species list that can be used to inform the regulation (prohibition) of the sale of highly invasive, non-native species.
- Collaborate with agencies and municipalities on utility-scale solar development issues to assist them with developing solar standards that protect habitats.
- Collaborate with state institutions, NGOs and retail nurseries to develop a statewide campaign to promote the sale and use of native plants.
- Collaborate with agencies and other partners on updating the noxious weed list more frequently and include pest species from further south that may migrate northward with climate change.
- Redefine eligibility criteria for land acquisition of wetlands and uplands to account for sea-level rise impacts.

South Carolina Conservation Bank Strategies: (SCCB)

- **Action:** Use habitat cores data in the Conservation Priority Model as an indication of where species of concern are likely, especially for areas that have not yet been surveyed.

GIC Recommendations for SCCB

- SCCB should prioritize conserving highest value habitat cores by assigning points based on habitat quality to properties under consideration due to their proximity to protected lands.

South Carolina Forestry Commission Strategies: (SCFC)

- **Action:** Prioritize land acquisition using Habitat Core data to ensure highest quality habitats are conserved.

  Partners: TNC, OSI, SCOR, SCCB

- **Action:** Work with landowners to show them their properties on the online map and how their land contributes to connectivity and habitat.

- **Action:** Utilize the information to emphasize the importance of the agency's Fire/Firewise work- habitat cores/connectivity along with water quality etc.

- **Action:** Use the data to show SCFC foresters the bigger picture of forest connectivity importance on the landscape and give those foresters talking points to show the multiple benefits connected forests can provide as more leverage for maintaining and protecting forests.

GIC Recommendations for SCFC

- Develop Community Wildfire Protection Plans with communities at the wildland-urban interface (WUI).
- Develop a messaging and marketing campaign to promote the Firewise program across the state (this program is currently underutilized).
- Utilize the risk maps from this report to address silvicultural sites that may be lost.
- Help localities recognize and plan for healthy forests in long range and master plans.
- Collaborate on forest management initiatives with the South Carolina Office of Resiliency.

South Carolina Department of Transportation Strategies:

- **Action:** Educate South Carolina Mitigation Association (SCMA) about the GI Plan and Model. They will use habitat cores data as they set up banks.

  Partners: SCMA and members

- **Action:** Use habitat cores data to guide local trail development and long-term conservation in relation to bike/pedestrian planning and infrastructure.

  Partners: MPOs, COGs, SCPRT, NPS, local parks and recreation departments.

- **Action:** Determine regional and local conservation and mitigation priorities through the GI Plan and Model to better match statewide goals with local priorities. Use the GI Plan and Model as part of decision-making processes.

  Partners: SCFC, SC DHEC, SC Energy Office, SCOR, COGs, MPOs

- **Action:** Use the data with the state's Mitigation model (Water Resource Registry) to identify watersheds in which to conduct mitigation (e.g. restoring stream buffers and habitats that would also restore an important corridor as well as watersheds that support high value habitat cores or have species that can be protected). For example, the Northern long eared bat habitat will require mitigation.

  Partners: State Mitigation Association (includes 80 mitigation banks, 100 people- prioritizing where to protect and restoration opportunities).

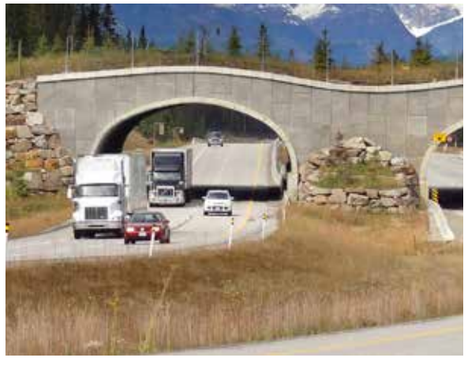
- **Action:** Work is on-going to expand and repair culverts across the state. This work could include opening up streams (e.g. replacing a culvert with a bridge, daylighting, restoration, expanding openings for wildlife passage) so that those which provide high value corridor connections could be designed to expand that passageway to open up more connectivity. As culverts are replaced, wildlife passage enhancements could be added. SCOT can commit to one wildlife bridge or tunnel per region of the state. Also consider adding in or referencing the Aquatic Connectivity GIS data from SARP: https://connectivity.sarpdata.com/

- **Action:** Work with SCFC to identify properties they can assist SCDOT in managing.

- **Action:** SCDOT will present at Trees SC conference in November 2023.

GIC Recommendations for SCDOT

- Incorporate wildlife enhancements when expanding roads and replacing bridges across the state.
- Collaborate with DNR on a study of wildlife-vehicle collisions and a means of targeting important locations for alternate wildlife crossings.
- Consult habitat cores and corridors maps and data when creating 6-year regional transportation plans to avoid bisecting or impacting these habitat features as much as possible.
- Reverse the policy of excessive clearing of forest and trees, currently 100' alongside rights-of-way. Opening up lands along roads to remove forests and add grass can increase deer browse and vehicle collisions.



Wildlife overpasses or tunnels facilitate movement across roads and reduce conflicts.

South Carolina Parks, Recreation and Tourism Strategies: (SCPRT)

- **Action:** Habitat cores and corridors maps can aid PRT in determining what properties best meet their mission for protecting wildlife and acquiring new parks. Use the maps to inform collaboration across agencies for a connected landscape – ie: Black River Initiative, a 70-mile-long riverine network of 12 local, state, and private parks connected by a recreational water trail along the river between the towns of Kingstree and Georgetown. The new park network includes South Carolina's first new state park in nearly 20 years, the state's first-ever riverine park, and the first state park in this majority African American region of the state. See: https://storymaps.arcgis.com/stories/7dd7c6c3f6484b9db11de75fbfaf7c57

- **Action:** Utilize the maps to aid in understanding how state parks' lands fit into the larger landscape and how parks can contribute to corridors with other land-owning agencies.

