

Guidance for incorporating regional information into State Wildlife Action Plans in the Southeast

Executive summary

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, in 2020 AFWA established a President’s Task Force on Shared Science & Landscape Conservation Priorities, which recommended that State Wildlife Action Plans (SWAPs) serve as a framework for regional coordination and collaboration.

SWAPs identify Species of Greatest Conservation Need (SGCN) and outline strategies to sustain them, including conservation actions to promote species recovery and prevent federal listings under the Endangered Species Act. In many ways, there are several commonalities among SWAPs in the Southeast. Some of these commonalities are a result of collaboration through the Southeastern Association of Fish and Wildlife Agencies (SEAFWA) and other partnerships. Several SEAFWA states share common SGCN as well as Regional Species of Greatest Conservation Need (RSGCN). There are also landscape-scale threats or stressors that impact many of the SEAFWA states, such as climate change impacts, invasive species, and loss of habitat. At the same time, each SWAP is unique and reflects the species, habitats, and resources of each state. Additionally, each state has the autonomy and authority to develop a SWAP that best suits that state’s needs.

SWAPs offer a means for states to collaborate at meaningful landscape scales. Through coordination and by considering how to leverage cross-jurisdictional opportunities, the states can design and implement efficient and effective strategies to best support both state-specific SGCN and RSGCN. Additionally, some of the threats that impact SGCN (e.g., climate change impacts) are regional as well as local in scale and addressing them may require coordinating multiple partners across state boundaries.

States also encounter common challenges as they revise their SWAPs, which they are required to do every ten years. A subcommittee for the SEAFWA Wildlife Diversity Committee (WDC) recently surveyed all SWAP coordinators in the Southeast region to elicit information about how each state approaches their SWAP revisions, what tools they use, and what elements they find most challenging. The survey found that the majority of states consider identifying or updating SGCN and incorporating climate change information as the most challenging components of their SWAP revision. In addition, most states reported identifying threats and conservation actions and developing habitat classifications as moderately challenging to accomplish.

The intent of this document is to illustrate how SEAFWA states can use existing, publicly available regional information to help inform their SWAPs and identify collaborative strategies to implement

conservation actions to support SGCN and RSGCN. States can use this document to augment their SWAP revisions and/or to develop an additional SWAP chapter that focuses on landscape-scale information and how to best align conservation efforts with neighboring states and other partners. By providing specific examples and case studies, this document showcases how these regional resources can be included in SWAP revisions without increasing the burden to states during the SWAP revision process.

By using consistent regional information and approaches that complement local data and efforts, the states may be able to better address SWAP revision challenges and align their plans. Similarly, by outlining how each state contributes to regional conservation priorities, and by identifying potential landscape level threats that may impact SGCN and RSGCN, the SEAFWA states may be able to better maintain natural ecosystem processes, connect our region's lands and waters, and offer the greatest benefit to SGCN and the public.

Each SWAP is required to address eight common elements as outlined by Congress. Using the information in this guide can help states meet at least six of those requirements by:

1. Integrating information on the distribution and abundance of wildlife whose ranges may expand beyond individual states, including low and declining populations that represent the diversity and health of the state's wildlife and the region.
2. Integrating regional priorities across the landscape to assess the location and condition of key habitats and community types that may provide co-benefits and support cross-jurisdictional priorities as well as those of the individual state.
3. Integrating regional information on landscape level stressors such as climate change, habitat loss, and other challenges can help states better describe and assess problems which may adversely affect state-specific SGCN and RSGCN that occur within their state, and priority research and survey efforts needed to identify factors which may inform improved restoration conservation of these species and their habitats.
4. Integrating regional information to better be able to identify, describe and prioritize potential cross-jurisdictional conservation actions to conserve SGCN and RSGCN as well as the habitats upon which they depend.
5. Integrating regional information to better inform plans for monitoring the health of species populations, habitats, and plans for monitoring the effectiveness of conservation actions and adapting these conservation actions based on new information.
6. Identifying potential cross-jurisdictional opportunities to coordinate with federal, state, and local agencies and Indian tribes in developing and implementing the wildlife action plan.

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State contributions to regional priorities and the conservation landscape

One way to support the alignment of SWAPs as an efficient and effective way to support cross-jurisdictional conservation actions and sustain SGCN is to use existing regional information to assess the landscape. Within the SEAFWA region, there are several partnerships, initiatives, and consortiums that seek to provide landscape scale information and evaluate widespread trends and metrics. States can take advantage of these resources to assess how their statewide priorities are represented and to look for opportunities to collaborate with neighboring states to efficiently manage for their SGCN. Two resources that provide states with information to both support state-specific and regional priorities are the Southeast Conservation Blueprint and Regional Species of Greatest Conservation Need.

The Southeast Conservation Blueprint

The [Southeast Conservation Blueprint](#) is the primary product of the [Southeast Conservation Adaptation Strategy \(SECAS\)](#). SECAS is a regional conservation initiative that was started in 2011 by the Southeastern Association of Fish & Wildlife Agencies (SEAFWA) and the federal agencies of the Southeast Natural Resource Leaders Group (SNRLG). It spans the Southeastern United States (15 states) and Caribbean (Puerto Rico and the U.S. Virgin Islands) and brings together diverse partners to design and achieve a connected network of lands and waters that supports thriving fish and wildlife populations and improved quality of life for people. The overarching goal of SECAS is a 10% or greater improvement in the health, function, and connectivity of Southeastern ecosystems by 2060.

The Southeast Conservation Blueprint (Blueprint) is the primary product of the SECAS. It is a living, spatial plan that identifies important areas for conservation and restoration across the Southeast and Caribbean. The Blueprint stitches together smaller subregional plans into one consistent map, incorporating the best available information about key species, ecosystems, and future threats. More than 1,700 people from 500 different organizations have actively participated in its development so far.

While the Blueprint is a regional plan, it can also be used at a local scale. Conservation professionals across the Southeast use the Blueprint to bring in new funding to support conservation actions, identify organizational priorities, and inform decision-making. For example, the Blueprint has already been used by some states to help inform their Conservation Opportunity Areas (COAs) and to help guide statewide conservation priorities.

Using the Blueprint to explore regional conservation priorities—South Carolina

South Carolina has a wide diversity of habitats, environmentally important areas, and scenic resources within the boundaries of its 19.9 million acres of land and water (USDA 2000). Several partners within the state are working with the South Carolina Department of Natural Resources to help conserve this important landscape. According to the Protected Areas Database of the United States (PAD-US, v2.1), approximately 2.5 million acres of South Carolina are considered protected.

The Blueprint recognizes 10.2 million acres, or roughly 52% of the state of South Carolina, as a priority for shared conservation action (Figure 1). About 5.4 million acres (27%) are considered to have high conservation value, meaning that the included lands and waters are some of the most important for ecosystem health, function, and connectivity in the Southeast. An additional 4.7 million acres (24%) of the state are considered to have medium conservation value. These are areas that might require more

restoration, but are important for buffering and connecting high value areas. Almost 2 million acres of South Carolina's protected landscape are identified within the Blueprint as either high (617,227 acres) or medium conservation value (1.3 million acres) ([Table 1](#)).

Table 1. Protected lands and waters considered protected within South Carolina. These numbers are estimates based on the Protected Areas Database of the United States (PAD-US v2.1) and may not reflect the most up-to-date assessments.

Priority category	Total acreage	Acres considered protected in PAD-US
High conservation value	5,478,364 (28%)	617,227
Medium conservation value	4,791,789 (24%)	1,337,594
Not identified as high or medium conservation value	19,919,038 (48%)	436,111
Total	19,919,038	2,390,934

Much of the South Carolina landscape also plays an important role in connectivity. In the Blueprint connectivity analysis, approximately 5.2 million acres of the state is considered either a hub or corridor. Approximately 2.6 million acres are identified as hubs, which are large patches (~5,000+ acres) of highest priority Blueprint areas and/or protected lands. About 2.5 million acres are identified as corridors, which connect those hubs within broad areas of established conservation interest for connectivity.

As species disperse across the landscape—especially as climatic shifts occur—looking at how South Carolina contributes to regional connectivity and connects to neighboring states could help identify opportunities to collaborate across boundaries to provide valuable dispersal routes for state-specific and regional SGCN.

There are many ways to use the Blueprint to complement local or other regional datasets. For example, We can “filter” the Blueprint to identify areas that are conserved resilient to climate change and are also identified as having high or medium conservation value (Fig X). The Nature Conservancy (TNC) has developed two regional datasets - the [Resilient Sites for Terrestrial Conservation in Eastern North America](#) and the [Resilient Coastal Sites for Conservation in the Atlantic Seaboard and Gulf of Mexico](#). The Resilient Sites for Terrestrial Conservation identifies areas with the capacity to continue supporting species diversity and ecosystem function in the face of climate. Coastal resilient sites depict the ability of coastal habitats to migrate to adjacent lowlands in response to sea-level rise, based on the physical and condition characteristics of current tidal complexes, their predicted migration space, and surrounding buffer areas—characteristics like marsh complex size, sediment balance, water quality, and many others. By filtering the Blueprint to identify places that are considered resilient states can find places where conservation action may support multiple benefits including local priorities.

The Blueprint also comes with a free support service – [Blueprint user support](#) – which is available across the SEAFWA geography. Staff are available to help make maps, perform geo-spatial analyses, and help states use and integrate the Blueprint within their SWAP revisions.

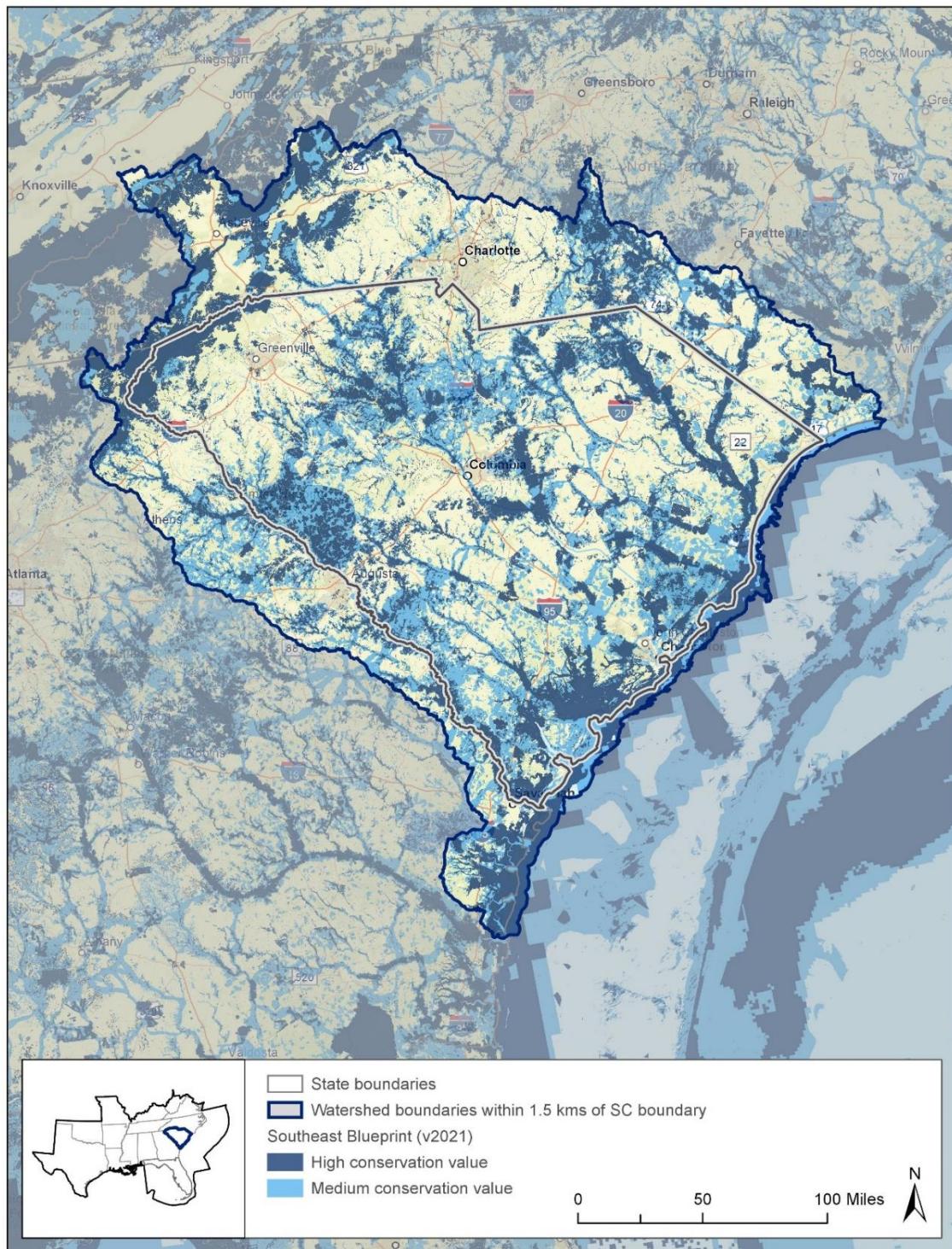


Figure 1. The Southeast Blueprint (v2021) in the state of South Carolina and surrounding watersheds. High conservation value areas are the lands and waters that are the most important for ecosystem health, function, and connectivity. This class covers roughly 30% of the Southeast Blueprint geography. Medium conservation value areas are lands and waters that might require more restoration, but are important for buffering and connecting high value areas. This class covers an additional 20% of the Southeast Blueprint geography.

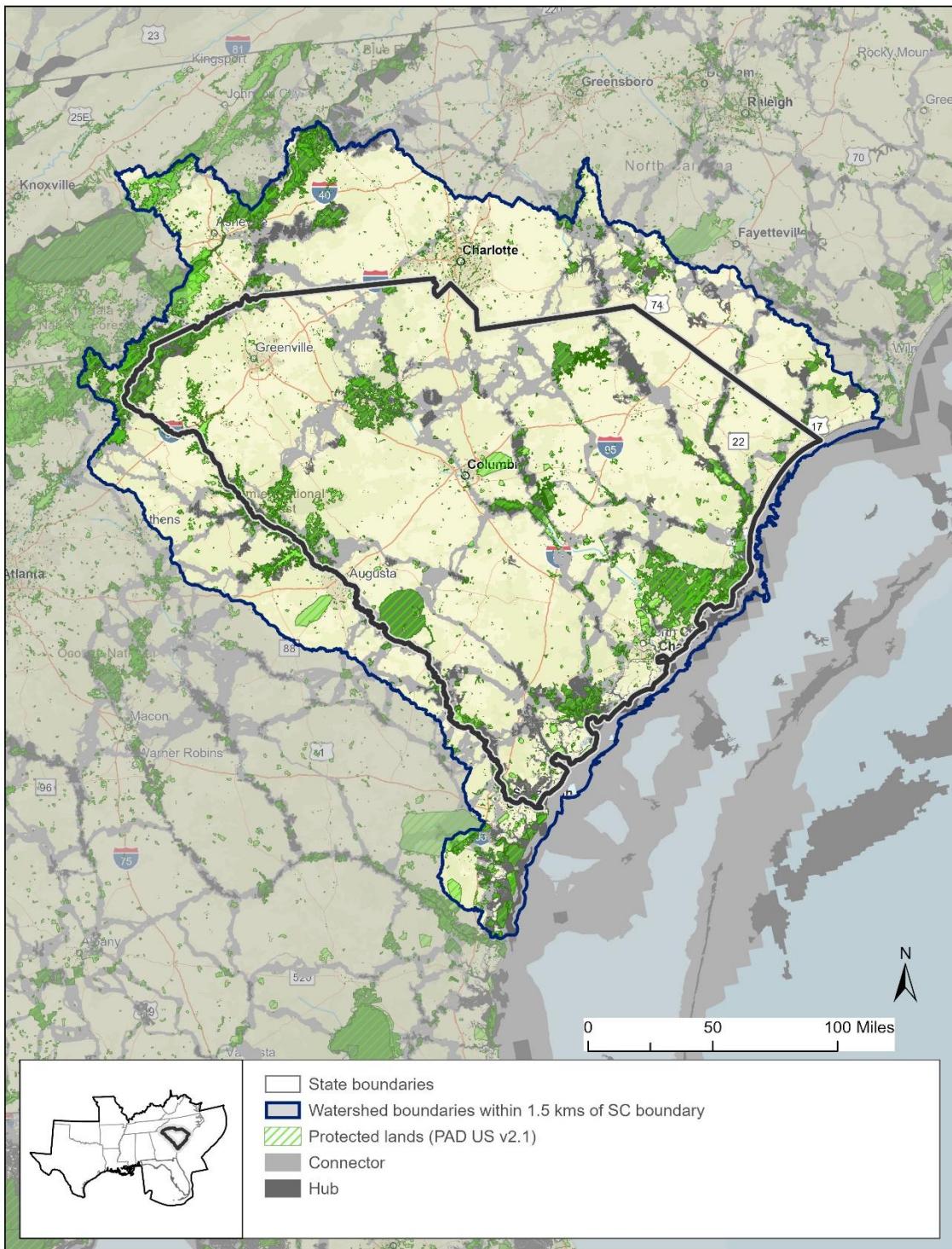


Figure 2. Protected areas and Blueprint hubs and connectors in the state of South Carolina and surrounding watersheds. Southeast Blueprint 2021 includes a layer that combines the hubs and corridors underlying Southeast Blueprint 2021 in the South Atlantic, Florida, and Appalachian subregions. Within the state of South Carolina, a least-cost path connectivity analysis is used to identify corridors that link hubs across the shortest distance possible, while also routing through as much Blueprint

priority as possible. Inland hubs are large patches (~5,000+ acres) of highest priority Blueprint areas and/or protected lands and inland corridors connect those hubs within broad areas of established conservation interest for connectivity.

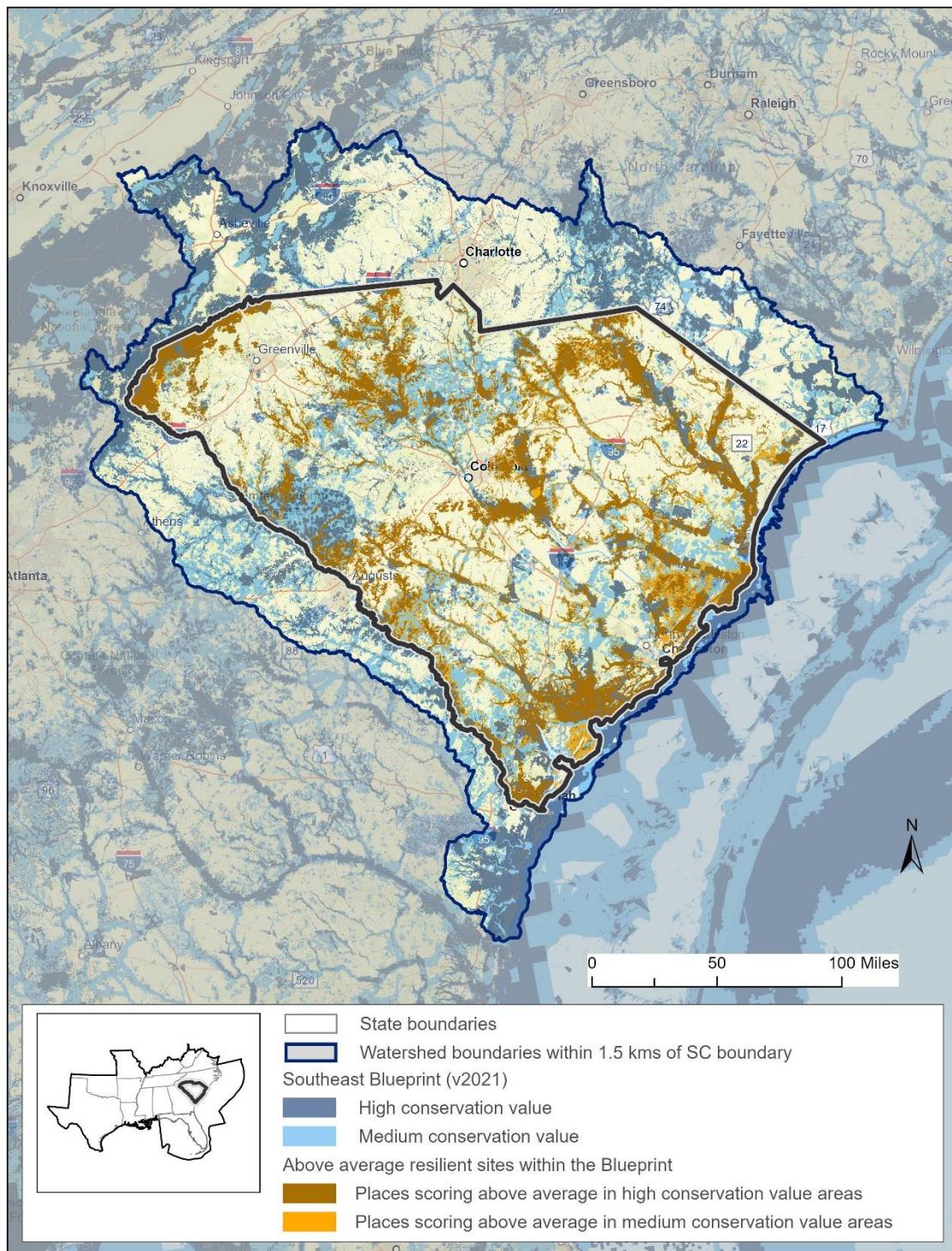


Figure 3. Areas within the Blueprint that are also considered resilient.

