

Preparing for the Future

PHOTO BY ALAN CRESSLER, USGS

The Department of the Interior Southeast Climate Science Center (SE CSC) is one of eight regional Climate Science Centers managed by the U.S. Geological Survey National Climate Change and Wildlife Science Center. We work with natural and cultural resource managers to gather the scientific information and build the tools needed to help fish, wildlife, and ecosystems adapt to the impacts of climate change.

Since it began operation in 2010, the SE CSC has been organized to accomplish three goals:

- ➔ Provide decision-focused, research-based information that supports transparent global change adaptation decisions;
- ➔ Convene conversations among decision makers, scientists, and managers about key ecosystem adaptation decisions;
- ➔ Build the capacity of natural resource professionals, university faculty, and students to understand and frame natural resource adaptation decisions and develop and use research-based information to make adaptation decisions.

MEET THE SE CSC TEAM



TOP ROW, L-R
GERARD MCMAHON
NICK HADDAD
RYAN BOYLES
ARANZAZU LASCURAIN



BOTTOM ROW, L-R
MITCH EATON
ADAM TERANDO
CARI FURNESS
SIMEON YUREK



SCIENCE THEMES

The SE CSC Science Plan is developed in consultation with partners in the Southeast conservation community to identify and address information needs for making climate and land use change-related adaptation decisions. Six science themes framed activities in the first phase:

- Climate and Other Appropriate Projections to Use for Resource Management
- Land Use and Land-Cover Change Projections
- Impacts of Climate Change on Water Resources
- Ecological Research and Modeling
- Coastal and Nearshore Marine Environments
- Impacts of Climate Change on Cultural-Heritage Resources

Learn more about our science planning

> bit.ly/SciencePlanning

Highlights

RECENT NOTABLE EVENTS

→ WORKSHOP

Ecological Drought in the Southeast United States: Balancing Competing Demands for Water Supplies: Info and Workshop Report

> bit.ly/SECSEcoDrought

→ LAUNCH OF RED MAPLE CITIZEN SCIENCE PROJECT

> bit.ly/MapleCitizenScience

→ REGIONAL ENGAGEMENT WORKSHOPS FOR FOURTH NATIONAL CLIMATE ASSESSMENT

> bit.ly/NCA4_SE_REW

RECENT NOTABLE PUBLICATIONS

→ USGS REPORTS

The Department of the Interior Southeast Climate Science Center synthesis report 2011–15 – Projects, products, and science priorities, Varela et al., 2016

> bit.ly/SECSCSynthesisReport

Five-Year External Reviews of the Eight Department of Interior Climate Science Centers: Southeast Climate Science Center

> pubs.er.usgs.gov/publication/70187078

Assessing climate-sensitive ecosystems in the southeastern United States, Costanza et al., 2016

> pubs.er.usgs.gov/publication/ofr20161073

Sea-level rise modeling handbook: Resource guide for coastal land managers, engineers, and scientists, Doyle et al., 2015

> pubs.er.usgs.gov/publication/pp1815

→ WHITE PAPER

Identifying Decision-Focused Climate Adaptation Activities and Aligning Priorities Across Multiple Sectors and Scales in the Southeastern United States

> bit.ly/NAF2015SoutheastWorkingGroup

→ BOOK CHAPTER

Uncertainty Quantification and Propagation for Projections of Extremes in Monthly Area Burned Under Climate Change, Terando et al., 2016

> onlinelibrary.wiley.com/book/10.1002/9781119028116

→ JOURNAL ARTICLES

Urban warming reduces aboveground carbon storage, Meineke et al., 2016

> rsps.royalsocietypublishing.org/content/283/1840/20161574

Global change and conservation triage on National Wildlife Refuges, Johnson et al., 2015

> www.ecologyandsociety.org/vol20/iss4/art14/

Hydro-Climatological Influences on Long-Term Dissolved Organic Carbon in a Mountain Stream of the Southeastern United States, Singh et al., 2016

> dl.sciencesocieties.org/publications/jeq/abstracts/45/4/1286

Meta-analysis of Natural Resource Conservation Plan Evaluations, Foster et al., 2016

> www.seafwa.org/publications/journal/?id=402065

Beyond just sea-level rise: considering macroclimatic drivers within coastal wetland vulnerability assessments to climate change, Osland et al., 2015

> onlinelibrary.wiley.com/wol1/doi/10.1111/gcb.13084/full

The Sensitivity of WRF Downscaled Precipitation in Puerto Rico to Cumulus Parameterization and Interior Grid Nudging, Wootten et al., 2016

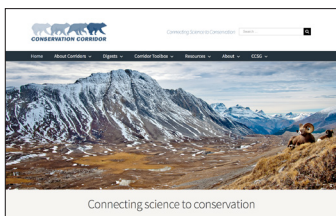
> journals.ametsoc.org/doi/abs/10.1175/JAMC-D-16-0121.1

→ SEE ALL OUR PUBLICATIONS

> bit.ly/SECSCpublications

RESOURCES AND TOOLS

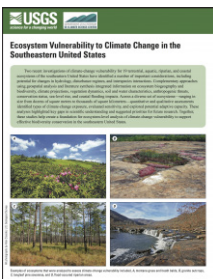
→ CONSERVATION CORRIDOR



Bridges the science and practice of conservation corridors and provides up-to-date findings from science that will inform applied conservation.