  Partners: DNR, SCFC etc. (multi agency collaboration)

- **Action:** Add the GI Plan model to the other models currently used by SCPRT. Corridors are currently derived from sources that include TNC Resiliency, Southeast Blueprint, SCDNR RT&E Species) to justify land acquisition for new parks based on cores habitat, resiliency, and recreation along rivers.

GIC Recommendations for SCPRT

- Focus on connectivity to parks by working to protect and restore land outside the park boundaries.
- Update existing and create new forest management plans for state parks.
- Collaborate with adjacent landowners on management issues to protect habitats.

South Carolina Department of Health and Environmental Control Strategies: (DHEC)

- **Action:** Share habitat cores and corridors maps with grantees including private groups, municipalities, etc. Encourage grantees to use the maps to determine where to pursue projects such as riparian buffers, easements, cover crops, etc.
- **Action:** Engage stakeholders to improve and protect water quality and drinking water resources to support increased habitat quality through grant funding for riparian buffers and BMPs to improve water quality, as well as easements to protect water quality.

Partners: COGs, NGOs, counties, local municipalities.

GIC Recommendations for DHEC

- Through the Brownfields Voluntary Cleanup Program, encourage and facilitate the reuse/redevelopment of brownfields and other contaminated sites for solar development to reduce pressure to clear and disturb natural landscapes.

Center for Heirs Property Preservation Strategies:

- **Action:** Educate historically underserved landowners on their role in conservation by sharing habitat cores maps/data in workshops or one on one meetings.

Partners: NRCS, SCFC. Currently working with 500 landowners with 40,000 acres. GI maps can aid in landowner education – where their land fits into habitat/connectivity. Since economics is of prime importance and ecosystem services are important, find ways that landowners could capitalize on carbon market, protecting land for supporting water supplies, etc. Convey to funders the value of land conservation/ecosystem services such as water quality, etc.

Trees SC Strategies:

- **Action:** Promote Urban and Community Forestry in SC through education opportunities with members and partner organizations.

Partners: Local planners, Urban Foresters, SCFC, Clemson Extension, SCAPA.

GIC Recommendations for Trees SC

- Promote the Green Infrastructure Plan and HUB site to member groups to plan for forest conservation and connectivity.

South Carolina Office of Regulatory Staff, Energy Office Strategies:

- **Action:** Educate solar community, local government, and energy industry about expanding solar and EV infrastructure in ways that reduce the risk to habitats/green infrastructure. Create educational presentations and add habitat cores model into agency GIS data, provide model solar ordinances and connect stakeholders.

Partners: SC Solar Council, Municipal Association, Palmetto Clean Fuels, SCAPA, universities, Technical Colleges, Broadband, Sustain SC, Carolinas Clean Energy Business.

- **Action:** Offer educational resources- solar ordinance resources and, model solar ordinances. This can assist with local permitting because there is no state law related to solar development.

Partners: Create an outreach campaign to reach key stakeholders including the SC Planning Association, Counties, etc.

GIC Recommendations for Energy Office and SCOR:

- Incentivize and provide guidance for low impact solar development including incentives for solar development on buildings, over parking lots, on brownfield sites, on landfills, etc.
- Work with SCFC and the Farm Bureau to protect highest value habitat cores and agricultural soils from loss or degradation by solar development.

South Carolina Office of Resilience Strategies: (SCOR)

- **Action:** As SCOR develops recommendations for actions to decrease flood vulnerability in SC, they will include properties appropriate for buyout and conservation. The habitat cores data can be overlaid with SCOR's data to prioritize projects that would offer co-benefits of protecting habitat and landscape connectivity in addition to flood mitigation.
- **Action:** Integrate and prioritize protection of habitat cores and connectivity into the watershed-based resilience planning process SCOR plans to coordinate. Integrate cores and corridors as part of existing priorities for protection- flood hazard areas, marsh migration areas, wetlands, best infiltration areas.

Partners: SC Resilience Plan Advisory Committee, COGs, Local governments

South Carolina Department of Agriculture Strategies:

- **Action:** Protect and grow agriculture Industry and protect working lands for food security and economic development through education, funding to focus on conservation easements, Agribusiness development, marketing, research, promotion, Farmlink and Agritourism.

Partners: Farm Bureau, Extension offices.

GIC Recommendations for SC Department of Agriculture:

- Work with SCCB to protect land with class I and II Agricultural soils in areas at risk of solar and residential development.
- Work with the Energy Office to educate farmers on the benefits of low impact solar design and agrivoltaics – combining solar and farming.

South Carolina Association of Conservation Districts Strategies:

- **Action:** Share maps with Conservation Districts, local government, landowners, and citizens.

Sustain South Carolina Strategies:

- **Action:** Integrate GI Plan data into the Watershed Resources Registry (WRR) tool to inform users of areas of high-quality habitat and conservation priorities. The WRR is a state-specific online mapping tool allowing environmental professionals to identify potential sites for restoration or preservation in an attempt to move toward a more holistic approach to mitigation. Sustain SC led the effort to establish South Carolina's WRR tool. See: https://watershedresourcesregistry.org/states/southcarolina.html
- **Action:** Sustain SC is integrating sustainable business goals with local environmental solutions. Sustain SC can share the GI Plan maps and data with clients and members to guide ecologically-focused economic development initiatives, and corporate development that minimizes impacts on habitat and sustainable corporate investments.

Open Space Institute/ Land Trusts Strategies:

- **Action:** Use site specific data to support decisions on easements and for landowner education. When seeking funding it is important to be able to demonstrate habitat importance and connectivity. Maps can be used in management plans. Easement language is important; allowing for working land easements that provide for changes in land use from forestry to ag or vice versa.
- **Action:** Find ways to combine the DHEC 319 restoration projects and priorities with the acquisition and protection work.