Regional Species of Greatest Conservation Need (RSGCN)

The National Wildlife Federation (NWF), as part of [the Vital Futures project funded by the U.S. Geological Survey](#), initiated a process for identifying a set of regional species identified as priorities in the 15 Southeastern SWAPs. The SEAFWA Wildlife Diversity Committee collaborated with NWF and other partners to evaluate these species and produced a list of 960 regional priority species, or “Regional Species of Greatest Conservation Need” (RSGCN). With the full list of RSGCN released in 2019, this effort aligns with the Northeast Association of Fish and Wildlife Agencies (NEAWFA) RSGCN.

Identifying the SEAFWA 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: the level of conservation concern (i.e., extinction risk), regional stewardship responsibility (i.e., importance of the Southeast in conservation of the species), and biological or ecological significance (e.g., unique evolutionary lineages). The regional assessment focused on species in key groups, including vertebrates (mammals, birds, reptiles, amphibians, and fishes) as well as several better-known groups of invertebrate animals (freshwater mussels, crayfish, and bumblebees). Scientific experts in each of these taxonomic groups were convened to evaluate the species and identify those 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 and very high concern. Through this established process for identifying RSGCN, this list can now be updated as the states’ SGCN lists change over time.

Across the Southeast, freshwater fish (with 281 species) represent the group with the greatest number of regional priority species, followed by crayfish (172) and freshwater mussels (136). Together these three groups of aquatic organisms represent nearly two-thirds (61%) of regional priority species. Including amphibians, many of which depend on freshwater habitats, increases the proportion of aquatic species on the regional priority to 72%.

Table 2. Number of Regional Species of Greatest Conservation Need by taxonomic group and concern level. Of the 960 regional priority species, nearly one-third (31%) are regarded as “very high concern.” Another 44% were assessed as “high concern” with the remaining quarter of species considered to be “moderate concern.”

RSGCN taxonomic group	Very high concern	High concern	Medium concern	Total
Mammals	11	28	28	67
Birds	10	47	17	74
Reptiles	18	45	27	90
Amphibians	26	46	33	105
Freshwater fish	84	104	93	281
Marine fish	18	11	1	30
Crayfish	54	84	34	172
Mussels	70	54	12	136
Bumblebees	2	1	2	5
Total	293	420	247	960

The number of regional priority species identified for each state varies widely, as depicted in Figure 4. These patterns reflect the underlying diversity of species in each state—particularly the number of at-risk 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 use of 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. Regional endemics or near-endemics are, almost by definition, more likely to occur in centrally located states than in states on the periphery of the region. Overall, more than half (55%) of RSGCN are shared by three or more states and are therefore prime targets for cross-state conservation collaborations. The remaining 45% of species have narrow ranges, being found in just one or two states.

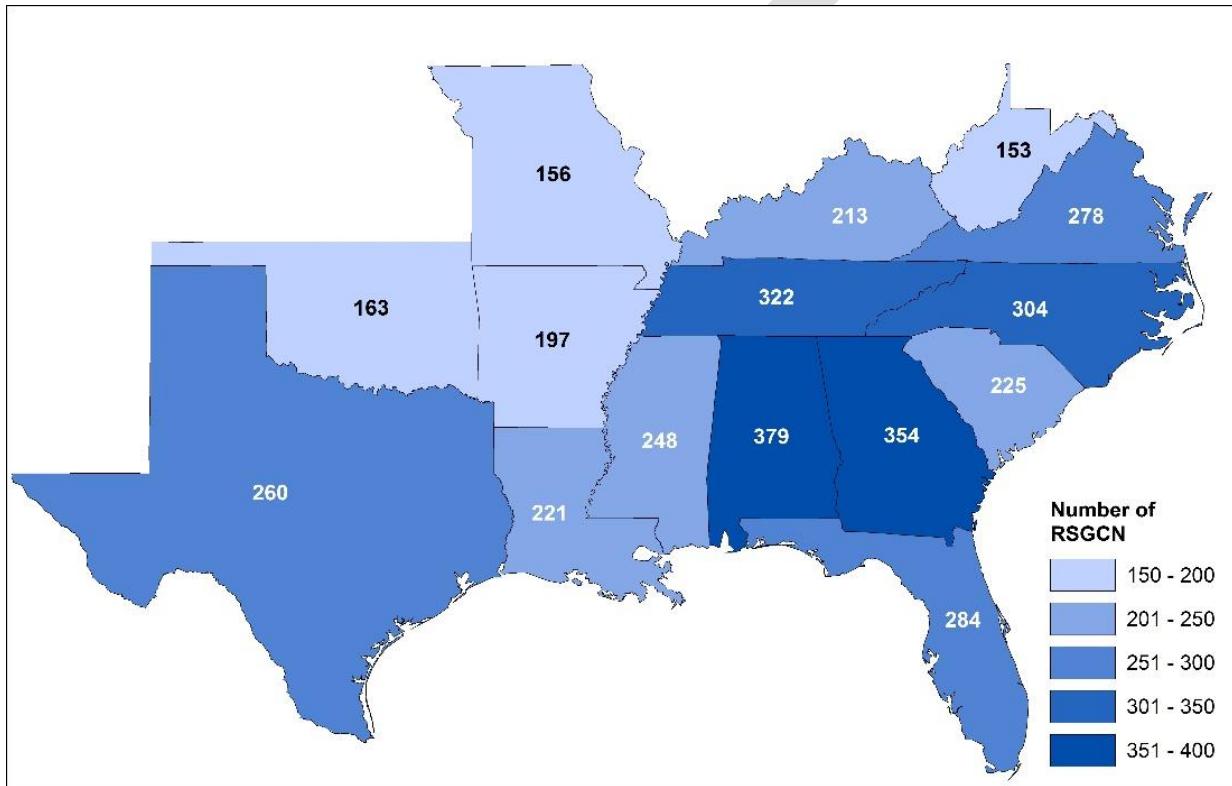


Figure 4. This figure was developed by the National Wildlife Federation and provided by John Kanter and Bruce Stein. It represents the number of RSGCN identified for each SEAFWA state.

John Kanter and Bruce Stein from the National Wildlife Federation [provide a summary overview of developing the RSGCN](#) and there is also [a final report for the SEAFWA RSGCN](#), prepared by Terwilliger Consulting, Inc

The full list of RSGCN is available at <https://www.nwf.org/Our-Work/Wildlife-Conservation/southeast-regional-priority-species>. <https://georgiabiodiversity.org/natels/sersgcn> and <https://www.nwf.org/Our-Work/Wildlife-Conservation/southeast-regional-priority-species>.

RSGCN and opportunities for collaboration - North Carolina, South Carolina, and Georgia
 There are 960 RSGCN identified within the SEAFWA geography, which can be a daunting list when considering how to develop strategies and collaborations. By summarizing the RSGCN list, states can find

out what they have in common with neighboring states and highlight shared responsibilities. Assessing shared responsibilities can aid in prioritizing conservation actions and identifying opportunities for cross-state collaborations. For example, South Carolina has 225 RSGCN, of which 12 only occur in South Carolina and North Carolina, four only occur in South Carolina and Georgia, and nine only occur in South Carolina and its two neighboring states (GA and NC). The number of shared species varies by state, with Alabama and Georgia having the highest number of shared RSGCN, at close to 2,000 species (Figure 5). As an example, South Carolina shares the most RSGCN with North Carolina (Figure 5) and RSGCN rated as “Very High Concern” (Figure 6) with Georgia.

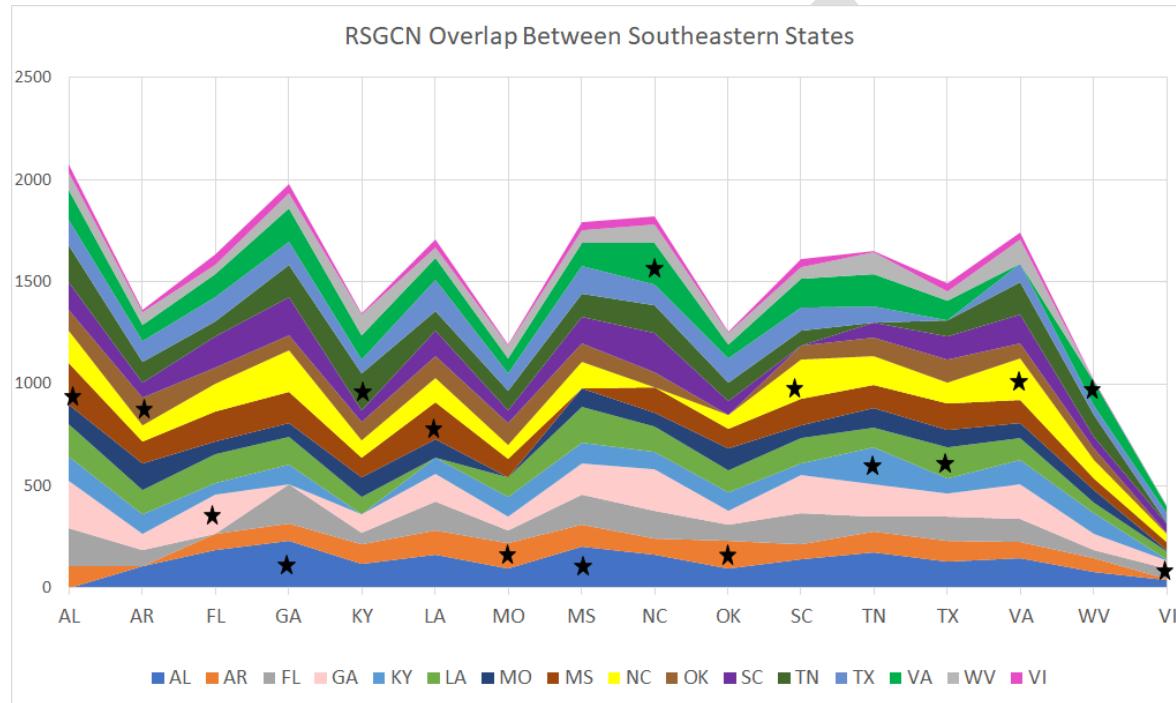


Figure 5. Number of RSGCN in common between Southeastern states. Stars indicate highest overlap.

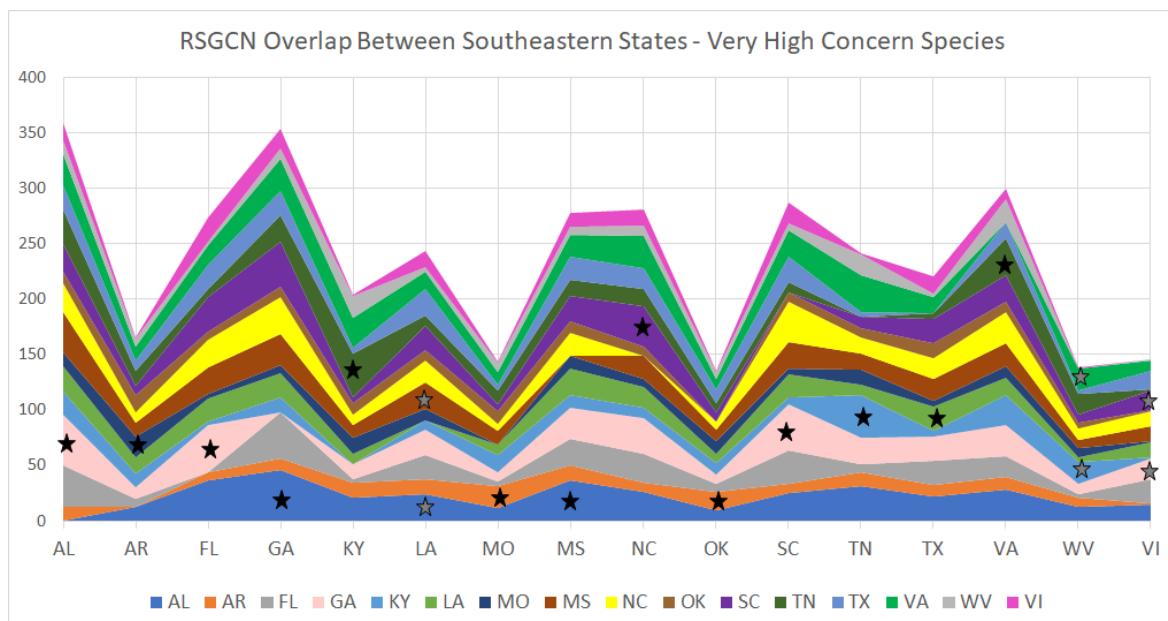


Figure 6. Number of “very high concern” RSGCN in common between Southeastern states. Stars indicate highest overlap, gray stars indicate a tie.

Additionally, RSGCN can be summarized by a select set of states. For example, South Carolina may want to assess shared species by taxa with its neighboring two states, Georgia and North Carolina. Figure 7 shows the number of shared RSGCN and SEAFWA endemic species by taxa across those three states. Birds are the most commonly shared species across these three states, while amphibians and fish have the highest number of shared SEAFWA endemics. The 9 species found in only these three states are fish and mussels.

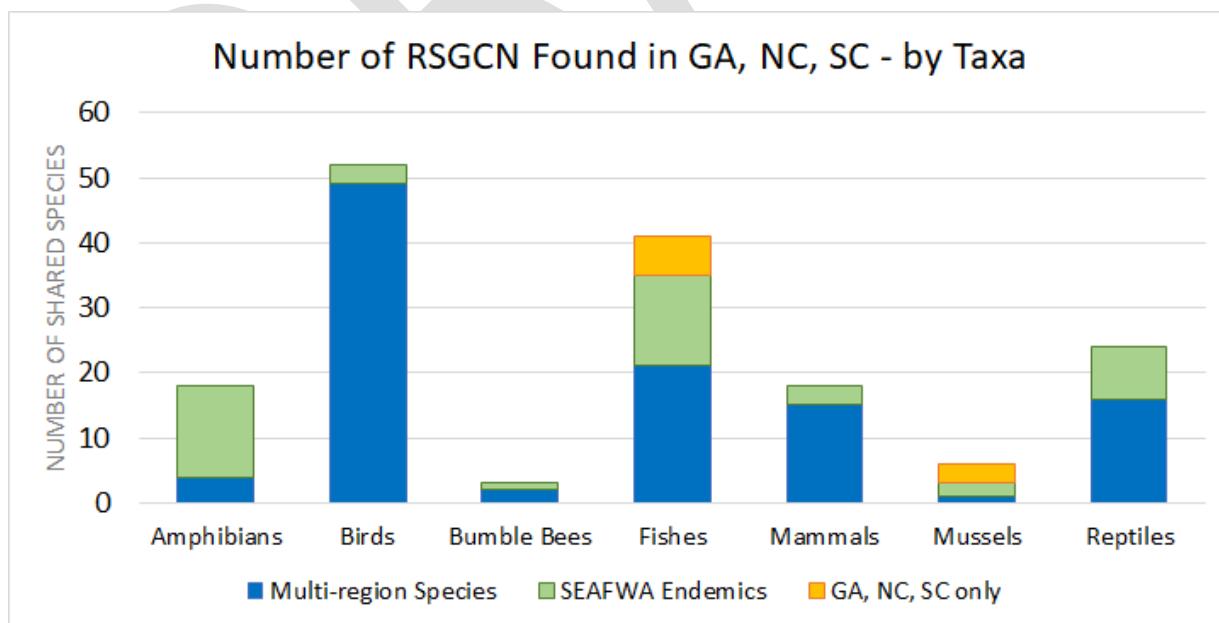


Figure 7. RSGCN found within GA, NC, and SC by taxa.

Further evaluation of the RSGCN data can identify the number of RSGCN, by taxa and by level of concern, that each state shares with South Carolina (Figure 8 and Figure 9).

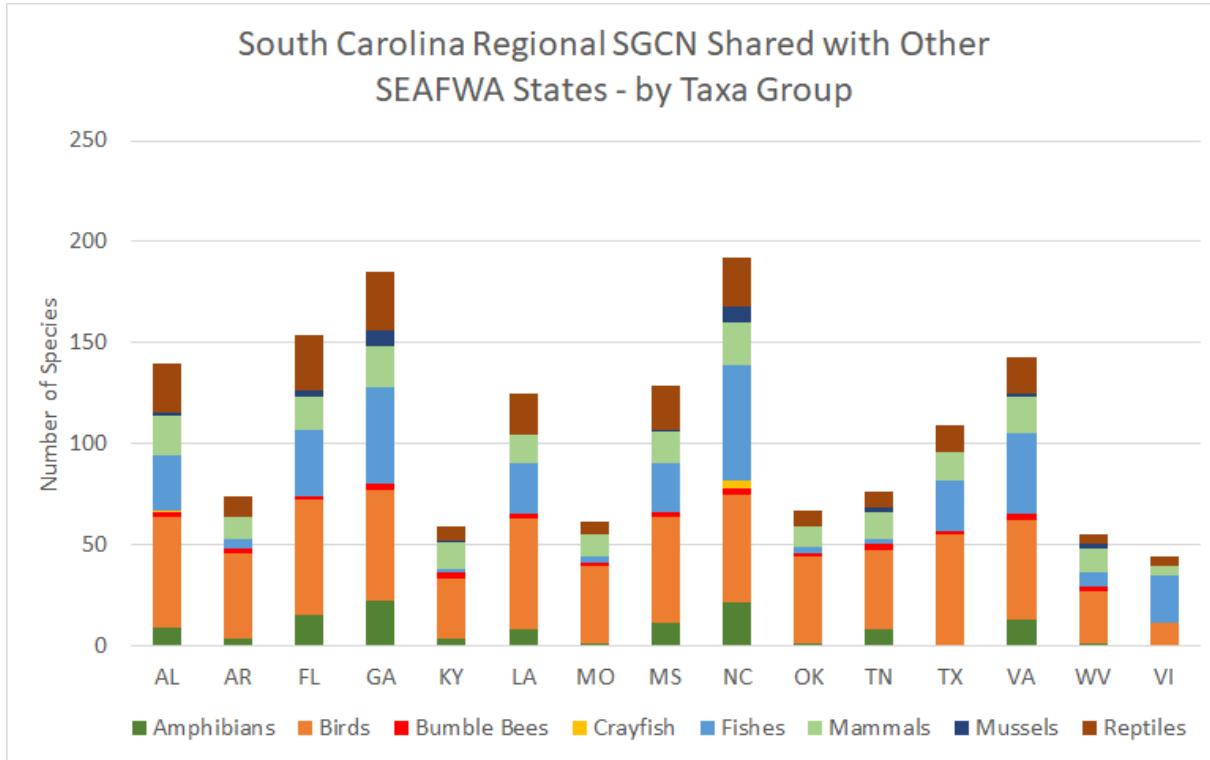


Figure 8. Number of South Carolina RSGCN, by taxa, shared with other southeastern states.