> conservationcorridor.org/

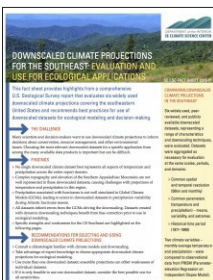
→ SCIENCE FACT SHEETS



Ecosystem Vulnerability to Climate Change in the Southeastern United States



Keeping Pace: A short guide to navigating sea level rise models



Downscaled Climate Projections for the Southeast: Evaluation and Use for Ecological Applications

> bit.ly/SECSCFactSheets

→ SOUTHEAST GLOBAL CHANGE MONITORING PORTAL



Metadata portal connects users to biological, chemical, and physical data important for assessing global change in the Southeast.

> bit.ly/GlobalChangeMonitoring



Turning Uncertainty into Useful Information for Conservation Decisions

Uncertainty is always present in conservation and other socio-

ecological decisions, which can make choices uncomfortable and challenging. All choices have consequences – including the choice to do nothing. This fact sheet discusses the pervasiveness of uncertainty, the importance of understanding varying perceptions of uncertainty, and avenues for progress in the presence of uncertainty and differing risk tolerances.

> bit.ly/UncertaintyFactSheet

SE CSC *by the* NUMBERS

We cover **11** states and **2** U.S. territories – that's **22%** of the **U.S. population!**

Since 2011:

62

graduate students trained in **climate** and **global change**

over **30** projects **funded**

110

resulting publications

> **2000** citations of our science publications

65

NCSU Faculty Affiliates engaged with center

138 scientists

from institutions across the U.S. involved in **research**

Actionable Science

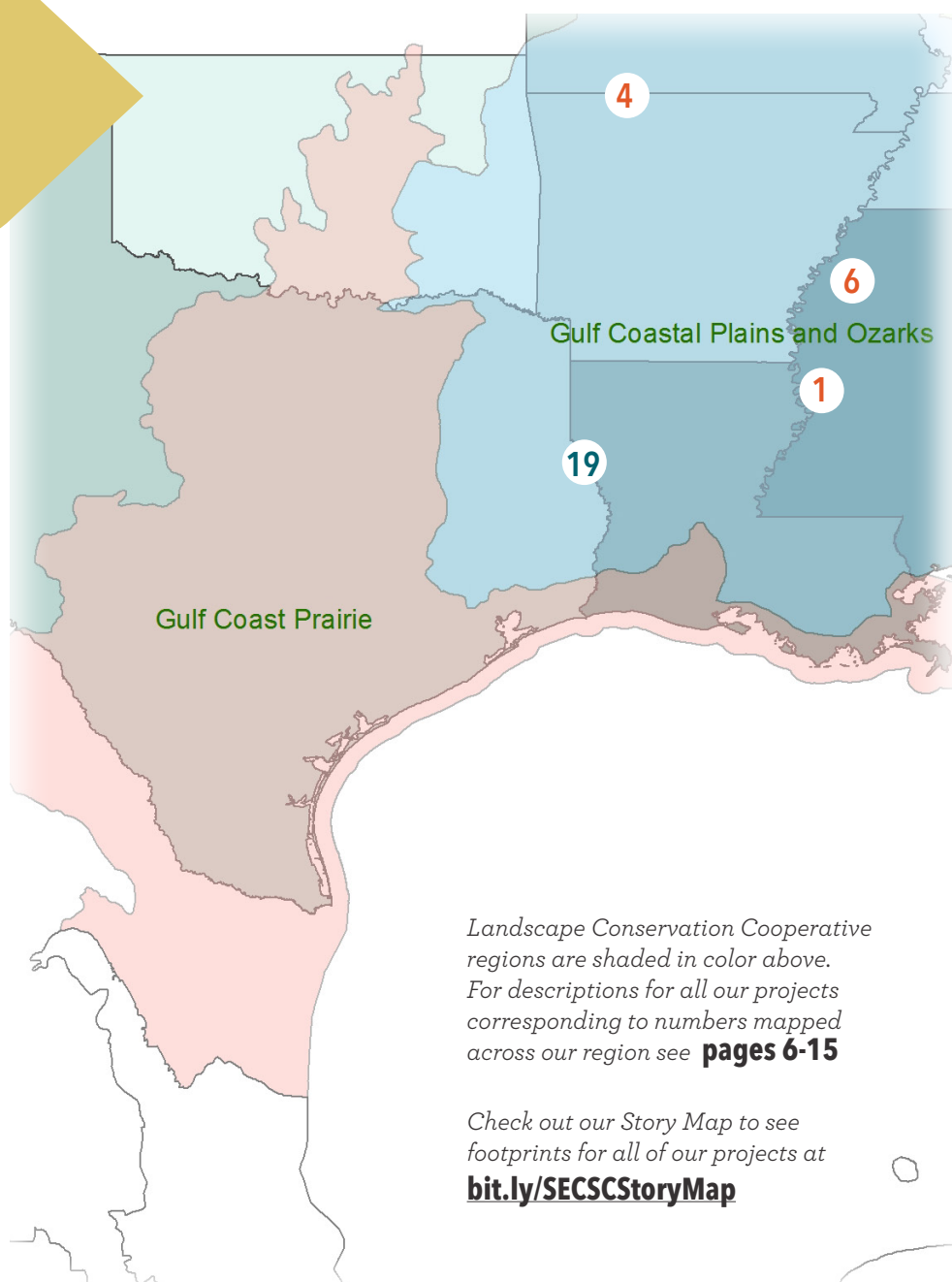
Where we work

Research funded by the Southeast Climate Science Center encompasses a range of science activities that advance understanding of the **exposure** and **impacts** of global change on resources that matter to our partners and to framing decisions about **adaptation** strategies, emphasizing principles of co-production.