Catawba Nation Strategies

- **Action:** Protect the Catawba River Corridor. The Catawba River Corridor has been the home of the Catawba people for over 6000 years. This corridor is a priority for protection and restoration. Wetland restoration and dam removal should be considered for habitat restoration and flood control. Traditionally, Catawba clay holes for pottery making were located along the Catawba River.
- **Action:** Consult habitat cores data to plan for growth that protects habitats. The Catawba Nation should consult the maps and data from the GI plan to protect habitat cores as they plan new construction projects and purchase land for housing. The Catawba Nation should consider creating a master plan informed by green infrastructure to guide future growth, development, and expansion of the Reservation.
- **Action:** Increase buffer widths along the Catawba River. There are existing requirements for buffers along the Catawba River ranging from 30-50' buffers. These should be standardized and increased.

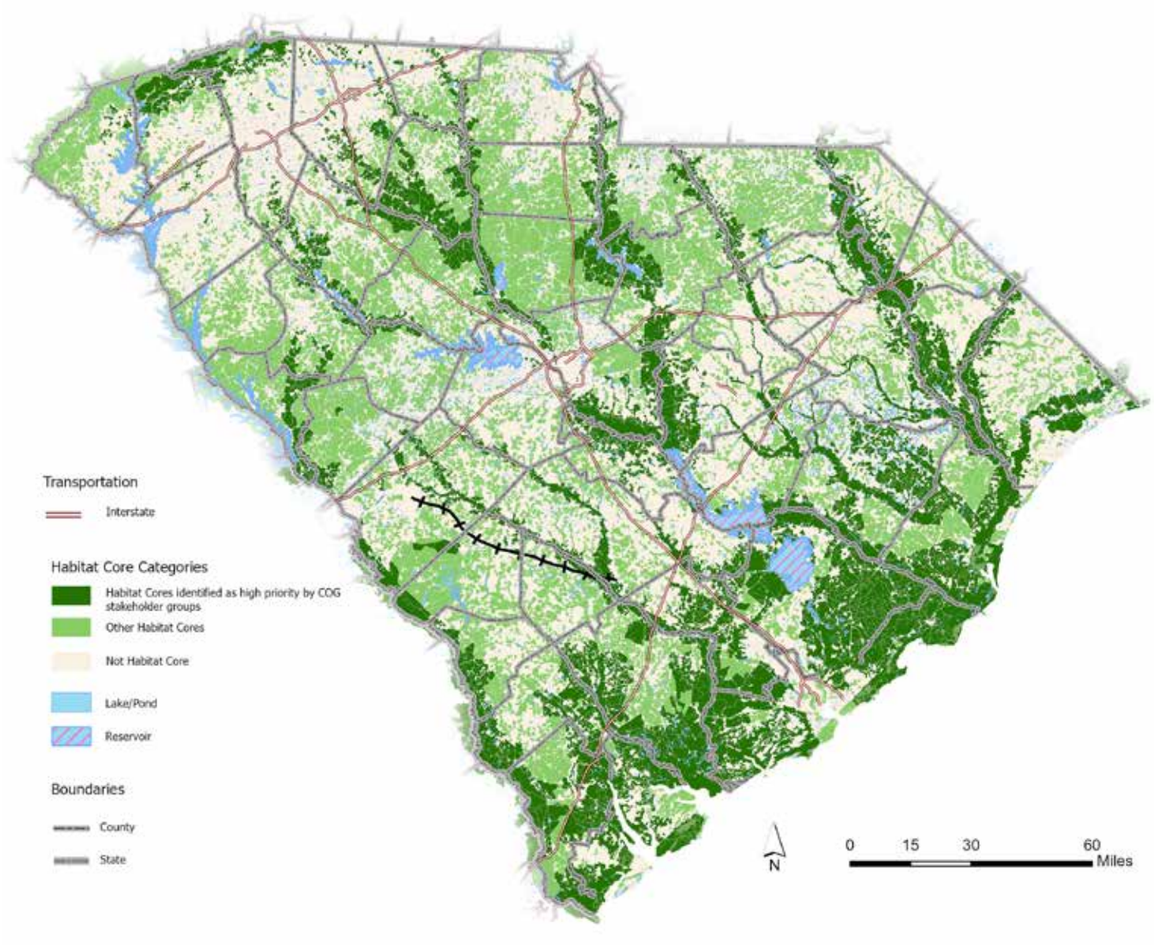
Regional COG Strategies

Each of the ten COGs also developed strategies for protecting and restoring a connected landscape. The COG chapters that describe these regional strategies can be found at the hubsite here: https://scgiplan-gicinc.hub.arcgis.com/ or at www.gicinc.org or https://www.scfc.gov/management/urban-forestry/. Some examples include:

- **Implement a Green Space Sales Tax**: Counties should consider placing the Green Space Sales Tax on their ballots to raise funds to conserve more land in the region. Counties can use the funds collaboratively to protect land across county boundaries.
- **Create and strengthen solar ordinances:** Create solar ordinances in the counties lacking any ordinance and strengthen solar ordinances in the counties that have ordinances in place. The South Carolina Energy Office has resources for creating or updating solar ordinances and examples of model solar ordinances.
- **Use GI Plan data and maps in all upcoming county comprehensive plan updates**: The COGs should utilize data and maps from this GI Plan to provide county specific maps and encourage their use in all upcoming comprehensive plan updates in the region, thereby prompting counties to plan for their natural assets as green infrastructure.
- **Use data and maps to guide zoning:** Rural communities in the region should consider establishing zoning guided by habitat cores, corridors, and agricultural soils data to protect these natural assets. Counties should create zoning overlay districts for important corridors to require wider buffers and other means of restoration and protection of the corridors.
- **Collaborative regional planning:** Cities, towns, and counties should collaboratively define growth boundaries and infrastructure investment locations. The habitat cores and corridors data should be used to guide these land planning decisions.
- **Conservation subdivision ordinances:** Counties should pass conservation subdivision ordinances with incentives to encourage this type of development. For more information see GIC's conservation development guide here: https://www.scfc.gov/wp-content/uploads/2021/06/urbconnectguide.pdf

The COGs also identified priority areas for protection and restoration. These areas are depicted on the map on page 41.