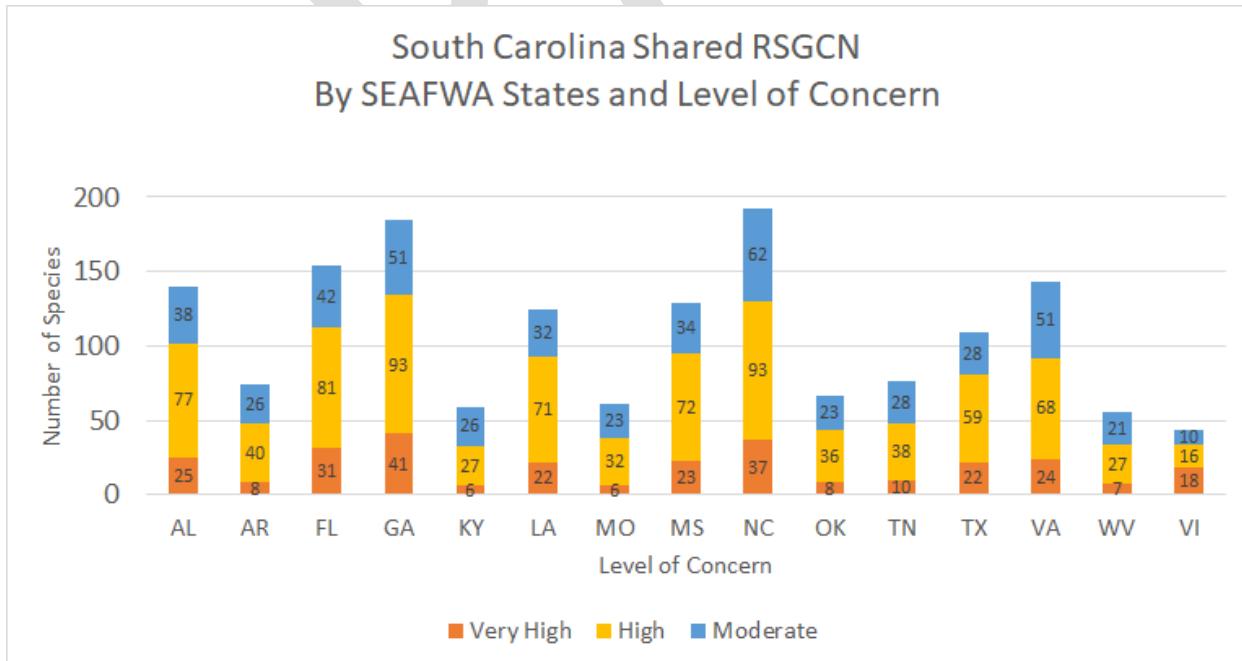


Figure 9. Number of South Carolina RSGCN shared with other southeastern states, by level of concern.

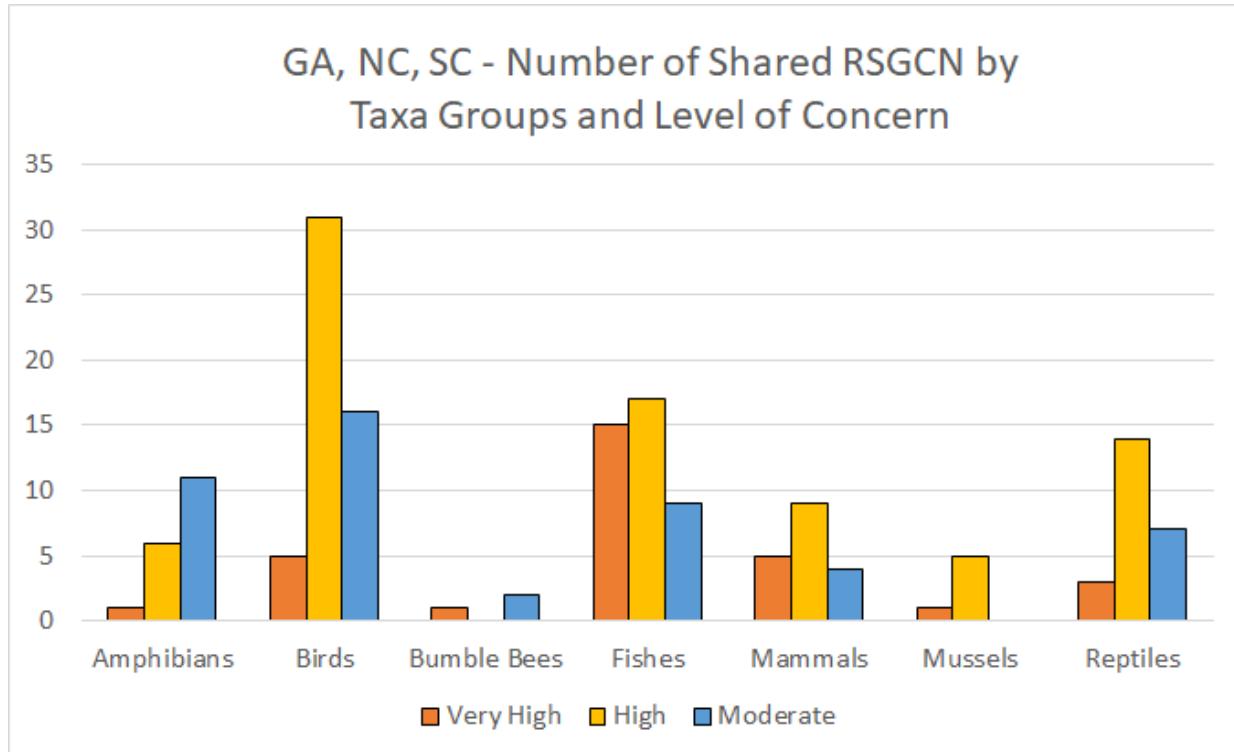


Figure 10. Number of RSGCN found in GA, SC, and NC by taxa and level of concern.

Of the 162 RSGCN found in at least GA, SC, and NC, there are 31 species of very high concern, 82 of high concern, and 49 of moderate concern (Figure 10). Fish contribute the most to the very high concern group with 15 of the 31 species. Birds contribute the most to the high concern group with 31 of the 82 species.

Regional Species of Greatest Conservation Need and the Southeast Conservation Blueprint—North and South Carolina

The Blueprint can help identify important areas for conservation across a species' predicted range. Habitat maps from the [USGS Gap Analysis Project \(GAP\)](#) are available for approximately 290 of the RSGCN at the species level. While GAP does not include habitat maps for invertebrates or plants, it does include a high percentage of the vertebrate RSGCN species (93% of amphibians, 92% of birds, 76% of mammals, and 77% of reptiles). There are an additional 90 subspecies on the RSGCN list that have USGS GAP habitat maps—at the species level. However, some of the GAP products draw from outdated landcover data.

Species predicted habitat maps were built using a national wildlife habitat relational database based on habitat associations described in published literature. The maps are created at 30-meter resolution using core datasets, including detailed land cover, elevation, and hydrological characteristics (for example, salinity, water type, and velocity). While the actual distributions of many species are likely to be habitat-limited, suitable habitat will not always be occupied because of population dynamics and species interactions. Furthermore, these maps correspond to mid-scale characterizations of landscapes, but individual animals may deem areas to be unsuitable because of the presence or absence of fine-

scale features and characteristics that are not represented in the GAP models (e.g. snags, vernal pools, shrubby undergrowth).

All data, including model inputs, are available from the USGS Gap Analysis Project Species Habitat Maps on ScienceBase: <https://www.sciencebase.gov/catalog/item/527d0a83e4b0850ea0518326>.

The habitat maps can be used with the Southeast Blueprint to identify a species' habitat across its range, attributed by the Southeast Blueprint's conservation values (high and medium) (**Figure 11**). The example below shows the modeled habitat for the Chamberlain's dwarf siren, attributed with the Southeast Blueprint conservation values. Areas in the dark blue show modeled habitat with a high conservation value, areas in light blue a medium conservation value, and areas in grey (very few and representing small areas in this example) as areas include in the modeled habitat but not identified as either high or medium in the Southeast Blueprint. Combining the Southeast Blueprint with the modeled habitat of species that occur in multiple states can help visualize and highlight important areas for species conservation across multiple jurisdictions. As recommended by AWFA, cross-jurisdictional or regional strategies may be needed to enhance ecosystem resiliency, function, and connectivity—especially in the face of climate change.

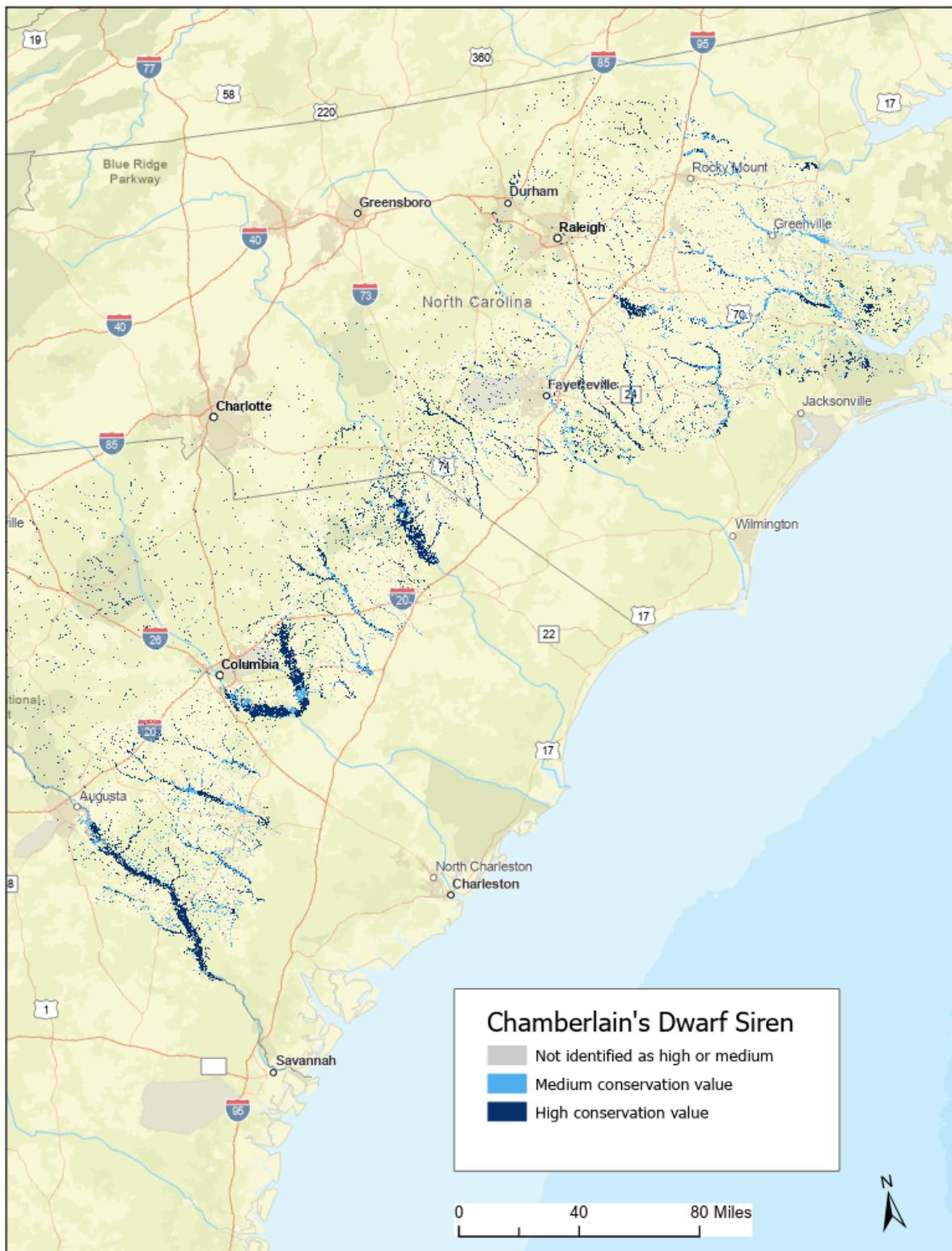


Figure 11. Southeast Blueprint conservation value within Chamberlain's dwarf siren modeled habitat (USGS GAP).

Regional threats – climate change

Across the Southeast, urbanization, climate change, and other threats are rapidly changing the landscape. While each state must evaluate the impact of these threats within their unique jurisdiction and within their SWAP, it's also important to consider how to align conservation action and strategies across jurisdictional boundaries. Some threats affecting SGCN and their habitats are most naturally viewed from a regional perspective and require a coordinated response from state wildlife agencies. By assessing threats at a regional scale, SWAPs can recommend conservation actions at more meaningful scales for sustaining species, making states more likely to achieve their conservation goals.

In the Southeast, climate change will impact many natural habitats and ecological processes and the critical ecosystem services they provide. The magnitude and rate of climate change associated with greenhouse gas emissions under current scenarios are posing a high risk of abrupt and irreversible regional-scale change in the composition, structure, and function of terrestrial and freshwater ecosystems. The broad spatial and temporal scales associated with climate present an unprecedented challenge for fish and wildlife agencies.

Earth's climate system is complicated. It incorporates thousands of factors that interact in space and time around the globe and over many generations. Scientists use advanced computer systems to simulate climate and predict future climate. Industries increasingly rely on information from these models to guide decision-making. With a changing climate, this information is more important than ever.

Envisioning how future environmental conditions might affect management of natural resources depends on having projections of what those conditions might be. Projections of future climate are based on general circulation models, also called "global climate models" (GCMs). The international community has invested in more than 50 model configurations to conduct simulations under multiple greenhouse gas emissions scenarios to produce hundreds of climate projections.

Climate models represent the best available science to understand how the climate system responds to changes in greenhouse gas concentrations. Climate models are not forecasts of the weather for the next several decades or centuries—instead they are sophisticated models that can be useful for assessing future risk due to changing greenhouse gas emissions. Climate models are often available as an ensemble that can be used collectively to better describe uncertainty and therefore risk. An ensemble of models permits *much* better characterization of uncertainty about future change since models performing the same experiment (or multiple simulations from the same GCM) can be analyzed together.

For natural resource managers, climate model results are going to be more useful for impact assessments when research has established clear, well-constrained and understood links between climate variables and species dynamics. These models can be a useful piece in the puzzle for assessing risk to species and habitat. Using a range of climate models helps us to better characterize the uncertainties of future climate and therefore the potential risk to species and habitats.

The results of climate projections are detailed in [Assessment Reports \(AR\) produced by the Intergovernmental Panel on Climate Change](#). These reports detail the latest scientific consensus on

climate dynamics, climate projections, and potential impacts. The Fifth Assessment Report (IPCC 2014) used Regional Concentration Pathways (RCPs) as a basis for the report's findings. A one-page overview of RCP's is available [here](#).

There are a lot of models available and it can be overwhelming to try to figure out what to use. A few things to consider that may help with this process:

- Decide on the climate parameters that best represent the change that will impact the resource in question. The most frequently chosen parameters are precipitation and temperature. However, many other parameters are available from many models that may link more closely to the extreme conditions that put the resource at risk, including maximum and minimum temperature, precipitation, runoff, soil moisture storage, and evaporative deficit. These can all be viewed on the National Climate Change Viewer (U.S. Geological Survey, 2019, <https://www.usgs.gov/tools/national-climate-change-viewer-nccv>).
- Decide on the level of downscaling needed based on the spatial extent of the resource. The National Climate Change Viewer offers summary statistics at the national, state, county, and watershed scale. Depending on the parameters, the change in scale may substantially change the summary statistics.
- Identify other criteria beyond the GCM climate parameter projections that are relevant to the decision-making process. Other criteria might include the use of particular models by partners or repeating the use of models from previous projects when comparison is desired.

Integrating climate change into SWAPs

The [AFWA 2009 Voluntary Guidance document](#) provides recommended steps for developing and implementing adaptation strategies (AFWA 2009, Table 1 and pgs. 5-9). Much of the guidance includes taking a broader, regional approach to incorporating climate adaptation into SWAPs. This guidance document hopes to illustrate and provide examples of how to best integrate regional climate change information and adhere to the following AFWA's recommended steps for developing and implementing adaptation strategies including:

1. Engage diverse partners and coordinate across state and regional boundaries
2. Take action on strategies effective under both current and future climates
3. Clearly define goals and objectives in the context of future climate conditions
4. Consider appropriate spatial and temporal scales
5. Consider several likely/probable scenarios of future climate and ecological conditions
6. Use adaptive management to help cope with climate change uncertainties

Evaluating species' vulnerability to climate change

As [part of the survey administered to SWAP coordinators in 2021](#), integrating climate change was reported by a majority of the states to be one of the most challenging components to upcoming SWAP revisions. Anecdotally, some SWAP coordinators noted that it is difficult to discern what tools are available, what the right tool is to use, and how to decide at what scale and what timeframe into the future to use the tools. Also, beyond sea-level rise, it can be difficult to determine what climate-change

associated threats to include and how to spatially represent how they will impact the landscape and potential management strategies.

In past SWAP revisions, SEAFWA states took different approaches to considering species vulnerability to climate change. Florida, Louisiana, Tennessee and West Virginia included an evaluation of the climate vulnerability of SGCN that used a vulnerability assessment tool developed by NatureServe, called the [Climate Change Vulnerability Index](#) (CCVI; Young). CCVI is a worksheet-based tool that calculates a vulnerability score describing how vulnerable a particular species is to climate change. By design, this score is distinct from NatureServe's national vulnerability ranking system that considers other threats. A species could rate as not particularly vulnerable in terms of its 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. direct and indirect exposure to climate change and its sensitivity to climate change.

As part of an ongoing project with the University of Tennessee intended to support SWAP revisions, the Southeast Climate Action Science Center will provide species vulnerability assessments to SEAFWA states to help prepare their 2025 SWAPs. This will include providing state-specific reports summarizing 455 CCVI estimates spanning 200 of the 960 RSGCN in the Southeast region ([Figure 12](#)) and provide an easy reference for species vulnerability to climate change for some RSGCN. Collectively, these assessments suggest that, of the RSGCN that have been assessed so far, 29% of terrestrial RSGCN are vulnerable to climate change and 70% of aquatic or marine RSGCN are vulnerable to climate change. The Southeast Climate Action Science Center currently hosts monthly working group sessions aimed at supporting states integrate climate change into their SWAP revisions as well as other climate related topics.

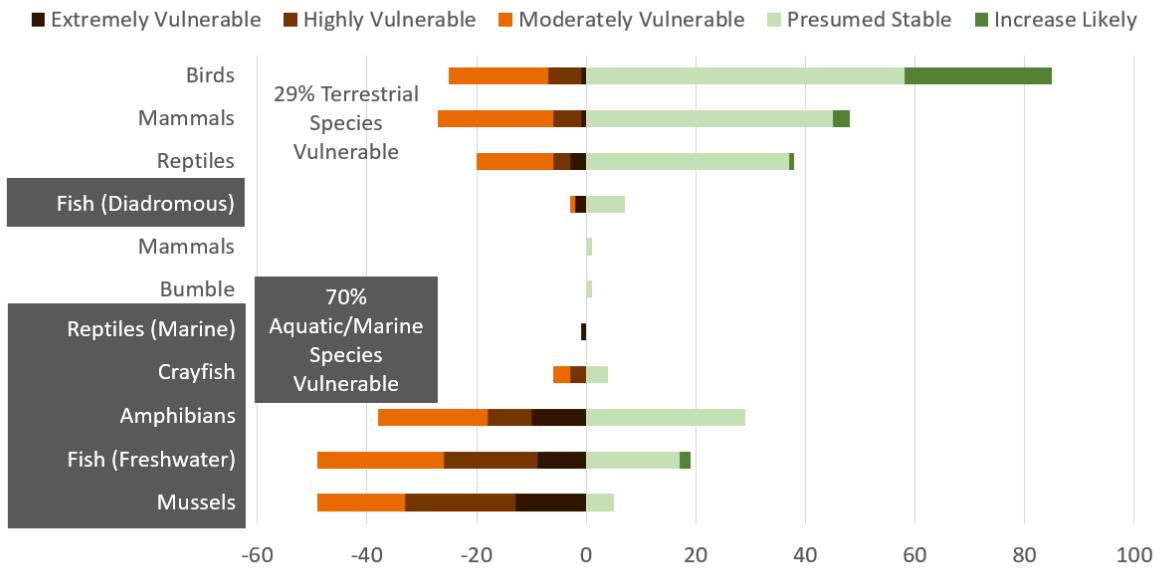


Figure 12. This figure represents 455 estimates of vulnerability to climate change for 200 RSGCN from different taxonomic groups as evaluated in CCVI estimates from 10 different sources. CCVI evaluates species as falling into one of 5 vulnerability categories.

Shifting species ranges

Changing winter temperature extremes, wildfire patterns, sea levels, hurricanes, floods, droughts, and warming ocean temperatures are expected to redistribute species and greatly modify ecosystems. Climate change has led to range contractions in nearly half of studied terrestrial animals and plants in North America; this has generally involved shifts northward or upward in elevation. Habitat fragmentation and loss of connectivity (due to urbanization, roads, dams, etc.) can prevent species from tracking shifts in their required climate; efforts to retain, restore, or establish climate corridors can, therefore, facilitate movements and range shifts. The ecological resources and species that each state is tasked with serving will be much different in the future. In order to identify conservation actions that will lead to successful outcomes for SGCN/RSGCN, it's important to take into account a more dynamic picture of species' ranges.

