CHAPTER 10: SOUTH CAROLINA – A REGIONAL PERSPECTIVE

In 2018, the Association of Fish and Wildlife Agencies (AFWA) adopted a resolution on landscape conservation that recognized "the importance of collaborating at landscape scales to help fish and wildlife agencies meet their statutory and regulatory responsibilities to conserve fish and wildlife and their habitats." In response to the resolution, AFWA established a President's Task Force on Shared Science and Landscape Conservation Priorities in 2020, which recommended that State Wildlife Action Plans (SWAPs) serve as a framework for regional coordination and collaboration.

Within this Plan, South Carolina has identified Species of Greatest Conservation Need (SGCN) and outlined strategies to sustain them, including conservation actions to promote species recovery and prevent federal listings under the Endangered Species Act. But to sustain the species that are South Carolina's responsibility to protect—and that also reflect the rich biodiversity, culture, and history of the State—South Carolina must consider its role and the influences of the larger Southeast landscape.

This chapter examines regional, landscape-scale considerations for South Carolina and serves as a means for the State to find potential collaborations to best support the State's SGCN and Regional SGCN (RSGCN). Additionally, some of the threats that impact SGCN (e.g. climate change) have consequences locally, statewide, and regionally. Addressing these threats effectively requires aligning conservation strategies across state boundaries. By using consistent regional information shared by other states to inform their own SWAPs, South Carolina can better contribute to regional conservation priorities, identify potential landscape-level threats, and help connect the Southeast Region's lands and waters.

South Carolina's Conservation Portfolio: Connecting the Region's Lands & Waters

South Carolina supports a wide diversity of habitats, culturally and historically significant landscapes, and ecosystems that provide benefits to the State as well as the broader Southeast Region. South Carolina plays an important role in connecting the lands and waters of the Southeast Region, as well as hosting regionally important ecosystems and habitat types like salt marsh and longleaf pine. Many regional and local partners and partnerships are working with the South Carolina Department of Natural Resources (SCDNR) to help conserve the State's iconic landscapes. The Nature Conservancy's South Carolina Chapter (SC TNC) manages the best available dataset depicting protected conservation lands within the State. Based on this dataset, more than 3.1 million acres (15%) of the State are considered protected with more in queue for protection. This includes important landscapes like National Wildlife Refuges, National Forests, State Wildlife Management Areas (WMAs) and Heritage Preserves (HPs), State Parks, and private conservation easements.

In addition to contributing to the conservation landscape of the Southeast, South Carolina's lands and waters also benefit the State's economy. In 2023, the Bureau of Economic Analysis estimated that the outdoor recreation economy generated $8.6 billion in value for the State's Gross Domestic Product and another $4.2 billion in wages and salaries (US Bureau of Economic Analysis for Outdoor Recreation 2024). Beyond providing recreational value, natural landscapes also support working lands such as agriculture and timber. As of 2023, South Carolina supported more than 4.6 million acres of farmland across 22,600 farms, and crop production alone was valued at more than $908 million (US Department of Agriculture 2024).

Birdwatching is one of the most popular ecotourism activities in the world (Schwoerer and Dawson 2022).

Fly fishing in the Congaree River just below the confluence of the Broad and Saluda Rivers.
Photo by Stewart Grinton, SCDNR, ret.

South Carolina and the Southeast Conservation Adaptation Strategy (SECAS)

The Southeast Conservation Adaptation Strategy (SECAS) is a regional conservation initiative that spans the Southeastern United States and Caribbean. SECAS brings together diverse partners around an ambitious goal: a 10% or greater improvement in the health, function, and connectivity of Southeastern ecosystems by 2060. The Southeast Conservation Blueprint is the primary product of SECAS. The Blueprint is a living, spatial plan that identifies priority areas where conservation action would make an impact toward creating a connected networks of lands and waters, based on a suite of natural and cultural resource indicators and a connectivity analysis.

As of May 2025, more than 2,500 people from over 650 different organizations have been actively involved in developing the Blueprint. At least 37 staff from SCDNR alone have participated in workshops to review and improve the Blueprint, along with many other conservation practitioners from across the State. Since 2014, the Blueprint has been used by a broad suite of partners to inform many different conservation actions across the State. For example, since 2018 the Blueprint has been used to help inform the South Carolina Conservation Bank, a statewide land authorization and funding source. South Carolina DNR staff have used the Blueprint to guide the creation of this SWAP's Conservation Opportunity Areas and where to focus land protection efforts through various acquisition grant programs.

Maps of the Blueprint (v. 2024) and other regional data are provided within this chapter. These maps also include a boundary that extends beyond the State (a "bleed-over") and includes watersheds where South Carolina shares a conservation or species management interest with its neighboring states. This boundary was developed by identifying all watersheds (HUC 8) within 1.5 kilometers of the State boundary and then selecting shared watersheds of conservation interest with SCDNR staff and partners from the Southeast Aquatic Resources Partnership (SARP). By looking beyond the State's boundaries, South Carolina can consider how to best align conservation actions and identify cross-jurisdictional opportunities with neighboring states to maximize benefits for SGCN with wider ranges.

The Blueprint recognizes more than 10.64 million acres, or roughly 51% of the State, as a priority for connecting the region's lands and waters (Table 10-1, Figure 10-1). About 5.18 million acres are rated as highest or high priority. An additional 4.3 million acres are rated as medium priority. An additional 1.15 million acres are considered priority connections, or key linkages (corridors) between priority areas that can help facilitate the flow of species and ecological processes within the State while also considering connectivity within the broader region. Together, these classes represent important areas for shared conservation action to connect lands and waters and improve ecosystem health. The Blueprint includes about 60 indicators that represent both natural and cultural resources and collectively represent ecosystem health, function, and connectivity across terrestrial, freshwater, coastal, and marine systems. Examples include imperiled aquatic species, cores of intact natural habitat, natural floodplain landcover, prescribed fire frequency, and more. Indicator data is available on the Blueprint page of the SECAS Atlas.

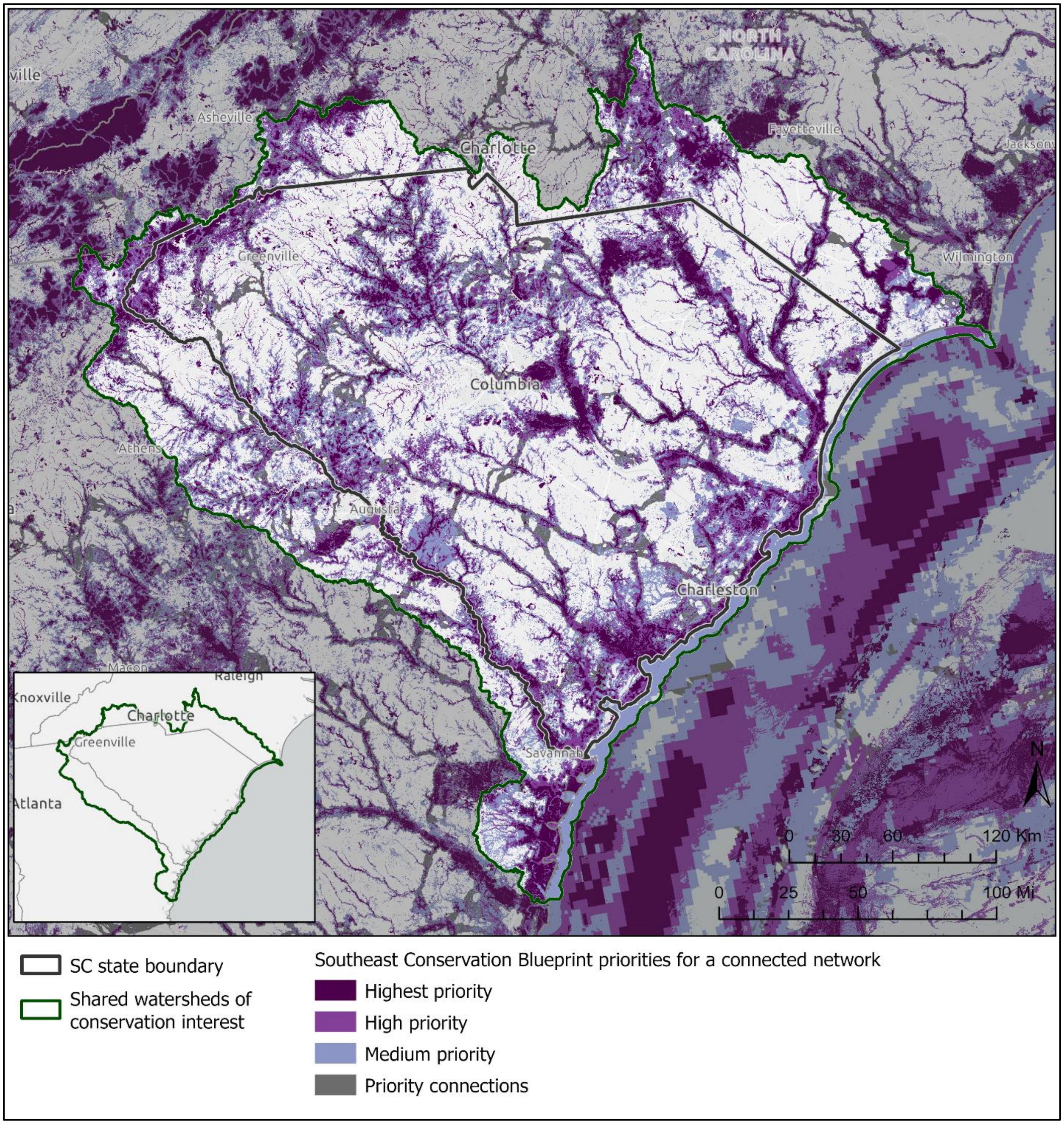


FIGURE 10-1: Southeast Blueprint (v. 2024) priorities within South Carolina and surrounding watersheds of conservation interest shared with Georgia and North Carolina.

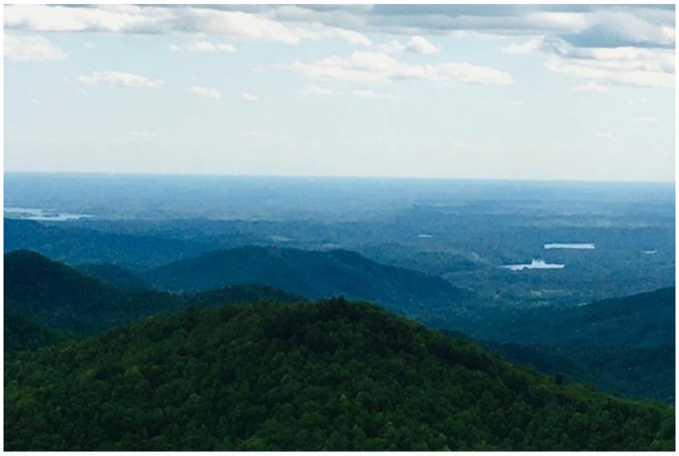
Based on the conserved lands database that is managed by SC TNC, the vast majority (88%) of the States's conserved lands are identified within the Blueprint as a priority for a connected network of lands and water (Table 10-1). This means that while these conserved areas are contributing to the State's conservation portfolio—and represent unique habitats and locally important areas—they are also contributing to a wider regional conservation strategy. The State's conservation portfolio exemplifies a complementary landscape-scale approach to conservation that links local actions with conservation outcomes that contribute at a broader geographic scale.

TABLE 10-1: Lands and waters considered protected within South Carolina. These numbers are estimates based on the Conserved Lands Database managed by SC TNC (accessed January 27, 2025) and may not reflect the most up-to-date information.

Priority for a connected network	Acres of each Blueprint (v. 2024) priority category within SC	Acres of conserved lands (SC TNC) prioritized in the Blueprint and their percentage of total protected lands
Highest	2,189,951 (10.7%)	1,019,339 (34%)
High	2,994,812 (14.6%)	802,619 (26%)
Medium	4,309,630 (21%)	771,028.17 (25%)
Priority connections	1,150,540 (5.6%)	79,452 (3%)
Lower priority	9,850,093 (48.1%)	368,488 (12%)
Total	**20,495,027 (100%)**	3,040,926 **(100%)**

The Southeast Blueprint also includes a least-cost path connectivity analysis that identifies corridors that link coastal and inland areas and span climate gradients. The corridors connect hubs across the shortest distance possible, while also routing through as much Blueprint priority as possible. The hubs that anchor the connectivity analysis are large patches of highest priority Blueprint areas and/or protected lands. About 6.7 million acres (33%) are considered either a hub or a corridor, providing opportunities to support species movement and migration—an important strategy for helping wildlife adapt to landscape-level changes (Figure 10-2).

Ensuring landscape connectivity across jurisdictional boundaries is becoming increasingly important for species management as changes in land use, climate, and weather patterns shift species distributions. Collaborating with the neighboring states of Georgia and North Carolina to identify cross-boundary species migration and habitat pathways can increase regional connectivity for state SGCN.



The Blue Ridge Mountains of South Carolina. Photo by Anna Smith, SCDNR

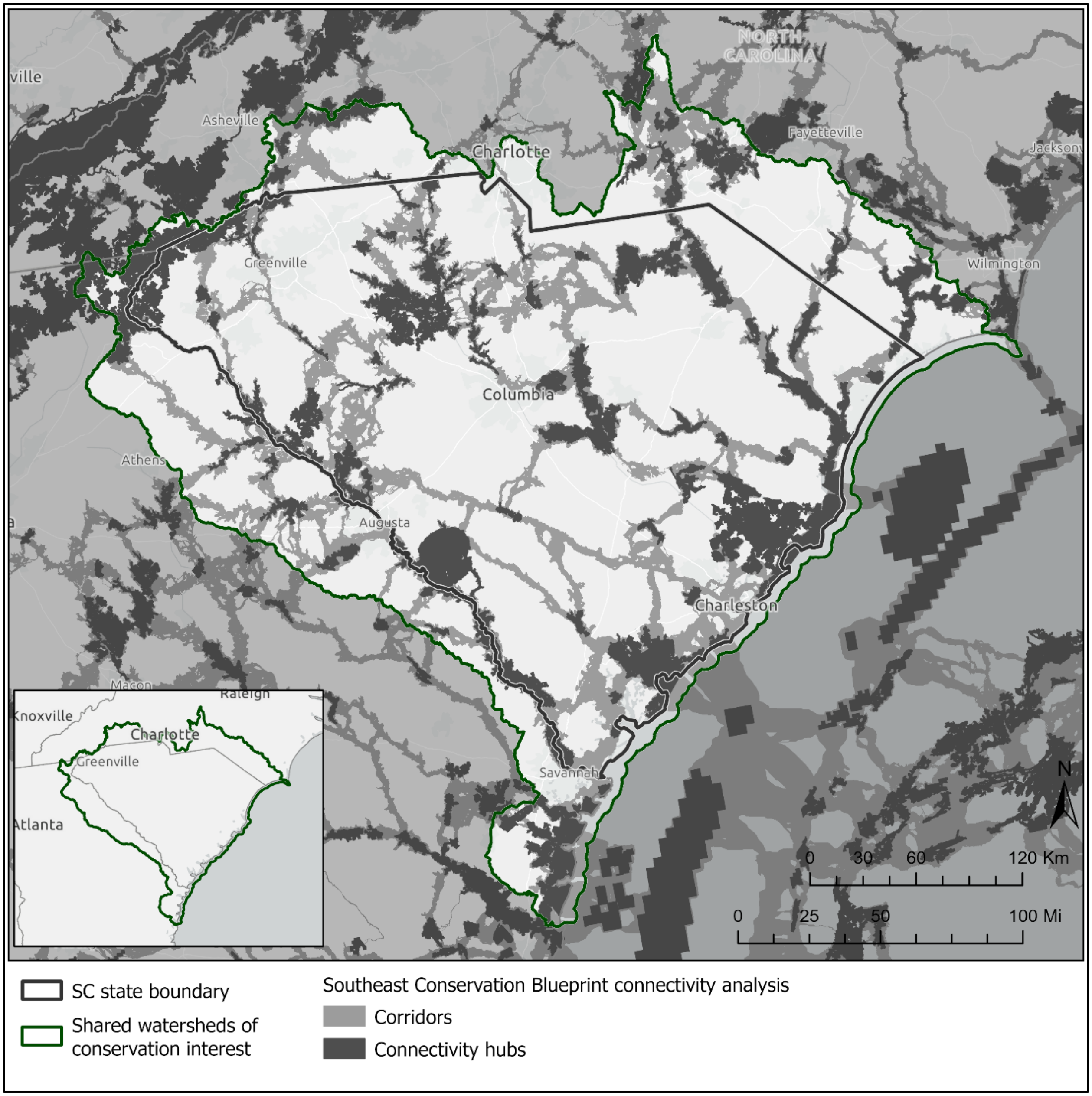


FIGURE 10-2: Southeast Blueprint connectivity analysis (v. 2024) showing hubs and corridors in South Carolina and surrounding watersheds shared with Georgia and North Carolina. The Blueprint uses a least-cost path connectivity analysis to identify corridors that link hubs across the shortest distance possible, while also routing through as much Blueprint priority as possible. In the continental Southeast, hubs are large patches (~5,000+ acres) of highest priority Blueprint areas and/or protected lands.