South Carolina COG Priority Areas Map



This map depicts the priority habitat cores for protection and restoration as identified by COG stakeholder groups.

APPENDIX

Funding Opportunities

Arbor Day Foundation, Tree City USA Grants Benefits: https://www.arborday.org/programs/tdgreenspacegrants/

Duke Energy Foundation: https://www.duke-energy.com/community/duke-energy-foundation/south-carolina

Longleaf Alliance: Planting Funds for longleaf pine seedlings: https://longleafalliance.org/longleaf-planting-funds/

National Fish and Wildlife Foundation Grants: https://www.nfwf.org/programs

- **Acres for America** leading public-private land conservation partnership. https://www.nfwf.org/programs/acres-america
- **Bring Back the Native Fish** protects sensitive native fish species across US. https://www.nfwf.org/programs/bring-back-native-fish
- **Conservation Partners Program** provides funding to support technical assistance to private landowners to maximize benefits of Farm Bill programs. https://www.nfwf.org/programs/conservation-partners-program
- **Five Star Urban Waters Restoration Grant Program** seeks to address water quality issues in priority watersheds. https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program
- **Longleaf Landscape Stewardship Fund** supports longleaf pine restoration projects. https://www.nfwf.org/programs/longleaf-landscape-stewardship-fund
- **National Costal Resilience Fund** restores natural infrastructure to protect coastal communities that enhance habitats for fish and wildlife. https://www.nfwf.org/programs/national-coastal-resilience-fund

National Park Service: The Land and Water Conservation Fund State and Local Assistance Program.

- https://www.scprt.com/recreation/recreation-grant-programs/land-and-water-conservation-fund
- https://www.scprt.com/recreation/outdoor-recreation-legacy-program

Natural Resources Conservation Service (NRCS): Regional Conservation Partnership Program - $1.5 million (longleaf restoration money – both potential and existing) and $900,000 to purchase bargain easements region-wide.

- https://www.nrcs.usda.gov/programs-initiatives/rcpp-regional-conservation-partnership-program
- https://www.nrcs.usda.gov/programs-initiatives/rcpp-regional-conservation-partnership-program/critical-conservation-areas

South Carolina Department of Health and Environmental Control (DEHC): https://scdhec.gov/environment/businesses-communities-go-green/environmental-loans-grants-businesses-communities

- Clean Up Assistance Grant
- Nonpoint Source Pollution Grant
- State Revolving Fund

South Carolina Department of Natural Resources (DNR): Flood Mitigation Assistance Grants https://www.dnr.sc.gov/water/flood/mitgrants.html

South Carolina Department of Parks, Recreation, and Tourism: https://www.scprt.com/grants

South Carolina Emergency Management Division: https://www.scemd.org/recover/mitigation/

- Hazard Mitigation Grant Program
- Flood Mitigation Assistance Program
- Building Resilient Infrastructure and Communities Program

The South Carolina Energy Office: https://energy.sc.gov/incentives/grants

South Carolina Forestry Commission (SCFC)

- **Urban Forestry Grants for Technical Assistance to SC Municipalities** https://www.scfc.gov/management/urban-forestry/urban-forestry-grants/
- **Cost Share and Incentive Programs** https://www.scfc.gov/management/landowner-services/cost-share-programs/

USDA FSA Conservation Programs: https://www.fsa.usda.gov/programs-and-services/conservation-programs/index

U.S. Fish and Wildlife Service: https://www.fws.gov/service/financial-assistance

- National Coastal Wetlands Conservation Grants
- John H. Prescott Marine Mammal Rescue Assistance Grant Program
- Urban Bird Treaty Grant
- Traditional Conservation Grants
- Habitat Conservation Plan (HCP) Planning Assistance Grants
- Habitat Conservation Plan (HCP) Land Acquisition Grants
- Recovery Land Acquisition Grants
- Webless Migratory Game Bird Grants
- North American Wetlands Conservation Act (NAWCA) Grants
- Partners for Fish & Wildlife (PFW)-75-90% cost share to landowners for habitat improvements. https://www.fws.gov/program/partners-fish-and-wildlife

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Technical Appendix

This section describes the data and methods used to create the natural asset model and overlay maps. All data are available to view or download at the hubsite here: https://scgiplan-gicinc.hub.arcgis.com/ or at www.gicinc.org or https://www.scfc.gov/management/urban-forestry/.

A habitat is the natural home or environment of an animal, plant, or other organism in which a species lives and it comprises the locality in which it can find food, shelter, protection, and reproductive partners. The physical factors of a habitat include soil type, underlying geology, hydrology, temperature range and seasonal changes, as well as biotic factors, such as the availability of food and the presence of predators. Every organism has certain habitat needs in order to thrive, many of which overlap with other species. The habitat cores model classifies the landcover as to its size (large enough to be a habitat core) and ranks each core as to its ecological value for supporting native species.

In short, the habitat cores' model accomplishes several major things:

1) It identifies large, patches of habitat (habitat cores).

2) It identifies smaller patches that do not provide the same degree of benefits as cores, but are still valuable for habitat (habitat fragments).

3) It calculates metrics for each core and habitat fragment, and ranks it based on these metrics to help prioritize conservation decisions.