Shifting bird ranges—Survival by degrees

Audubon has developed an interactive web-based tool called Survival by Degrees to visualize possible range shifts for a range of species: <https://www.audubon.org/climate/survivalbydegrees>. Audubon scientists studied 604 North American bird species using 140 million bird records—including observational data from bird lovers across the country. The bird data was plugged into the same climate models used by more than 800 experts in 80 countries to map where each bird might live in the future under a changing climate. Audubon's new science shows that two-thirds (64%) (389 out of 604) of North American bird species are at risk of extinction from climate change. The science also shows changes can be improved or 76% of the species at risk if actions are taken now.

The tool allows users to explore by species as well as geographically by Flyway, State, or Zip Code. Maps are updated based on current conditions and three warming scenarios, +1.5°C, +2.0°C, and +3.0°C. This tool draws from over 70 data sources and more than 140 million bird records. Data sources include eBird, U.S. Geological Survey, North American Breeding Bird Survey, and Global Biodiversity Information Facility. The tool uses the latest climate modeling methods and models from the Intergovernmental Panel on Climate Change Fifth Assessment Report.

Survival by Degrees can be used to visualize potential range shifts for SGCN/RSGCN. Some species may shift into or out of a particular state based on the climate change factors used as input into the tool. This information can highlight which areas may serve as climate refugia and aid in prioritizing actions. For example, the Reddish Egret an RSGCN, currently winters along the Gulf coast, extending into the southern portions of the Georgia coast (Figure 15a). With a warming scenario of 2.0°C, the Reddish Egret's winter range is projected to increase along the Gulf and Atlantic coasts, extending along the Georgia coastline and moving into South Carolina (Figure 15b).



Figure 15a. Current winter range of Reddish Egret (source: Audubon Survival by Degrees)



Figure 15b. Projected winter range of Reddish Egret with a 2.0°C increase in temperature (source: Audubon Survival by Degrees)

The Eastern whip-or-will, a wider-ranging RSGCN, is projected to lose quite a bit of its summer range in the southeast with a warming scenario of a 1.5°C increase in temperature (Figure 16a). However, the winter range expands northward under that same scenario, shifting into southern areas of Mississippi, Alabama, Georgia, and South Carolina (Figure 16b). Again, this information can help guide conservation and management decisions when considering seasonal needs of species and where the most important areas may be in the future.

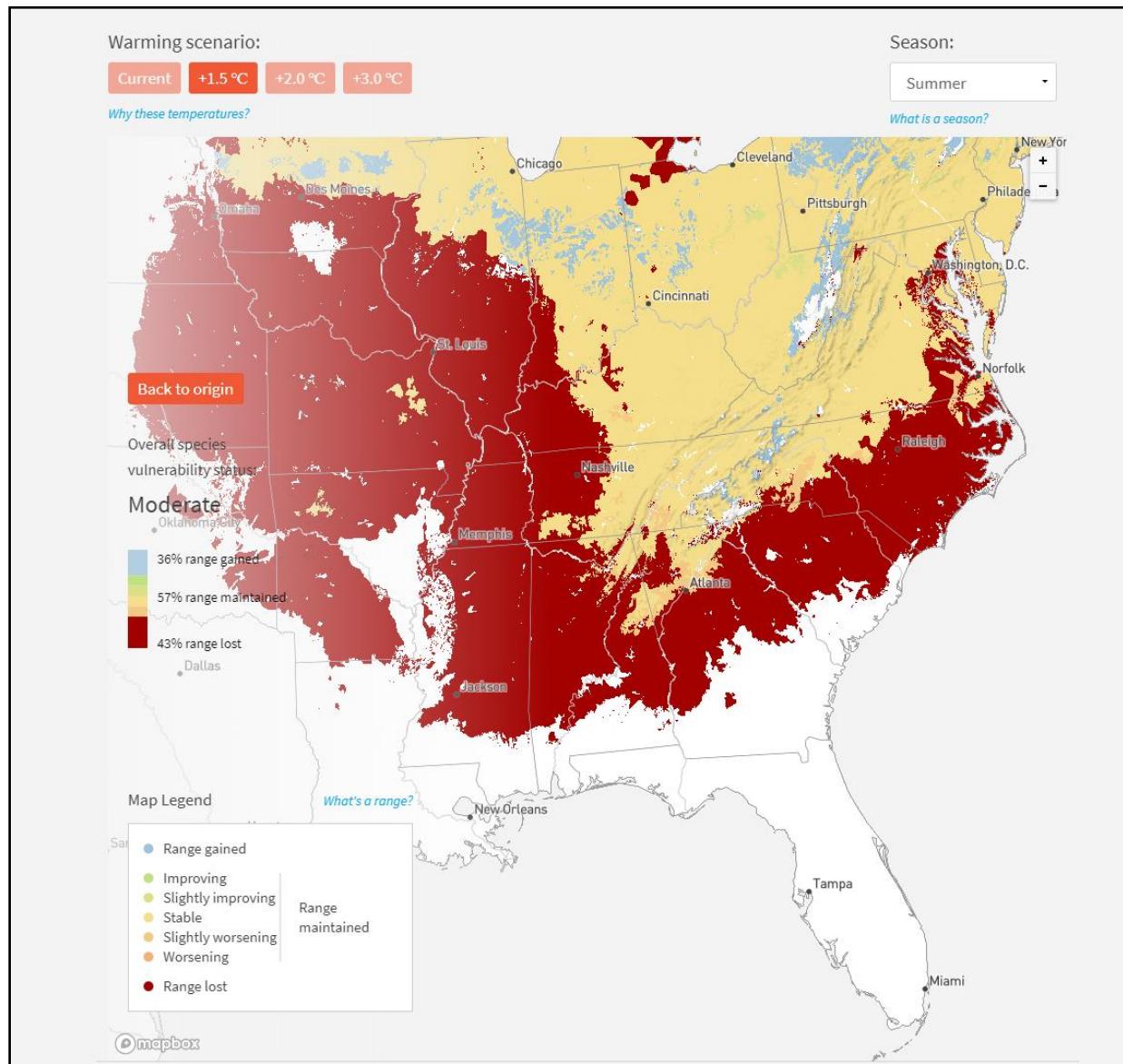


Figure 16a. Projected summer range of Eastern whip-poor-will with a 1.5°C increase in temperature (source: Audubon Survival by Degrees)



Figure 16b. Projected winter range of Eastern whip-poor-will with a 1.5°C increase in temperature (source: Audubon Survival by Degrees)

The Survival by Degrees tool also provides information regarding climate change threats potentially impacting a particular species (Figure 17). The tool describes the climate threats facing species under the different climate warming scenarios and by season. According to the tool, during the summer months with a 3.0°C increase in temperature, threats to the Reddish Egret will include spring heat waves, urbanization, and sea level rise (Figure 17).

Climate Threats Facing The Reddish Egret

Choose a temperature scenario below to see which threats will affect this species as warming increases. The same climate change-driven threats that put birds at risk will affect other wildlife and people, too.

Warming scenario:

+1.5°C +3.0°C

[Why these temperatures?](#)

Season:

Summer

[What is a season?](#)

- Spring Heat Waves**
Spring heat waves endanger young birds in the nest.
- Urbanization**
Cities demolish bird habitat, and are often located in the places birds need.
- Sea Level Rise**
Sea level rise permanently consumes coastal habitat.

Figure 17. Projected climate threat facing the Reddish Egret with a 3.0°C increase in temperature (source: Audubon Survival by Degrees)

Changes to season

By the late 21st century under the higher scenario (RCP8.5), the freeze-free season is expected to lengthen by more than a month (Figure 13). Reductions in the frequency and intensity of cold winter air temperature extremes can allow tropical and subtropical species to move northward and replace more temperate species. Where climatic thresholds are crossed, certain ecosystems and landscapes will be transformed by changing winter air temperatures.

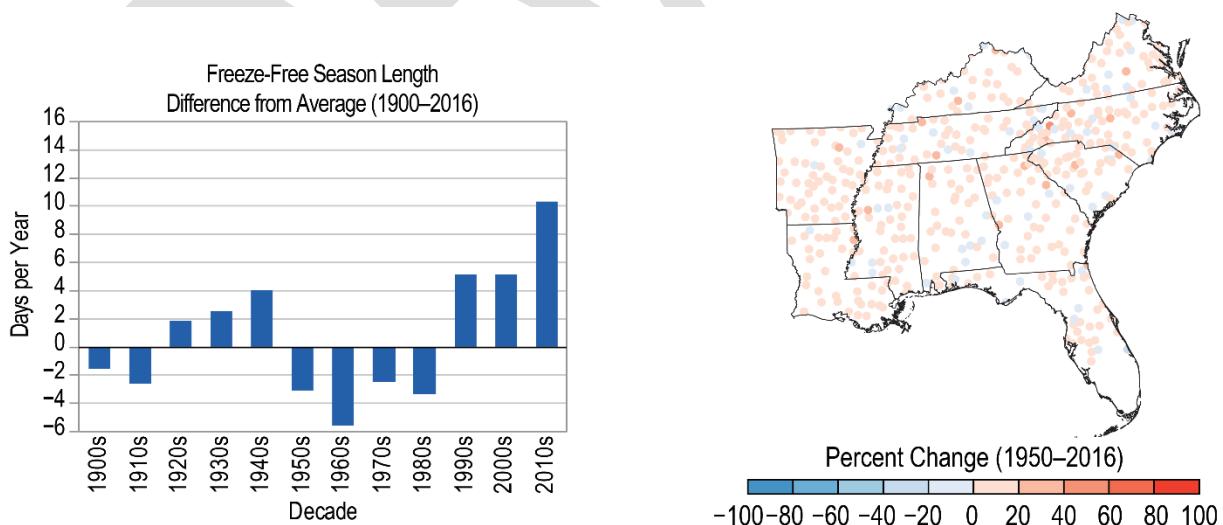


Figure 13. Variability and change in the length of the freeze-free season. (left) The bar chart shows differences in the length of the freeze-free season by decade (1900–2016) as compared to the long-term average for the Southeast (right). The map shows

trends over 1950–2016 for individual weather stations. The length of the freeze-free season has increased at most stations, particularly since the 1980s. Sources: NOAA NCEI and CICS-NC.

Increasing winter temperatures are expected to result in a northward shift of the zones conducive to growing various types of plants, known as plant hardness zones. The USDA plant hardness zones are based on the average lowest minimum temperature for the year, divided into increments of 5°F (Figure 14). Based on these projected changes, freeze-sensitive plants, including non-native invasive species, would be able to survive in new areas. Plant hardness zone maps help convey the importance of winter air temperature extremes for species and natural systems in the Southeast. Large changes are projected across the region, but especially in Kentucky, Tennessee, and northern Arkansas.

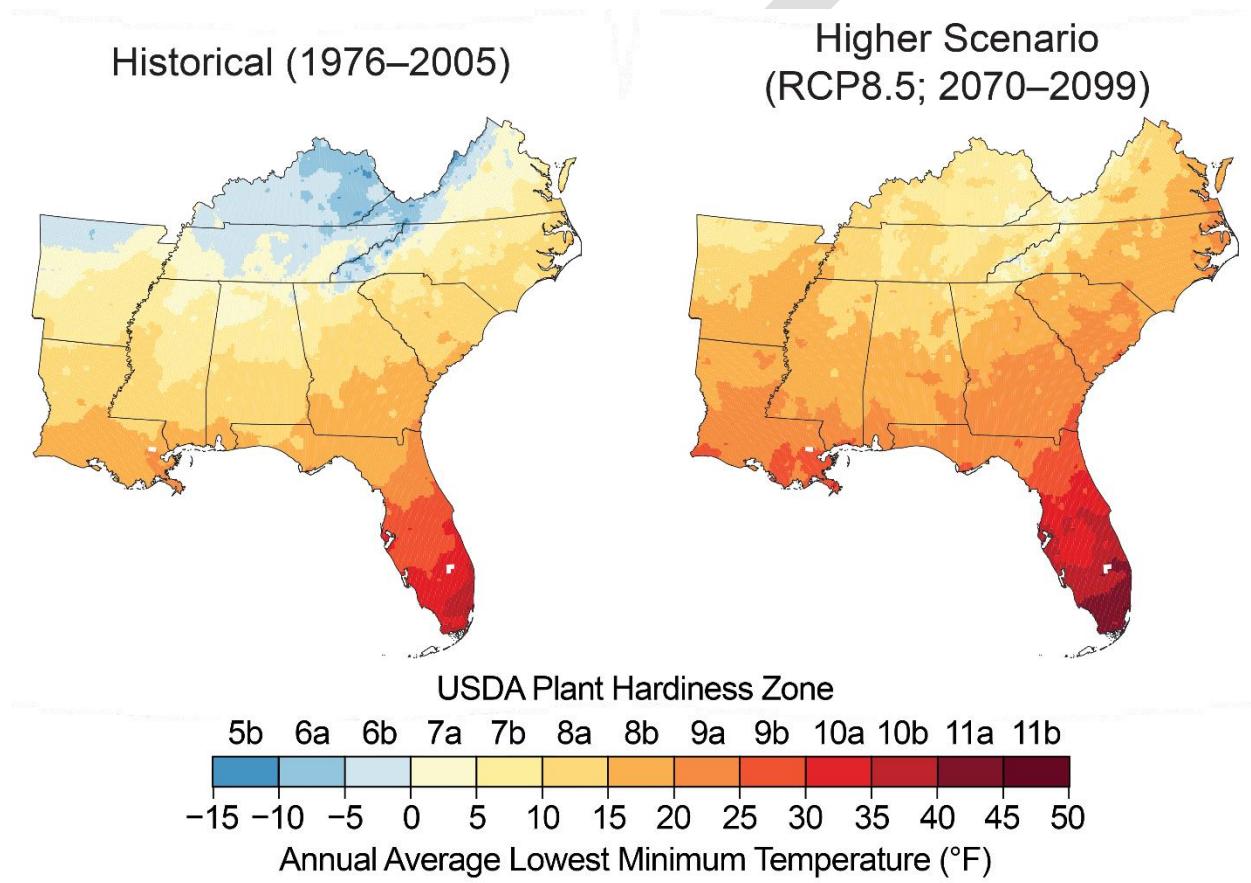


Figure 14. The mean projected changes in the plant hardiness zones, as defined by the U.S. Department of Agriculture (USDA), by the late 21st century (2070–2099) under a higher scenario (RCP8.5). Sources: NOAA NCEI and CICS-NC. (Carter et al., 2018, NCA4, Figure 19.15.

Continued reductions in the frequency and intensity of winter air temperature extremes are expected to change which species are able to survive and thrive in a given location. Along the coast, warmer winter temperatures are expected to allow mangrove forests to move northward and replace salt marshes.

In addition to plants, warmer winter air temperatures will also affect the movement of, and interactions between, many different kinds of organisms. For example, certain insect species, including mosquitoes and tree-damaging beetles, are expected to move northward in response to climate change. And some

bird species, including certain ducks, are not expected to migrate as far south in response to milder winters, which could affect recreational birding and hunting opportunities. Changing winters are expected to favor some problematic invasive species. For example, in South Florida, the Burmese python and the Brazilian pepper tree are two freeze-sensitive, non-native species that have, respectively, decimated mammal populations and transformed native plant communities within Everglades National Park. In the future, warmer winter temperatures are expected to facilitate the northward movement of these problematic invasive species, which would transform natural systems north of their current distribution.

The introduction of invasive species, along with climate-driven range shifts, is creating new species interactions and novel ecological communities, or combinations of species with no historical analog. Climate change can favor nonnative invading species over native ones. Extreme weather events aid species invasions by decreasing native communities' resistance to their establishment and by occasionally putting native species at a competitive disadvantage, although these relationships are complex and warrant further study. Climate change can also facilitate species invasions through physiological impacts, such as by increasing per capita reproduction and growth rates.

Sea Level Rise

Due to the extent of sea level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, flooding, and erosion. Coastal terrestrial and freshwater ecosystems are highly sensitive to increases in inundation and salinity. Sea level rise will result in the rapid conversion of these systems to tidal saline habitats. Historically, coastal ecosystems in the region have adjusted to sea level rise by vertical and horizontal movement across the landscape. As sea levels continue to rise, some coastal ecosystems will be submerged and converted to open water, and saltwater intrusion will allow salt-tolerant coastal ecosystems to move inland at the expense of upslope and upriver ecosystems.

Sea level rise will impact species in multiple ways. The most direct way will be through loss of habitat due to inundation. States can assess the potential impact of sea level rise across a species' range using data from the USGS GAP habitat maps, the Southeast Blueprint, and [NOAA sea level rise data](#). The NOAA sea level rise data is available via download and through an online map viewer. Developed by the Office of Coastal Management, the sea level rise viewer offers access to data and information about the risks of sea level rise, storm surge, and flooding along the coastal United States. The viewer provides an easy way for users to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). The sea level rise data can not only help identify where sea level rise impacts will most likely occur, but it can also be used to assess where places identified as both species habitat and high priority in the Southeast Blueprint may be impacted ([Figure 18a and 18b](#)).

NOAA recently released their 2022 Sea Level Rise Technical Report that provides updated projections through 2150 for all U.S. Coastal waters. It provides the most up-to-date sea level rise projections that can help assess potential changes in average tide heights and height-specific threshold frequencies (<https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>).

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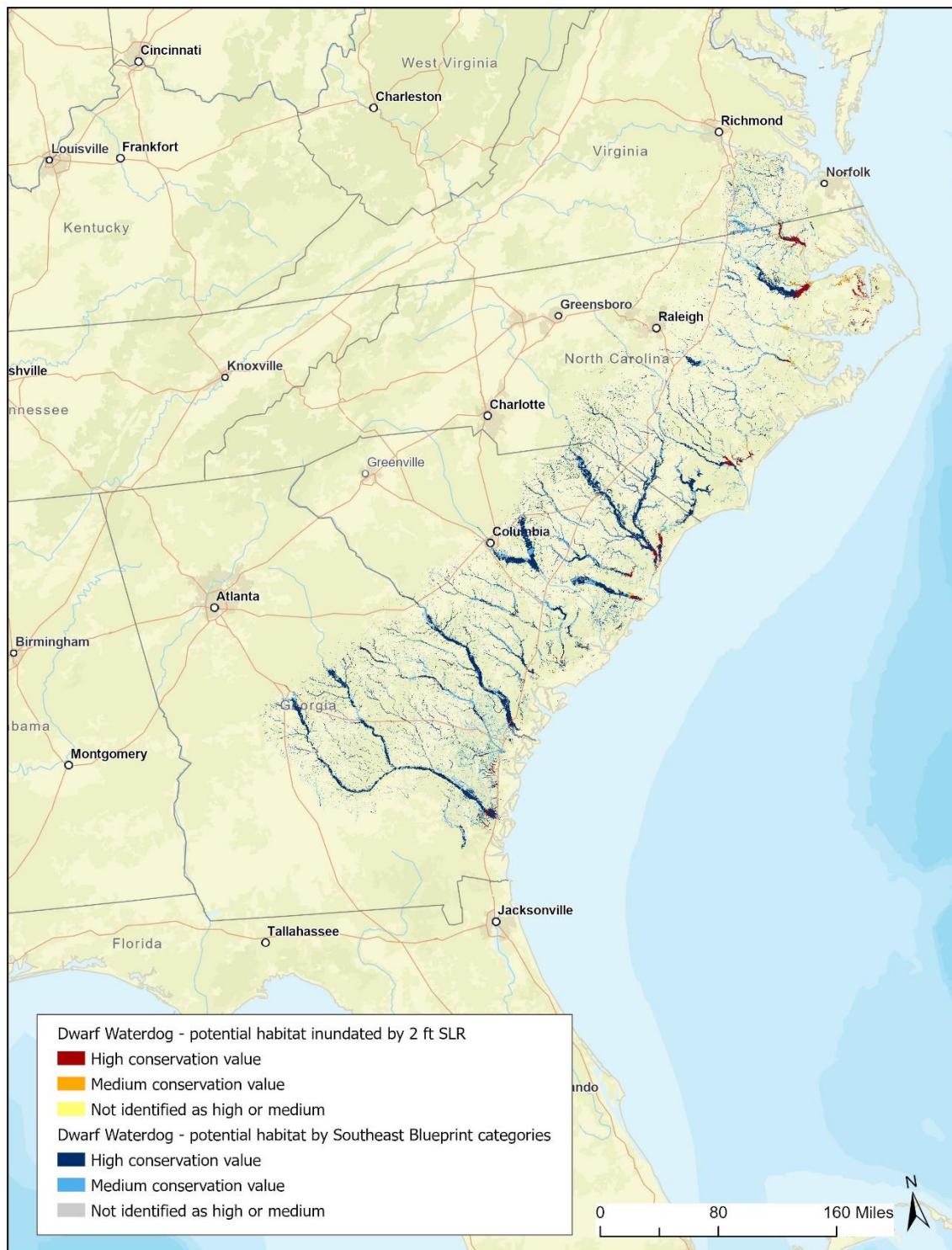


Figure 18a. Dwarf waterdog modeled habitat across the Southeast, classified by Southeast Conservation Blueprint level categories and a 2 ft rise in sea levels.