One lens to characterize the landscape of South Carolina is by its ecoregions, as defined in Chapter 2. Ecoregions are identified by analyzing areas where ecosystems and the type, quality, and quantity of environmental resources are generally similar. Evaluating ecoregions that South Carolina shares with its neighbors is one way to identify cross-boundary conservation opportunities, as these areas share similar mosaics of biotic, abiotic, terrestrial, and aquatic ecosystems. The table below show how much of each ecoregion within the State is prioritized in the Southeast Blueprint. In particular, the Blue Ridge and Coastal Zone ecoregions support significant Blueprint priorities.

TABLE 10-2: Amount of ecoregion prioritized by the Southeast Blueprint (2024).

South Carolina ecoregions	Acres of ecoregion prioritized by the Blueprint	Percent of ecoregion within SC prioritized by the Blueprint
Blue Ridge	263,617.10	89%
Piedmont	3,491,609.88	51%
Sandhills	1,387,638.49	58%
Coastal Plain	3,805,040.91	43%
Coastal Zone	1,076,588.42	82%

South Carolina and the SECAS Goal

Through SECAS, partners work together to design and achieve a connected network for the benefit of ecosystems, species, and people, and to achieve the SECAS goal: a 10% or greater improvement in the health, function, and connectivity of Southeastern ecosystems by 2060. The work of SCDNR and conservation partners within the State help advance this goal. In addition to the Southeast Blueprint, SECAS releases an annual report—Recent Trends in Southeastern Ecosystems—that assesses progress toward the SECAS goal using the best available data. This report assesses progress toward the SECAS goal using information from existing monitoring programs and is intended to facilitate discussion around conservation actions needed to meet the goal.

Recent Trends in Southeastern Ecosystems (2024) synthesizes 13 different assessments to evaluate 20 indicator trends. Some assessments, like eBird, inform multiple indicators. Assessments encompass a range of sources from remotely sensed data like the National Land Cover Database to long-term citizen science monitoring programs like eBird. States can use this SECAS goal report to assess their own progress (Table 10-3) and overall trends for the broader Southeast Region. However, not all SECAS goal indicators can be assessed at the state level because they do not apply to the geography or because of limitations with the source information used to inform the indicators. Out of the total 20 SECAS goal indicators, 14 are assessed for the State. Tables 10-4, 10-5, 10-6, and 10-7 then go into the species driving Southeastern states' progress towards the four bird category goals.

Like other states in the Southeast, South Carolina has:

- Increases in forested wetland birds, longleaf pine area, upland forest birds, working lands conservation, and water quality.
- Declines in areas without invasive plans, beach birds, grassland and savanna area, grassland and savanna birds, salt marsh area, landscape condition, undeveloped land in corridors, and natural landcover in the floodplain.

Unlike other states in the Southeast, South Carolina has:

- A decline instead of increase in forested wetland area.

- Much smaller increases in forested wetland birds, longleaf pine area, and upland forest birds.
- Greater increases in water quality. Of the 15 states and territories assessed, only 8 had improvements. South Carolina, North Carolina, and Georgia had the largest improvements.

TABLE 10-3: Overview of recent trends in ecosystem indicators comparing South Carolina and the Southeastern US. Indicators shown in green are on track to meet the goal (≥1% increase every 4 years); indicators shown in yellow (<1% increase) and red (declines) are not.

Ecosystem	Type	Indicator	South Carolina yearly % change	Southeast yearly % change
Terrestrial				
	Health	Areas without invasive plants	0.25% decline	0.33% decline
		Beach birds	1.67% decline	1.42% decline
		Forested wetland area	0.03% decline	0.08% increase
		Forested wetland birds	1.65% increase	2.85% increase
		Grassland & savanna area	0.55% decline	0.31% decline
		Grassland & savanna birds	2.1% decline	2.2% decline
		Longleaf pine area	1.63% increase	4.5% increase
		Salt marsh area	0.01% decline	0.03% decline
		Upland forest birds	0.18% increase	0.98% increase
	Function	Working lands conservation	7.24% increase	11% increase
	Connectivity	Landscape condition	0.02% decline	0.02% decline
		Undeveloped land in corridors	0.03% decline	0.02% decline
Freshwater				
	Health	Natural landcover in floodplains	0.01% decline	0.008% decline
	Function	Water quality	0.03% increase	0.003% increase

TABLE 10-4: BEACH BIRDS. Goal status by state for each beach bird species from 2012-2022, abbreviated for space. "Increase/off track" indicates a small increase insufficient to meet the goal, while "increase/on track" indicates a larger increase. "High" indicates higher confidence and "low" indicates lower confidence in the trend. Selected bird species are Southeast Regional Species of Greatest Conservation Need (RSGCN) associated with this habitat and with sufficient data for eBird trend analysis.

	American Oystercatcher	**Black Skimmer**	**Gull-billed Tern**	**Least Tern**	**Piping Plover**	**Royal Tern**	**Willet**
AL	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Decline | Off track | Low	Decline | Off track | High
AR				Decline | Off track | High			
FL	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | Low	Decline | Off track | High
GA	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Decline | Off track | High	Decline | Off track | High
KY				Decline | Off track | Low			
LA	Increase | On track | Low	Decline | Off track | High	Increase | On track | High	Decline | Off track | High		Increase | On track | High	Decline | Off track | High
MO				Decline | Off track | High			
MS	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | High		Decline | Off track | High	Decline | Off track | High
NC	Increase | On track | Low	Decline | Off track | High	Increase | On track | Low	Increase | Off track | Low	Decline | Off track | High	Increase | On track | High	Decline | Off track | High
OK				Decline | Off track | High			Decline | Off track | High
SC	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Decline | Off track | High	Decline | Off track | High
TN				Decline | Off track | High			

TX	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Increase | On track | High	Decline | Off track | High
VA	Decline | Off track | Low	Decline | Off track | Low	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High
PR	Increase | On track | High		Increase | On track | Low	Increase | On track | High		Increase | On track | High	Decline | Off track | High
VI	Increase | On track | High			Increase | On track | High		Increase | On track | Low	

TABLE 10-5: FORESTED WETLAND BIRDS. Goal status by state for each forested wetland bird species from 2012-2022, abbreviated for space. "Increase/off track" indicates a small increase insufficient to meet the goal, while "increase/on track" indicates a larger increase. "High" indicates higher confidence and "low" indicates lower confidence in the trend. Selected bird species are Southeast Regional Species of Greatest Conservation Need (RSGCN) associated with this habitat and with sufficient data for eBird trend analysis.

	Prothonotary Warbler	**Swainson's Warbler**	**Swallow-tailed Kite**	**Yellow-throated Warbler**
AL	Increase | On track | Low	Increase | On track | High	Increase | On track | High	Increase | On track | High
AR	Increase | On track | High	Increase | On track | High		Increase | On track | High
FL	Decline | Off track | High	Decline | Off track | Low	Increase | On track | High	Increase | On track | Low
GA	Increase | Off track | Low	Increase | On track | High	Increase | On track | High	Increase | On track | High
KY	Increase | On track | High	Increase | On track | High		Increase | On track | High
LA	Decline | Off track | Low	Increase | On track | High	Increase | On track | High	Increase | On track | High
MO	Increase | On track | High	Increase | On track | High		Increase | On track | High
MS	Increase | On track | High	Increase | On track | High	Increase | On track | High	Increase | On track | High
NC	Decline | Off track | Low	Increase | On track | High	Increase | On track | High	Increase | On track | High
OK	Increase | On track | High	Increase | On track | High		Increase | On track | High
SC	Decline | Off track | Low	Increase | On track | High	Increase | On track | High	Increase | On track | High

TN	Increase | On track | High	Increase | On track | High		Increase | On track | High
TX	Increase | On track | High	Increase | On track | High	Increase | On track | High	Increase | On track | High
VA	Decline | Off track | Low	Increase | On track | High		Increase | On track | High
WV	Increase | On track | High	Increase | On track | High		Increase | On track | Low

TABLE 10-6: GRASSLAND & SAVANNA BIRDS. Goal status by state for each grassland and savanna bird species from 2012-2022, abbreviated for space. "Increase/off track" indicates a small increase insufficient to meet the goal, while "increase/on track" indicates a larger increase. "High" indicates higher confidence and "low" indicates lower confidence in the trend. Selected bird species are Southeast Regional Species of Greatest Conservation Need (SGCN) associated with this habitat and with sufficient data eBird trend analysis.

	American Kestrel	**Eastern Meadowlark**	**Grasshopper Sparrow**	**Loggerhead Shrike**	**Northern Bobwhite**	**Prairie Warbler**	**Red-cockaded Woodpecker**	**Scissor-tailed Flycatcher**
AL	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | Low	Decline | Off track | High
AR	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Increase | On track | High	Decline | Off track | High
FL	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	
GA	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High
KY	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Decline | Off track | High
LA	Decline | Off track | High	Decline | Off track | High		Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High
MO	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Decline | Off track | High
MS	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | Low	Decline | Off track | High

NC	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Increase | On track | Low	Increase | On track | Low
OK	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Increase | On track | High	Increase | On track | High	Decline | Off track | High
SC	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | Low
TN	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High		Decline | Off track | High
TX	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Increase | Off track | Low	Increase | On track | Low	Decline | Off track | High
VA	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Increase | On track | High	Decline | Off track | High
WV	Decline | Off track | Low	Decline | Off track | High	Decline | Off track | High	Decline | Off track | High	Decline | Off track | Low	Decline | Off track | High		Decline | Off track | High
PR	Decline | Off track | Low		Decline | Off track | High					
VI	Decline | Off track | Low							

TABLE 10-7: UPLAND FOREST BIRDS. Goal status by state for each upland forest bird species from 2012-2022, abbreviated for space. "Increase/off track" indicates a small increase insufficient to meet the goal, while "increase/on track" indicates a larger increase. "High" indicates higher confidence and "low" indicates lower confidence in the trend. Selected bird species are Southeast Regional Species of Greatest Conservation Need (RSGCN) associated with this habitat and with sufficient data for eBird trend analysis.

	Cerulean Warbler	**Louisiana Waterthrush**	**Wood Thrush**	**Worm-eating Warbler**
AL	Decline | Off track | High	Increase | On track | High	Increase | On track | High	Decline | Off track | High
AR	Increase | On track | High	Increase | On track | High	Increase | On track | High	Decline | Off track | Low
FL		Decline | Off track | Low	Increase | On track | High	
GA	Decline | Off track | High	Increase | On track | High	Increase | On track | High	Decline | Off track | High

KY	Decline | Off track | High	Increase | On track | Low	Increase | On track | High	Decline | Off track | High
LA		Increase | On track | Low	Increase | On track | High	Increase | On track | Low
MO	Decline | Off track | High	Decline | Off track | Low	Increase | On track | High	Decline | Off track | High
MS	Decline | Off track | Low	Increase | On track | High	Increase | On track | High	Decline | Off track | High
NC	Decline | Off track | High	Increase | On track | Low	Increase | On track | High	Decline | Off track | High
OK	Increase | On track | Low	Increase | On track | High	Increase | On track | High	Decline | Off track | High
SC	Decline | Off track | High	Increase | On track | High	Increase | On track | High	Decline | Off track | High
TN	Decline | Off track | High	Increase | Off track | Low	Increase | On track | High	Decline | Off track | High
TX		Increase | On track | High	Increase | On track | High	Increase | On track | High
VA	Decline | Off track | High	Increase | On track | Low	Increase | On track | High	Decline | Off track | High
WV	Decline | Off track | Low	Increase | On track | High	Increase | On track | High	Decline | Off track | High

Regional Species of Greatest Conservation Need

Each State's wildlife action plan identifies SGCN, or the species most in need of proactive conservation attention (see Chapter 6 for a list of South Carolina's SGCN). After the 2015 SWAP revisions, nearly 6,700 SGCN were identified by the states and territories of the SEAFWA region (Rice et al. 2019).

However, many SGCN occur across multiple states. Effectively managing and conserving these species requires actions and management strategies that will best allow for species movement and ensure the availability of key ecological attributes provided by different habitats across the landscape at different times. To help support long-term conservation goals for imperiled plant and animal species, conservation partners have developed Regional Species of Greatest Conservation Need (RSGCN) lists.

Animal RSGCN

In 2019, the National Wildlife Federation, as part of the Vital Futures project funded by the US Geological Survey, prioritized the large number of SGCN collectively identified in the previous iteration of 15 Southeastern SWAPs. Across the 15 Southeastern states, the combined lists of SGCNs totaled nearly 6,700 species (Rice et al. 2019, National Wildlife Federation 2023).

The Southeastern Association of Fish and Wildlife Agencies (SEAFWA) Wildlife Diversity Committee collaborated with the National Wildlife Federation and other partners to evaluate these species and produce a final list of 960 regional priority species (1,034 including subspecies), or animal RSGCN. A report, "Regional Species of Greatest Conservation Need in the Southeastern United States," was written to detail the methodology used to develop the RSGCN list (Rice et al. 2019). A dataset for the RSGCN list is available online (Georgia Department of Natural Resources 2024). This effort aligns with the Northeast Association of Fish and Wildlife Agencies' similar project to develop a RSGCN list for the Northeast Region.

Identifying animal RSGCN drew upon a collaborative process among Southeastern state fish and wildlife agencies and partners that involved more than 100 experts and used a set of consistent criteria to review current scientific information and evaluate state-identified SGCN. Species were evaluated based on several primary factors, including: 1) the level of conservation concern (i.e. extinction risk), 2) regional stewardship responsibility (i.e. importance of the Southeast in conservation of the species), and 3) biological or ecological significance (e.g. unique evolutionary lineages). The regional assessment focused on species in key taxonomic groups, including vertebrates (mammals, birds, reptiles, amphibians, and fishes) as well as several better-known groups of invertebrate animals (freshwater mussels, crayfish, and bumblebees) (Table 10-8). Scientific experts in each of these groups convened to evaluate and identify those species that warranted identification as a regional priority. Additionally, the science teams characterized the level of conservation concern for each regional priority, ranging from "moderate" to "high" to "very high" concern. Through this established process, the RSGCN list can be updated as the States' SGCN lists change over time.

The number of RSCGN that are considered the stewardship responsibilities of each state varies widely. These patterns reflect the underlying diversity of species in each state—particularly the number of imperiled and/or limited range species—which is also influenced by a state's size and diversity of habitats. These patterns are also influenced by the "regional stewardship responsibility" criterion in the assessment of priority species.