Ecological Integrity is the ability of an ecological system to support and maintain a community of organisms whose species composition, diversity and functional organization are comparable to those of natural habitats within a region. The intactness of natural lands is a key underpinning for the ecological integrity of a given area. An expanse with large, contiguous tracts of natural land will exhibit a high degree of intactness. Conversely, an area with small, isolated patches of natural lands will demonstrate a high degree of fragmentation, leading to more impacts to species' survival and movement.

The more fragmented a landscape is, the less intact it is. Intactness relates to the size and integrity of a habitat – the degree to which it is fragmented or not. Fragmentation can be directly measured, and is assessed in terms of a ratio of intact habitat to overall landscape area.

Landcover refers to the surface types covering the land, generally vegetation types, water or hard surfaces. In GI maps, analysis is applied to a habitat types covering the land, such as forests, wetlands, and dunes.

Habitat cores are intact areas of natural land cover at least 100 acres in size and at least 200 meters wide. They are derived from the best available national data to create complete coverage for the contiguous United States. In the United States, most GI models including this project, utilize the National Land Cover Data set (NLCD), which is updated every 5 years. For this project NLCD 2019 was the most recent dataset available.

Datasets used to create the habitat core geometry

1) NLCD Land Cover 2019

2) National Wetlands Inventory (The U.S. Fish and Wildlife Service)

3) National Hydrography Dataset (flowlines for streams, waterbodies for lakes, and NHD area)

4) Roads and Highways (SC Department of Transportation)

5) Railroad Tracks (SC Department of Transportation)

The following NLCD land classes were considered as natural habitat for this model:

6) 11 Open water

7) 31 Barren Land

8) 41 Deciduous Forest

9) 43 Evergreen Forest

10) 71 Herbaceous

11) 90 Wooded Wetlands

12) 95 Emergent Wetlands

These land classes are basically merged or dissolved into a binary raster representing natural area polygons. The polygons are then analyzed for meeting the minimum 100-acre size by using GIS to buffer 300 feet inwards from the edge of the natural area (the edge width determined by prior research on impact zones) and if 100 acres remains, it is deemed a habitat core. The edge is then added back in as it is still part of the core and, even though some impacts occur, the interior is large enough to support a diversity and multitude of native species for the region. These polygons are then overlaid with a diverse assortment of physiographic, biologic and hydrographic layers to calculate metrics that describe each core. These metrics are the foundation for assessing what makes each core unique and whether or not a core should be a conservation priority.

Data used for preliminary ranking:

1) Geometry: Area, Thickness and Compactness (Created from the habitat core polygons)

2) Topographical index Score from DEM (National Elevation Dataset USGS)

3) Wetland Score (NWI)

4) Soil Diversity (SSURGO soil types)

5) Stream Score (Using NHD Plus Streams)

6) Species Richness Raster (Biodiversity mapping.org)

7) Rare, Threatened, and Endangered Species from the Element Occurrences (Heritage Trust Program)

GIC partnered with Esri to make the data available on an Esri ARCGIS data hub site. The GI Habitat Model can be viewed and the data can be downloaded at this link: https://scgiplan-gicinc.hub.arcgis.com/

Process Overview

The model can be broken into four steps.

STEP 1: The first step identifies areas that have the potential to be part of a habitat core, such as forests, wetlands, water bodies and dunes. Agricultural fields are not considered eligible to be in a core:

- 11 Open Water
- 31 Barren Land
- 41 Deciduous Forest
- 43 Evergreen Forest
- 71 Herbaceous
- 90 Wooded Wetlands
- 95 Emergent Wetlands

STEP 2: The second step brings together features including roads, urbanized area, buildings and railroads, all of which create significant disturbances and fragmentation effects. Any part of the habitat land (from Step 1) that is within 100 meters of a fragmenting feature is removed. Once this edge habitat is taken out, individual cores of interior habitat are identified by calculating their area in acres. Habitat patches of less than 10 acres are also deleted.

Habitat patches with areas ranging from 10 to 99 acres are then classified as habitat fragments and remain in the analysis, while habitat patches of 100 or more acres are classified as cores.

The corresponding edge habitat of each core or habitat fragment, which was previously removed to calculate the size of each core, is then added back in.

STEP 3: After the cores have been identified, in Step Three, a variety of statistics that describe each core are calculated and what is inside it, such as how many rare species there are. Some of these statistics are used in the final step to create a composite score that approximates each core's ecological integrity and quality.

STEP 4: The final step ranks each core based on those key attributes that were calculated in Step Three. Each core is ranked according to ten attributes: area (acres); thickness (how many feet across at its widest); topographic diversity (standard deviation of elevation); species richness (mean predicted number of species); percent wetland cover; soil diversity (number of SSURGO associations); compactness ratio (optimal shape); stream density (linear feet per acre); and abundance of rare, threatened, and endangered species (number of total observations), and the diversity of rare, threatened, and endangered species (number of unique species observed).

The habitat cores are then divided into five natural breaks for each of the attributes mentioned, and given a score based on which group each core falls into. In other words, the cores are ranked against each another and then divided into generally speaking; 20% aggregations. Note: quintiles were used in the original model – however, after comparison of the two approaches it was decided natural breaks put more importance on the best cores and more appropriately represented results.

Each core is then scored for every attribute, for a total of ten scores, each ranging from one to five. A score of one indicates that the core's score is lower than the 20th percentile when compared to the other cores being assessed. A score of five indicates that the core's score is higher than the 80th percentile.

Score (Core Score) –the core quality index value based on geometric values and soil variety, endemic species max, biodiversity priority index and ecological systems redundancy. Each core's ten scores are then summed, after being multiplied by the following weights:

Note that the resulting Core Quality Index (CQI) is relative and will not be comparable to results from another run of the model for a different location. For example, if two counties run the model individually, the results will not be comparable. However, if comparable results are desired, it is simply a matter of using the entire two-county region as the input area of interest. This approach avoids using hard thresholds that may not apply in all areas of the state, and also creates differentiation between core rankings within the area of interest where it may not exist if hard thresholds were used. This also allows localities to identify their best habitat relative to their area rather that compared to the entire state or region. This comparison could be made by running the model at two scales: for example, one local and one regional. For the outputs presented in this report, cores were compared within each of the ten Councils of Government and then these results were "stitched together" to form the final state model.