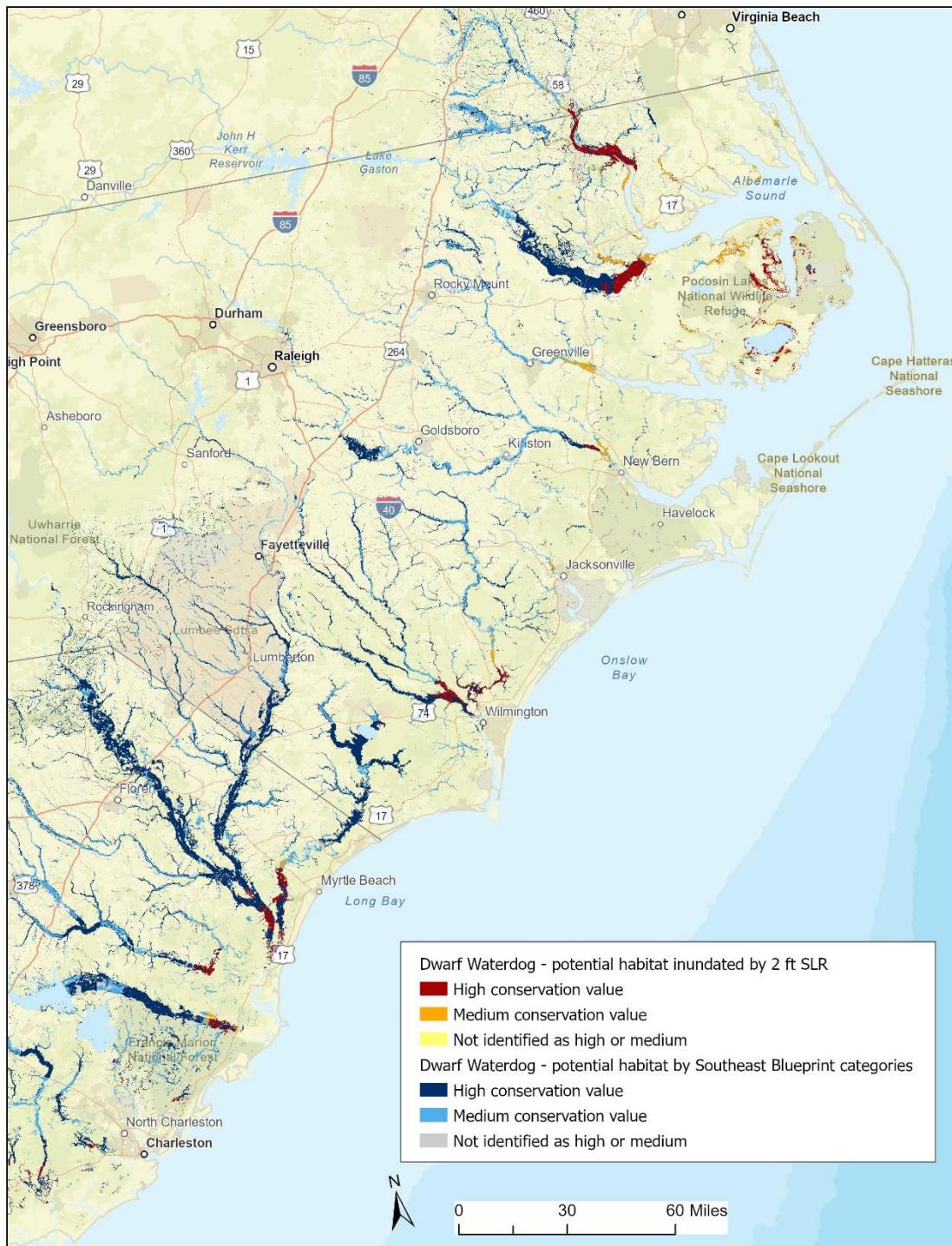


Figure 15b. Dwarf waterdog modeled habitat across along the coast of North and South Carolina, classified by Southeast Conservation Blueprint categories and a 2 ft rise in sea levels (zoomed in view of Figure 18a).

Regional threats – habitat fragmentation

Landscape connectivity is a critical component of ecosystem health, and in recent decades has become a popular conservation strategy. In light of climate change, connectivity is recognized for its potential to improve resilience and provide additional adaptation strategies for fish and wildlife. However, maximizing these benefits will require managers to fully consider climate change impacts and adaptation strategies. A large percentage of both terrestrial and freshwater species face increased extinction risk under projected climate change during and beyond the 21st century, especially as climate change interacts with other stressors, such as habitat modification, over-exploitation, pollution, invasive species, and barriers to migration or other impediments to life cycles.

Maintaining or re-establishing connectivity is frequently discussed as a reasonable approach for addressing climate impacts on species sustainability because it can allow animal and plant species to respond to changes when they need to and at their own pace (recognizing that some species may need help more immediately through assisted migration or other strategies). This approach also can be useful in dealing with the uncertainties surrounding species' responses to climate stressors. Given the complexity of ecological systems and species' dynamics, we may never know what gradient (temperature, moisture, food availability, competition, predation) each species will respond to first. Providing quality habitats and connections between them offers a potentially efficient approach to conserving maximum biodiversity.

Habitat fragmentation and human land uses hinder the movement of species, further reducing their ability to shift their distributions in response to climate change. The ability of plant and animal species to retreat in response to rising waters (from both sea level rise and flood events) will be affected by barriers preventing their migration, including human-made structures such as buildings, bulkheads, roadways, dams, and other obstructions. Additionally, human-made ecosystem alterations, whether already existing or instituted in response to the effects of climate change, may lead to increased habitat loss, degradation, and fragmentation. For example, the use of hardened shoreline stabilization measures coupled with more intense storms could lead barrier islands (and their habitats) to fragment and disappear. The effects of roads as barriers altering natural hydrology will be exacerbated by changes in the amount of precipitation and large storm events. If precipitation patterns shift to fewer rainfall events with larger amounts of rainfall, existing transportation infrastructure such as bridges and culverts, and water infrastructure such as dams may not be sufficient to accommodate the increased flow.

Understanding and reestablishing habitat connectivity across terrestrial, freshwater, and marine systems can help ecosystems adapt to changing environmental conditions. Identifying and conserving climate change refugia (i.e., areas relatively buffered from climate change that enable species to persist) in ecological corridors can help species stay connected. Regional efforts to restore ecosystems, increase habitat connectivity, and protect ecosystem services across boundaries through collaborations among state and tribal entities, educational institutions, nongovernmental organizations, and partnerships are critical. Rigorous evaluation of adaptation efforts are important and will allow managers to fully assess the effectiveness of proposed adaptation measures.

The Association of Fish and Wildlife Agencies' Climate Adaptation Committee charged a small working group in September of 2019 to develop a toolkit focused on climate-informed landscape connectivity (https://www.fishwildlife.org/application/files/9216/1582/0864/Connectivity_and_Climate_Change_Toolkit_FINAL.pdf). The purpose of the tool is to provide state fish and wildlife agency planners and managers with the information necessary to account for and incorporate climate considerations in the planning and implementation of terrestrial and aquatic connectivity initiatives. The toolkit is structured as a gateway to provide users with information, tools, and resources critical to understanding and deploying climate adaptation strategies related to landscape connectivity. Unfortunately, no one-size-fits-all approach works for these kinds of initiatives, and so the goal of the toolkit was to provide users with a variety of considerations and resources to identify their needs.

Throughout the sections, users will find Key Resources which provide links and brief annotations that will direct users to websites, tools, journal publications, and other resources for more information. Sections may also contain case studies that take the user to websites or reports that provide a deeper dive into on-the-ground examples. In addition, many sections also contain key strategies that identify broad management strategies that can be implemented to more fully incorporate climate change considerations into connectivity initiatives. All the sections begin with general background information and the subsequent lists are designed to help managers quickly find detailed information as they need it. There is a section on project planning and how to ensure that conservation actions are climate-smart.

Changing Patterns of Fire

In the Southeast region, changing fire regimes (defined by factors including frequency, intensity, size, pattern, season, and severity) are expected to have a large impact on natural systems. In the future, rising temperatures and increases in the duration and intensity of drought are expected to increase wildfire occurrence and reduce the effectiveness of prescribed fire. Moreover, rapid urban expansion near managed forests may reduce opportunities to use prescribed fire, which could lead to native species declines, increased wildfire occurrence, and economic and health impacts.

Over the last century, invasive insects, logging, and pathogens have transformed some forests in the region. Warmer temperatures and insects have led to the loss of cold-adapted boreal communities, and flammable, fire-adapted tree species have been replaced by less flammable, fire-sensitive species. High temperatures, increases in accumulated plant material on the forest floor, and seasonal droughts can collectively produce extreme wildfires. Intra-annual droughts are expected to become more frequent in the future. Thus, drought and greater fire activity are expected to continue to transform forest ecosystems in the region.

Regional opportunities for collaboration

Integrating Department of Defense priorities and working in collaboration

The Department of Defense (DoD) manages nearly 29 million acres within the United States. These land and water resources are necessary to support vital military readiness testing, training, and operations. But they also encompass some of the most important and biodiverse lands under federal control. DoD managed lands provide habitat for nearly 500 federally listed plant and animal species and for over 550

additional at-risk species, including 60 listed species and 74 species-at-risk that occur only on DoD lands. Protecting species and managing natural resources helps DoD sustain the use of their lands for realistic and mission-essential testing, training, and operations.

Many of the imperiled species and critical habitats DoD is working to preserve and sustain are similarly important to the SEAFWA member states and may present opportunities for cooperative conservation across jurisdictional boundaries. This is especially true given the new authorities and funding support Congress has provided DoD over the past 25 years to enable DoD to undertake mission-supporting conservation outside its installation fence lines. Given the frequent alignment between military and conservation goals, working with the DoD bases within many of the SEAFWA states may offer opportunities to promote conservation actions and collaborate with the DoD to support both regional and state-specific SGCN.

[Integrated Natural Resource Management Plans \(INRMPs\)](#)

There is already an existing avenue of collaboration with the DoD through the Integrated Natural Resource Management Plans (INRMPs). INRMPs serve as management plans for the highly diverse habitats for which the DoD is responsible. INRMPs are installation-specific and designed to balance conservation and mission activities in order to satisfy environmental legal requirements without compromising the capability of installation lands to support the military mission. INRMPs were made mandatory for all installations (including, on a voluntary basis, state-owned National Guard installations) with significant natural resources in 1997 as part of a comprehensive revision of the Sikes Act, which is the statute governing natural resources management on military lands (16 U.S.C. §§670 et seq.). INRMPs must be prepared in cooperation with the U.S. Fish and Wildlife Service and appropriate state fish and wildlife agencies, and are meant to reflect the mutual agreement of the three parties concerning the conservation, protection, and management of fish and wildlife resources.

For the most part, the INRMPs prepared following the 1997 amendments were inward-looking and focused primarily on those lands and resources within DoD installation boundaries. It soon became apparent, however, that many installation species and habitats could be more effectively and efficiently managed on an ecosystem or landscape scale. When questions arose over DoD's legal authority to spend appropriated funds for conservation beyond its installation fence lines, DoD sought—and Congress enacted—express authority enabling DoD to do so. The first such authority (10 U.S.C. §2684a) was enacted in 2003 and provided the impetus for the Readiness and Environmental Protection Integration Program (REPI), which enables DoD to enter into cost-shared agreements with specified parties (including states or a political subdivision of a state) to acquire interests in real property in order to, among other purposes, preserve habitat or improve installation resilience. Properties targeted for acquisition using this authority need only be ecologically related to a military installation in order to be eligible. A second authority was added to the Sikes Act in 2008 (16 U.S.C. §670c-1(a)(2)) to enable DoD to enter into cooperative agreements with various entities (including state and local governments) to provide for the maintenance and improvement of natural resources located off of a military installation or state-owned National Guard installation in order to relieve or eliminate restrictions on military activities. Importantly, this authority may be used to facilitate off-installation natural resources management when a real property may not be necessary nor available.

These new authorities, coupled with the significant funding Congress has made available for the REPI program, have opened the door to a wide variety of partner arrangements between DoD and the states. Closer coordination of INRMPs with SWAPs is critical to identifying potential opportunities for cooperative natural resources management projects between DoD and the states. States already have a statutory seat at the table during the preparation and annual reviews of DoD installation INRMPs—this should be recognized as an opportunity to bring off-installation conservation opportunities to the installation’s attention. Conversely, inviting installation natural resources managers to be more engaged in the SWAP process could reveal to the states previously unrecognized opportunities to collaborate on cost-shared conservation projects to the mutual benefit of DoD and the states, as well as the species and habitats addressed by the effort.

[The Readiness and Environmental Protection Integration \(REPI\) program](#)

The Readiness and Environmental Protection Integration (REPI) program addresses land use conflicts that restrict military activities. A key component of the REPI Program is the use of encroachment management partnerships, referred to as REPI projects, authorized by Congress within 10 USC 2684a. These cost-sharing partnerships between the military services, state and local governments, and private conservation organizations acquire easements or other interests in land from willing sellers that preserve critical buffer areas and habitat near our military installations. The REPI program works the twin imperative of military readiness and environmental protection—a unique convergence of shared interests.

In the Fiscal Year 2019 National Defense Authorization Act (NDAA), Congress expanded the REPI authority in 10 USC 2684a to extend the traditional REPI real property authorities to address military installation resilience. Specifically, the language now includes a provision that allows the Secretary of Defense or the Secretary of a military department to “enter into an agreement to address the use or development of real property in the vicinity of, or ecologically related to, a military installation... for the purposes of ... preserving off base habitat on the property in a manner that ... maintains or improves military installation resilience.”

“Military installation resilience” carries a specific definition in the law: “the capability of a military installation to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions, that do, or have the potential to, adversely affect the military installation or essential transportation, logistical, or other necessary resources outside of the military installation that are necessary in order to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions.” “Anticipated or unanticipated changes in environmental conditions” encompasses climate change.

This was one of a series of legislative measures passed by Congress between 2017-2019 that expressed concern about the impacts of climate change and incorporated military installation resilience as a valid objective and rationale for using existing DoD authorities. For example, resilience provisions were added to the Office of Economic Adjustment’s authorities, specifically allowing it to be considered during Joint Land Use Studies (now called Compatible Use Studies). Resilience was also incorporated into the

Defense Access Roads certification process, which authorizes the Department to make off-base investments to critical roads to address climate-driven impacts.

By incorporating resilience into 10 USC 2684a, a statute focused on limiting encroachment impacts on military testing, training and operations, Congress has cast climate change as an encroachment concern. This is how REPI will absorb this responsibility—maintaining its focus on readiness and expanding its encroachment mission to incorporate climate change as a threat.

[Sentinel Landscape Partnerships](#)

The U.S. Department of Agriculture (USDA), Department of Defense (DoD), and Department of the Interior (DOI) define sentinel landscapes as areas in which natural and working lands are well suited to protect defense facilities from land use that is incompatible with the military's mission. Founded in 2013, Sentinel Landscape Partnerships are a collaborative effort by the DoD, DOI, USDA, state and local governments, and non-governmental organizations to work with private landowners to advance sustainable land management practices around military installations. These partnerships strengthen military readiness, conserve natural resources, bolster agricultural and forestry economies, and increase climate change resilience

Once the Federal Coordinating Committee designates a location as a sentinel landscape, USDA, DoD, and DOI work with local partners to equip private landowners with the resources necessary to carry out sustainable management practices on their properties. Sustainable management practices such as farming, ranching, and forestry not only offer economic and ecological benefits, but also protect defense facilities from incompatible development that can constrain the military's ability to carry out training and testing activities.

Sentinel landscape partners accomplish their objectives by connecting private landowners with voluntary state and federal assistance programs that provide tax reductions, agricultural loans, disaster relief, educational opportunities, technical aid, and funding for conservation easements. By aligning these programs in sentinel landscapes, government agencies use taxpayer dollars more efficiently and accomplish more on the ground with fewer resources. There are currently ten sentinel landscapes across the country, with several of those in the Southeast region.

[Army Compatible Use Buffer program](#)

The Army Compatible Use Buffer (ACUB) program is designed to minimize incompatible development and loss of habitat by using permanent conservation easements, fee-sales, or other interests in land from willing landowners. In the case of conservation easements or similar agreements, the landowner retains ownership and rights to use the land for the purposes specified in the agreement.

[DoD partnerships and conservation actions supporting SWAPs - Georgia](#)

The state of Georgia has successfully partnered with the DoD through a variety of programs that has led to the protection of important habitat and maintained mission readiness for the military. Some of these successes have resulted from working with the DoD through the ACUB program, Sentinel Landscapes, and a credits and protection program. Through its partnerships, Georgia has set several precedents for other states to leverage and learn from.

For example, the Georgia Department of Natural Resources (DNR) partnered with The Nature Conservancy and the U.S. Army at Fort Benning to create the Chattahoochee Fall Line Wildlife Management Area (WMA). Through the ACUB program, ecologically significant lands near the military installation's border are now protected from development. Chattahoochee Fall Line WMA supports a large landscape of priority habitats that have enormous potential for ecological restoration, including expansion of a fire-managed longleaf pine ecosystem beneficial to the red-cockaded woodpecker, gopher tortoise and other imperiled species. As a wildlife management area, it also provides public recreation lands for such activities as hunting, hiking, fishing, camping, and wildlife viewing. In addition to the acquisition of the property, there will also be a stewardship endowment to help manage that property.

Due to its proximity to urban areas like Columbus, GA, Fort Benning benefited as a partner in mitigating encroachment issues within its ACUB. Through the lens of looking at future urbanization, the ACUB program provides resources to Fort Benning to acquire lands and through their partnership, Georgia DNR was able to help the base identify places recognized within the SWAP as having high ecological value and implement easements and acquisitions. The state of Georgia also helped set a precedent with Fort Benning with offsite mitigation. In the past, any conservation credits needed to be within the ACUB boundary, but in this project, they were able to acquire a property further away from Fort Benning. Through a FWS agreement, the habitat improvements implemented by Georgia DNR will provide credits to the base. It is also possible to extend this credit across state lines.

There is also a long-term vision to expand the ACUB designated boundary around Fort Benning eastward to include areas considered to be of high ecological importance by the state. These areas include the sandhills region and gopher tortoise habitat. In addition, through the management of pine stands, this area may be suitable for future reintroductions for red-cockaded woodpeckers. In addition to the ecological benefits and progress towards state priorities, the property acquisition within the base's compatible buffer zone mitigates encroachment issues and offers the base future credit towards off-site mitigation.

An added benefit for the state of Georgia is its participation in the Southeast Regional Partnership for Planning and Sustainability (SERPPAS). SERPPAS brings together state environmental and natural resource officials from North Carolina, South Carolina, Georgia, Alabama, Florida, and Mississippi with federal agencies including DoD. As a wider partnership, SERPPAS works to encourage compatible resource use decisions and improve coordination for the benefit of regional planning, conservation, economic development, and sustainability. This partnership, comprised of state and federal agencies, promotes collaboration in making resource-use decisions supporting national defense, conservation of natural resources, and sustainable working lands and communities in the Southeast United States.