Nearly 70% of regional priority species are endemic to the 15-state SEAFWA region. Overall, more than half (55%) of RSGCN are shared by three or more states, presenting opportunities for cross-state conservation collaboration. The remaining 45% of RSGCN have narrow ranges and are found in just one or two states. By taxa, fish and crayfish represent 47% of all RSGCN within the region. Many aquatic habitats and ecosystems within the Southeast are highly fragmented, resulting in severe limitations to ecosystem integrity and species persistence regionwide. Habitat fragmentation in rivers and streams is a determining factor in the decline in abundance of numerous species such as Eastern Brook Trout, freshwater mussels, and amphibians such as Eastern Hellbender.

TABLE 10-8: List of Southeast animal RSGCN by taxa and their level of concern ("very high", "high", or "moderate"). Fish have the most species categorized as "very high concern" and represent 30% of all RSGCN within the Southeast region.

Animal RSGCN taxonomic group	Very high concern	High concern	Moderate concern	Total
Amphibians	30	52	34	116 (11%)
Birds	10	56	18	84 (8%)

Bumblebees	2	1	2	5 (.4%)
Crayfish	53	86	34	173 (17%)
Fishes	101	120	96	317 (30%)
Mammals	18	37	30	85 (8%)
Mussels	69	55	13	139 (13%)
Reptiles	18	58	39	115 (11%)
Total	**302**	**466**	**266**	**1,034 (100%)**

Plant RSGCN

The Southeast is home to more than 11,000 native plant species, 30% of which are endemic, meaning they are found only in the Southeast). In 2023 the Southeast Plant Conservation Alliance (PCA) released the first plant RSGCN list in the nation. The PCA worked with a broad coalition of partners including the Atlanta Botanical Garden, NatureServe, and Terwilliger Consulting, and received funding from the US Fish and Wildlife Service. This list narrows down the vast number of plants native to the Southeast to 1,824 species that are a regional conservation priority based on criteria such as rarity, threats, and needed conservation actions. The plant RSGCN list complements the Southeastern animals RSGCN list developed in 2019 to create a more complete picture of the region's exceptional biodiversity.

To develop a pool of potential species to draw from, the PCA worked with NatureServe to compile a list of more than 10,000 vascular plants native to any of the SEAFWA states considering each species' G-Rank (global rarity), S-Rank (subnational or state rarity) and endemism. Unfortunately, due to data limitations, plants native to Puerto Rico and the US Virgin Islands could not be included.

The full list received extensive review from botany experts, a technical team composed of representatives from each state, and NatureServe. Based on partner feedback, the technical team assigned each species a level of conservation concern rating ranging from "low" to "very high" or "manual review needed" (Figure 10-3). Any plant scoring "moderate" or above was ultimately considered an RSGCN. After cleaning the data to remove redundancies, the complete Southeastern plant list evaluated 9,271 species and prioritized 1,824 as RSGCN with 72% of the plant RSGCN are endemic to the Southeast.

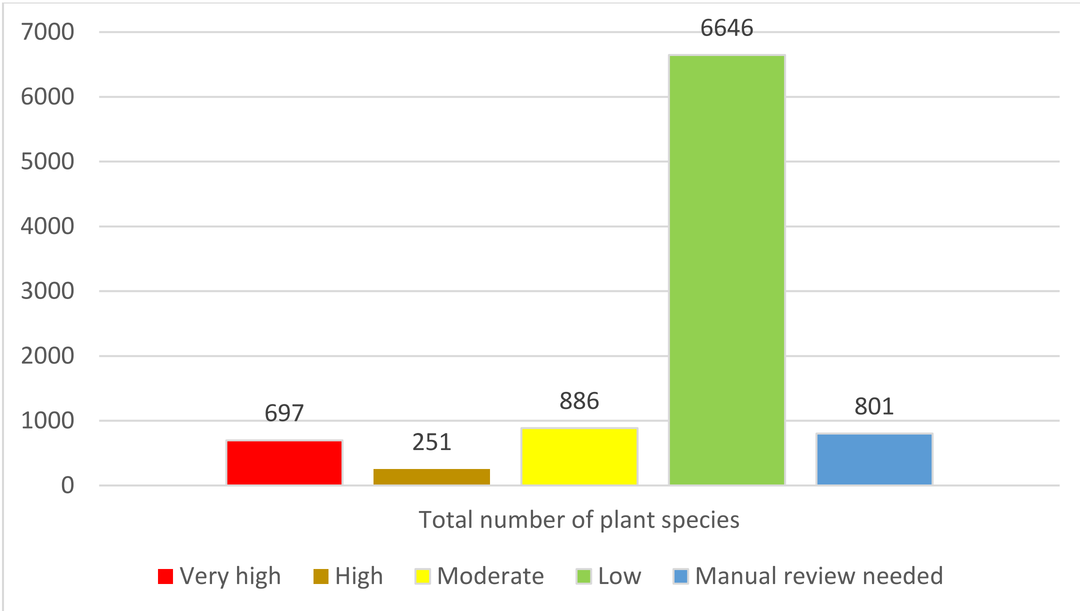


FIGURE 10-3: Plants with a very high, high, or moderate level of conservation concern are considered plant RSGCN

To better understand shared plant needs and threats at the ecosystem level, the PCA cross-walked each plant RSGCN to its primary habitats using US National Vegetation Classification (USNVC) "Groups" (Tables 10-9 and 10-10). The USNVC provides a widely used, standardized system of classifying vegetation types and habitats. The distribution of RSGCN across ecosystems demonstrates their diversity and broad geographic extent. A total of 31 USNVC Groups contained at least 10 plant RSGCN, indicating that many of the region's ecosystems support plant species of conservation need. As many of these same habitats tend to provide crucial habitat for animal RSGCN as well, conserving these ecosystems can safeguard regional biodiversity more broadly.

TABLE 10-9: The top 15 U.S. National Vegetation Group Assignments for all Southeast plant RSGCN, showing longleaf ecosystems supporting this highest number of priority plants.

USNVC groups serving as primary habitat	Number of plant RSGCN
Wet-Mesic Longleaf Pine Open Woodland	80
Xeric Longleaf Pine Woodland	43
South Florida Slash Pine Rockland	29
Central Interior Alkaline Open Glade & Barrens	29
Appalachian - South-central Interior Mesic Forest	28
Tamaulipan Dry Mesquite & Thornscrub	28
South Atlantic & Gulf Coastal Plain Pondshore & Wet Prairie	22
Blackland & Coastal Tallgrass Prairie	21
Florida Xeric Scrub	18
South Atlantic & Gulf Coastal Dune & Grassland	17
Atlantic & Gulf Coastal Plain Seep	16
Southern Coastal Plain Mixed Evergreen Swamp	13
Southern Mesic Beech - Oak - Mixed Deciduous Forest	12
Southern Appalachian Rocky Outcrop	11
Southeastern Coastal Plain Barrens & Glade	9
Central Interior-Appalachian Riverscour Barrens & Prairie	9
Caribbean Hardwood Hammock & Coastal Strand Forest	9
Coastal Live Oak - Hickory - Palmetto Forest	9
Appalachian Mafic Barrens	8
Central & Southern Appalachian Seep	8

TABLE 10-10: The USNVC groups serving as primary habitat that support the most plant RSGCN within South Carolina (“very high” and “high” concern only).

USNVC groups serving as primary habitat	Number of plant RSGCN
Wet-Mesic Longleaf Pine Open Woodland (G190)	34
Appalachian - South-central Interior Mesic Forest (G020)	12
South Atlantic & Gulf Coastal Plain Pondshore & Wet Prairie (G915)	11
Xeric Longleaf Pine Woodland (G154)	10
Atlantic & Gulf Coastal Plain Seep (G187)	6
Piedmont-Coastal Plain Oak Forest & Woodland (G165)	4
Southern Appalachian Rocky Outcrop (G670)	4
Southern Mesic Beech - Magnolia - Oak Forest (G007)	3
Southeastern Coastal Pocosin & Shrub Bog (G186)	3
South Atlantic & Gulf Coastal Plain River & Basin Freshwater Marsh & Wet Meadow (G188)	3

By far the USNVC group that supports the most plant RSGCN within the State is wet-mesic longleaf open woodland. These wet open woodlands occur within coastal plains and include wet pine flatwoods and wet pine savannas (NatureServe Explorer 2024). These habitats are dominated by longleaf pine with grassy understories (NatureServe Explorer 2024).

Several regional datasets can help South Carolina identify lands and waters that support both animal and plant RSGCN and find opportunities to collaborate with other states. For example, habitat maps at the species level from the USGS Gap Analysis Project (GAP) are available for approximately 290 animal species and 90 sub-species on the RSGCN list. While GAP does not include species habitat maps for invertebrates or plants, it does include a high percentage of vertebrate RSGCN (93% of amphibians, 92% of birds, 76% of mammals, and 77% of reptiles). Using GAP species habitat models in combination with other tools, like the Southeast Blueprint, can help identify areas where conservation actions are likely to yield co-benefits for other species, habitats, and ecosystem services. All data, including model inputs, are available from the USGS Gap Analysis Project Species Habitat Maps on ScienceBase.

Using available habitat maps from GAP for specific RSGCN, along with regional conservation plans like the Southeast Blueprint, can also help to identify not only a species' habitat across its range, but areas where conservation action can achieve multiple co-benefits. For example, using GAP data for animal RSGCN that fall within the Southeast Blueprint can help visualize and highlight important areas for species conservation across multiple jurisdictions. As recommended by AFWA, cross-jurisdictional or regional strategies can enhance ecosystem resiliency, function, and connectivity, especially in the face of climate change.

South Carolina's Stewardship of Animal RSGCN

Within the Southeast Region, 223 animal RSGCN occur within South Carolina. The most common RSGCN taxa represented in South Carolina are fish (64) and birds (58) (Figure 10-4). While South Carolina shares stewardship of their SGCN and RSGCN with multiple other states, it has the most in common with Florida, Georgia, North Carolina, and Virginia. However, South Carolina also shares many animal RSGCN considered "very high" concern with North Carolina, Virginia, and Louisiana (Figure 10-5).

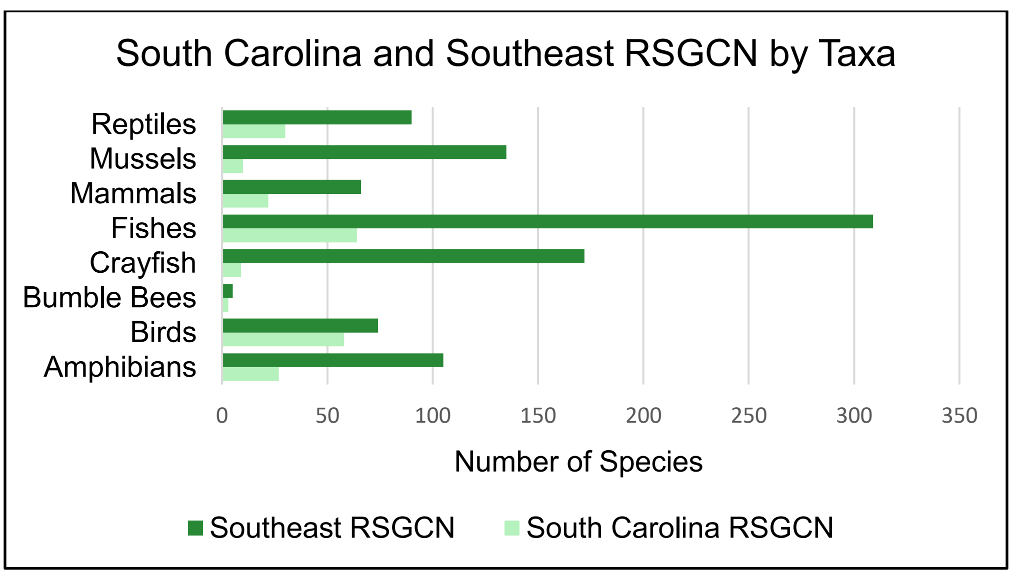


FIGURE 10-4: RSGCN taxa represented in South Carolina.

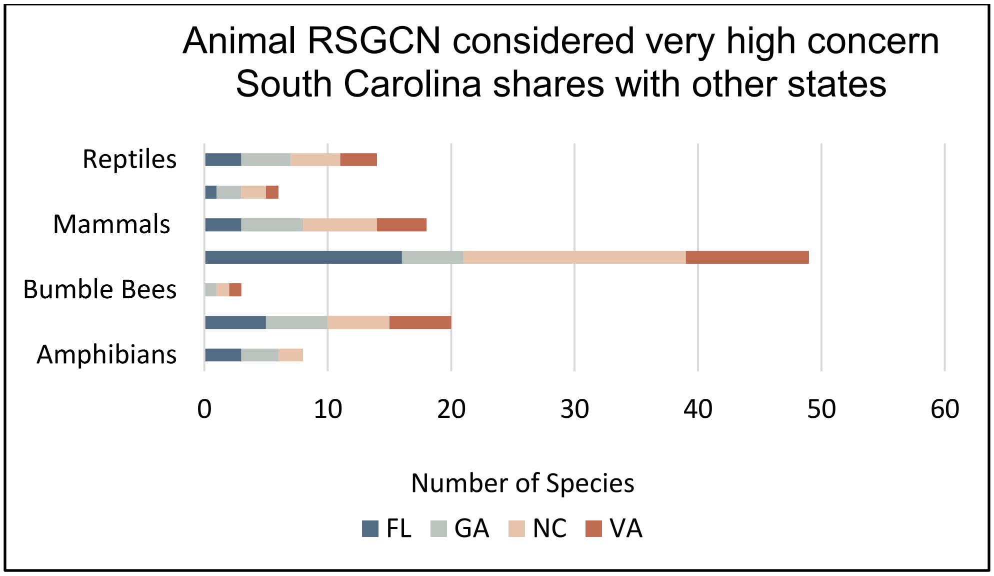


FIGURE 10-5: Animal RSGCN considered very high concern that South Carolina shares with Florida, Georgia, North Carolina, and Virginia.

South Carolina is also home to multiple species that are not only endemic to the SEAFWA region but are also found in only one other state. By identifying shared RSGCN, South Carolina can prioritize conservation actions that not only provide benefits within its boundaries but also support a regional landscape. For example, South Carolina can identify conservation strategies aimed at improving aquatic connectivity that also improve water quantity and quality in watersheds and streams that cut across state lines.

A Changing Climate

Many factors impacting the Southeast regional landscape are often too pervasive for any one agency to address independently, like sea-level rise, changing weather patterns, and habitat loss. While South Carolina must evaluate the impact of landscape level stressors and threats like climate change and land use change within its own boundaries, management efforts must also be coordinated on a regional scale. The AFWA 2022 (2nd Edition) Voluntary Guidance for States to Incorporate Climate Adaptation into State Wildlife Action Plans provides recommended steps for developing and implementing adaptation strategies. Much of the guidance includes taking a broader, regional approach to incorporating climate adaptation into SWAPs.