DIRECTORS' MESSAGE

At the Southeast Climate Science Center, we address the key natural resource conservation challenge of our time: helping people to manage climate and land use changes in ways that sustain the coupled human and natural systems on which our region depends. We assess these changes and their impacts on the features that define the Southeast's special landscapes that support thriving agriculture, cities, and economic opportunities; clean water; diverse human communities; abundant outdoor recreational opportunities; and a diversity of plants and animals. Our goal is to help both public and private partners throughout our region use this information to make climate-smart adaptation choices now, and to train the current and next generation of scientists to help decision makers with climate-smart actions in the future.

GERARD MCMAHON, USGS DIRECTOR
NICK HADDAD, NCSU DIRECTOR

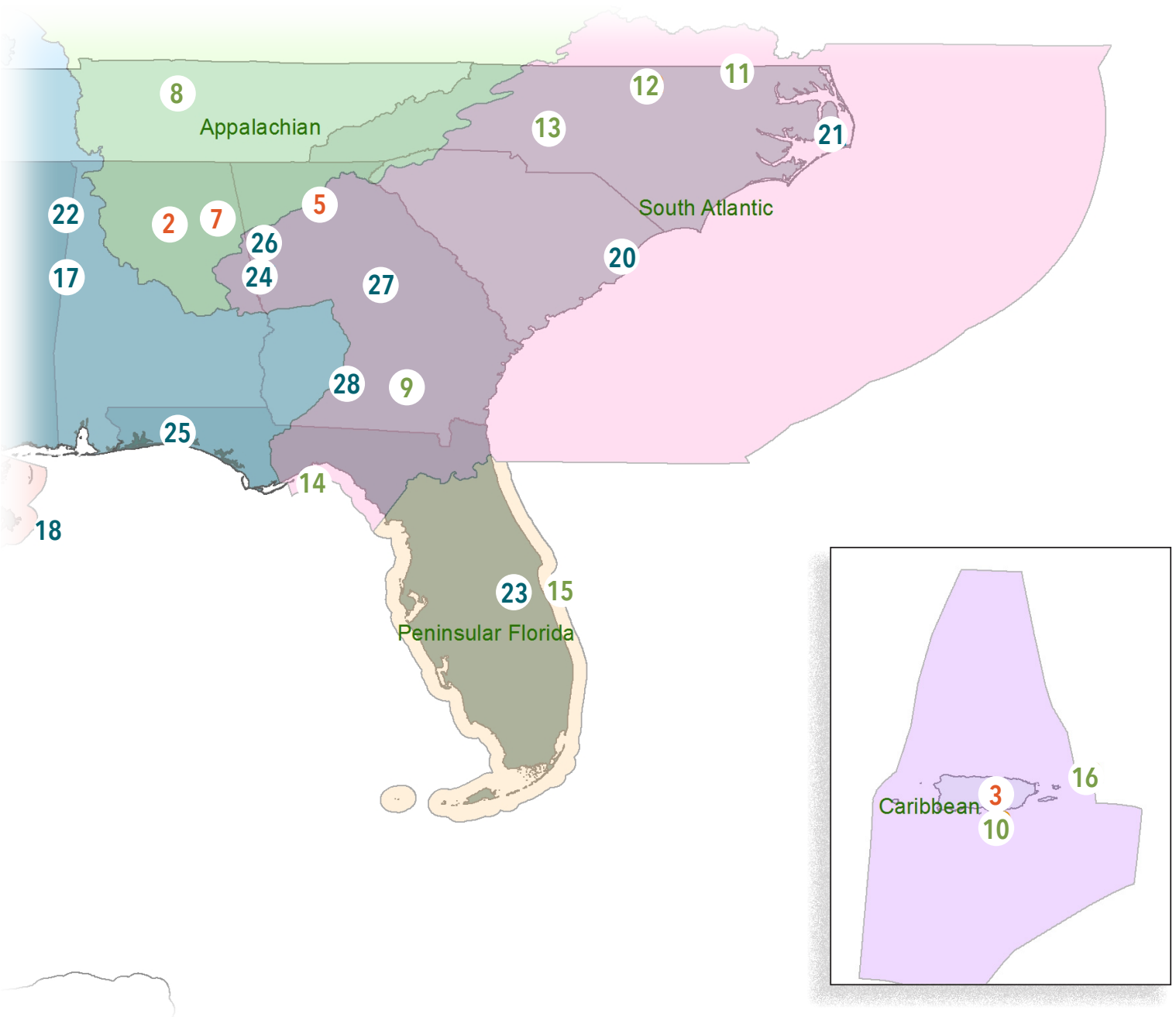


*Landscape Conservation Cooperative regions are shaded in color above. For descriptions for all our projects corresponding to numbers mapped across our region see **pages 6-15***

*Check out our Story Map to see footprints for all of our projects at **bit.ly/SECSCStoryMap***

"We're seeing earlier, warmer, and wetter springs, and we know that affects the fishing and hunting experience. We're hearing from our hunters and anglers that fish and wildlife are not following the patterns of old and they are having to change their methods to be successful. And they're asking us to do something about it. But we need the ability to understand the climate changes that are occurring and to be able to explain this to our citizens. We need science to show us what kind of changes will happen and experts to help show us how to use all this great science to actually change how we manage our habitat and wildlife."