Attribute	Weight	Description/Rationale
Area	**0.4**	The raw surface area of a core is the single most important variable for supporting ecosystem functions.
Thickness	**0.1**	Core thickness measures the radius of the largest circle that can be drawn within each core, without going outside the core. Interior habitat is important for many species, and this metric is also a measure of fragmentation.
Topographic Diversity	**0.05**	There are higher diversity of communities where there is vertical stratification of land.
Species Richness	**0.1**	Predicted (modeled) number of species present, on average. Weight is less than actual observations (RTE Element Occurrences).
Percent Wetland Cover	**0.05**	Wetlands are some of the most productive ecosystems, and provide a number of benefits including wildlife and fish habitat, water filtration and erosion and flood control.
Soil Diversity	**0.03**	Contributes to a potential diversity of plant communities.
Compactness Ratio	**0.02**	The compactness ratio is the ratio between the area of the core and the area of a circle with the same perimeter as the core. This is one measure of 'roundness'; a circular core functions better than an elongated core because the depth to its interior is more consistent and it has less edge compared to interior (all other things being equal).
Stream Density	**0.1**	Streams within interior forests are more likely to contain pristine aquatic conditions than unforested streams, in addition to providing valuable habitat, a source of water, and improving water quality. The greater the density of surface waters the more aquatic habitat is likely, which relates to greater potential for more diverse species of flora and fauna.
RTE Species Abundance	**0.05**	The raw number of observations. Weighted less than the number of unique species observed (since there may be many observations of a single species). Only observations since 1980 are included. Older observations may no longer be accurate.
RTE Species Diversity	**0.1**	The number of unique species observed in the core. Only observations since 1980 are included. For example, if there are 10 observations of rare, threatened, and endangered species inside a core, but nine of them are of the same species, the Species Diversity score would be 2.

Dataset: Study_Area

Description: A polygon layer representing the area of interest (e.g., a county's boundary).

Dataset: LULC

Description: Land Use/Land Cover data, in a raster format. GIC used the National Land Cover Dataset 2019.

Acquisition: Available from the National Map viewer and download platform (National Land Cover Database).

Dataset: NWI_wetlands

Description: National Wetlands Inventory.

Acquisition: U.S. Fish and Wildlife Service state download portal.

Dataset: SSURGO_soils

Description: Soil Survey Geographic Database (SSURGO 2.2).

Acquisition: National Resource Conservation Service data gateway.

Dataset: National Hydrography Dataset

Description: The National Hydrography Dataset represents water features. The three pieces of the dataset used in this methodology are 'flowlines,' 'areas,' and 'waterbodies.' These are represented in three separate feature classes (hereafter referred to as NHD_flowline, NHD_area and NHD_waterbody).

Acquisition: The National Map viewer and download platform.

Dataset: species_richness

Description: Data created by adding Bird Richness plus Mammal Richness.

Acquisition: Data can be downloaded from https://biodiversitymapping.org/

Dataset: element_occurrences

Description: South Carolina Rare, Threatened, and Endangered Species inventory.

Acquisition: South Carolina Department of Natural Resources.

Dataset: dem

Description: A digital elevation model for the area of interest.

Acquisition: National Elevation Dataset (NED) distributed with ESRI GI Planning dataset 2017.

Dataset: roads

Description: Interstates, highways, and local roads.

Acquisition: South Carolina Department of Transportation GIS/Mapping portal.

Dataset: rr_tracks

Description: Railroad tracks.

Acquisition: South Carolina Department of Transportation GIS/Mapping portal.

Dataset: buildings

Description: Building locations

Acquisition: Microsoft AI Assisted Building Footprints used in Bing Maps. Can be downloaded from https://www.microsoft.com/en-us/maps/building-footprints

EndemicSpeciesMax (Endemic Species Max) – the maximum count of endemic species (trees, freshwater fish, amphibians, reptiles, birds, mammals) per core when overlaid with an Endemic Species dataset (10 KM) resolution from BiodiversityMapping.org.

Geometry score Acres (Acres) – core area in acres.

Class (Core Size Class) – the size class for each core (area – water). If < 100 acres = fragment, if < 1000 = small, if < 10000 = medium, if > 10K = large.

Thickness (Thickness) – represents the deepest or thickest point within each core. Essentially, it is the radius (in cells) of the largest circle that can be drawn within each core without including any cells outside the core. Cores with greater "depth or thickness" are preferred because they represent larger and potentially safer interior core areas.

Soil_Variety (Soil MUKey Variety) – the number of different SSURGO MUKEY units appearing within a core. These are map units from the Department of Agriculture's National Cooperative Soil Survey. Variety of soils is a surrogate for diversity in habitat potential. Greater variety should equate to greater habitat potential. Data have been collected over the last 100 years and are most intensively mapped in areas with high agricultural potential. Data are missing for many national forests, national parks and arid lands.

Topo_Std (Elevation Variability Standard Deviation) – the standard deviation of the topographic diversity from NED 30 meter resolution, using zonal statistics within a core. The presumption is that the larger the deviation, the greater the potential is for a diversity of habitat types.

Strm_Len_ft (Stream Length All (ft) (NHD)) – stream length (all types) in feet within a core. This captures the broadest possible collection of hydrologic features from the National Hydrography Dataset. These may over represent the presence and availability of water, particularly in the southwest. Strm_LenPerAcre (Stream Length All (ft) per Core Acre (NHD)) – stream length (all types) in feet within a core/core area in acres. This captures the broadest possible collection of hydrologic features from the National Hydrography Dataset.