Temperature Changes

Projections of Earth's future surface temperatures depend primarily on future emissions and how sensitive the climate system will be to these emissions. Projections of climate change can be examined using two approaches: 1) global warming levels (GWLs); and 2) scenarios. GWLs are defined levels of warming for Earth's average temperature that correspond to increases of 2.7 °F (1.5 °C), 3.6 °F (2 °C), 5.4 °F (3 °C), and 7.2 °F (4 °C) degrees above pre-industrial levels (IPCC2018, Arias et al. 2021). A scenario-based approach can be used to explore plausible climate outcomes under a coherent future trajectory of greenhouse gases and other anthropogenic forcings (Leung et al. 2023). The Fourth National Climate Assessment (NCA4) used projections created with Representative Concentration Pathways (RCPs) to project and talk about future climate in the United States (USGCRP 2018), while instead, the Fifth National Climate Assessment (NCA5) used newly developed climate projections created with Shared Socioeconomic Pathways (SSPs) that represent plausible trajectories of GDP and population growth plus trends of economic and technological progress globally for the 21st-century (USGCRP 2023). The climate projections used in the NCA5 were created using global climate models from the Coupled Model Intercomparison Project Phase 6 (CMIP6) that were statistically downscaled to translate largescale changes in the climate under a given SSP or GWL to local scales for impact assessment and planning (Basile et al. 2023). Three of the SSPs used with the new climate models from the CMIP6 correspond to three of the RCPs used with the past global climate models from the Coupled Model Intercomparison Project Phase 5 (CMIP5) in their overall forcing levels (SSP1-2.6 corresponds with RCP2.6, SSP2-4.5 with RCP4.5, and SSP5-8.5 with RCP8.5) (Leung et al. 2023). Therefore, we can use scenarios to inform us when the planet will reach a certain global warming level and will use a mix of the SSPs and GWLs hereafter to show climate impacts throughout this section.

Using available climate change data and information that assumes a specific Global Warming Level (GWL) or SSP-based scenario can allow land managers to consider possible future conditions. Exactly when and if we reach a particular GWL depends on the trends of Global emissions and how sensitive the climate system is to these emissions (Figure 10-6).

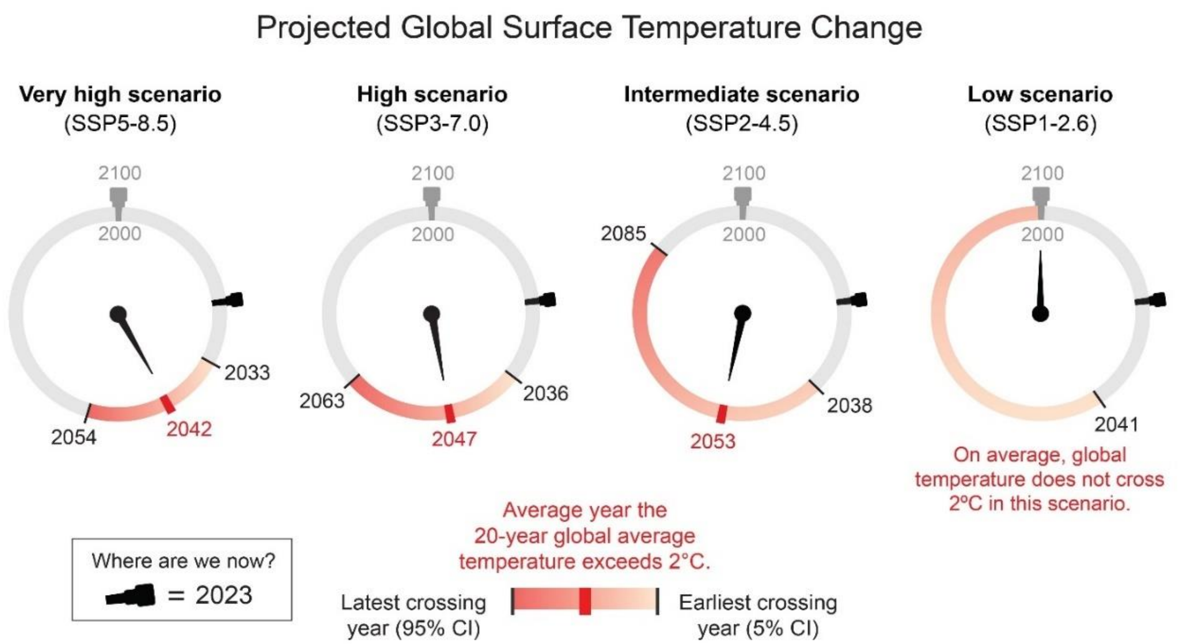


FIGURE 10-6: This figure represents an example of how various scenarios can be linked to specific GWLs and different timescales and is taken from the NCA5, Figure 2.14 (Marvel et al. 2023). In this example, the IPCC AR6 assessed warming projections for four future scenarios, with projected years at which the 2°C (3.6°F) global warming level would be reached. For example, under a very high scenario (SSP5-8.5), models project reaching 2°C between 2033 and 2054, with an average estimate of 2042. Under a low scenario (SSP1-2.6), the 5% CI (confidence interval) range begins in 2041, but the average projection shows that warming would actually stay below 2°C.

For example, in a very high scenario such as SSP5-8.5, the Earth is very likely to exceed a GWL of 2 (3.6 °F) between 2033 and 2054, depending on the climate sensitivity to greenhouse gas emissions from each global climate model (Marvel et al 2023; Figure 10-6). By contrast, in a low scenario such as SSP1-2.6, the Earth is very likely not to cross GWL 2 at all (Marvel et al. 2023; Figure 10-6). However, the rate of global warming varies across these scenarios as well, with high and very high scenarios assuming the Earth warms faster (Marvel et al. 2023). Since 1850, the Earth's temperature has risen by an average of 0.11° Fahrenheit per decade and, as of 2023, rising about 2 °F in total (Climate Change: Global Temperature | NOAA Climate.gov). However, since 1982, the rate of warming increased over 3 times as fast to about 0.36°F per decade. Currently, the planet is estimated to warm by nearly 5.4°F by the end of this century, meaning crossing a GWL 3 threshold, despite current global emission reduction pledges, according to the most recent United Nation's Annual 2023 Emissions Gap Report (Emissions Gap Report 2023 | UNEP - UN Environment Programme). Based on these trends, it is likely that the habitats, ecosystems, and conditions of South Carolina will also change as faster rates of climate change also increase the challenge of adaptation for natural systems and wildlife.

Climate projections use the best available physical science to predict how the climate system will respond to changes in human activities, but not all climate projections are developed in the same manner (IPCC 2023). Climate experts across the world have produced more than 50 global climate models under multiple greenhouse gas emissions and socioeconomic scenarios, each with unique variations and nuances. Some have undergone transformations like downscaling to improve spatial resolutions for smaller areas in order to make management decisions at a local scale. The most recent climate projections used in the Fifth NCA and associated climate parameters can be viewed on the National Climate Change Viewer. This tool, developed by the US Geological Survey, allows for visualizations of climate change impacts, such as days of extreme heat under projections of degree warming days, under SSP-based scenarios, and Global Warming Levels (Alder and Hostetler 2013). Additionally, these data are available as interactive maps and layers as part of the Fifth National Climate Assessment Interactive Atlas (National Climate Assessment Interactive Atlas (globalchange.gov)) and is where we have derived our spatial climate data for this report. Information pertaining to sea-level rise, as well as easy-to-understand state-level summaries on climate change impacts, are available from the National Oceanic and Atmospheric Administration (NOAA) website via their Sea-level Rise Technical Reports and Sea-level Rise Viewer Tool as well as their State Climate Summaries (Kunkel et al. 2022, Sweet et al. 2022).

In the Southeast, climate change will have pervasive impacts on natural habitats, ecological processes, and ecosystem services; regional efforts to mitigate or adapt to these impacts will be extremely important. According to NCA4 and NCA5, conditions in the Southeast may change dramatically (USGCRP 2018, 2023). Both Assessments indicate that current trends will continue such as increasing frequency, intensity, and duration of heatwaves, increasing wildfire risk, and rising sea levels. The most pertinent projected changes include extreme heat, extreme precipitation events, more intense drought, sea-level rise, and stronger tropical cyclones, as well as decreases in the intensity and frequency of cold-season events. Despite the significant threat climate change poses to the landscape, understanding the tools and resources available to address climate change and develop effective strategies is difficult. As part of the survey administered to SWAP coordinators in 2021, the majority of SEAFWA states/territories reported integrating climate change as one of the most challenging aspects of upcoming SWAP revisions. Anecdotally, some SWAP coordinators noted that it is difficult to discern what tools are available, decide which tool is the right one to use, and choose the appropriate scale and timeframe when using tools. Some reported it is also challenging to determine what climate-change associated threats to include and how to spatially represent their impacts. As such, the Southeast Climate Adaptation Science Center (SECASC) has provided data and information for this chapter to help translate the actionable implications of future climate projections.

Precipitation Changes and Extreme Weather Events

Like the rest of the Southeast, South Carolina is predicted to experience a number of climate impacts, though the magnitude of change often varies by ecoregion, emissions scenario, and future timeframe. Generally, these impacts include hotter summers, warmer winters, more frequent extreme precipitation events, and rising sea levels (USGCRP 2018, 2023).

Generally, the number of extremely hot days (i.e. days with afternoon high temperatures of at least 95°F) are predicted to increase although there are differences in the degree of how many hotter days are expected across the State (Table 10-11). Under various global warming levels, summer nighttime minimum temperatures that exceed 70°F, and daytime maximum temperatures that exceed 95°F, become the norm in South Carolina (Alder and Hostetler 2013; USGCRP 2018; Hoffman 2023).

Lake Jocassee during the 2011 drought. Photo by Doug Young.

As nighttime temperatures rise, some species may also be impacted. Warmer nights can have a profound impact on animal and plant health because temperatures are generally lower at night, normally allowing the environment to cool down. Additionally, heatwaves in the U*S* have become hotter, more frequent, more widespread, and longer lasting in recent decades and are projected to continue, which has implications for drought in the region. The 5th NCA projects that the number of extremely hot days (days with maximum temperatures ≥95°F) may increase across South Carolina, with the most pronounced changes occurring in the central portions of the *S*tate (Table 10-11; Figure 10-7).

TABLE 10-11: Approximate observed historical and the future projected number of extremely hot days per year (i.e. days with afternoon high temperatures of at least 95°F) by EPA Level III ecoregions within South Carolina. The table summarizes projected future number of days for low, moderate, and high Shared Socioeconomic Pathway (SSP) emission scenarios using CMIP6-LOCA2 threshold and extreme event metric projections (Alder 2024) summarized at the ecoregion level by the Southeast and South Central Climate Adaptation Science Centers. For each future time period, numbers in parentheses represent the percent change between the models' future projections and the models' historical simulations. Observed historical summaries were generated with data from Pierce et al. (2021).

Historical & Future Projections: Number of Days with Maximum Temperatures ≥ 95°F			
SSP	**Observed Historical: 1950-2014**	**2025-2049 Projections** (percent change from historical simulation)	**2050-2074 Projections** (percent change from historical simulation)
Blue Ridge Ecoregion			
Low (SSP2-4.5)	3 days/year	10 days/year (430%↑)	17 days/year (775%↑)
Moderate (SSP3-7.0)		10 days/year (380%↑)	20 days/year (900%↑)
High (SSP5-8.5)		12 days/year (480%↑)	28 days/year (1290%↑)
Piedmont Ecoregion			
Low (SSP2-4.5)	14 days/year	35 days/year (170%↑)	47 days/year (260%↑)
Moderate (SSP3-7.0)		35 days/year (165%↑)	53 days/year (305%↑)
High (SSP5-8.5)		37 days/year (190%↑)	63 days/year (390%↑)
Southeastern Plains			
Low (SSP2-4.5)	17 days/year	42 days/year (165%↑)	55 days/year (240%↑)
Moderate (SSP3-7.0)		41 days/year (160%↑)	61 days/year (280%↑)
High (SSP5-8.5)		46 days/year (180%↑)	73 days/year (355%↑)
Middle Atlantic Coastal Plain Ecoregion			
Low (SSP2-4.5)	13 days/year	35 days/year (180%↑)	47 days/year (275%↑)
Moderate (SSP3-7.0)		34 days/year (170%↑)	51 days/year (310%↑)
High (SSP5-8.5)		38 days/year (210%↑)	65 days/year (425%↑)
Southern Coastal Plain Ecoregion			
Low (SSP2-4.5)	9 days/year	25 days/year (200%↑)	36 days/year (330%↑)
Moderate (SSP3-7.0)		25 days/year (190%↑)	39 days/year (365%↑)
High (SSP5-8.5)		28 days/year (240%↑)	53 days/year (535%↑)

Additionally, if the earth surpasses GWL 2°C above pre-industrial levels for a sustained period of time, the number of days where the temperature reaches 95°F or higher will increase across the State, compared to the past 30 years (1991-2020).

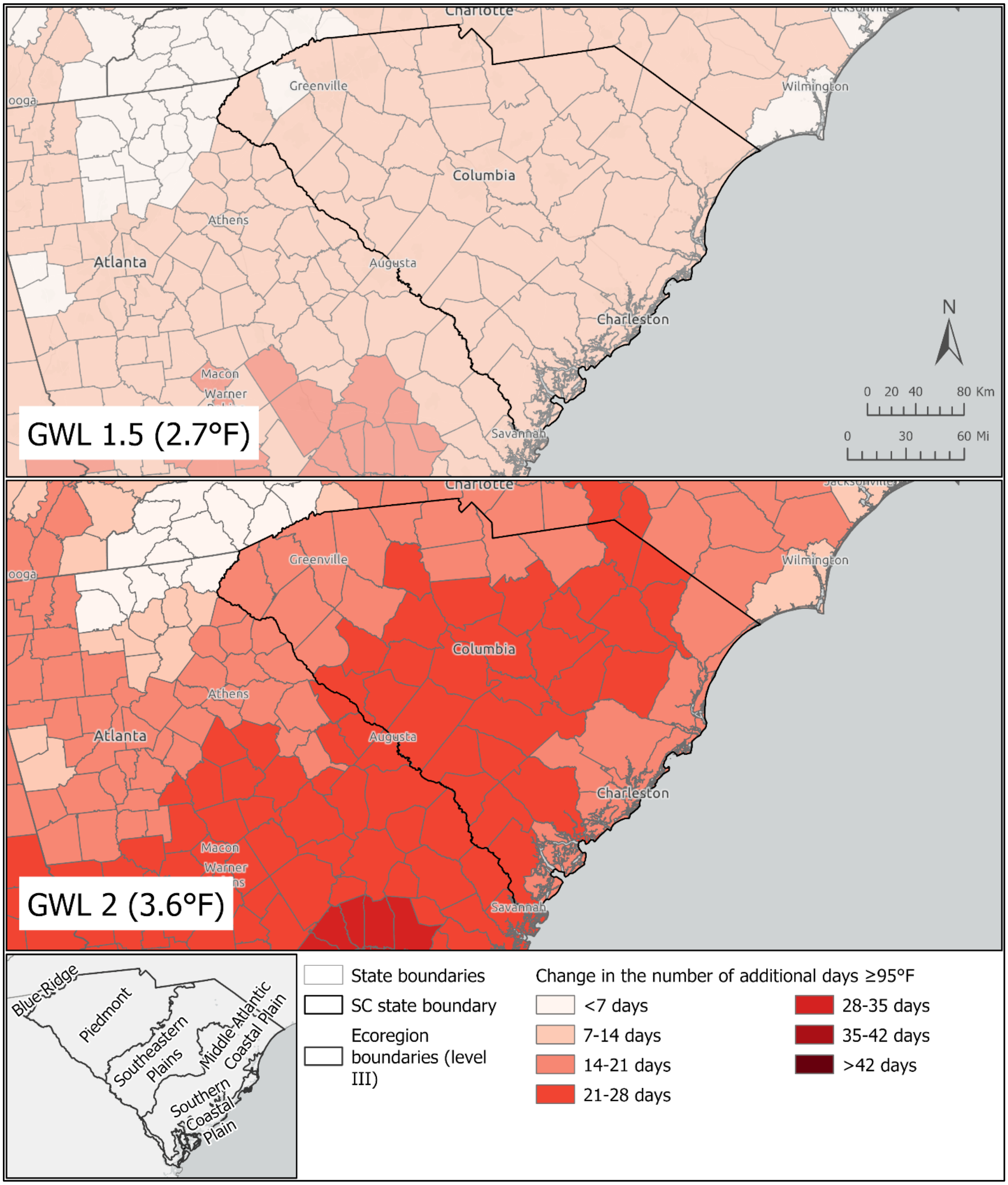


FIGURE 10-7: Projected future changes in the number of days of Extreme Maximum Temperatures (threshold temperature of 95°F) compared to preindustrial levels (1851-1900) based on GWL 1.5 (global temperature increase of 2.7°F) and GWL 2 (global temperature increase of 3.6°F). Note that this is not the *total number* of days, as presented in the table above, but the number of *additional* days where temperatures will reach ≥ 95°F. Figure created from data in the "Atlas of the 5th National Climate Assessment" web tool (National Climate Assessment Interactive Atlas (globalchange.gov; USGCRP et al. 2024) accessed on July 23, 2024.