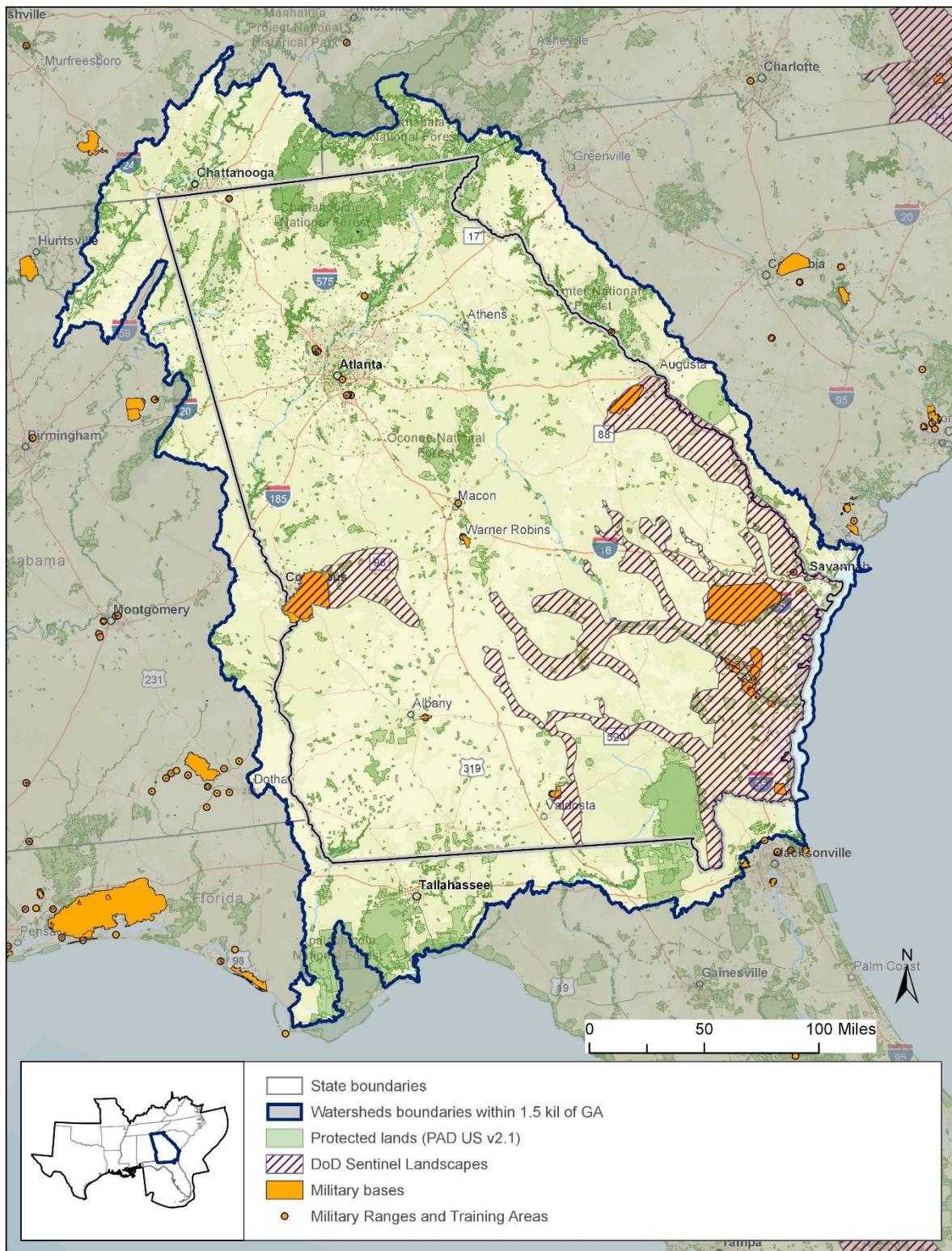


Figure 16. Military mission interests and the conservation landscape in and around the state of Georgia. REPI special use airspace and Sentinel Landscape Partnerships in the state of Georgia can also be leveraged by neighboring states to help support shared species of interest and their habitats.



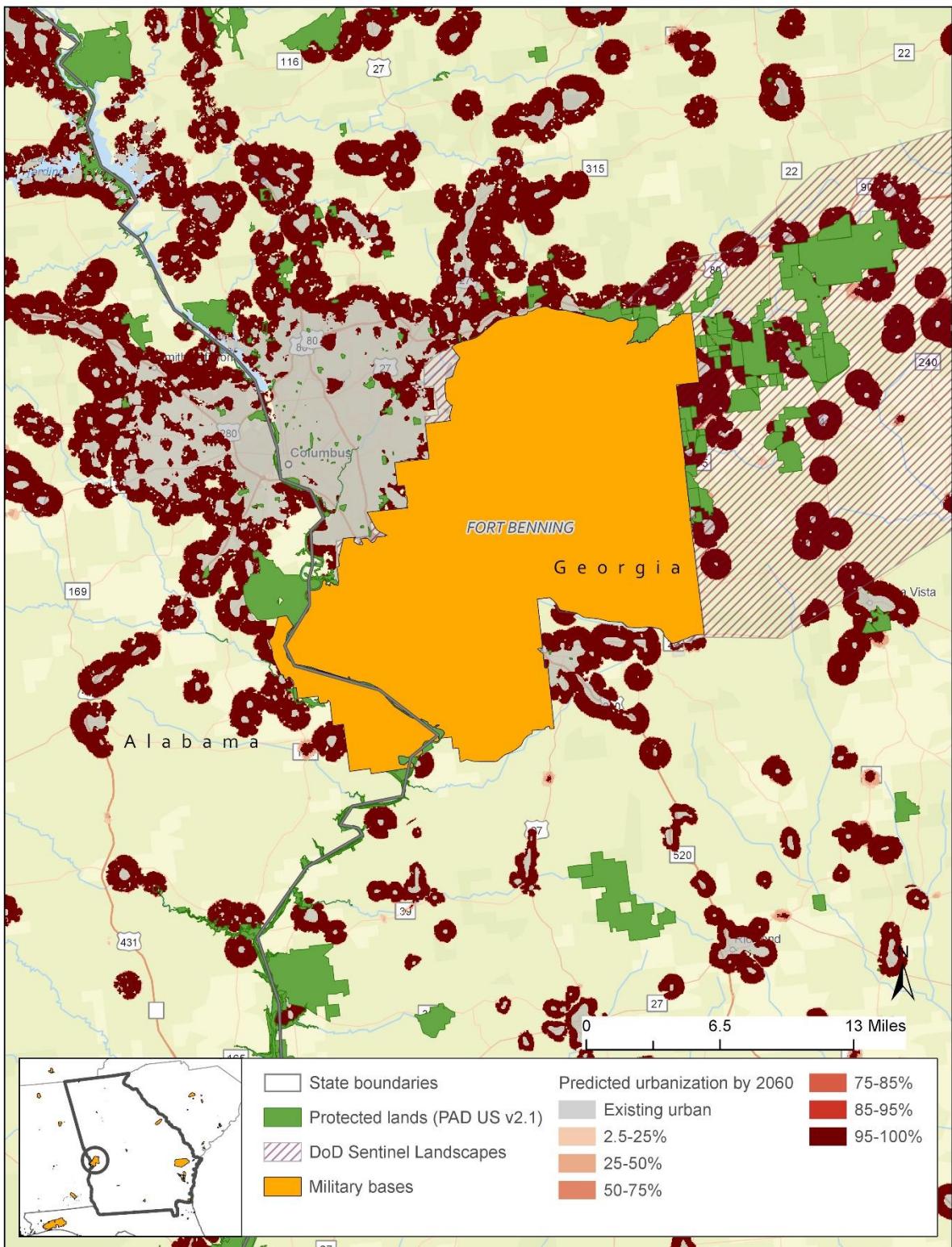


Figure 17. Fort Benning, GA and projected urbanization by 2060. Projected urbanization is derived from the SLEUTH urban growth model, which predicts the likelihood that an area will urbanize at every decade from 2020 to 2100. Darker reds indicate

higher probability of urbanization. 2009 served as the baseline for current urban areas. The 2009 urban extent combined developed areas from the 2001 National Landcover Database with areas of high road density from U.S. Census TIGER Line data for 2000, 2006, 2008, and 2009. The model used patterns of road network growth from 2000-2009 to predict what future urbanization would look like if those trends continued. It considered the influence of topography on ease of development and excluded areas that are difficult or impossible to develop, like water bodies, beaches, protected conservation lands, and most wetlands.

Monitoring and assessing trends

One of the aims of this guidance is to help states integrate regional information to be better able to propose plans for monitoring species and habitats, as well as plans for monitoring the effectiveness of conservation actions and adapting to respond to new information. As habitats and species' ranges shift, there is even more emphasis on understanding the resulting impact of conservation actions and the best places to apply them.

By aligning monitoring efforts, states can make better informed decisions about their SGCN in regards to the impact of species shifts caused by changes in climate and the resulting potential gains and losses or new refugia. In addition, states can better prepare and be aware of new occurrences and expansions of invasive species.

SECAS goal report

Through SECAS, partners work together to design and achieve a connected network for the benefit of ecosystems, species, and people. The long-term goal for SECAS is a 10% or greater improvement in the health, function, and connectivity of Southeastern ecosystems by 2060. To stay on track for achieving that goal, a 1% improvement will be needed every 4 years. While the primary product of SECAS is the Southeast Conservation Blueprint, which serves as the framework to achieve this goal, there is also an ongoing effort to track and report on regional ecosystem metrics.

Every year, SECAS releases a report—*Recent Trends in Southeastern Ecosystems*—that assesses progress toward the SECAS goal using the most recent 3-6 years of available data from existing monitoring programs. This annual assessment of shared measures of progress toward the SECAS goal provides an essential evaluation that helps to focus conservation actions and track resulting impacts. It is based on a synthesis of 13 different assessments covering the Southeast (Breeding Bird Survey America's Longleaf Range-wide Accomplishment Reports, National Coastal Condition Assessments, etc.). The near-term goals identify minimum progress needed to stay on track with meeting the long-term goal.

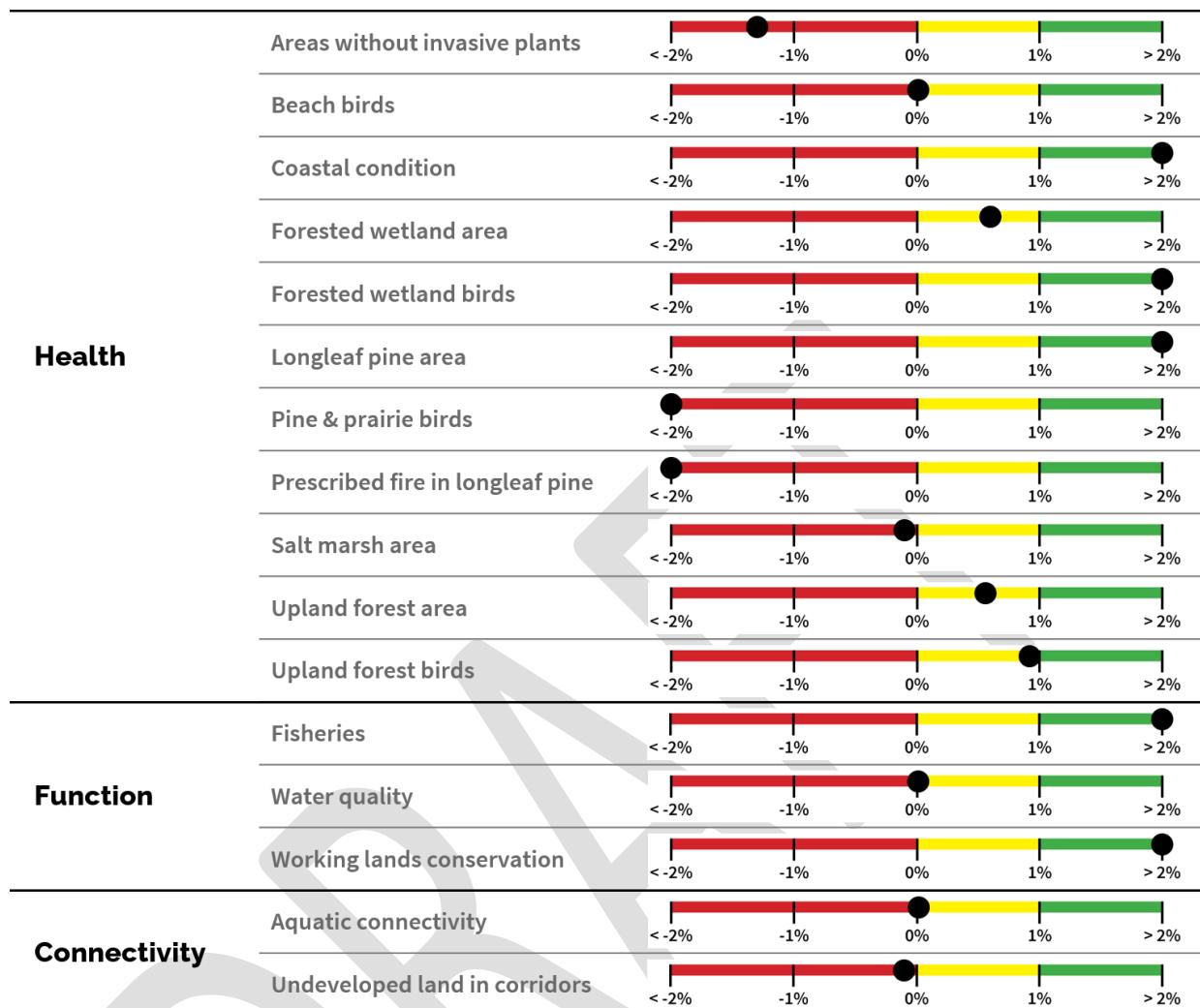


Figure 18. This figure represents the estimated percent change over 4 years in indicators that represent the health, function, and connectivity of southeastern ecosystems, based on most recently available data.

Using the goal report to inform monitoring - North Carolina, South Carolina, and Georgia

States can use the goal report to both assess their state's progress as well as overall trends for the wider Southeast region. This is one way to identify where states may be able to facilitate discussion around conservation actions for shared priorities as well as find ways to contribute to monitoring programs to inform the annual report. The table below is an example of how a monitored suite of RSGCN birds species are performing in the states of North Carolina, South Carolina, and Georgia. From the goal report, while the longleaf pine area is on track to meet the SECAS goal, the indicators representing pine and prairie bird species and prescribed fire are not. By using the indicators from the goal report, states can see how they contribute to these indicators and consider where to collaborate with neighboring states to support conservation actions for RSGCN that are shared responsibilities and experiencing declines.

Table 3. Recent trends in bird species that are considered SEAFWA RSGCN within NC, SC, and GA. Brighter colors indicate higher confidence. Data is derived from the Breeding Bird Survey.

Indicator	Species	North Carolina	South Carolina	Georgia
Forested wetland birds	Prothonotary warbler	Decline - Low confidence	Increase - Low confidence	Increase - Low confidence
	Swallow-tailed kite		Increase - Low confidence	Increase - High confidence
	Yellow-throated warbler	Increase - Low confidence	Decline - High confidence	Decline - Low confidence
	Swainson's warbler	Increase - Low confidence	Increase - Low confidence	Increase - Low confidence
Pine and prairie birds	Northern bobwhite	Decline - High confidence	Decline - Low confidence	Increase - Low confidence
	Grasshopper sparrow	Decline - Low confidence	Decline - Low confidence	Increase - Low confidence
	Prairie warbler	Decline - High confidence	Decline - High confidence	Decline - High confidence
	Loggerhead shrike	Decline - Low confidence	Increase - Low confidence	Decline - Low confidence
	Bachman's sparrow	Increase - Low confidence	Increase - Low confidence	Increase - Low confidence
Upland forest birds	Cerulean warbler	Decline - Low confidence		
	Wood thrush	Decline - Low confidence	Increase - Low confidence	Increase - Low confidence
	Louisiana waterthrush	Increase - Low confidence	Decline - Low confidence	Decline - Low confidence
	Worm-eating warbler	Decline - Low confidence	Decline - Low confidence	Increase - Low confidence

Appendix - Other regional resources

South Atlantic Coastal Study (SACS)

The SACS is a comprehensive study that applies watershed planning concepts to identify actions for advancing coastal resilience along the 65,000 miles of tidally influenced shoreline across North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Puerto Rico, and the U.S. Virgin Islands.

Coastal management is a shared responsibility with numerous agencies and stakeholders, including federal agencies, non-governmental organizations (NGOs), tribal nations, state, academia, and local partners, working together to address coastal challenges. More than 1,400 stakeholders and partners participated in the SACS through multiple workshops, webinars, reviews, and individual correspondence.

Additional resources for integrating climate change information

Climate change science

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change ([IPCC](https://www.ipcc.ch/)) is the United Nations body for assessing the science related to climate change. The IPCC prepares comprehensive Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. It also produces Special Reports on topics agreed to by its member governments, as well as Methodology Reports that provide guidelines for the preparation of national greenhouse gas inventories as required by the UN Framework Convention on Climate Change:

<https://www.ipcc.ch/>.



- [IPCC Fifth Assessment Report \(AR5\) 2014](#)

The Synthesis Report (SYR) of the IPCC Fifth Assessment Report (AR5) provides an overview of the state of knowledge concerning the science of climate change, emphasizing new results since the publication of the IPCC Fourth Assessment Report (AR4) in 2007:

<https://www.ipcc.ch/report/ar5/syr/>

- [IPCC Sixth Assessment Report \(AR6\) \(2022\)](#)

The IPCC is currently in its Sixth Assessment cycle, during which the IPCC will produce the Assessment reports of its three Working Groups, three Special Reports, a refinement to the methodology report and the Synthesis Report. The Synthesis Report will be the last of the AR6 products, due for release in 2022.<https://www.ipcc.ch/report/sixth-assessment-report-cycle/>

National Climate Assessment

The [Fourth National Climate Assessment](https://www.globalchange.gov/climate-change) is a comprehensive and authoritative report on climate change and its impacts in the US. Information is presented in two volumes: Volume I: Climate Science Special Report and Volume II: Impacts, Risks, and Adaptation in the US. Developed by the U.S. Global Change Research Program (USGCRP), a federal program mandated by Congress to coordinate federal research and investments in understanding the forces shaping the global environment, both human and natural, and their impacts on society: <https://www.globalchange.gov/climate-change>.

Volume I: The Climate Science Special Report (CSSR), published in 2017, serves as the first volume of NCA4. It provides a detailed analysis of how climate change is affecting the physical earth system across the United States and provides the foundational physical science upon which much of the assessment of impacts in this report is based. The CSSR integrates and evaluates current findings on climate science and discusses the uncertainties associated with these findings. It analyzes trends in climate change, both human-induced and natural, and projects major trends to the end of this century. To obtain an understanding of likely changes to climate variables of interest, begin by reviewing information in the most current National Climate Assessment (NCA4), which includes national and regional summaries of ongoing and projected change.

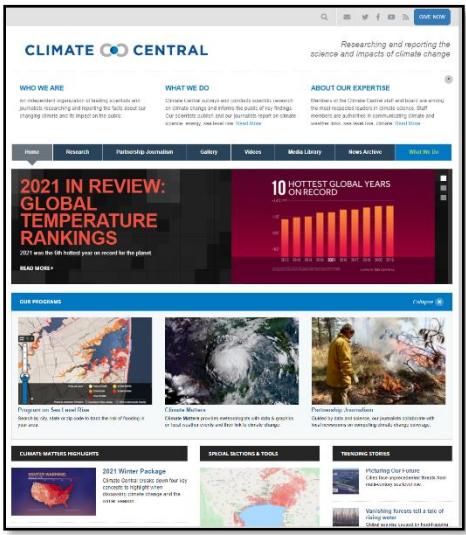
Volume II: Volume II focuses on the human welfare, societal, and environmental elements of climate change and variability for 10 regions and 18 national topics, with particular attention paid to observed and projected risks, impacts, consideration of risk reduction, and implications under different mitigation pathways. Where possible, NCA4 Volume II provides examples of actions underway in communities across the United States to reduce the risks associated with climate change, increase resilience, and improve livelihoods. There are 29 chapters, divided into three major sections: National topics, Regions, and Responses.

- NCA4 Volume I: <https://science2017.globalchange.gov/>
- NCA4 Volume II: <https://nca2018.globalchange.gov/>
- Southeast chapter: <https://nca2018.globalchange.gov/chapter/19/>

State Climate Summaries

[State Climate Summaries](https://statesummaries.ncics.org/) were produced in response to a growing demand for state-level information in the context of the Third National Climate Assessment (NCA) and subsequent sustained activities. The 2022 version represents a new and improved summary for each state that provides more up-to-date information on observed changes in climate, including both long-term trends and extreme weather events relevant to that state: <https://statesummaries.ncics.org/>.

Climate Central



[Climate Central](#)—Researching and reporting the science and impacts of climate change. Climate Central is an independent organization of scientists and journalists researching and reporting the facts about changing climate and its impact on the public. Climate Central surveys and conducts scientific research on climate change and informs the public of key findings. Climate Central's scientists publish and journalists report on climate science, energy, sea level rise.