WetlandsPct (Percentage Wetlands Area per Core (NWI)) – the percentage of wetlands (from NWI – includes "Estuarine and marine", "freshwater emergent", or "freshwater forested/shrub") within a core. This is expressed as a number ranging from 0.0 to 100. From the US Fish and Wildlife Service's National Wetlands Inventory http://www.fws.gov/wetlands/. Cores with more wetlands have better habitat potential than those with less.

Corridors

Corridors provide pathways for species' movement, forage, nesting and mating. Wider corridors are correlated with greater species' abundance and diversity. How wide is wide enough? The answer will depend on the ecosystem and the species, but generally wider is better. Ideally, interior habitat needs to be present for it to be a corridor. In forested landscapes, it is recommended that these connections are at least 300 yards wide. That includes a central 100-foot pathway width of interior habitat, with a 100-foot wide edge on either side to protect safe passage and buffer against human intrusion and invasive species. Streams are natural corridors and the width of the vegetative corridor on either side should reflect the stream order (i.e. larger streams need wider forested buffers).

Corridors were modeled using a series of "blockages" representing levels of obstructions or pathways that might present to a variety of flora and fauna. In this approach, the natural features (originally created for the habitat cores model Step 2) was used a base. The layer was then processed in ways resulting in several raster that could be used as a "limit" a creature might be able to traverse. A series of cost path analysis were then run to test the results these limits represented.

Steps:

Starting from the natural areas created in building the habitat cores (Step 2), three "Hard Rule" scenarios were applied.

1. **Width Rule:** Natural Areas were buffered in 2 pixels (approximately 180 feet) and then buffered back out 2 pixels. The result leaves areas more than 4 pixels wide (about 360 feet) that did not qualify as habitat cores but still viable routes for flow through.

2. **Water Rule:** Since roads are used to split the landscape, exceptions needed to be made where water bodies flowed under a road. Bridge data were tested but not adequate, so the rule used was simply if NHD Area polygons go under the road and continues to the other side, there is some type of flow. Cores connected by water were identified this way.

3. **Developed Open Space and Agriculture:** Since Agriculture can be a path for many species and developed open space represents a large range of features generally large open spaces they were added back to the natural features. Cores that can be linked via Agriculture and open spaces were identified.

Corridors are commonly thought of as linear paths fitting the above rules linking two places. However, the possibilities are limitless within the area of those bounding features. The modeled results were therefor manually interpreted from the spatial analysis results to more simply represent them in this report.

Further steps could be taken to evaluate point to point possibilities using a COST PATH analysis and the COST Surface method created in the original habitat cores model. In this process the surface of the earth is represented as a raster dataset with each cell in the raster having a numeric value, but instead of representing elevation (as in a digital elevation model) or a type of land cover, the value represents the level of effort required to move across that cell. However, the values have meaning only in relation to each other. In this case the "cost" to cross a road is large (and often lethal) whereas a stream running under a bridge provides a way for wildlife to safely cross underneath. Additional possibilities for the "Hard Rules" could be passage of certain size roads or even allowing low density residential as a traversable landcover type.

Overlay Maps

Themed overlay maps were created to show other values supported by the cores, as well as other green infrastructure resources such as agricultural soils that are important to people. The following data sources were used to create these themed overlays. As noted, planners and community groups also contributed some of the cultural and recreational data based on their local knowledge.

These asset maps were created and overlaid on the cores maps to show whether and how cores supported these recreational, scenic, historic or environmental values. The following data inputs were used to create the asset maps. These overlays are shown in the COG maps section of this report.

Asset Maps Shared Data

INPUTS

- Protected Lands
  — Data downloaded from The Nature Conservancy, July 2022
  — These data were categorized by ownership, indicating whether the land was protected by the federal or state government, and classifying the rest as "All Other Protected Lands."
- Lake/Pond, Reservoir, Rivers
  — Esri Data and Maps 2021
- State and County Boundaries
  — Esri Data and Maps 2021
- Highways, Major Roads, Railways, Airports
  — Esri Data and Maps 2021
- Populated Places
  — Esri Data and Maps 2021

Agriculture Maps & Data

INPUTS

- Agricultural Suitability Soils
  — Survey Geographic Database: "NonIrrigatedCapabilityClass", displaying classes ranked I and II.
- Agricultural Easements
  — The Nature Conservancy. This data was selected by the attribute "d_Des_Tp", and filtered to only show protected land classified as Agricultural Easements.

Water Maps & Data

INPUTS

- Public Water Supply Groundwater Protection Zones
  — South Carolina Department of Health and Environmental Control.
- Shellfish Management Areas
  — South Carolina Department of Health and Environmental Control.
- Public Water Supply Surface Intakes
  — South Carolina Department of Health and Environmental Control.
- Emergent Herbaceous Wetlands (2019)
  — National Land Cover Database NLCD 2019.
- Watershed Boundaries (HUC 10)
  — National Hydrography Dataset.
- 100 Year Flood Zones
  —FEMA Flood Insurance Risk Map

Recreation Maps & Data

INPUTS

- Public Access Protected Lands
  — The Nature Conservancy July 2022
- Carolina Thread Trial
  — Catawba Lands Conservancy.
- Scenic Byways
  — South Carolina Department of Transportation's ArcGIS page.
- Blueways
  — Data downloaded from compilation created by Paddle SC: https://www.gopaddlesc.com/paddle-sc
- Scenic Rivers
  — South Carolina Department of Natural Resources.
- Green Crescent Trail
  — City of Clemson partnered with the Town of Central and the Town of Pendleton
- Community-Identified Recreation Asset Paths
  — Trails delineated with reference to trails listed on TrailLink website: https://www.traillink.com/
- Palmetto Trail
  — Data obtained from Palmetto Conservation.
- East Coast Greenway
  — Data obtained from East Coast Greenway Alliance.
- Bike Trails
  — Florence County Planning Department.
- Swamp Rabbit Trail
  — Greenville County Planning Department.
- Beach Access Points
  — Data downloaded from the Department of Health and Environmental Control.
- Recreation Asset Points
  — United States Public Asset Database: https://www.usgs.gov/programs/gap-analysis-project/science/pad-us-data-download
- Community-Identified Recreation Asset Points
  — Data identified by workshop participants.