Nine-banded Armadillos have experienced a range expansion, now making them a common site in South Carolina. Their rooting and diet can put them into direct conflict with native species. Photo by Anna Smith, SCDNR.

Winter temperatures are the fastest warming season in most of the US. In general, the number of extremely cold days (i.e. days with low temperatures of at least 32°F or lower) in South Carolina is predicted to decrease (Table 10-12). Winter conditions are key drivers of individual species performance and community composition in terrestrial habitats because species vary in susceptibility to these winter drivers (Williams et al. 2014). Shorter and warmer winters may cause species range shifts that would allow for warm-adapted species to dominate and shift distributions of cold-adapted species. For example, overwintering bird populations are responding to a warming climate (e.g. poleward shifts) by favoring the formation of winter bird communities dominated by warm-adapted species instead of cold-adapted species (Princé and Zuckerberg 2014, Osland et al. 2021). Range shifts that bring new species into a region or state leads to reconsiderations of what defines a "native species." Species that have moved into South Carolina in recent decades include the Coyote and Nine-Banded Armadillo. Rosette Spoonbills have now been documented nesting in the State.

Roseate Spoonbills have been documented nesting in SC. Photo by Norman Welsh, USFWS public domain

Additionally, winter conditions (e.g. snowfall, low temperatures) have a major effect on ecological processes such as litter decomposition, mineralization rates, nutrient leaching and gas fluxes in the soil, and hydrological processes. Winter soil freezing also affects insect and microbial communities for the subsequent warm season (Campbell et al. 2005). If the earth surpasses GWL 2°C above pre-industrial levels for a sustained period of time, the number of days where the temperature reaches 32°F or lower (freezing temperatures) will decrease across the State, compared to the past 30 years (1991-2020) (Figure 10-8).

TABLE 10-12: Approximate observed historical and future projected number of extremely cold days per year (days with minimum temperatures <32°F) for EPA Level III ecoregions within South Carolina. The table summarizes projected future number of days for low, moderate, and high SSP emission scenarios using CMIP6-LOCA2 threshold and extreme event metric projections (Alder 2024) summarized at the ecoregion level by the Southeast and South Central Climate Adaptation Science Centers. For each future time period, numbers in parentheses represent the percent change between the models' future projections and the models' historical simulations. Observed historical summaries were generated with data from Pierce et al. (2021).

Historical & Future Projections: Number of Extremely Cold Days (Min Temperatures ≤ 32°F)			
SSP	**Observed Historical: 1950-2014**	**2025-2049 Projections** (percent change from historical simulation)	**2050-2074 Projections** (percent change from historical simulation)
Blue Ridge Ecoregion			
Low (SSP2-4.5)		19 days/year (25%↓)	19 days/year (30%↓)
Moderate (SSP3-7.0)	65 days/year	19 days/year (25%↓)	20 days/year (35%↓)
Low (SSP5-8.5)		19 days/year (30%↓)	19 days/year (40%↓)
Piedmont Ecoregion			
Low (SSP2-4.5)		48 days/year (25%↓)	42 days/year (40%↓)
Moderate (SSP3-7.0)	63 days/year	48 days/year (25%↓)	40 days/year (45%↓)
High (SSP5-8.5)		46 days/year (30%↓)	35 days/year (50%↓)
Southeastern Plains Ecoregion			
Low (SSP2-4.5)		37 days/year (30%↓)	31 days/year (40%↓)
Moderate (SSP3-7.0)	51 days/year	37 days/year (30%↓)	29 days/year (45%↓)
Extreme (SSP5-8.5)		35 days/year (35%↓)	25 days/year (50%↓)
Middle Atlantic Coastal Plain Ecoregion			
Low (SSP2-4.5)		29 days/year (30%↓)	26 days/year (40%↓)
Moderate (SSP3-7.0)	42 days/year	31 days/year (30%↓)	25 days/year (45%↓)
High (SSP5-8.5)		29 days/year (35%↓)	21 days/year (50%↓)
Southern Coastal Plain Ecoregion			
Low (SSP2-4.5)		19 days/year (35%↓)	17 days/year (45%↓)
Moderate (SSP3-7.0)	26 days/year	20 days/year (30%↓)	16 days/year (45%↓)
Extreme (SSP5-8.5)		19 days/year (35%↓)	13 days/year (55%↓)

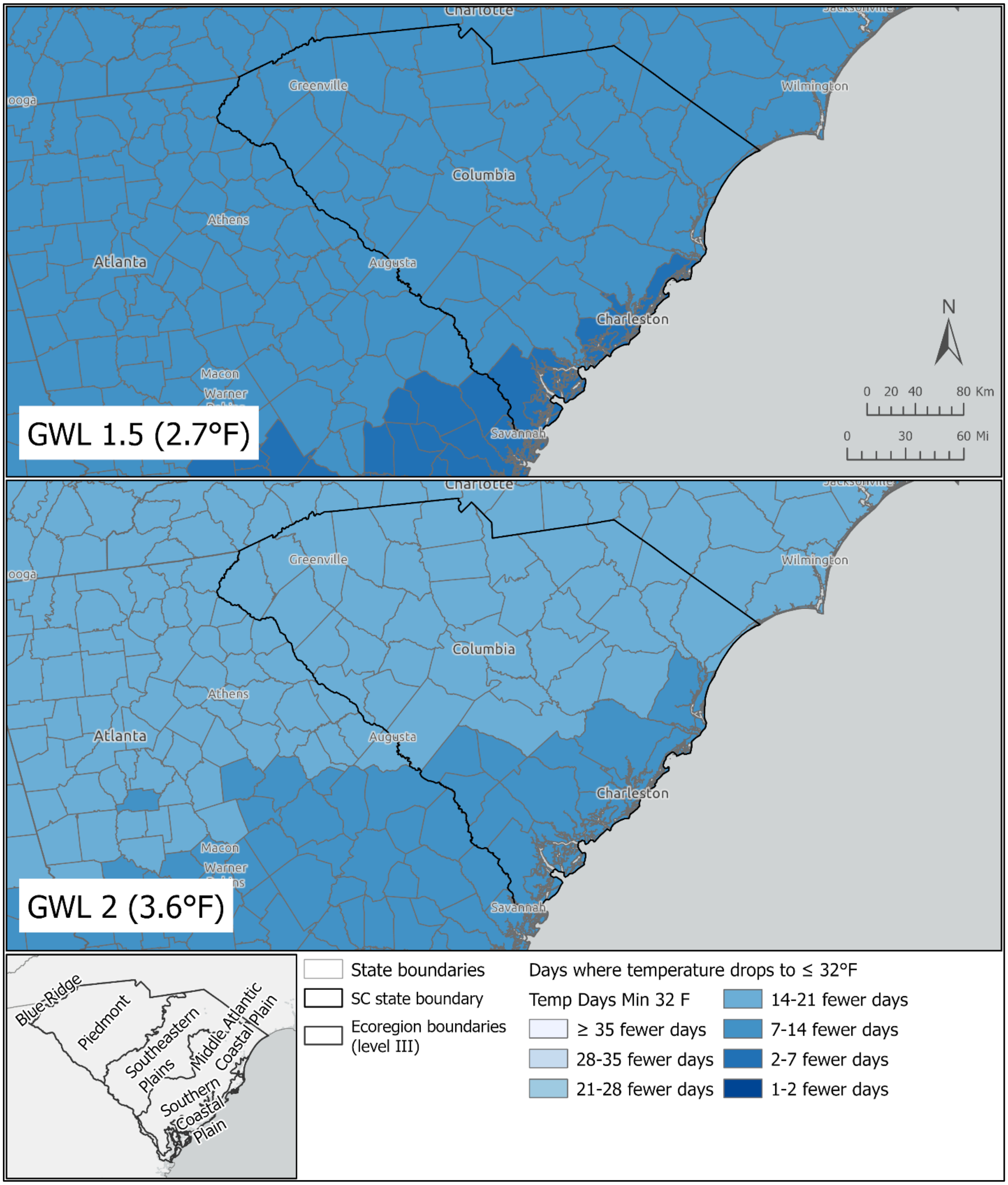


FIGURE 10-8: Change in days where minimum temperatures reach or drop below freezing (32°F) compared to preindustrial levels (1851-1900) based on GWL 1.5C (global temperature increase of 2.7°F) and GWL 3C (global temperature increase of 2.7°F). Figure created from data in the "Atlas of the 5th National Climate Assessment" web tool (National Climate Assessment Interactive Atlas (globalchange.gov); USGCRP et al. 2024).

In South Carolina, 15 out of the last 21 years have been characterized by warm-season drought conditions. However, little change in total annual precipitation is projected over this century, although the timing and intensity of precipitation events will change (Hoffman et al. 2023). Any increases in temperature will cause more rapid loss of soil moisture during consecutive dry days, increasing the intensity of naturally occurring droughts in the future. The Southeast has, in general, received more precipitation in the fall seasons but experienced drier conditions in spring and summer (Hoffman et al. 2023). Although hydrological droughts have become less frequent in eastern regions of the country since the 19th century, higher increases in evapotranspiration (the processes by which water is transferred to the atmosphere from Earth's surface) have generally made the Southeast more drought-prone than the Northeast (Hoffman 2023).

Other potential climate hazards may impact the state, such as extreme precipitation events, which are expected to increase in the future and often manifest as extreme weather and increased flooding (Wong et al. 2014). Total annual precipitation has been below average during most years since 2000 but was above average during the 2015–2020 period (Hoffman et al. 2023). There is no overall trend in annual precipitation since the beginning of the 20th century; however, a few recent years (notably 2015, 2018, and 2020) have been very wet. Between 2000 and 2015, the State experienced a below average number of 3-inch extreme precipitation events, but during the 2015–2020 period, the number was well above average (Hoffman et al. 2023).

The aftermath of Hurricane Florence on Longs, SC
Photo by Hope Mizzell, SCDNR.

In the Southeast region, extreme weather events are characterized by hurricanes and tropical storms that will likely increase in frequency and magnitude (USGCRP 2018). Tropical storms and hurricanes have been responsible for some of the Southeast's biggest and most damaging flooding events since 2018 (Hoffman 2023). The likelihood of hurricanes slowing down or stalling near the Southeast coastline has increased, which exacerbates the rainfall-related flooding threats from these storm systems (Hoffman 2023). Climate change is expected to strengthen North Atlantic hurricanes to at least Category 4 intensity and to undergo rapid intensification, as well as potentially increase the likelihood of storms making landfall (Hoffman 2023). More severe weather, and subsequent wave action, high winds, and storm surge, can severely erode beaches and dunes, eliminate sea turtle and shorebird nests, and degrade or erode maritime forests and salt marshes (USGCRP 2018).

Additionally, climate change projections suggest that the Southeast will get wetter, meaning some seasonal, annual average, and extreme precipitation amounts will increase across the region, driven mainly by more extreme events (e.g. precipitation of 3 or more inches in 24 hours) at higher levels of global warming (Hoffman 2023). Extreme rainfall that occurs while ocean water inundates and affects low-lying areas in the coastal plain (e.g. because of high tides or storm surges) creates compound flooding events (Hoffman 2023). Sea-level rise scenarios for the Southeast project a higher frequency of compound flooding by midcentury along the Atlantic coast (Hoffman 2023). Extreme rainfall events also contribute to increases in river and stream flooding across the landscape, which have different effects in different ecoregions and topography. For example, in the Appalachian Mountains where the susceptibility to landslides is already high, increases in extreme rainfall may lead to increases in landslides (Mirus et al. 2020). There is high spatial overlap between landslide susceptibility and biodiversity in the Appalachians which provides an opportunity to achieve co-benefits in both species conservation and development if these vulnerable sites are protected and restored (Li et al. 2022).

An October 2015 flood's impact on a Clarendon County road. Photo by SCDNR.

Table 10-13 summarizes approximate values for historically observed and future projections of extreme rainfall under different SSP scenarios for South Carolina ecoregions, while Figure 10-9 shows the projected future percent change in number of days per year with extreme precipitation (top 1% of rainfall) in South Carolina at GWL of 1.5 (2.7°F warmer than the last 30 years) and GWL 3 (2.7°F warmer than the last 30 years). While all ecoregions within South Carolina will experience days of extreme precipitation, the Blue Ridge and Piedmont ecoregions are projected to experience the greatest percent change in the number of days per year with extreme annual precipitation events across GWLs.

TABLE 10-13: Approximate observed historical and future projected number of days per year with extreme precipitation events (in the top 1% of historical rainfall events) for EPA Level III ecoregions within South Carolina. The table summarizes projected future number of days for low, moderate, and high SSP emission scenarios using CMIP6-LOCA2 threshold and extreme event metric projections (Alder 2024) summarized at the ecoregion level by the Southeast and South Central Climate Adaptation Science Centers. For each future time period, numbers represent the percent change between the models' future projections and the models' historical simulations. Observed historical summaries were generated with data from Pierce et al. (2021).