<https://www.climatecentral.org/>

Climate Change Information Repositories

Climate Adaptation Knowledge Exchange

The [Climate Adaptation Knowledge Exchange](#) (CakeX) is an online source of climate adaptation case studies and resources. The site shares lessons, ideas, and opportunities across the U.S. Case studies can be explored by adaptation phase, by topic, and by region. Additional filtering can be done by scale (e.g., local, state, regional), sector addressed (e.g., biodiversity, research, policy), target climate change impacts (e.g., temperature, flooding, erosion), and habitat (e.g., coastal, terrestrial, reef). Information is grouped into three categories: document, case study, and tool. <https://www.cakex.org/>

Climate Registry for the Assessment of Vulnerability

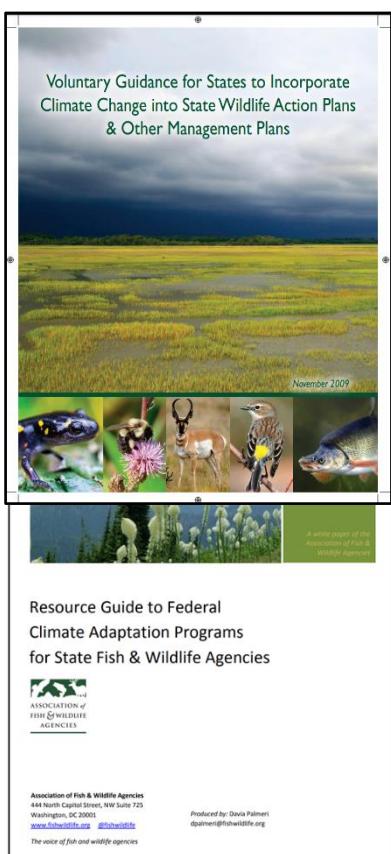
The [Climate Registry for the Assessment of Vulnerability](#) (CRAVe) was developed to make information about ongoing and completed Vulnerability Assessments (VAs) more readily accessible and available, so that resources devoted to such assessments can be most efficiently used. The registry includes VA descriptions of projects undertaken by federal and non-federal partners. The registry includes basic information about a vulnerability assessment, including project location and scale, assessment target or endpoint, contact information, managing agency and partner agencies, vulnerability assessment components (exposure, sensitivity, adaptive capacity), type of climate, sea-level, or hydrological change projections (hazards), methods for determining impact of hazards, and the purpose of the VA. Users can access the Registry to conduct searches across all vulnerability assessments to find necessary information for decision making. CRAVe is hosted on the CakeX site <https://crave.cakex.org/>.

The Climate Toolbox

The [ClimateToolBox](https://climatetoolbox.org/) is a collection of web tools for visualizing past and projected climate and hydrology of the contiguous U.S. It provides links to tools for addressing questions related to agriculture, climate, fire conditions and water. <https://climatetoolbox.org/>

- Strengths—Preferred downscaled data for many applications, some nice visuals for capturing model spread (scatter, box plots)
- Weaknesses - limited variables, limited to western US for some data, model error not captured

Guidance Documents



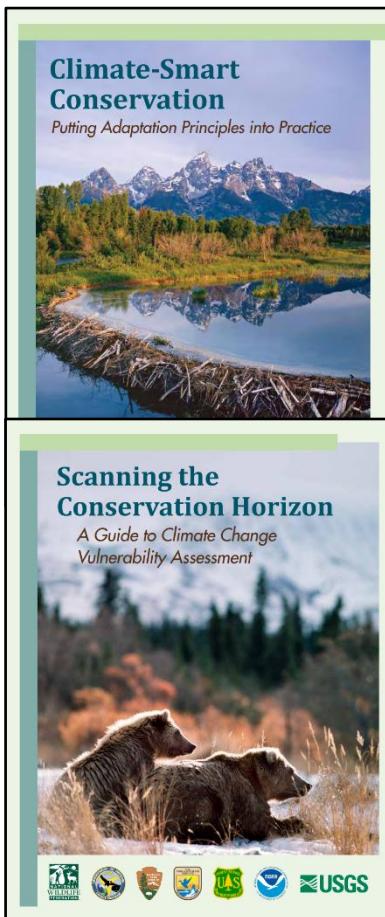
Incorporation of Climate Change into State Wildlife Action Plans

The [Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans and Other Management Plans](https://www.cakex.org/sites/default/files/documents/AFWA-Voluntary_Gudance.pdf) was developed by the Association of Fish and Wildlife Agencies (AFWA) in 2009. It provides recommended steps for developing and implementing adaptation strategies:

https://www.cakex.org/sites/default/files/documents/AFWA-Voluntary_Gudance.pdf

Guide to Federal Climate Adaptation Programs

The [Resource Guide to Federal Climate Adaptation Programs for State Fish and Agencies](https://www.aswm.org/pdf_lib/resource_guide_to_federal_climate_adaptation_programs.pdf) was developed by AFWA in 2014. The goal of this document is to provide that understanding and to prevent duplication of federal climate adaptation work on the state level. Utilizing resources already provided at the federal level will free up time for state level managers to incorporate climate adaptation knowledge in to plans, rather than producing their own adaptation science: https://www.aswm.org/pdf_lib/resource_guide_to_federal_climate_adaptation_programs.pdf



Climate Smart Conservation

The [Climate Smart Conservation: Putting Adaptation Principles into Practice](https://www.nwf.org/-/media/PDFs/Global-Warming/2014/Climate-Smart-Conservation-Final_06-06-2014.ashx) offers guidance for designing and carrying out conservation in the face of a rapidly changing climate. This guide was prepared as a means for helping put adaptation principles into practice, and for moving adaptation from planning to action.

Stein, B.A., P. Glick, N. Edelson, and A. Staudt (eds.). 2014. Climate-Smart Conservation: Putting Adaptation Principles into Practice. National Wildlife Federation, Washington, D.C. https://www.nwf.org/-/media/PDFs/Global-Warming/2014/Climate-Smart-Conservation-Final_06-06-2014.ashx

Climate Change Vulnerability Assessment

The [Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment](https://www.nwf.org/-/media/PDFs/Global-Warming/Climate-Smart-Conservation/NWFScanningtheConservationHorizonFINAL92311.ashx) is intended to provide resource managers and conservationists with guidance for understanding the basic concepts behind vulnerability assessments, and for identifying which approaches may best serve their specific needs.

Glick, P., B.A. Stein, and N.A. Edelson, editors. 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington, D.C. <https://www.nwf.org/-/media/PDFs/Global-Warming/Climate-Smart-Conservation/NWFScanningtheConservationHorizonFINAL92311.ashx>

Climate Action Plans

Federal Agencies Climate Action Plans

As directed by President Biden's January 28, 2021, Executive Order 14008, major Federal agencies are required to develop an adaptation and resilience plan to address their most significant climate risks and vulnerabilities. Going forward, as outlined in President Biden's December 8, 2021, Executive Order 14057 and accompanying Federal Sustainability Plan, agencies will implement the actions identified in their October 2021 Climate Adaptation and Resilience Plans and will provide annual updates on progress made. <https://www.sustainability.gov/adaptation/>

- Department of Interior: <https://www.sustainability.gov/pdfs/doi-2021-cap.pdf>
- Department of Agriculture: <https://www.sustainability.gov/pdfs/usda-2021-cap.pdf>
- Department of Defense: <https://www.sustainability.gov/pdfs/dod-2021-cap.pdf>
- Department of Energy: <https://www.sustainability.gov/pdfs/doe-2021-cap.pdf>
- Department of Transportation: <https://www.sustainability.gov/pdfs/dot-2021-cap.pdf>
- Environmental Protection Agency: <https://www.sustainability.gov/pdfs/epa-2021-cap.pdf>
- U.S. Army Corps of Engineers: <https://www.sustainability.gov/pdfs/usace-2021-cap.pdf>

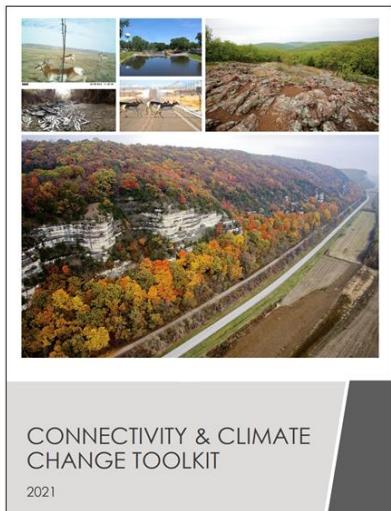
Climate Change Tools/ToolKits

U.S. Climate Resilience Toolkit

The [U.S. Climate Resilience Toolkit](#) is a website designed to help people find and use tools, information, and subject matter expertise to build climate resilience. The Toolkit offers information from all across the U.S. federal government in one easy-to-use location. Climate related information is provided for U.S. regions. The [Southeast region section](#) contains information on factors such as temperature, precipitation, future climate conditions, and climate-related hazards. There is a section on [climate change and impacts to ecosystems](#), with subsections on fire regimes, water resources, carbon balance, invasive species, biodiversity conservation, and protecting and enhancing the resilience of ecosystems. Other topics include [case studies](#) and a [tool catalog](#).



Connectivity and Climate Change Toolkit



The purpose of the [Connectivity and Climate Change Toolkit](#) is to provide state fish and wildlife agency planners and managers with the information necessary to ensure climate considerations are being accounted for and incorporated in the planning and implementation of terrestrial and aquatic connectivity initiatives. The toolkit is structured as a gateway to provide users with information, tools, and resources critical to understanding and deploying such climate adaptation strategies related to landscape connectivity. Unfortunately, no one-size-fits-all approach works for these kinds of initiatives, and so the goal of the toolkit is to provide users with a variety of considerations and resources to identify their needs.

https://www.fishwildlife.org/application/files/9216/1582/0864/Connectivity_and_Climate_Change_Toolkit_FINAL.pdf

NOAA Sea Level Rise Viewer

The [NOAA Sea Level Rise Viewer](#) is a web mapping tool that can be used to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). Photo simulations of how future flooding might impact local landmarks are also provided, as well as data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, and mapping confidence. <https://coast.noaa.gov/digitalcoast/tools/slriser.html>

- Strengths - visually intuitive, nice mapping, can explore range of future water levels
- Weaknesses - bathtub model - doesn't account for sediment, sand dynamics, tidal impacts, saltwater intrusion

The Climate Explorer

The [Climate Explorer](https://crt-climate-explorer.nemac.org/) is a web-based interactive tool that allows users to explore how climate is projected to change in any county in the United States, including Hawai'i and U.S. Territories. Information provided by county includes climate maps comparing past and future conditions, climate graphs to review past and projected values for climate variables, historical weather data, high tide flooding, and historical thresholds for temperature and precipitation. The tool also includes top climate concerns for the selected county. <https://crt-climate-explorer.nemac.org/>

- Strengths - visually appealing, local scale, many derived variables
- Weaknesses - tough to decipher range of risks for each emissions scenario, easy to mis-interpret time series for future, model error not captured

National Climate Change Viewer (NCCV)

The [National Climate Change Viewer](https://www.usgs.gov/tools/national-climate-change-viewer-nccv) is a web-based tool that includes comparison of past measurements (1981-2010) to future (2025-2049, 2050-2074, and 2075-2099) climate and water balance projections derived from 20 downscaled climate models for the RCP4.5 and RCP8.5 emissions scenarios. The viewer can be used either at the state and county level or with HUC watersheds.

<https://www.usgs.gov/tools/national-climate-change-viewer-nccv>

- Strengths - appropriate use of model ensemble, addresses limitations related to range of risks and time series misinterpretation
- Weaknesses - limited variables right now, model error not captured

Climate Adaptation Explorer

The [Climate Adaptation Explorer](https://climateadaptationexplorer.org/) was developed by the Florida Fish and Wildlife Conservation Commission and the US Fish and Wildlife Service. The Climate Adaptation Explorer provides a starting point from which to address the predicted impacts of climate change on Florida's fish, wildlife, and ecosystems. It is intended to serve as a resource in understanding potential impacts and to help in the development of adaptation strategies. The goal was that the "guide" would provide the tools for better integration of adaptation actions and tasks into broader policies and programs, serving as a toolkit to help natural resource managers and others understand and address the current and future impacts of climate change on Florida's ecosystems. Although developed for Florida, much of the information is transferrable to other states/regions. <https://climateadaptationexplorer.org/>

Climate Analysis Tool

The [Climate Analysis Tool](#)—Powered by Climate Wizard is part of the Climate Change Knowledge Portal. The tool was developed through collaboration between The Nature Conservancy, The University of Washington, and The University of Southern Mississippi. The Climate Wizard enables technical and non-technical audiences alike to easily and intuitively access leading climate change information and visualize the impacts anywhere on Earth. Climate Wizard Custom is a new tool where a user can define a relatively small geographic area of interest and conduct site-specific analyses using both historical data and possible future conditions. Sixteen general circulation models are available to provide a range of

possible outcomes, and users can analyze absolute and percentage changes in annual, seasonal or monthly climate conditions in graphic or map form. <http://climatewizard.ciat.cgiar.org/index1.html>

The Template for Assessing Climate change Impacts and Management Options ([TACCIMO](#))

TACCIMO, developed by USDA Forest Service, is a web-based information delivery tool that connects climate change science with **forest management and planning** needs. It is currently expanding to include information on agriculture, rangeland, and livestock planning as well. TACCIMO delivers access to the most current climate change science, including dynamically linked peer-reviewed publication findings describing effects and management options and interactive maps of climate projections and models that provide insight into climate influences on natural resources.

https://www.taccimo.info/tbl_sector_list.php

Additional Resources

Climate Science Centers

The USGS National and Regional [Climate Adaptation Science Centers](#) (CASCs) is a partnership-driven program that teams scientists with natural and cultural resource managers and local communities to help fish, wildlife, water, land, and people adapt to a changing climate. CASC staff work directly with land managers and other partners to create research and tools that can be applied directly to adaptation decisions. The CASC network is comprised of nine regional CASCs and one National CASC.

The [Southeast CASC](#), established in 2010, provides regionally-relevant scientific information, tools, and techniques to resource managers and communities in North Carolina, South Carolina, Georgia, Alabama, Mississippi, Florida, Tennessee, Arkansas, and the U.S. Caribbean. <https://secasc.ncsu.edu/>

USDA Climate Hubs

The Climate Hubs and their partners support USDA's Climate Adaptation and Resilience Plan connecting science and practice, and through tailored outreach activities. The Climate Hubs and their partners develop locally-specific tools and resources to help build climate change adaptation capacity across the country. The Climate Hub network includes 10 Regional Hubs. <https://www.climatehubs.usda.gov/>

The [Southeast Climate Hub](#) is working to deliver science-based knowledge and practical information on climate variability and change to farmers, ranchers, and forest land managers. They connect with public, academic, and private sector organizations, researchers, and outreach specialists to deliver tools and resources that help producers respond to challenges associated with climate variability and change -- such as drought, heat stress, excessive moisture, and changes in pest pressures.

<https://www.climatehubs.usda.gov/hubs/southeast>

Backgrounder: Readiness and Environmental Protection Integration (REPI) and Resilience

Introduction

In recent years, hurricanes, unprecedented rainfall events, wildfires, and rising temperatures have resulted in billions of dollars in damage to military installations and significant readiness impacts. In one recent stretch, hurricanes in Florida and North Carolina, coupled with record floods in Nebraska, imposed nearly \$10 billion in costs to DoD.

As the impacts of climate change are increasingly felt across the military enterprise, resilience has become a higher and higher priority, both within the Department of Defense and in Congress. These impacts will increase, and the DoD needs to ensure it can conduct its missions regardless.

Military training and testing ranges have felt the impacts as well—both directly and indirectly. Direct damage to ranges impacts their carrying capacity and their ability to support and sustain realistic training. Constraints stemming from environmental conditions can further impact readiness, such as limits to live-fire training during droughts. In the end, training days and access to training lands are lost, and the short and long-term capability of testing and training lands to support military requirements are diminished.

Looking into the future, these impacts can be expected to accelerate, creating a present-day imperative to prepare and to improve resilience to minimize impacts to readiness and the military mission.

Expanding REPI Authorities to Address Resilience

DoD initiated the Readiness and Environmental Protection Integration (REPI) program to combat the encroachment that can limit or restrict military training and testing. A key component of the REPI Program is the use of encroachment management partnerships, referred to as REPI projects, authorized by Congress within 10 USC 2684a. These cost-sharing partnerships between the Military Services, state and local governments, and private conservation organizations acquire easements or other interests in land from willing sellers that preserve critical buffer areas and habitat near our military installations. The REPI program works the twin imperative of military readiness and environmental protection—a unique convergence of shared interests.

In the Fiscal Year 2019 National Defense Authorization Act (NDAA), Congress expanded the REPI authority in 10 USC 2684a to extend the traditional REPI real property authorities to address military installation resilience. Specifically, the language now includes a provision that allows the Secretary of Defense or the Secretary of a military department to “enter into an agreement to address the use or development of real property in the vicinity of, or ecologically related to, a military installation... for the purposes of ... preserving off base habitat on the property in a manner that ... maintains or improves military installation resilience.”

“Military Installation Resilience” carries a specific definition in the law: “the capability of a military installation to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions, that do, or have the potential to, adversely affect the military installation or essential transportation, logistical, or other

necessary resources outside of the military installation that are necessary in order to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions.” Anticipated or unanticipated changes in environmental conditions is a term that encompasses climate change.

This was one of a series of legislative measures passed by congress between 2017-2019 that expressed concern about the impacts of climate change and incorporated military installation resilience as a valid objective and rationale for using existing DoD authorities. For example, resilience provisions were added to the Office of Economic Adjustment’s authorities, specifically allowing it to be considered during Joint Land Use Studies (now Compatible Use Studies). Resilience was also incorporated into the Defense Access Roads certification process, which authorizes the Department to make off-base investments to critical roads to address climate-driven impacts.

By incorporating resilience into 10 USC 2684a, a statute focused on limiting encroachment impacts on military testing, training and operations, Congress has cast climate change as an encroachment concern. This is how REPI will absorb this responsibility—maintaining its focus on readiness and expanding its encroachment mission to incorporate climate change as a threat.

This is not the first time that Congress has expanded the REPI authority to incorporate an encroachment problem that is somewhat different than that covered by the original statute. For example, the expansion of authority to allow it to address development in clear zones introduced a very different set of projects and transactions than was found in the original portfolio. Looking at the various projects that have been executed with REPI funds and under REPI authorities, there are clearly multiple types of encroachment issues that are addressed and addressing this new set of challenges is consistent with the broader encroachment mandate addressed by the REPI program.

In order to address this challenge, one has to address a set of interrelated questions.

1. First, in what ways do changes in environmental conditions negatively impact testing and training. In other words, how does climate change “encroach” on a military installation?
2. Second, how could the REPI authorities (both the traditional real property authority in 10 USC 2684a and related authorities such as the Sikes Act) counter these environmental encroachments?
3. Third, from a programmatic and readiness point of view, which of the kinds of projects that could reasonably fall under this new authority would have the most significant impact from a readiness perspective?
4. Finally, considering the overall REPI program to be more comprehensive than simply the acquisition of land, but rather the protection of readiness through environmental partnerships and other, related activities, what are the broader implications for the REPI program now that Congress has incorporated military installation resilience into the REPI mission? How should military installation resilience be incorporated into partnership activities such as the Southeast Regional Partnership for Planning and Sustainability (SERPASS) and the Western Regional Partnership (WRP)? Are there other activities or authorities that fall within the REPI program that could or should be modified to address military installation resilience?

The Encroachment of Climate Change

Obviously, the REPI program is not prepared to address every aspect of climate change, so in advance of trying to develop or assess projects, it is important to consider how climate change acts to encroach on military testing, training and operations. Encroachment is traditionally considered to be development close to military bases that interferes with operations, but depending on how loose of a definition one uses, sometimes endangered species protection is considered to be an aspect of encroachment, as it can impose constraints on training and testing.

Using the broader and more flexible approach to defining encroachment, in order to encompass the increasing constraints that climate change places on operations, there are several climate change impacts that will increasingly impact military training, testing, and operations. Some examples include:

- Sea Level Rise and Recurring Flooding, which could result in the loss of coastal training infrastructure or interruption of operations at low-lying bases.
- Inland Flooding, driven by precipitation events and/or snow melt, which can impact infrastructure and operations at inland bases located in flood zones.
- Increased Precipitation, which could overwhelm stormwater system capacity and damage ranges or installations generally.
- Increased Drought Conditions, which could make a base more susceptible to wildfire impacts and impede the conduct of live-fire activities.
- Increased Frequency of High Heat or Black Flag Days, which could significantly interrupt training schedules.
- Impacts on Protected Species or Habitat, amplifying existing constraints on testing and training where such species are present.
- Extreme Weather, which can significantly impact existing infrastructure and ranges—to include disrupting operations across an entire base.
- Increased Wildfires, endangering lives in local communities at the urban/wildland interface, destroying valuable habitat, and damaging existing infrastructure.

In the short term, these impacts force workarounds in testing and training or interruptions in operations. Over a longer period of time, climate change impacts could result in the loss of entire ranges, or at least a reduction in their carrying capacity.

REPI and Resilience Authorities

With this set of challenges in mind, and the intent of Congress clear that the REPI Program should be working to address them, the next step is to open the tool box and see if REPI has the right tools for this job.