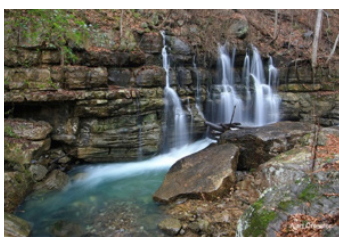
- BILL REEVES, TN WILDLIFE RESOURCES AGENCY



Actionable Science

1

ESTIMATING FUTURE WATER AVAILABILITY AND STREAM-FLOW IN THE SOUTHEAST



Regional hydrologic model provides managers historical and potential future information on water availability and timing in the Southeast.

Estimates of water flows in streams are critical to inform natural resource managers of water availability for both human and ecological needs. Monitoring flow using a streamgage provides information about the amount and timing of surface water resources. Hydrologic models can be used to estimate streamflow for streams without gages. This research developed a method to group watersheds that are gaged to provide accurate estimates of water availability regionally. Various models, techniques, and data were used to group watersheds across the southeastern United States based on their response to climate and their landscape setting. The result is consistent regional estimates of water availability for current and potential future climate and land cover in the Southeast.

Investigator: Jacob LaFontaine, USGS GA Water Science Center **Collaborators:** GCPO LCC **Duration:** May 2014 - Sep 2016 **Funding:** \$60,000

> bit.ly/GCPOHydroModeling

2

SOUTHEAST GLOBAL CHANGE MONITORING PORTAL



Metadata portal connects users to centralized biological, chemical, & physical data important for assessing global change in the Southeast.

Detecting change in ecosystems requires observations of living and non-living components over time. Many organizations make observations that are relevant to understanding global change processes, but the data are often not easily discoverable by other interested scientists and managers. This multi-phase project created a centralized web-based portal that allows users to discover, search, and connect to many types of environmental and biological data relevant to characterizing potential effects of climate and land use change on land, water, and wildlife in the Southeast. Data resources can be visualized and searched by types of measurements and/or by geographic criteria, increasing the usefulness of data collection efforts by a broad range of organizations.

Investigators: Damian Shea and Cari Furiness, NCSU **Collaborators:** ApplCC, CLCC, GCPO LCC, GCP LCC, PFLCC, SALCC **Duration:** Sep 2012 - Sep 2016 **Funding:** \$187,500

> bit.ly/GlobalChangeMonitoring

3

MODELING FUTURE TEMPERATURE AND PRECIPITATION FOR PUERTO RICO AND THE U.S. CARIBBEAN



Understanding local impacts of global climate changes in tropical island ecosystems lays the foundation for sound climate adaptation decisions.

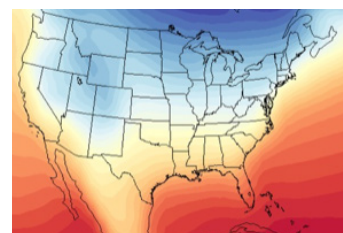
This research project developed a suite of dynamically downscaled projections for Puerto Rico and the U.S. Caribbean region. The framework provides a unique opportunity to advance knowledge about climate change impacts on island ecosystems in the global tropics. The resulting simulations fill a critical need for climate change information in Puerto Rico and the broader U.S. Caribbean by enabling future estimates of likely deviations from known ranges of species' thermal/moisture optima. This work furthers scientific understanding of local responses to global climate change and provides a basis for a robust decision-making approach to climate adaptation in the Caribbean LCC.

Investigators: Adam Terando, SE CSC, and Jaime Collazo, USGS NC Coop Unit **Collaborators:** UNC-CH, USFS, FL State Univ, CLCC **Duration:** Sep 2013 - Sep 2016 **Funding:** \$464,500

> bit.ly/CaribDownscaling

4

DOWNSCALING CLIMATE PROJECTIONS TO UNDERSTAND FUTURE TEMPERATURE AND PRECIPITATION PATTERNS IN THE SOUTHEAST



Climate projections at usable scales help inform climate impacts and adaptation strategies.

Researchers generated a series of datasets that provide projections of climate change at appropriate spatial scales to directly address specific management questions. These climate change projections are the result of statistically downscaling output from global climate models used in the Intergovernmental Panel on Climate Change Assessment Report 5. The datasets include not only daily temperature and precipitation, but other variables such as surface winds, humidity, and solar radiation that are needed in hydrologic and ecological modeling. Two products that cover the continental United States, one at a 4-km resolution and the other at a 6-km resolution, have been completed. This project also assessed how well the global climate models reproduce the Southeast's 20th century climate.

Investigators: Phil Mote, OR State Univ, and John Abatzoglou, Univ of ID **Duration:** Sep 2013 - Oct 2014 **Funding:** \$37,000

> bit.ly/CMIP5DownscalingSE

5

DEVELOPING LONG-TERM URBANIZATION SCENARIOS AS PART OF SOUTHEAST REGIONAL ASSESSMENT PROJECT



Regional modeling projects future changes in region due to urbanization, an important global change process that influences conservation decisions.

The southeastern U.S. spans a broad range of physiographic settings and has exceptionally high levels of faunal diversity, but many of these ecosystems are increasingly under threat due to rapid human development and climate change. Traditional urban growth models are very localized and data-intensive and lack the capability to be applied across large regions. Researchers modified the model framework and calibrations of the USGS SLEUTH urban growth model to develop urbanization scenarios as part of the Southeast Regional Assessment Project. This multi-phase project effort developed long-term urbanization modeling for the South Atlantic, Gulf Coastal Plains and Ozarks, and Appalachian LCCs, then extended modeling into the footprint of the Caribbean LCC.