Historical & Future Projections: Number of Days with Extreme Rainfall (Days with Rainfall > 99th percentile)			
SSP	**Observed Historical: 1950-2014**	**2025-2049 Percent Change in Future Projections from Historical Simulation**	**2050-2074 Percent Change in Future Projections from Historical Simulation**
Blue Ridge Ecoregion			
Low (SSP2-4.5)	3 days/year	34%↑	50%↑
Moderate (SSP3-7.0)		34%↑	50%↑
Low (SSP5-8.5)		38%↑	58%↑
Piedmont Ecoregion			
Low (SSP2-4.5)	3 days/year	35%↑	52%↑
Moderate (SSP3-7.0)		35%↑	46%↑
High (SSP5-8.5)		37%↑	58%↑
Southeastern Plains Ecoregion			
Low (SSP2-4.5)	4 days/year	27%↑	44%↑
Moderate (SSP3-7.0)		27%↑	38%↑
High (SSP5-8.5)		28%↑	55%↑
Middle Atlantic Coastal Plain Ecoregion			
Low (SSP2-4.5)	4 days/year	22%↑	35%↑
Moderate (SSP3-7.0)		21%↑	31%↑
High (SSP5-8.5)		24%↑	48%↑
Southern Coastal Plain Ecoregion			
Low (SSP2-4.5)	3 days/year	17%↑	30%↑
Moderate (SSP3-7.0)		17%↑	23%↑
High (SSP5-8.5)		20%↑	43%↑

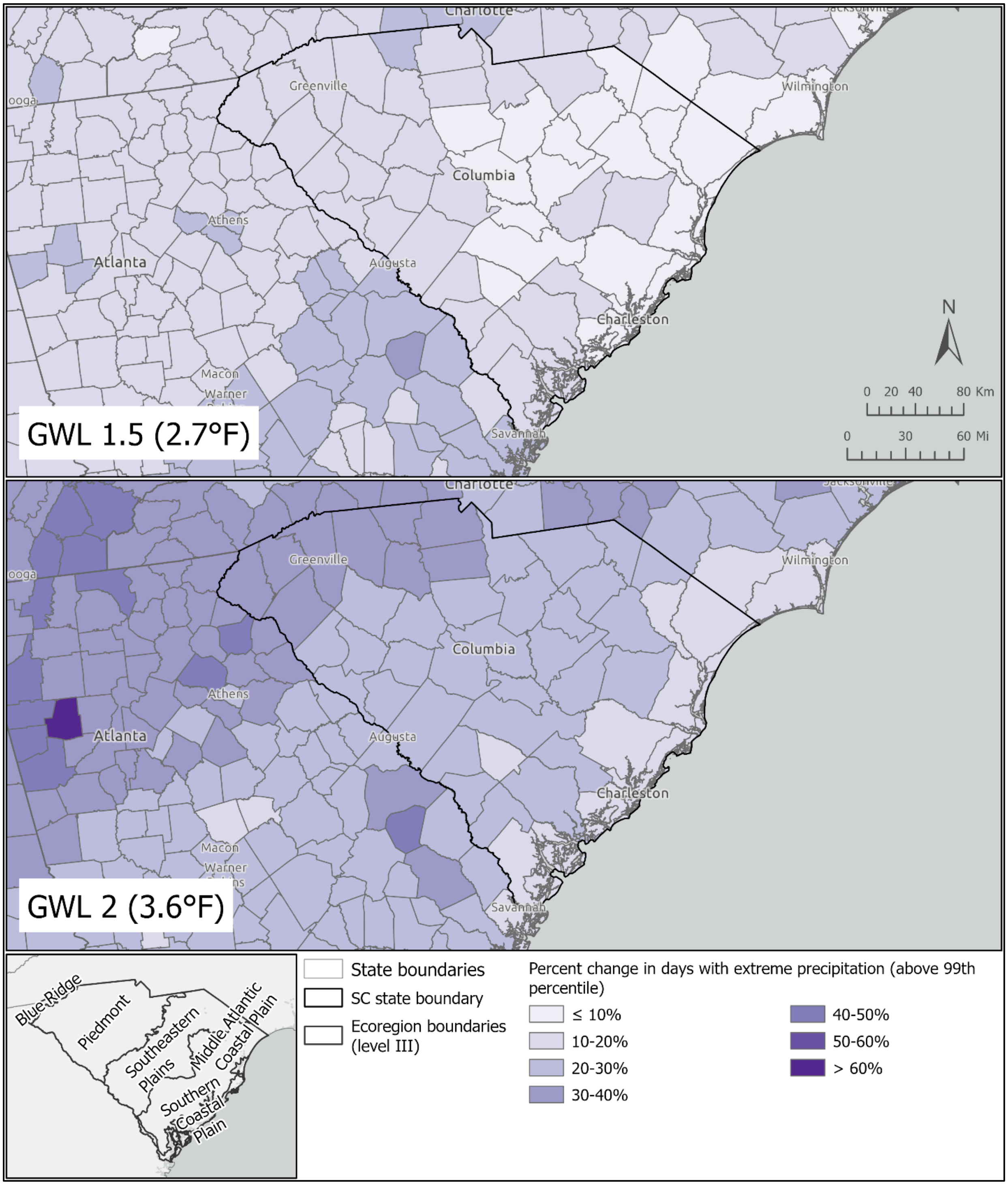


FIGURE 10-9: Future projected changes in the number of days per year of extreme precipitation (top 1% of rain events) compared to preindustrial levels (1851-1900) based on GWL 1.5C (global temperature increase of 2.7°F) and on GWL 2C (global temperature increase of 3.6°F). Figure created from data in the 'Atlas of the 5th National Climate Assessment" web tool (National Climate Assessment Interactive Atlas (globalchange.gov); USGCRP et al. 2024).

The Southeast has the highest aquatic diversity of any temperate system; however, the ecological relationships and life histories of many of the endemic species are not yet well understood within the constraints of climate change (Ingram et al. 2013). Freshwater ecosystems (e.g. streams, rivers, lakes, and wetlands) of the Southeast are highly vulnerable to warming. Impacts on rare species of fish and mussels are of particular concern in a changing climate. The combined effects of warming and changes in precipitation will likely alter overall hydrology including increased evapotranspiration and reduced stream base flow. Currently, many species declines are associated with widespread alteration of flow regimes and are expected to be exacerbated by climate change. Impacts of climate change on riverine and wetland ecosystems are predicted to also include increased water temperatures, which dictate many species' ranges and worsens low dissolved oxygen conditions (Ingram et al. 2013). In general, temperature regimes of freshwater ecosystems are projected to increase in parallel with shifts in air temperatures, which in turn may alter plant and animal communities including migratory birds (Princé and Zuckerberg 2015).

Sea Level Rise

Beyond the changes for temperature and precipitation, sea-level rise will also impact South Carolina. Sea level has risen and fallen over millions of years in South Carolina so that 80,000-100,000 years ago, it was where it is again today (Will Doer, SC Geological Survey – SCDNR, pers. comm.). Due to the magnitude of sea-level rise projected throughout the 21st century and beyond—coupled with subsidence—coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, flooding, and erosion (Wong et. al. 2014). Historically, coastal ecosystems in the region have adjusted to sea-level rise by vertical (accretion) and horizontal movement across the landscape. As sea levels continue to rise, some coastal ecosystems will be submerged and convert to open water, and saltwater intrusion will allow salt-tolerant coastal ecosystems to move inland at the expense of upslope and upriver ecosystems (e.g. salt marsh migration). Slope can affect marsh migration as can substrate such as clay (blocks movement) or sand (allows movement) (Will Doer, SC Geological Survey – SCDNR, pers. comm.).

The National Oceanic and Atmospheric Administration (NOAA) 2022 Sea Level Rise Technical Report, *Global and Regional Sea Level Rise Scenarios for the United States*, provides the most recent projections available to all US coastal areas out to the year 2150 (Sweet et. al 2022). The following tables show the predicted extent of flooding for coastal South Carolina at the average highest daily tide due to sea-level rise (Table 10-14) and the projected amount of sea-level rise by decade under various emissions scenarios (Table 10-15). Figure 10-10 also provides a statewide map of areas likely to experience flooding at high tide based on each foot of sea-level rise above current levels.

TABLE 10-14: Extent of flooding by projected average highest daily tide due to sea-level rise in South Carolina. Values from the NOAA sea-level rise inundation data.

Feet of sea-level rise	Acres	Percent of Area
0 feet	1,245,818	6.1%
1 foot	1,384,978	6.8%
2 feet	1,459,377	7.1%
3 feet	1,534,875	7.5%
4 feet	1,614,821	7.9%
5 feet	1,695,974	8.3%
6 feet	1,776,110	8.7%
7 feet	1,854,169	9.0%
8 feet	1,929,336	9.4%
9 feet	2,008,621	9.8%
10 feet	2,088,626	10.2%
Not projected to be inundated by up to 10 feet	*4,967,754*	*24.2%*
Sea-level rise unlikely to be a threat (inland counties)	*13,438,646*	*65.6%*
Total area	**20,495,027**	**100%**

TABLE 10-15: Projected sea-level rise by decade in South Carolina. Values are based on area-weighted averages of decadal projections for 1-degree grid cells that overlap this area based on NOAA's 2022 Sea Level Rise Report.

SLR Scenario	2020 (ft)	2030 (ft)	2040 (ft)	2050 (ft)	2060 (ft)	2070 (ft)	2080 (ft)	2090 (ft)	2100 (ft)
Low	0.36	0.56	0.77	0.97	1.1	1.3	1.4	1.5	1.6
Intermediate-low	0.38	0.61	0.86	1.1	1.3	1.6	1.8	2	2.3
Intermediate	0.39	0.64	0.91	1.2	1.6	2	2.5	3.1	3.8
Intermediate-high	0.39	0.68	1	1.4	2	2.6	3.4	4.2	5.2
High	0.4	0.69	1.1	1.6	2.3	3.3	4.4	5.5	6.8

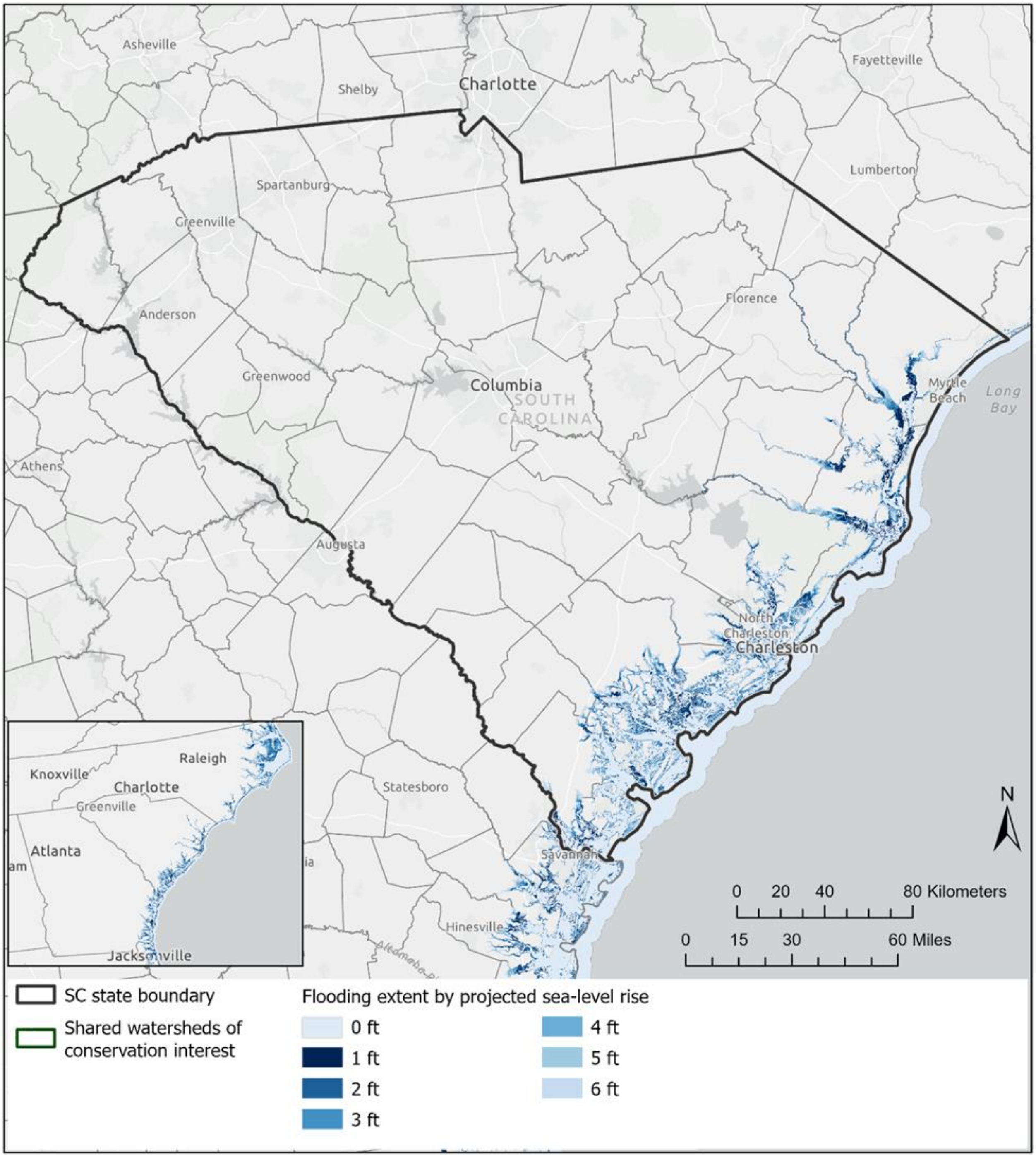


FIGURE 10-10: NOAA's sea-level rise (SLR) inundation models represent areas likely to experience flooding at high tide based on each foot of SLR above current levels. Darker blue areas will experience flooding first and at greater depth compared to lighter blue areas. These models are not linked to a future timeframe; see the projections in Tables 10-14 and 10-15. NOAA calculates the inundation footprint at "mean higher high water", or the average highest daily tide. The area covered in each SLR scenario includes areas projected to be inundated at lower levels. For example, the area inundated by 4 ft of SLR also includes areas inundated by 3 ft, 2 ft, 1 ft, and 0 ft of SLR (where 0 ft represents current levels).

Species' Responses to Changes in Climate: Vulnerability and Resiliency

As the climate, regional landscape, and weather patterns change, there is value in identifying regional strategies and conservation actions to support the SGCN and RSGCN that are most vulnerable to the impacts. A species is considered vulnerable to climate change if it is both sensitive and exposed to climate change impacts (Williams et al. 2008). For example, a species may be exposed to climate change because it experiences an impact like warmer stream temperatures, but if it is resilient to that change or able to disperse into new habitats, it may ultimately have low vulnerability. Conversely, a species that would be sensitive to climate change but is not exposed to any impacts may also not be considered vulnerable. Figure 10-11 visually represents these relationships. Understanding if a species is sensitive and will be exposed to climate change can help managers develop strategies to support the species most likely to be impacted.

Two common tools that have been used to determine climate vulnerability of species are 1) the Climate Change Vulnerability Index (CCVIs) (Young et al. 2016) developed by NatureServe and 2) environmental niche modeling-based vulnerability estimates produced by the academic research community. The CCVI is a worksheet-based tool where users apply readily available information about a species' natural history, distribution, landscape circumstances, and expert opinions to predict whether it will likely suffer a range contraction and/or population reduction due to climate change that results in a vulnerability score. By design, this score is distinct from NatureServe's national vulnerability ranking system that considers other threats. A species could score as not particularly vulnerable in terms of its Global or Subnational (State) rank (G-or S-rank), which is based on other factors, but could still rate as vulnerable to climate change. CCVI is based on an evaluation of the species' direct and indirect exposure to climate change and its sensitivity to climate change.

Ecological niche models (also called species distribution models) are a common approach for evaluating a species' vulnerability to climate change by the academic research community. These models start by identifying shared climate conditions at sites where a species is known to have occurred and then predict where similar climate conditions may be found on the landscape in the future. Some models also take into account the ability of a species to disperse to reach any new areas that may become climatically suitable. The resulting predictions from these models allow researchers to create spatially explicit estimates of whether suitable climate conditions for a species are likely to remain stable, become more widespread on the landscape (i.e. increase), or become more geographically rare in the future (i.e. decrease).

For example, if suitable climate conditions for a species were projected to decrease greatly in an area in the future, then the species would be considered more vulnerable to climate change than a species for which climate conditions were predicted to remain stable. It is important to note that raw data from niche models (e.g. spatial raster data) is not usually readily available to the public due to the large size of the files but instead is available in summary form in the research literature (i.e. academic journal articles). Therefore, more translational effort is needed with niche model results as the form of the data might not be readily interpretable by users. (Note: A collated and readily interpretable dataset of niche models conducted for Southeast RSGCN by researchers to date has been developed by the Armsworth lab at the University of Tennessee - Knoxville discussed in the next section of this chapter.)

Niche model results can be used in tandem with CCVI estimates to enhance the understanding of a given species' vulnerability, because CCVIs and niche models have complementary strengths that can help land managers make informed conservation decisions. Niche models offer more refined and spatially explicit predictions (i.e. changes in suitable habitat) about the direct exposure of a species to climate change but are only available for a limited set of species, in part because the models require extensive data on a species before they can be applied. CCVI estimates use an expert judgment-based approach that allows integration of different types of information about species and what might make them vulnerable to climate change (e.g. their natural history). It is important to compare CCVI estimates with available ecological niche model predictions for SGCN to fully understand a given species' vulnerability to climate change while keeping in mind the geographic (e.g. region or habitat evaluated) and biological contexts (e.g. estimated dispersal distance) of these assessments.