The first and most well-used tool in the REPI toolbox is 10 USC 2684a, the real property authority it uses when partnering with NGOs and other non-DoD entities to secure easements on valuable habitat or on land that sustains compatible land uses. However, even though this is the authority amended by Congress to incorporate resilience, it does not mean that it is the ideal way to address each of the climate change challenges, nor does it mean that it is able to address each of them equally well. In fact, the wide variety of resilience challenges that could reasonably fall under this new authority

differentiates it from the clear zone authority mentioned earlier. While the clear zone approach involves a straightforward purchase of parcels in designated zones, the military installation resilience challenges can vary from installation to installation and do not come with a straightforward ruleset with which to respond. In other words, protecting an installation from increased flooding and protecting it from wildfires may both reasonably fit under the heading of military installation resilience, but they don't lend themselves to the same set of solutions.

In addition, the Sikes Act offers complementary tools for improving resilience. The Sikes Act is the primary authority governing DoD management of natural resources, including the authority to enter into cooperative agreements for the management of natural resources both on and off of military installations. In other words, it authorizes DoD to engage in natural resources management projects without securing a real property interest. This authority clearly encompasses resilience projects, and enables DoD to pursue projects that are more complex when combined with its 10 USC 2684a authority. Intriguingly, the Sikes Act also authorizes military services to fund an endowment for natural resources management from a single year's appropriation—funding multiple years of support for a cooperative agreement up front.

The Sikes Act authority is already broad enough to permit agreements designed to address—through the maintenance and improvement of natural infrastructure both on and off installations—the observed and anticipated challenges associated with climate change. It is clearly a complementary authority that can be built into projects that leverage the recent REPI resilience authority.

[For additional details, please reference the accompanying document, "Using the REPI Authority and the Sikes Act to Address the Impacts of Climate Change on DoD"]

In addition to the authorities to execute projects, there are several new authorities that support the development of projects. For example, in the FY20 NDAA, Congress included a provision that would require installation-specific assessments of climate vulnerability, directing that it be incorporated into the installation master plan. As these assessments are conducted, installations should consider the natural resource tools in the REPI toolbox as ways to mitigate their climate vulnerabilities.

Complementing the planning process at the installation level, the Office of Economic Adjustment (OEA) has been pursuing efforts within its expanded authority to explore climate change impacts as part of its Compatible Use Studies (formerly Joint Land Use Studies). Specifically, they developed an Addendum focused on resilience to the Hampton-Langley AFB JLUS, which proposes multiple actions for increasing the resilience of the installation. OEA has also considered resilience in recent studies for Offutt AFB, Naval Weapons Station Earle, and Beaufort/Parris Island, and they are expanding their practice of developing resilience addenda for existing Compatible Use Studies. These reports may have already identified challenges and possible solutions, and should be part of any project development effort.

As projects are developed, local and State authorities may come into play. Resilience projects are likely to have regional, rather than precision, benefits, and there are likely to be resilience-focused programs and authorities that can be leveraged depending on the location.

Finally, as projects are developed, there may be authorities and programs specific to the aspect of climate encroachment being addressed. For example, one effort might address forest management to

reduce wildfire risk, while another might support wetlands development to address flooding. Other proposals could involve offshore oyster reefs to reduce storm surge associated with extreme weather or protecting upstream water resources to reduce the risk of drought. The REPI resilience authorities would encompass all of them, but partners would be able to leverage tailored authorities and programs to secure matching funds that might be different for each type of project.

Even though resilience projects may impact a broad area and have significant regional equities, projects pursued within the REPI program will need to make their primary focus the benefit to ranges, operations, and DoD equities more generally. REPI has a long tradition of balancing these equities—operational and environmental benefits—to achieve the mutually beneficial cost-sharing that is the heart of the 10 USC 2684a authority, but resilience programs and benefits will necessarily incorporate new stakeholders, new military and civilian beneficiaries, and new authorities.

Addressing Resilience Throughout the REPI Program

As discussed above, the REPI program is more than a single authority or a single tool, though it has been built around the 10 USC 2684a real property authority and associated projects. Its impact has stretched to partnerships built with communities and with a broader universe of stakeholders. Both SERPPAS and WRP, for example, are part of the REPI program though neither are directly related to the procurement of parcels.

Therefore, the expansion of REPI authority into the realm of military installation resilience should be incorporated into the expanded activities of the REPI program as well—particularly the aforementioned SERPPAS and WRP.

Sentinel Landscapes could address installation resilience in the goals of individual projects. Beyond the existing partnerships with DOI and USDA, the focus on resilience leads one to consider expanding Sentinel Landscapes to include, at a minimum, the Department of Homeland Security. DHS has a considerable amount of funding they will be making available for pre-disaster mitigation, and that funding complements the REPI resilience approach quite well. Other agencies, such as NOAA and the civilian side of the Army Corps of Engineers, would also be valuable partners on resilience projects.

In addition, REPI projects could benefit from collaborating with other DoD stakeholders and by leveraging other new authorities focused on military installation resilience. For example, OEA has already begun discussing resilience with selected communities (mentioned above), but more broadly, DoD relies on civilian infrastructure for critical services such as energy, water, wastewater, transportation, communications, and housing. There are more than a few resilience efforts that would lead to intuitive partnerships with local and state governments.

Conclusion—The Way Forward

At this point, across the Department, efforts to shore up military installation resilience are still in their formative stages. Much of the detailed planning at the installation level has not yet been conducted. At the same time, extreme weather impacts at locations such as Tyndall AFB, Camp Lejeune, and Offutt AFB have heightened concerns and brought political attention to this issue. The Hampton Roads region, with its ongoing flooding challenges and concentration of military infrastructure, has been a long-standing concern, but now other localities are turning their focus to this challenge.

The REPI program will approach this new authority deliberately and methodically, building first its expertise and understanding of work that is already ongoing and similar efforts that have been supported external to DoD. It can focus on integrating military installation resilience in the face of environmental changes as a separate category of encroachment and a separate set of projects starting in FY21 and contemplate how resilience will be fully incorporated in FY22.

The new resilience authority will be discussed by principals at both SERPPAS and WRP meetings over the coming year, both to start potential partners thinking about how to pursue it, but also to solicit their ideas and imagination regarding projects that could be pursued.

Both REPI and its partners will be able to cross-pollinate between REPI efforts and other DoD efforts such as military installation resilience plans and OEA sponsored Compatible Use Studies. This will both shorten learning curves and promote innovative proposals to address these critical issues.

In conclusion, resilience fits neatly into the REPI approach to protecting readiness when it views climate change as yet another form of encroachment. Resilience efforts are going to be somewhat different in character than previous efforts and may involve new stakeholders, but they appear to be quite compatible with the priorities, approaches, and legacy of the REPI program.

Using the REPI Authority (10 USC 2684a) and the Sikes Act (16 USC 670c-1) to Address the Impacts of Climate Change on DoD

Using the 10 USC 2684a (the “REPI authority”) to Address Climate Change

- The REPI authority (10 USC 2684a) provides authority for the Department of Defense to enter into cooperative and other forms of agreements with state and local governments and conservation NGOs (“eligible entities”) to protect DoD’s ability to test, train, and operate by addressing the use and condition of privately owned real estate through the acquisition from willing landowners of interests in such real estate.
- 10 USC 2684a was enacted in the FY 2003 NDAA to provide DoD an effective tool to address “outside the fence line” conditions on privately owned lands that could affect existing or possible future restrictions on military testing, training, and operations.
 - Prior to the enactment of 10 USC 2684a, the Army experienced significant training restrictions at Fort Bragg, NC, resulting from the legal mandate to avoid adversely affecting the red-cockaded woodpecker (RCW), a species listed as endangered under the Endangered Species Act (ESA). In response the Army, in what it termed the “Private Lands Initiative” (PLI), used the authority of the Sikes Act to work with conservation NGO’s, private landowners, and others to take actions to acquire interests in real estate in order to protect habitat for the RCW outside of the boundaries of Fort Bragg. The basis for using the Sikes Act as the authority for the PLI was that such off installation actions directly benefited the “on installation” status of the RCW.
 - 10 USC 2684a was enacted to both clarify and broaden the authority of DoD to enter into such agreements.
- As originally enacted, the authority under 10 USC 2684a could be used for two purposes:
 - Limiting the development or use of privately owned real property that would be incompatible with the mission of the installation; and/or
 - Preserving habitat on privately owned real property in order to “eliminate or relieve” current or anticipated statutory or regulatory restrictions that would adversely affect testing, training or operations.
 - Actions for such purposes were limited to private lands “in the vicinity” of a military installation.
- DoD funding for implementing such agreements was authorized to come from either or both of two sources: O&M funds provided to OSD specifically for REPI agreements (which OSD passes to the Services for execution) and funds (either O&M or RDT&E and without a specific limitation as to amount) that were provided to the Services for the operation of their installations and that the Services can use to provide funding for their agreements in addition to or instead of “REPI funds” provided by OSD.
- Since its original enactment, 10 USC 2684a has been amended multiple times in response to lessons learned from the implementation of the authority, and to make that authority more effective in protecting military readiness. Significant amendments include:
 - Broadening the geographic scope of where the authority could be used beyond just property “in the vicinity” of an installation to a much broader combined geographic and

- functional scope that includes property “in the vicinity of, or ecologically related to, a military installation ...or military airspace.”
- Adding the additional purpose of protecting Clear Zone areas.
 - Authorizing agreements to “provide for the management of natural resources” on private lands in which DoD has acquired an interest or right in pursuant to a REPI agreement.
 - Authorizing DoD to create, in effect, an endowment for funding such management into the future, allowing the REPI partner to invest funds provided for that purpose in an interest-bearing account, with any interest being used for such management. Notably, such authorized management actions include actions both to “preserve” habitat and to “restore” habitat, clarifying that the authorized “habitat” purpose of a REPI agreement includes actions beyond the mere protection of the existing condition of that habitat.
 - Authorizing an eligible entity receiving funds under a REPI agreement (or a Sikes Act agreement) to use those funds to “satisfy any matching funds or cost-sharing requirement” of any conservation program administered by the Department of Agriculture or the Department of the Interior.
- As concerns grew over the impacts on DoD installations and readiness activities resulting from severe weather and other conditions exacerbated by the current or anticipated impacts of climate change, both DoD and Congress began taking actions to address those current or anticipated impacts. In the FY 2018, 2019, and 2020 NDAA’s, Congress enacted numerous legislative provisions and amendments to existing laws designed to strengthen the ability of DoD to take actions to lessen those current and anticipated impacts. (Note: additional legislative changes addressing DoD resilience to climate change, including several amendments to 10 USC 2684a, are now being considered by Congress as part of the pending FY 2021 NDAA).
 - Two of those enactments directly affect the ability of DoD to take action under 10 USC 2684a in response to the threat of climate change:
 - A statutory definition of “military installation resilience,” codified in 10 USC 101(e)(8), that addresses not only impacts of severe weather and climate change to a military installation as such, but also impacts to “essential transportation, logistical, or other necessary resources outside of the military installation that are necessary in order to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions.”
 - The addition of an additional purpose of “preserving habitat” [on REPI-protected property] that...”maintains or improves military installation resilience.” Note that action regarding habitat under 10 USC 2684a for a resilience purpose may, but is not statutorily required to, also lessen or avoid legal or regulatory restrictions on readiness activities.
 - Under this amended authority, 10 USC 2684a is a powerful—but limited—tool to address the current or anticipated impacts of climate change on DoD and NG installations and such impacts on key civilian resources outside such installations providing critical mission support, such as key electrical power substations, potable water and storm water facilities, and the like.
 - The basic mechanism for addressing resilience using 10 USC 2684a is to work with REPI partners to preserve, manage, or restore so-called “green infrastructure” on lands where DoD has

acquired an interest in private real estate pursuant to a REPI agreement. Such “green infrastructure” involves the use, management, and/or restoration of nature or nature-based features such as wetlands, dunes, oyster reefs, and other natural features (see below under the Sikes Act for more detail) to avoid or lessen the impacts of coastal or inland flooding, sea level rise, or storm surge.

- Note that in a number of states, private parties can acquire real estate interests in sea bottom within “state waters,” and hence such sea bottom becomes “private real estate” for the purposes of a REPI agreement with an eligible entity to preserve, maintain, or restore features on that “sea bottom real estate” (such as an oyster reef) to lessen the impacts of storm surge on a coastal installation.
- Resilience to the threat of wildfires can be addressed under a REPI agreement by actions to manage the habitat on REPI-protected private property to reduce fuel loads (e.g., prescribed burning).
- In situations where the freshwater supply to an installation is threatened by drought conditions projected to worsen as a result of climate change, a REPI agreement can be used for the purpose of protecting upstream natural features on private lands such as forests that would assist in maintaining or improving in-stream flows for sources of freshwater for the installation.
- The power of REPI agreements to “maintain or improve military installation resilience” stems from:
 - The ability to leverage existing relationships throughout the country with “eligible entities” to enter into new or amended agreements or to use existing agreements for the additional purpose of maintaining or improving military installation resilience.
 - The functional as opposed to strictly geographical scope of where the REPI authority can be used.
 - The ability to fund what are in effect endowments for the long-term protection, maintenance, and restoration of “green infrastructure,” very often the limiting factor in the ability to successfully use “green infrastructure” as a resilience method.
 - The ability of REPI partners to use funds received from DoD under an agreement to meet the matching funds or cost-share requirements of USDA and DOI conservation programs, since such conservation programs frequently also provide additional resilience to the impacts of extreme weather and climate change.
 - The flexible nature of the funding that can be used by DoD for REPI agreements, including both funds specifically provided by Congress to OSD for that purpose and unspecified levels of funds provided to the Services to operate military installations.
- The limitations on the use of REPI agreements for a resilience purpose stem from:
 - The requirement that REPI agreements address only the use and condition of privately owned lands where the owner of such lands agrees to sell or donate an interest in such lands. Since effective action to maintain or improve resilience can require consistent approaches across a fairly large landscape that may include lands owned by a state or local government, a non-DoD federal agency, a tribe, or private lands where an owner chooses not to be a “willing seller,” agreements under REPI for resilience purposes can leave significant “resilience gaps.”

- The inability to use REPI agreements to fund resilience-related “grey infrastructure,” such as levees, breakwaters, improved culverts, and the like, since comprehensive resilience measures often require the use of both “grey” and “green” infrastructure,
- Given the potential power of REPI agreements, they warrant an increasingly prominent role in maintaining and improving military installation resilience.
- But because of the limitations on the use of the REPI authority alone for this purpose, a comprehensive approach to maintaining and improving military installation resilience should involve:
 - Combining the use of 10 USC 2684a, the Sikes Act (16 USC 670c-1), and other relevant DoD authorities, including
 - The resilience-related authorities administered by the Office of Economic Adjustment (OEA) under 10 USC 2391 (including the resilience aspects of Compatible Land Use Studies and resilience-related projects under the Defense Community Infrastructure Pilot (DCIP));
 - Inter-governmental support agreements with civilian authorities under 10 USC 2679;
 - Climate resilience authorities related to roads and bridges under the Defense Access Road (DAR) program under 23 USC 210;
 - Other DoD authorities that may be relevant in particular circumstances.
 - Full awareness and leveraging of the resilience programs of state and local governments and of other federal agencies, such as FEMA, NOAA, and the Corps of Engineers.

Using the Sikes Act to Address Climate Change

- The Sikes Act (16 USC §670 et seq.) is the primary legislative authority governing DoD’s management of natural resources.
 - Added to the Sikes Act in 1989, section 103a (16 USC §670c-1) originally authorized the Secretary of Defense to enter into cooperative agreements only “to provide for the maintenance and improvement of natural resources **on**...Department of Defense installations.” [Emphasis added]
 - In 2008, new paragraph (a)(2) was added to enlarge the scope of the authority to provide also for “[t]he maintenance and improvement of natural resources **located off** **of** a military installation or State-owned National Guard installation...to relieve or eliminate current or anticipated challenges that could restrict, impede, or otherwise interfere with, whether directly or indirectly, current or anticipated military activities.” [Emphasis added]
 - Also in 2008, subsection (a) was amended to permit the use of “interagency agreements with the heads of other Federal departments and agencies” for these same purposes.
 - And in 2014, new paragraph (b)(2) was added to permit the Secretary of a Military Department to fund, from a single year’s appropriation, what are, in effect, “management endowments” intended to cover the future costs of natural resources

management or improvement activities to be provided under a subsection (a) cooperative agreement.

- Undoubtedly, these amendments were enacted principally to give DoD installations greater authority to restore and manage habitat located “outside the fence line” for the purpose of relieving or eliminating current or anticipated ESA-related restrictions on the use of “inside the fence line” installation lands.
- That said, Section 103a is nonetheless clearly broad enough to permit agreements designed to address—through the maintenance and improvement of “natural infrastructure” both on and off installations—the observed and anticipated “challenges” associated with climate change.
- Natural or “green” infrastructure solutions seek to enhance the benefits provided by natural systems: reduced erosion and flooding; attenuated wave energy and storm surge; floodwater retention; enhanced water quality and groundwater recharge; and reduced runoff.
- Natural infrastructure solutions are often more cost effective than the installation of “grey” or built infrastructure.
- Natural infrastructure solutions encompasses a wide range of possible actions:
 - Restoring historical hydrology—e.g., wetlands and coastal marshes.
 - Reestablishing oyster reefs and submerged aquatic vegetation.
 - Restoring shoreline and dune vegetation.
 - Removing vegetation that restricts rainwater infiltration.
 - Enhancing riparian buffers.
 - Restoring high value habitat.
 - Using prescribed burns to reduce fuel for wildfires.
 - Etc.—see the burgeoning literature focused on the effects and functionality of green infrastructure.
- Section 103a should be seen as a potentially powerful tool to address the effects of climate change and reduce the risk of natural disasters.
 - Installations may wish to initiate discussions with surrounding communities, the Army Corps of Engineers, and other interested parties to identify mutually beneficial natural infrastructure projects to address climate change effects and reduce the risks associated with natural disasters.
 - To be effective, many “natural infrastructure” projects will require the combined efforts of many landowners and encompass property owned by private parties, state agencies, and agencies of the federal government. As a consequence, a multi-party cooperative agreement and a parallel interagency agreement (for federal agency partners) may need to be implemented.
 - To facilitate interagency cooperation, the recipient of funds provided pursuant to an agreement authorized by this section of the Sikes Act may use such funds to satisfy any matching funds or cost-sharing requirement of any conservation program administered by the Department of Agriculture or the Department of the Interior. [See 10 U.S.C. §2684a(h)]
 - Funding for activities under agreements authorized by this section of the Sikes Act may come from funds appropriated for operation and maintenance (O&M) of the Army,

Navy, Marine Corps, Air Force, or Defense-wide activities, or, for installations devoted primarily to research and development, funds appropriated for research, development, test, and evaluation (RDT&E).

- Because ensuring long-term and reliable funding for “natural infrastructure” solutions can be a challenge, the use of the Sikes Act “endowment” authority could be important in “filling the gaps” for such efforts, and in attracting other federal, state, and private funding.
- The REPI authority (10 U.S.C. §2684a) includes as a stated purpose the maintenance and improvement of “military installation resilience”; consequently, agreements to address climate change and promote military installation resilience ought, in most cases, to cite both of these mutually reinforcing authorities—i.e., 10 U.S.C. §2684a and 16 U.S.C. §670c-1—in order to be positioned to take advantage of opportunities as they arise..
- 10 U.S.C. §2864 was amended in 2019 to require installation master plans for all major military installations to address military installation resilience.
 - IAW paragraph (c)(6) of this section, the resilience component of these plans is required to discuss “[a]greements in effect or planned...for the purpose of maintaining or enhancing military installation resilience or resilience of the community infrastructure and resources” that are necessary to maintain mission capability and vulnerable to threats posed by extreme weather events and other changes in environmental conditions.
 - Clearly, Congress intended this change to §2864 to prompt installations to identify and address present and projected future climate change-related threats to military installation resilience.
 - Just as clearly, Sikes Act cooperative and interagency agreements (and agreements under 10 USC 2684a) with a resilience purpose or effect are precisely the type of agreements Congress had in mind in enacting the requirement to include discussion of “agreements in effect or planned” in military installation resilience plans.
- Helpful references:
 - *Climate Adaptation for DoD Natural Resources Managers: A Guide for Incorporating Climate Considerations into Integrated Natural Resources Management Plans*, available from the National Wildlife Federation and soon to be on DENIX.
 - “*Climate Change Planning Handbook: Installation Adaptation and Resilience*,” NAVFAC Jan 2017 (see, particularly, Appendix D).
 - Army Corps of Engineers “Engineering with Nature” Initiative, Engineer Research and Development Center Environmental Laboratory, <https://ewn.erdc.dren.mil/>.