Investigator: Jaime Collazo, USGS NC Coop Unit **Collaborators:** NCSU, USGS **Duration:** Jul 2011 - Sep 2014 **Funding:** \$98,000

> bit.ly/CaribbeanUrbanization

6

EVALUATING THE USE OF MODELS FOR PROJECTING FUTURE WATER FLOW IN THE SOUTHEAST



Evaluation of seven hydrological models shows that more local-scale calibration predicts streamflow better than simple regional models.

Assessing the impact of flow alteration on aquatic ecosystems has been identified as a critical area of research nationally and in the Southeast. This project produced a synthesis and evaluation of seven hydrologic models in the southeastern region of the U.S., including all states of the Southeastern Association of Fish and Wildlife Agencies and Puerto Rico. It provides Landscape Conservation Cooperatives and other resource managers with a useful database of who is doing what, where, how, and how well in terms of hydrological modeling for global change impact studies across the Southeast.

Investigators: Jonathan Kennen, USGS NJ Water Science Center, and Stacy Nelson, NCSU **Collaborators:** USFS, CLCC, GCPO LCC, GCP LCC, PFLCC, SALCC **Duration:** Jun 2012 - Jul 2013 **Funding:** \$45,000

> bit.ly/SEHydroModeling

7

EVALUATING DOWNSCALED CLIMATE MODELS FOR PROJECTING FUTURE CHANGES IN THE SOUTHEAST



Many downscaled climate models exist using different methods, accuracy, & confidence for impact & adaptation analysis. Guidelines on best practices are included.

To better assess how climate change could affect multiple sectors, including ecosystems, climatologists have created several climate projections that contain information from global climate models translated to regional or local scales. The goals of this project were to assess the needs of ecologists in the Southeast for downscaled climate projections, synthesize the information available, and evaluate a selection of downscaled climate projections based upon the needs of the ecological community in the Southeast. The project produced a guide that provides scientific information and guidance to enable resource managers and others to make science-based climate change adaptation decisions. Web-based decision tools guiding downscaled product selection were also developed.

Investigators: Ryan Boyles and Adrienne Wootten, NCSU **Collaborators:** USGS, FL State Univ **Duration:** Aug 2012 - Dec 2013 **Funding:** \$45,000

> bit.ly/DownscalingSynthesis

8

ASSESSING CLIMATE-SENSITIVE ECOSYSTEMS IN THE SOUTHEASTERN UNITED STATES



For 12 SE US ecosystems analyzed for climate vulnerability, 5 are highly & 6 are moderately vulnerable. Strategies for management were developed.

The Southeast contains a unique diversity of ecosystems that provide important benefits such as habitat for wildlife and plants, water quality, and recreation. Researchers assessed climate change vulnerability for twelve ecosystems in the southeastern U.S. and Caribbean by synthesizing data and literature related to three components of vulnerability: climate sensitivity, climate change exposure, and adaptive capacity. A qualitative vulnerability rating for each ecosystem was developed and critical management actions for reducing the vulnerability of each ecosystem were identified. Of the twelve ecosystems assessed, five were rated as having high vulnerability, six had moderate vulnerability, and one had low vulnerability.

Investigators: Jaime Collazo and Bill Wolfe, USGS **Collaborators:** ApplCC, CLCC, GCPO LCC, GCP LCC, PFLCC, SALCC, NatureServe, NCSU **Duration:** Jul 2012 - Dec 2013 **Funding:** \$100,000

> bit.ly/VulnerableEcosystems

Actionable Science

9

PROVIDING SCIENCE FOR THE CONSERVATION OF ANIMALS IN THE SOUTHEASTERN LONG-LEAF PINE ECOSYSTEM



Range-wide models and partnerships will inform conservation actions for at-risk amphibian and reptile species in the longleaf system.

The longleaf pine ecosystem supports several animal species that are a priority for review to determine if they are threatened or endangered due to losses or changes in habitat. These include the gopher tortoise, striped newt, gopher frog, southern hognose snake, and Florida pine snake. This project involves collaborations with other partners conducting species assessments to identify conservation actions expected to improve the status of these five at-risk species across their range. Using input from this partner network, models will link the status of each species with features of the landscape to produce range-wide models of species status across jurisdictions.

Investigator: Clinton Moore, USGS GA Coop Unit **Collaborators:** USFWS, NPS, USFS, DoD, SEAFWA, PFLCC, SALCC, UGA **Co-sponsors:** NRCS, GCPO LCC **Duration:** Aug 2016 - Jul 2018 **Funding:** \$50,000

> bit.ly/LongleafAtRiskSpecies

10

CLIMATE CHANGE IMPLICATIONS FOR THE CONSERVATION OF AMPHIBIANS IN TROPICAL ENVIRONMENTS



Research assesses eco-physiological limits & adaptive capacity of 3 endangered frog species. Decision framework will aid conservation strategies.

Investigators are collecting occupancy data for several amphibian species to quantify the effects of climate on the distribution and persistence of several amphibian species and to serve as ecological input for an optimal decision-making framework for a habitat conservation strategy that ensures the long-term persistence of amphibians and reptiles in Puerto Rico in the advent of downscaled climate projections, this work will increase understanding of the level of dependence and key uncertainties between climate (particularly moisture-related variables) and the distribution and persistence of species of conservation concern.