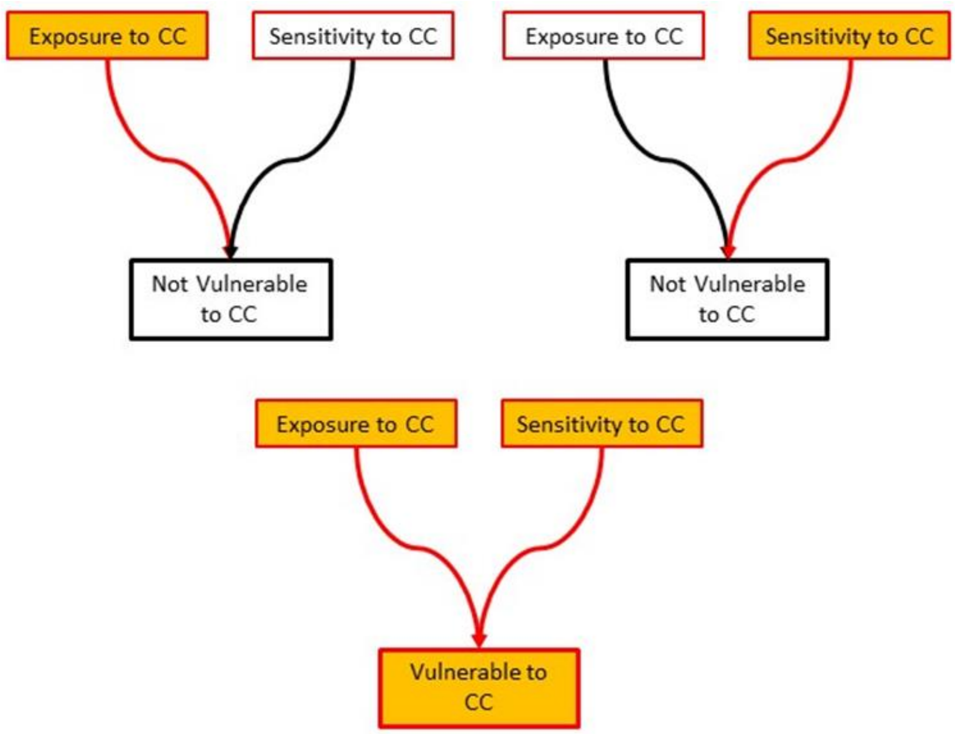


FIGURE 10-11: Climate change vulnerability is measured by both the exposure to and sensitivity to climate change. The figure is based on work by Williams et al. 2008.

Summary of Available Climate Change Vulnerability Indices

The USGS Southeast Climate Adaptation Science Center (SE CASC) and the University of Tennessee - Knoxville launched a research effort to support the SEAFWA states in integrating climate change considerations into their 2025 SWAP updates. This effort collated CCVI scores from 10 data sources within the eastern United States. It draws from CCVI assessments published in four SWAPs in the Southeast (West Virginia, Byers & Norris 2011; Tennessee, Glick et al. 2015; Florida, DuBois et al. 2011; and Louisiana, Holcomb et al. 2015) as well as the

Illinois SWAP (Walk et al. 2011), Natural Heritage Programs in the Northeast (Schlesinger et al. 2011, Furedi et al. 2011), the Appalachian and North Atlantic Landscape Conservation Cooperatives (Sneddon & Galbraith 2015, Sneddon & Hammerson 2014), and the National Park Service Cumberland Piedmont Network (Bruno et al. 2012), all of which were informed by state conservation practitioners. This work compiles 1,600 CCVI estimates for 795 species (Note: some species have multiple CCVI estimates coming from different states). Many of these are on the RSGCN list for the Southeast. For South Carolina, 150 SGCN have been scored using the CCVI estimates to date by other institutions. Figure 10-12 summarizes the combined results for these CCVI assessments.

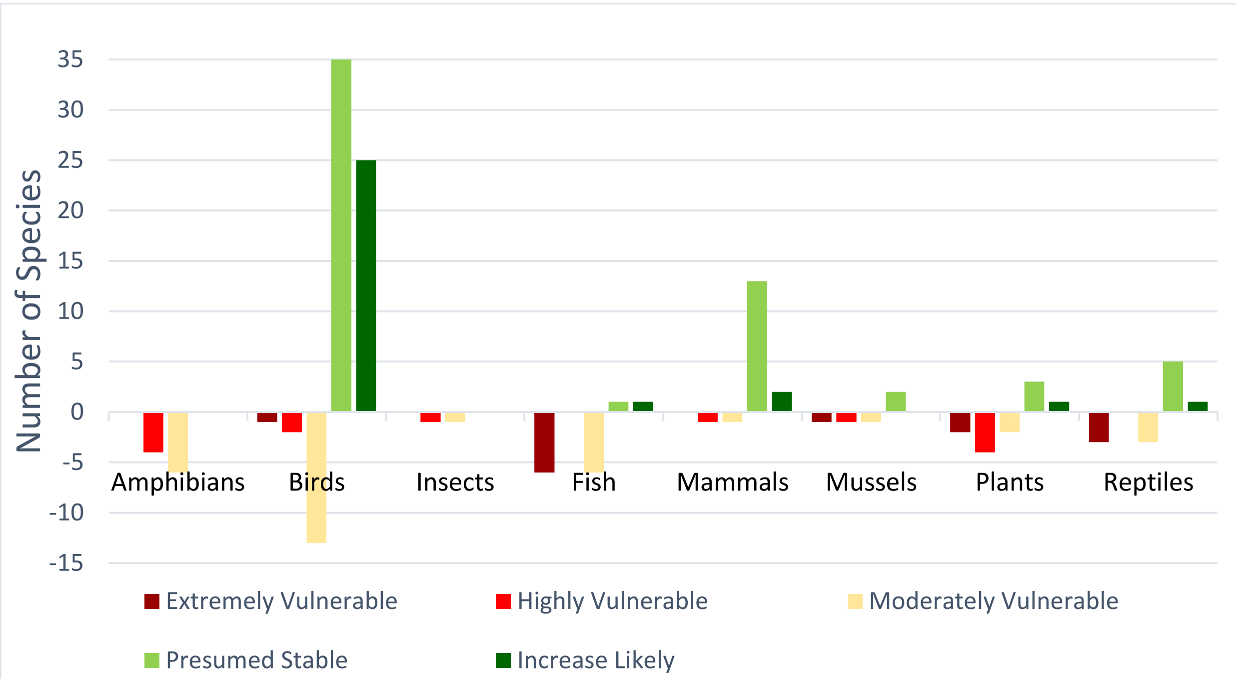


FIGURE 10-12: South Carolina SGCN estimated to be vulnerable, stable, or may increase in population based on available CCVI estimates from SEAFWA states (i.e. in their 2015 SWAPs) and other sources compiled by Armsworth et al. (*in progress*).

To date, most CCVI assessments for South Carolina's SGCN have focused on birds. Many of these CCVI assessments indicate that while some bird species may be vulnerable, a larger proportion may remain stable or increase under changing climatic conditions. Though more assessments are needed for other taxa, especially those that are not as well studied, these CCVI estimates suggest that amphibian and fish SGCN within South Carolina may be the most vulnerable to climate change.

Summary of Available Ecological Niche Models

In addition to the collation and summary of CCVI estimates, the SE CASC and the University of Tennessee have summarized complementary information on available ecological niche models.

For South Carolina, 148 SGCN have been evaluated to date, which consists of 430 vulnerability scores (note: some species have multiple scores for different future climate scenarios) across 12 academic research studies (Mckenny et al. 2007; Iverson et al. 2008; Matthews et al. 2011; Sutton et al. 2014; Bucklin et al. 2015; Struecker & Milanovich 2017; Pandey & Papeş 2018; Bateman et al. 2020; Lawler et al. 2020; Zellmer et al. 2020; Zhu et al. 2021; Lyon & Papeş 2022). Figure 10-13 summarizes the combined results for these ecological niche models.

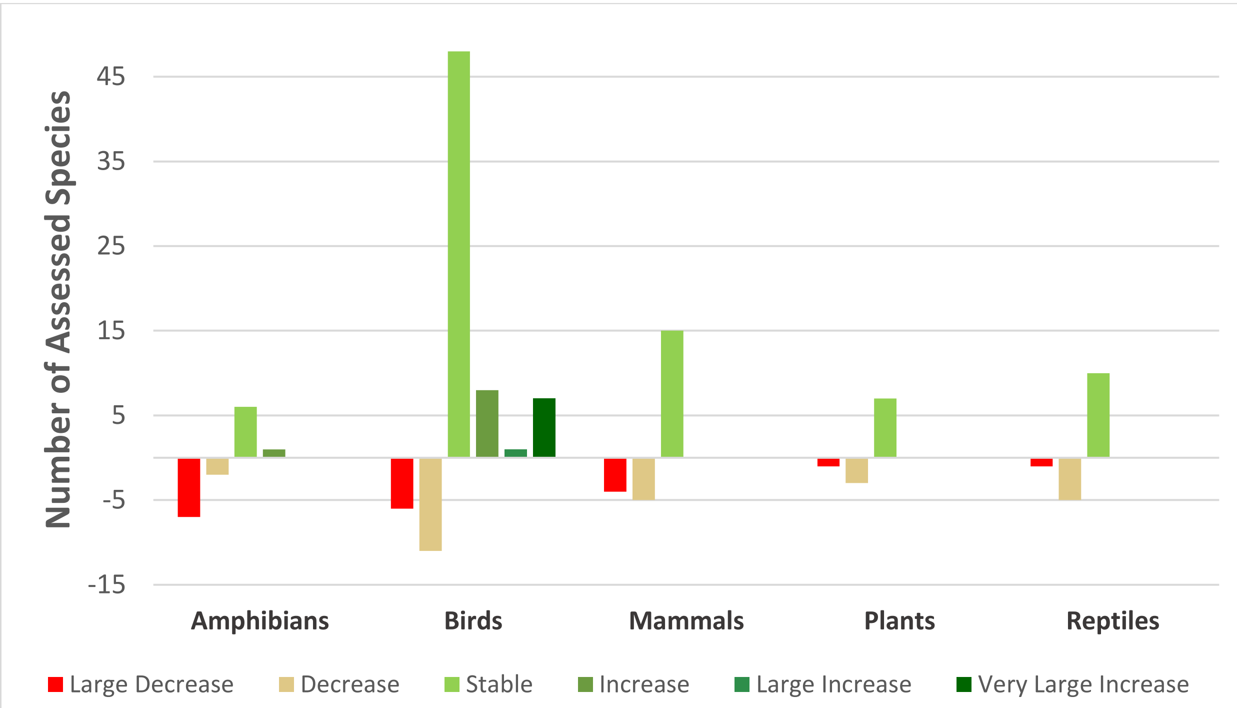


FIGURE 10-13: South Carolina Species of Greatest Conservation Need (SGCN) whose ranges may decrease, remain stable, or increase based on climate change vulnerability scores from available ecological niche models across 12 studies compiled by Armsworth et al. (*in progress*).

Like the CCVI assessments, most niche models to date focus on birds. Based on the assessments, many bird species may experience increases in their climatically suitable landscape within the Southeast Region. However, for the amphibians, plants and reptiles evaluated with niche models to date, there appears to be roughly equal proportions of climatically suitable areas for SGCN decreasing as increasing.

Comparing CCVI and Available Ecological Niche Models Results

Comparing the results of the ecological niche models to the CCVI estimates for SGCNs within South Carolina reveals similar trends for taxa that were evaluated using both methods. All taxa within the Southeast (including plants) will experience some vulnerability (i.e. moderately, highly, extremely vulnerable) and some decreases (i.e. decrease or large decrease). But looking beyond birds, results suggest that amphibians and reptiles are projected to have large proportions of their populations vulnerable to climate change. Amphibians have the fewest species with predicted stable populations across both methods, and no species within this assessment are presumed stable or increasing in the CCVI estimates. Birds have the most species identified as vulnerable to climate change, but also the most species with predicted stable or increasing populations across both approaches, partially due to how many more bird SGCN have been evaluated compared to other taxa.

Currently, few species overlap between both the CCVI and ecological niche model datasets, which limits the scope of comparisons. In particular, niche model estimates are not yet available for many aquatic species such as fishes and mussels, which the scientific literature suggests may be some of the most vulnerable to climate change in South Carolina and the Southeast Region (Halpern and Kappel 2012; Poff et al. 2012; Ingram et al. 2013). However, the available CCVI for these aquatic taxa suggests that fish have the greatest number of South Carolina SGCN predicted to be extremely vulnerable to climate change.

Yet, by comparing these two methods, there is support for focusing climate adaptation strategies on the conservation of amphibians and aquatic species. SARP already considers identification and remediation of anthropogenic barriers to aquatic organism passage a priority conservation action, and this can also be an important climate adaptation strategy to support the resilience of fish and other species that rely on aquatic connectivity.

Comparing CCVIs and Ecological Niche Models: Appalachia as a Refuge for Salamanders and Other Threatened Amphibians

The Southeastern US is recognized as a global biodiversity hotspot for amphibians with nearly 200 unique species, more than 50 of which are endemic to the region (Duellman 1999). The potential impacts of climate change on amphibians in the Southeast is of great concern given the strong relationship between climate and the distribution and patterns of amphibian diversity (Milanovich et al. 2010, Barrett et al. 2014). Table 10-16 summarizes the available CCVI and ecological niche model data for a selection of amphibian SGCN in South Carolina.

There is some alignment between CCVI estimates and vulnerability scores from ecological niche models. For example, CCVI assessments indicate that both the Green and Seepage Salamanders are considered "moderately vulnerable" to climate change. Similarly, the ecological niche models suggest both species are projected to experience "large decreases" in climatically suitable areas across their ranges within the Southeast.

When there is disagreement across the tools, it is important to consider how the analyses were conducted. CCVI estimates do not include spatially explicit data, and in many cases, the ecological niche model results suggest a species may be more vulnerable to climate change than estimated by the CCVIs due to changes in suitable habitat. However, there are other species like the Tiger and Four-toed Salamander, where the assessments differ due to disparities in the scale of analysis between the various methods (i.e. CCVI estimates conducted for individual states and niche models conducted at the region or ecoregion level). For the disagreement between the vulnerability estimates for the Tiger and Four-toed Salamander, it is recommended to examine the spatial extent and biological assumptions (e.g. assumed dispersal capacity of the species) of the niche models and the parameters used for the CCVI assessments, as they could be driving the discrepancies in vulnerability estimates. In some cases, where large discrepancies exist between the two methods, further vulnerability assessments may be needed.

TABLE 10-16: Assessment of climate vulnerability for amphibian SGCN based on available CCVI estimates and ecological niche model vulnerability scores from recent studies geographically close to or within SC. CCVI estimates taken from Bruno et al. (2012), Sneddon & Galbraith (2015), and NatureServe (2023). Niche model vulnerability scores calculated by Armsworth et al. (*in progress*), Sutton et al. (2014), Zellmer et al. (2020), and Zhu et al. 2021.

	Species	SC SCGN	Southeast RGSCN	CCVI	Niche models
Salamanders					
Frosted Flatwoods Salamander	*Ambystoma cingulatum*	X	X	Not assessed	Large Decrease
Tiger Salamander	*Ambystoma tigrinum*	X		Extremely vulnerable	Stable
Green Salamander	*Aneides aeneus*	X	X	Moderately Vulnerable	Large Decrease
Hellbender	*Cryptobranchus alleganiensis*			Highly - Moderately Vulnerable	Large Decrease
Seepage Salamander	*Desmognathus aeneus*	X	X	Moderately Vulnerable	Large Decrease
Southern Dusky Salamander	*Desmognathus auriculatus*			Not assessed	Stable
Four-toed Salamander	*Hemidactylium scutatum*	X		Moderately Vulnerable	Stable
Webster's Salamander	*Plethodon websteri*	X	X	Not assessed	Large Decrease
Other Amphibians					
Pine Barrens Tree Frog	*Hyla andersonii*	X	X	Not assessed	Large Decrease
Gopher Frog	*Lithobates capito*	X	X	Highly Vulnerable	Large Decrease
Wood Frog	*Lithobates sylvaticus*	X		Moderately Vulnerable	Decrease

However, across the assessment methods, almost all South Carolina salamander SGCN, as well as many other amphibian SGCN, are estimated to be at least moderately vulnerable to climate change and projected to experience decreases in suitable land area (i.e. habitat). Given that the Blue Ridge and Piedmont Ecoregions of South Carolina, which are crucial habitat for many amphibian SGCN, are expected to experience the greatest increase in maximum temperatures and greatest increase in precipitation (see A Changing Climate section), conservation action and management for amphibians in these parts of the State is of greatest priority.