ANALYSIS

- All habitat cores that intersected with recreation assets were selected, after creating buffers for the features represented by points.

Culture Maps & Data

INPUTS

- Gullah-GeeChee Cultural Heritage Corridor
  — Data provided by the South Carolina Department of Natural Resources.
- Battlefield Boundaries:
  — Data obtained from the National Park Service American Protection Program, and the American Battlefield Trust.
- Intracoastal Waterway
  — Asset identified by Waccamaw COG stakeholders.
- Saint Helena's Cultural Overlay
  — Data provided by Lowcountry COG stakeholders.
- Community Preservation Districts
  — Data provided by Lowcountry COG stakeholders.
- Historic Fishing Sites
  — Data provided by Lowcountry COG stakeholders.
- National Register Sites
  — Data downloaded from the National Park Service's National Register of Historic Places.
  — All National Register sites encompassing 10 acres or greater were included with a few exceptions for smaller, unique sites requested by stakeholders.
- USPAD Sites
  — Data downloaded from the United States Public Access Database.
  — These assets were queried by keyword and category based on their relevance to GIC's display classes, with additional assets brought into the display as requested by stakeholders.
- Community-Identified Cultural Asset Points
  — Data identified by workshop participants.
- National Register Areas
  — National Register Polygons data downloaded from South Carolina Archsite, by The South Carolina Institute of Archaeology and Anthropology, and the South Carolina department of Archives and History.
- Scenic Byways
  — South Carolina Department of Transportation's ArcGIS page.
- Blueways
  — Data downloaded from compilation created by Paddle SC: https://www.gopaddlesc.com/paddle-sc
- Habitat cores from GIC analysis.
- Restricted archaeological sites downloaded from South Carolina ArchSite: http://www.scarchsite.org/

ANALYSIS

- All habitat cores that intersected with cultural assets were selected, after creating buffers for the features represented by points.

Risks

Development Maps & Data

INPUTS

- Protected lands data
  — Data received from The Nature Conservancy July 2022.

  — These areas were excluded from the development layer because of their protected land status.

- SLEUTH (Urban Growth Model) – to year 2060
  — This dataset represents the extent of urbanization (for the year 2060) predicted by the model SLEUTH, developed by Dr. Keith C. Clarke, at the University of California, Santa Barbara, Department of Geography and modified by David I. Donato of the United States Geological Survey (USGS) Eastern Geographic Science Center (EGSC). Further model modification and implementation was performed at the Biodiversity and Spatial Information Center at North Carolina State University. Downloaded from: https://databasin.org/datasets/e5860ced8b4844e88431cdbefe425e1a/

RESULTS

- Ranked as HIGH if development reduces size of core to smaller than 100 acres.
- Ranked as MODERATE if development covers more than 20% of core.
- Otherwise risk is LOW.

Solar Development Maps & Data

INPUTS

- Argonne Lab's Solar Site Suitability Analysis
  —The main purpose of the EISPC Energy Zones (EZ) Study was to develop a comprehensive mapping tool that would enable EISPC members and other stakeholders to identify areas within the U.S. portion of the Eastern Interconnection that are suitable for the development of clean (low- or no-carbon) electricity generation. GIC used solar site suitability as a risk due to the potential for conversion of habitat cores into land developed for power generation.
  —Download tool: https://ezmt.anl.gov/

- Areas to exclude as suitable from the model as determined by the local stakeholder committees are as follows:
  — Wetlands
  — Protected lands

RESULTS

- Wetlands and protected lands were excluded.
- Ranked as HIGH where risk is 55% and above.
- Ranked as MODERATE where risk is 45%-55%.
- Ranked as LOW where risk is less than 45%.

Sea Level Rise Maps & Data

INPUTS

- NOAA 2017 sea level rise data.
  —The intermediate-high curve was chosen based on the likelihood of occurring in the future and from feedback from local and state stakeholders that this is the most commonly used curve for long-range planning in coastal regions. The curve showed 2 feet rise by 2060. NOAA's sea level rise curves can be found at the following link: https://coast.noaa.gov/slrdata/

RESULTS

- Risk ranked as HIGH where habitat core covered by sea level rise.
- Risk ranked as LOW if no sea level rise.

Storm Surge Maps & Data

INPUTS

- NOAA storm surge data.
  —This national depiction of storm surge flooding vulnerability helps people living in hurricane-prone coastal areas along the U.S. East and Gulf Coasts, Puerto Rico, U.S. Virgin Islands (USVI), Hawaii, and Hispaniola to evaluate their risk to storm surge hazard. https://www.nhc.noaa.gov/nationalsurge/

  —Data from NOAA SLOSH Model for Storm Surge Category 3.

RESULTS

- Risk ranked as HIGH where habitat core covered by storm surge.
- Risk ranked as LOW if no storm surge.

Impaired Waters Maps & Data

INPUTS

- 2018_Water_Quality_Assessments_and_303(d)_list
  —Provide locations of stations assessed for the 2018 303(d) list.

  —These points represent the location of water quality monitoring sites with data assessed during the 2018 303(d) listing cycle. The impairment(s), if any, is(are) identified in a column by site.

RESULTS

- These points were only used for reference. (There were not results associated with this map)