Investigator: Jaime Collazo, USGS NC Coop Unit **Collaborators:** NCSU, UNC-CH, CLCC, PRDENR; Univ of PR **Duration:** Mon 2015 - Aug 2019 **Funding:** \$140,000

> bit.ly/TropicalAmphibianConservation

11

CONSEQUENCES OF URBANIZATION AND CLIMATE CHANGE ON HUMAN AND ECOSYSTEM HEALTH



Urban trees can tell us a lot about future forest health. Insect response to warming is more variable in southern cities.

This project will investigate how tree selection at the local scale affects biodiversity and ecosystem services. Expanding to the regional scale, the study will determine the extent to which trees in cities can be used to predict heat-related threats to rural forests. Ongoing investigations of heat-related stress and pest outbreaks in urban and rural forests will provide management recommendations. Specific goals are to: 1) determine tree (and arthropod) characteristics that affect tree-dependent biodiversity, tree herbivory, and resilience of both trees and biodiversity to warming; and 2) understand how urbanization (and heat) influences pest populations in order to predict future distributions of pests (and loss of biodiversity) in natural forests.

Investigators: Steve Frank and Rob Dunn, NCSU **Collaborators:** SALCC **Duration:** Sep 2015 - Aug 2018 **Funding:** \$375,000

> bit.ly/UrbanizationConsequences

12

FORESTS OF THE FUTURE: INTEGRATED ASSESSMENT OF CLIMATE CHANGE & ECOSYSTEM DIVERSITY



Long-term forest warming enables integrated study of climate change impacts on insect & soil microbial communities & ecological processes.

Estimates of extinction rates and population losses attributable to climate change are often based on modeled biogeographic distributions, which rely on simple relationships between present-day distributions of species and climate variables to estimate distributions of species under future climate. Remarkably few experimental manipulations of the effects of changes in climate, and in particular temperature, have been conducted on animal populations and communities or on ecological processes dependent on their dynamics. This work built upon the longest-running, largest-scale forest warming experiment in the world to synthetically consider the effects of warming on diverse taxonomic and functional groups, from fungi and bacteria to herbivores and plant pathogens.

Investigator: Rob Dunn, NCSU **Collaborators:** USGS, SE CSC, NPS, SALCC **Duration:** Mon 2014 - Sep 2017 **Funding:** \$85,000

> bit.ly/FutureForests

13

TREE EATERS: PREDICTING THE RESPONSE OF HERBIVORES TO THE INTEGRATED EFFECTS OF URBAN AND GLOBAL CHANGE



Cities can be sentinels of climate change. Urban warming and drought stress combine to increase abundance of some pests.

This multi-phase project used urban warming as a proxy for global warming to develop predictive models of how warming influences beneficial and pest insects for cities in the Southeast and across the east coast more generally. The investigators were also able to predict how tree health will respond to these changes in insect communities. Comparing project results to those garnered from herbarium specimens (many insects can be found on herbarium specimens) showed that the effects of urban warming match those of climate change through time. A second body of work built on these discoveries to consider how to protect trees and forests from the pests that do better with warming.

Investigators: Rob Dunn and Steve Frank, NCSU **Collaborators:** SALCC **Duration:** Jun 2011 - Sep 2015 **Funding:** \$310,000

> bit.ly/TreeEaters
> bit.ly/ClimateChangeWildlife

14

ECOLOGICAL IMPLICATIONS OF MANGROVE FOREST MIGRATION IN THE SOUTHEASTERN U.S.



Warmer winters will transform coastal wetland ecosystems: mangrove forests (trees) will expand northward and replace salt marshes (grasses).

Coastal wetlands purify water, protect coastal communities from storms, sequester (store) carbon, and provide habitat for fish and wildlife; they are also vulnerable to climate change. Changes in winter climate (warmer temperatures and fewer freeze events) may transform coastal wetlands in the northern Gulf of Mexico, as mangrove forests are expected to expand their range and replace salt marshes. This research specifically investigated the impact of mangrove forest migration on coastal wetland soil processes. Results indicate that mangrove forest expansion will bring about both above- and below-ground ecosystem changes. The most striking and apparent changes will occur above ground as forests develop and replace grasslands.

Investigator: Michael Osland, USGS WARC **Collaborators:** USGS, Univ of LA, GCPO LCC **Duration:** Sep 2012 - Sep 2014 **Funding:** \$272,000

> bit.ly/MangroveMigration

15

THE VULNERABILITY OF SEA TURTLE NESTING BEACHES TO CLIMATE CHANGE IN THE SOUTHEAST



Comparisons of historical sea turtle nesting habitats with projected changes in beaches give managers guidance for conserving vulnerable turtles.

This project assessed the vulnerability of key sea turtle nesting beaches to climate change in the Southeast. Researchers examined previous records of sea turtle nesting locations in the Southeast to identify the characteristics of these beaches, then predicted the future suitability of these beaches for nesting based on projected climate change. Identifying locations where beach habitat will no longer be suitable for nesting will help managers determine what action needs to be taken to protect loggerheads. Some of the nesting beaches used by loggerheads are also used by other endangered sea turtles, such as the Kemp's ridley, green, and leatherback sea turtles. Therefore, this project provides information for multiple species of national conservation concern.

Investigator: Kristen Hart, USGS **Collaborators:** USGS, Univ of FL **Duration:** Jul 2011 - Apr 2014 **Funding:** \$150,000

> bit.ly/SeaTurtleNestVulnerability

16

IMPACT OF OCEAN WARMING AND ACIDIFICATION ON GROWTH OF REEF-BUILDING CORALS



Growth patterns in coral skeletons, much like growth rings in trees, can serve as important archives for the reconstruction of past ocean conditions.