Adaptation Strategies

Identifying adaptation strategies to address impacts and vulnerability is a step towards climate resiliency. Climate adaptation and mitigation comes in various forms, and multiple frameworks have been built to support planning for and implementing climate adaptation. Most climate adaptation frameworks generally include:

1. Recognizing limitations to adaptation, such as the degree of natural resource management, availability of funding, or staffing capacity; and
2. Deciding which type(s) of adaptation approach(es) meet specific conservation goals.

Two well-known examples of frameworks include the Resist-Accept-Direct (RAD) Framework developed by the US National Park Service (see also Chapter 9 where it is discussed) and the Climate Adaptation in Practice: Resistance, Resilience and Transition (RRT) Framework developed by Colorado State University. There are also multiple sources for adaptation and mitigation strategies. The Adaptation Workbook, a compilation of resources developed by the Northern Institute of Applied Climate Science and its partners, provides an excellent overview of strategies.

The Adaptation Workbook is broken down into sections, one of which is Adaptation Strategies and Approaches. In this section, climate adaptation strategies are listed in what are known as "menus"—categorized by focus areas—with the goal of providing conservationists with specific, actionable adaptation options from which to select. The menus are not all-encompassing, nor are they intended to serve as guidance for management decisions. They simply serve as a starting point for those interested in climate adaptation so that they do not have to start from scratch.

Climate adaptation menus that apply to the Southeast United States include:

Agriculture
Fire-Adapted Ecosystems
Forests
Forest Carbon Management
Forested Watersheds
Grasslands
Non-Forested Wetlands
Recreation
Saltwater Coastal Ecosystems*
Tribal Perspectives
Urban Forests
Wildlife Management

**in development*

Working in Resilient Landscapes

Regardless of the projected impacts of climate hazards, some portions of the State are predicted to be more resilient than others. Focusing conservation actions within resilient places is a climate-smart investment.

Terrestrial Resilience
Much of South Carolina's natural landscape is considered a resilient terrestrial site. The Nature Conservancy (TNC) developed a data set called Resilient Land Data and identifies areas with different landscape characteristics that influence an area's capacity to maintain species diversity

and ecosystem function in the face of climate change. It measures two factors that influence resilience. The first, landscape diversity, reflects the number of microhabitats and climatic gradients created by topography, elevation, and hydrology. The second, local connectedness, reflects the degree of habitat fragmentation and strength of barriers to species movement. Highly resilient sites contain many different habitat niches that support biodiversity and allow species to move freely through the landscape to find suitable microclimates as the climate changes. Resilience emphasizes diverse landscapes where species are likely to be able to move and adjust to changing conditions. While the species themselves may change, these areas are likely to be able to host a continued diversity of species into the future.

Coastal Resilience

South Carolina's coastal and estuarine environments are key areas to build and sustain resiliency in the face of climate change. In particular, tidal marshes and habitats provide vital ecosystem services like shoreline stabilization, water filtration, food production, and recreational opportunities. Identifying places where tidal marshes and habitat provide resiliency to climate hazards currently and in the future is a key strategy in mitigating climate change impacts.

SCDNR biologist, Grace Lewis, measures changes in wetland elevation using the Surface Elevation Tool. Photo by SCDNR.

The US Geological Survey (USGS) used remote sensing to calculate the unvegetated-vegetated ratio of tidal wetlands, which compares how much of a wetland is not covered by plants (e.g. sediment, rocks, open water) to how much is covered by plants. Marshes that maintain a higher proportion of vegetation tend to be more stable and resilient to threats like sea-level rise, erosion, and coastal development. This data offers a lens to identify marshes that may be good candidates for restoration to help them persist in the face of changing conditions (USGS 2017). Recent research shows that a high unvegetated-vegetated ratio correlates with elevation measurements that detect vertical changes due to accretion, subsidence, or compaction—meaning that stable marshes with high vegetative cover tend to better keep pace with sea-level rise.

In addition to resilient terrestrial sites, TNC also developed Resilient Coastal Sites, which provides a way to map and visualize coastal habitats with the capacity to migrate to adjacent lowlands in order to sustain biodiversity and natural services under increasing inundation from sea-level rise. Scientists from TNC evaluated more than 1,200 coastal sites in the South Atlantic region that contained tidal marsh and tidal habitats to identify places more likely to continue to support biological diversity and ecological functions under rising sea levels (Anderson and Barnett 2019). It is based on the physical and condition characteristics of current tidal complexes, their predicted migration space, and surrounding buffer areas. These characteristics include marsh complex size, shared edge with migration space, sediment balance, water quality, natural landcover, landform diversity, and many others.

Case Study: Adapting to Changing Weather Patterns and Effects on Prescribed Burning

Wildland fire has shaped much of the biodiversity across the Southeast. Not only do many SGCN rely on habitats maintained by fire, but so do several game species like Eastern Wild Turkey and Northern Bobwhite quail. Prescribed fire, also called prescribed burning or controlled burning, is a critical tool for managing habitat for wildlife, reducing wildfire risk, and meeting ecological objectives like suppressing invasive species and maintaining disturbance-dependent habitat like grasslands (i.e. Piedmont prairies) and longleaf pine savannas. Historically, wildland fire occurred at large landscape-level scales with much of the Coastal Plain, Sandhills and Piedmont Ecoregions likely adapted to fire return intervals of 4-6 years with longer fire return intervals closer to the Blue Ridge Ecosystem (Figure 10-14) (Guyette et al. 2012).

A prescribed fire in a grassland returns nutrients to the soil.
Photo by Anna Smith, SCDNR.

In the Southeast Region, it is likely that a changing climate will impact fire regimes (defined by factors including frequency, intensity, size, pattern, season, and severity of fire), which may have a large impact on natural habitats and systems. In order to conduct prescribed burns safely, land managers must burn during times where specific meteorological criteria (suitable weather conditions within which burning may occur based on maximum daily temperature, daily average relative humidity, and daily average wind speed) are met, as well as within the social criteria of municipalities (Kupfer et al. 2022). Based on available research for historical and future prescribed burn windows, changes in climate are projected to shift the available time windows where these conditions are available (Kupfer et al. 2022). Moreover, rapid urban expansion near managed forests may reduce opportunities to use prescribed fire, which could lead to declines in native species, increases in nonnative species, increases in wildfire occurrence, and negative impacts to economic and human health.

Wildfires reach the crown of trees, destroying even hardy species like pines. Photo of the Gaston Fire of 1966 by SCW.

Given that the Southeast is a historically fire-adapted landscape (see Chapter 2), this has significant implications for overall ecosystem health in the region. Many animal and plant SGCN and RSGCN are fire-dependent, like Red-cockaded Woodpeckers, Indigo Snakes, pitcher plant species, and Smooth Purple Coneflower. According to the 2023 Southeast Blueprint fire frequency indicator, an estimated 687,527 acres were burned from 2013-2021 in South Carolina with only slightly more than 40,000 acres burned three times or more (Southeast Conservation Adaptation Strategy 2023). While across the Southeast, prescribed fire is increasing in some ecosystems like longleaf pine, this trend needs to continue to increase in order to meet the regional SECAS goal as well as to support SGCN and other statewide objectives.

A prescribed burn under loblolly pines helps control competing vegetation and reduce the risk of wildfire. Photo by Anna Smith, SCDNR.

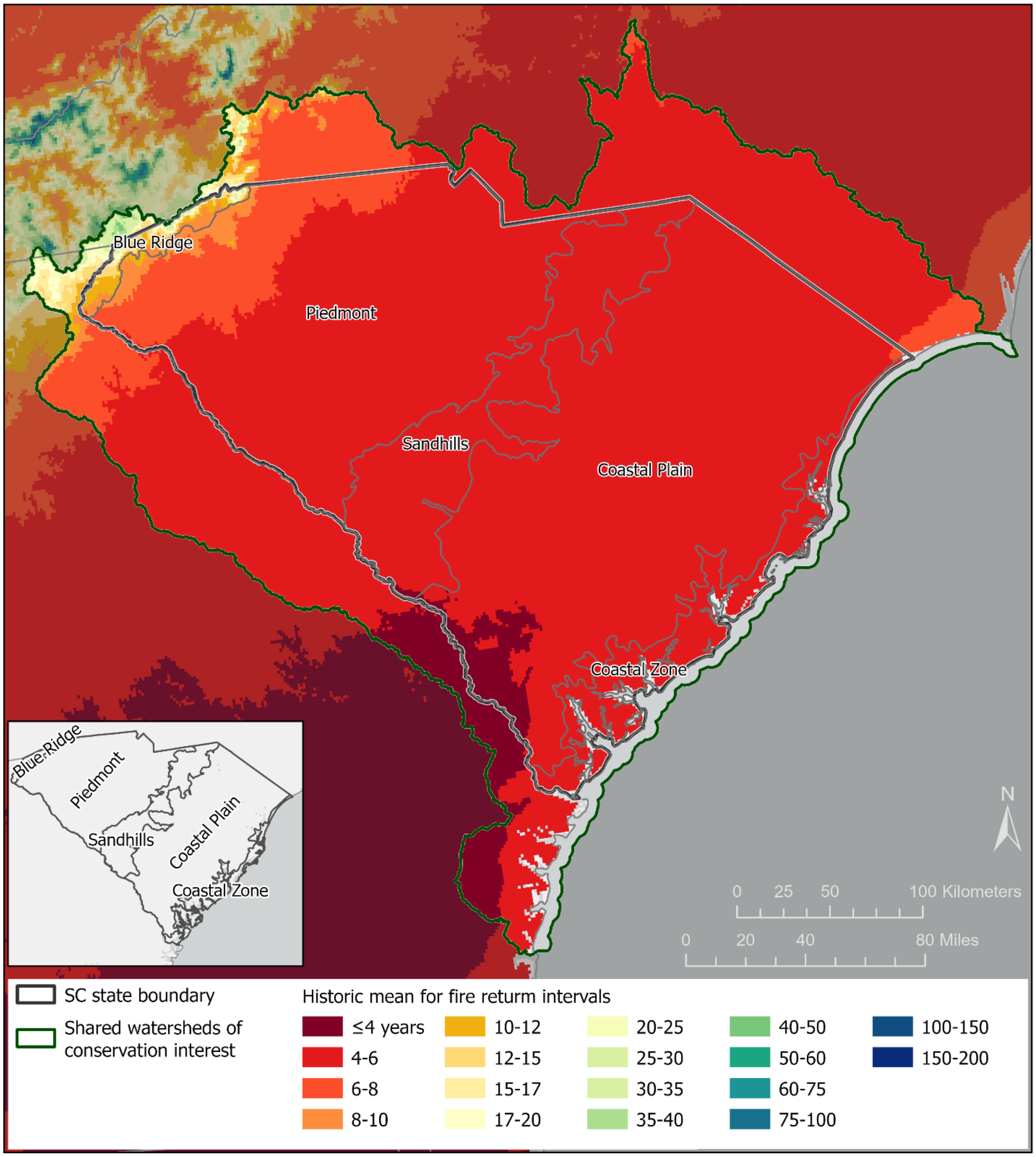


FIGURE 10-14: This map depicts likely historic fire return intervals as predicted by the Physical Chemistry Fire Frequency Model (PC2FM) developed by Guyette et al. (2012). This equation relies on theories and data in physical chemistry, ecosystem ecology, and climatology to predict likely historic fire return intervals.

Researchers working with the SE CASC conducted a study aimed at evaluating the potential impacts of projected climatic change on prescribed burning opportunities in the Southeast (Kufer 2020). Understanding how burn windows, or when there are suitable weather conditions to conduct a prescribed burn, will shift is important for land managers not only for managing habitats but also for securing the resources required to conduct the burns; these include fire specialists, burn crews, equipment, and securing permits. The study, which included much of the Southeast, considered how many days per season met the conditions to conduct prescribed burns under two RCP scenarios: RCP 4.5 representing an intermediate scenario and RCP 8.5 representing a very high scenario.

The study also provided a baseline for comparison by projecting conditions from 2010 to 2017. The seasonal trends from this time window show that South Carolina has experienced year-round opportunities to conduct prescribed burns, especially during the spring (March to May). While conditions were less favorable during the summer months (June to August), especially in the Piedmont Ecoregion (Figure 10-15), there were still opportunities to conduct burns in this growing season. Conducting prescribed burns in the summer growing season can help control invasive plants and improve habitat quality.

The study found that under both scenarios, the percentage of suitable days for conducting prescribed burning significantly decreased by 2100, especially during summer months (Kupfer et al. 2022). Although historically, almost 65% of summertime days met the burn window criteria, under the intermediate scenario 40.6% of days in the summer were suitable and under the very high scenario only 21.9% of the days in summer were suitable for conducting prescribed burns (Jewell 2020, Kupfer et al. 2022). These results also vary across the region with much less opportunities to conduct summer burns in some states, like Louisiana, compared with South Carolina. These changes are even more significant for land management given that summers may start earlier, be hotter, last longer, and have more periods of drought.

Examining future conditions from 2040-2049 under the intermediate-emissions RCP4.5 and higher-emissions RCP 8.5 scenarios suggests that there will be less suitable conditions to conduct prescribed burning during the summer growing season in South Carolina, especially in the Piedmont Ecoregion. Overall South Carolina will likely continue to experience favorable conditions to conduct prescribed burns during the fall, spring, and winter seasons. In addition, other states with shared RSGCN stewardship responsibility with South Carolina—like Georgia and Louisiana—are projected to experience much more dramatic declines in the percentage of suitable days to conduct prescribed burns. Therefore, South Carolina might be in a better position than other Southeastern states to conduct prescribed burning to maintain important fire-dependent habitats, as well as contribute to local and regional goals for prescribed burning.

FIGURE 10-15: Average percentage of days each season with suitable prescribed burning conditions under different future time periods and emissions scenarios. Projected conditions from 2010-2017 under RCP4.5 was used as a baseline because it most closely aligned with the climate scenario that South Carolina is currently experiencing. This is compared to the forecasted percentage of suitable prescribed burning conditions for 2040-2049 under the RCP4.5 and RCP8.5 emissions scenario.

With shifting seasonal windows and conditions that will be conducive to conduct prescribed burns, it will also be important to consider how to best distribute resources across the State to adapt to these changing conditions along with airsheds and air quality. With a constricted window to be able to conduct prescribed burns, it is likely that more practitioners will burn in concentrated timeframes where conditions are suitable (S. Cammack, GADNR, pers. comm). This may lead to concerns with overwhelming airsheds as they can only hold so much smoke, and if transport winds or dispersion are low, smoke will remain in the airshed over longer times (S. Cammack, GADNR, pers. comm). This may impact the size or duration of burns through the burn permit system, especially with recent changes in the National Ambient Air Quality Standards (S. Cammack, GADNR, pers. comm). It may be important to balance what are currently considered as marginal or poor days for burning with future opportunities while also considering information on fine particle matter (PM2.5).

A prescribed burn reduces fuel loads on the forest floor. Photo by Anna Smith, SCDNR.

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