Coral reefs are some of the most biologically rich and economically valuable ecosystems in the world. This study identified differences in climate vulnerability among three important reef-building coral species. Coral cores were used to examine variability in ocean temperature and coral growth over the past century. The work was a part of a larger effort to investigate the response of corals to changing ocean conditions in the Florida/Caribbean region and inform resource management decisions regarding reef restoration and species protection policies.

Investigator: Ilsa Kuffner, USGS **Duration:** Jul 2011 - Jan 2013 **Funding:** \$250,000

> bit.ly/CoralClimateVulnerability

Actionable Science

17

TURNING THE SCIENCE OF CONNECTIVITY INTO ACTION: FINDING MODEL CONSISTENCY AND IDENTIFYING PRIORITY HABITATS FOR CONSERVATION



Future connectivity in the Southeast will decrease, and outlining priorities and trade-offs for conservation and management responses is key.

Maintaining connectivity between habitats and wildlife populations will be a key management strategy for conserving biodiversity in the Southeast into the future. This multi-phase project will assess which connections are most important for management actions in the face of climate change. This will build on the first phase, which modeled and mapped connectivity for three animals that inhabit bottomland forests, and showed key connections in the landscape both currently and in the future. New work will assess trade-offs between current and future connectivity and extend work on the prioritization of core habitat areas and central points of connectivity.

Investigator: Nick Haddad, NCSU
Collaborators: SALCC, PFLCC, GCPO LCC, AppLCC **Duration:** Sep 2012 - Jun 2017 **Funding:** \$370,000

> bit.ly/ConnectivityScience

18

IDENTIFYING CONSERVATION OBJECTIVES FOR THE GULF COAST HABITATS OF THE BLACK SKIMMER AND GULL-BILLED TERN



Models will derive conservation objectives for Black Skimmer and Gull-billed Tern, which typify sustainable gulf habitats & other at-risk birds.

This research, part of a large regional project, focuses on the Black Skimmer and Gull-billed Tern, two species identified as representative of sustainable gulf habitats and designated as USFWS Species of Conservation Concern and Gulf Coast Joint Venture Priority Species. They are also characteristic of a variety of other beach and barrier-island nesting birds whose nesting habitats are threatened by sea-level rise. Statistical models will link each bird's population abundance to habitat characteristics that could be influenced by different management actions and will use this information to identify conservation objectives under different conservation scenarios.

Investigator: James Cronin, USGS WARC **Collaborators:** GCPO LCC, GCP LCC, PFLCC, SALCC, SC CSC, USFWS, GCJV **Duration:** Oct 2016 - Sep 2018 **Funding:** \$30,000

> bit.ly/BlackSkimmerHabitat

19

ENHANCING THE CAPACITY OF COASTAL WETLANDS TO ADAPT TO SEA-LEVEL RISE AND COASTAL DEVELOPMENT



In response to sea-level rise, coastal wetlands will migrate landward at the expense of upslope and upriver ecosystems.

This project builds on a recent study that identified areas where coastal wetlands may adapt via landward migration along the northern Gulf of Mexico coast, one of the most sea-level-rise-sensitive and wetland-rich regions of the world. This project will produce customized landscape conservation-design products focused on landward migration corridors for coastal wetlands, providing scientific information that can be used by environmental managers to enhance the adaptive capacity of coastal wetlands in the face of sea-level rise and coastal development.

Investigator: Michael Osland, USGS WARC **Collaborators:** GCPO LCC, GCP LCC, PFLCC, SALCC, SC CSC **Duration:** Apr 2016 - Mar 2018 **Funding:** \$30,000

> bit.ly/CoastalWetlandMigration

20

CLIMATE CHANGE ADAPTATION FOR COASTAL NATIONAL WILDLIFE REFUGES



Collaborative engagement will address complex social, economic, and ecological impacts of global change in coastal South Carolina.

This multi-phase project partners with the South Carolina Low-Country Wildlife Refuge Complex to engage local communities, agencies, and organizations in understanding shared values and interests, strategies to adapt to current and future changes, and areas of collaboration or conflict. Project goals are: 1) produce state-of-the-art science that is useful for those working to protect coastal resources in South Carolina; 2) collectively describe plausible futures that can identify robust adaptation strategies and serve as a basis for communication among diverse stakeholders; and 3) foster greater understanding and collaborative decision making among those that benefit from and value Cape Romain and surrounding area. The first phase of the project developed a prototype decision framework.

Investigators: Mitchell Eaton, SE CSC; Fred Johnson and Julien Martin, USGS WARC **Collaborators:** USFWS, USGS, NCSU, NE CSC, DJ Case, MBL **Duration:** Oct 2013 - July 2018 **Funding:** \$1,307,000

> bit.ly/CoastalRefugeDesign

21

PROTECTING CULTURAL RESOURCES IN THE FACE OF CLIMATE CHANGE



Framework for making robust decisions about protecting threatened cultural resources is being developed at Cape Lookout, with plans to expand.

Climate change is challenging the long-term persistence of many cultural resources. For example, those located in coastal areas, such as historic lighthouses, are threatened by sea-level rise, shoreline erosion, and more frequent severe storm events. To address the critical gap, to identify the impacts of climate change on cultural resources, researchers are developing a strategy to aid decision makers in climate adaptation planning efforts. The strategy integrates assessments of the relative significance of specific cultural resources and their vulnerability to climate change. The strategy will be pilot tested with a subset of buildings listed on the National Historic Register at Cape Look National Seashore, located on North Carolina's barrier islands.

Investigator: Erin Seekamp, NCSU
Collaborators: SE CSC, NPS, SALCC
Duration: Aug 2015 - Sep 2017
Funding: \$135,000

> bit.ly/CulturalResourceAdaptation

22

VITAL FUTURES: CONSERVATION ADAPTATION PLANNING FOR LANDSCAPE AND CLIMATE CHANGE IN THE SOUTHEAST



Regional conservation adaptation planning will be facilitated by coordination of climate-aligned goals, strategies, and principles of partners.

This project will support the efforts of the Southeast Conservation Adaptation Strategy, which aims to develop a collaborative network of conservation partners, shared conservation goals, and regional strategies to manage fish, wildlife, and other natural resources into the future. To help accomplish these goals, the project team will evaluate existing conservation plans and expected land and climate change impacts, and in collaboration with the Southeast conservation community, identify opportunities to incorporate landscape and climate change considerations into state and regional conservation actions.

Investigators: Kirstin Dow, Univ of SC; Bruce Stein, NWF **Collaborators:** GCPO LCC, GCP LCC, PFLCC, SALCC
Duration: Sep 2015 - Sep 2018
Funding: \$983,000

> bit.ly/VitalFutures

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DYNAMIC RESERVE DESIGN IN THE FACE OF CLIMATE CHANGE AND URBANIZATION



Guidance was developed to optimize the acquisition of lands to meet reserve objectives in the face of dynamic urbanization and growth.

Reserve design is a process that must address ecological, social, and political factors to identify parcels of land in need of protection to sustain wildlife populations and other natural resources. Making land acquisition choices is challenging because it occurs over a long time-frame and involves consideration of future conditions such as climate and urbanization changes. The Everglades Headwaters National Wildlife Refuge hosts several threatened and endangered species and habitats. This study combined a structured decision making framework, optimal solution theory, and forecasts of population growth from urbanization models to design optimal configurations for the refuge and to guide land acquisition prioritization.

Investigator: Stephanie Romañach, USGS WARC **Collaborators:** USGS, Univ of FL, USFWS **Duration:** Sep 2013 - Aug 2015 **Funding:** \$286,000

> bit.ly/DynamicReserveDesign

24

DEVELOPING A CONSERVATION DECISION GUIDANCE LIBRARY FOR SOUTHEAST CONSERVATION ADAPTATION STRATEGY



Longleaf pine management plans need better development of action and implementation protocols and improved decision problem definition methods.

A priority of the Southeast CSC is to support the planning and implementation of Southeast Conservation Adaptation Strategy. This project examined the decision-making context, decision-making process, and management planning associated with the restoration of open pine ecosystems in the Southeast. The quality of 35 management plans from federal, state, and NGOs were evaluated along with results of manager interviews. Newer plans were better than older ones. Researchers also developed a questionnaire that may be used in future research projects to evaluate how socio-structural drivers and personalities of decision makers influence their decision making.

Investigators: Nils Peterson and Fred Cubbage, NCSU **Collaborators:** GCPO LCC, SALCC **Duration:** Feb 2013 - Jun 2015 **Funding:** \$76,000

> bit.ly/ConsDecisionLibrary

Actionable Science

25

STRUCTURED DECISION MAKING AS A TOOL FOR COASTAL RESTORATION: A CASE STUDY ON SHIP ISLAND, MISSISSIPPI



Barrier island restoration project was used to develop a decision-making framework that can be expanded to other coastal adaptation projects.

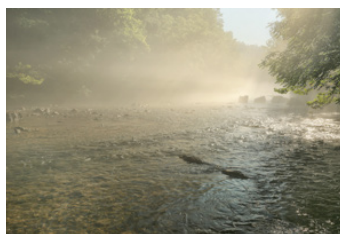
Under the Mississippi Coastal Improvements Program, the US Army Corps of Engineers will place up to 22 million cubic yards of sand to restore the physical integrity of Ship Island. Researchers solicited input from project stakeholders, scientists, and engineers and incorporated this information, along with modeling and quantitative analysis, into a framework to inform decision making, should the island incur storm damage while the restoration is underway. This structured decision-making process yielded management recommendations that can be quickly and effectively implemented, while helping participants maximize the island's future resilience. It also led to a general decision framework and process that can be expanded and adapted for other barrier island and coastal restoration projects.

Investigator: Greg Steyer, USGS WARC
Collaborators: GCPO LCC **Duration:** Jun 2013 - May 2015 **Funding:** \$113,000

> bit.ly/BarrierIslandSDM

26

TURNING UNCERTAINTY INTO USEFUL INFORMATION FOR CONSERVATION DECISIONS



Project synthesizes information about and guidance for communicating and using uncertainty in making conservation decisions.

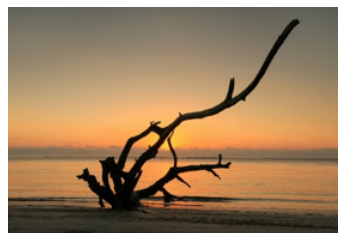
One of the most pervasive problems facing natural resource managers and science communicators is the existence of numerous social and ecological uncertainties. The objective of this project was to help facilitate strategic decision support and synthesize the state of the science related to communicating and using uncertain information in conservation decision making. This tool was developed through interdisciplinary interactions and a comprehensive literature review with a focus on climate change in the southeastern U.S. Researchers produced a fact sheet that discusses the pervasiveness of uncertainty, the importance of understanding varying perceptions of uncertainty, and avenues for progress in the presence of uncertainty and differing risk tolerances.

Investigators: Brian Irwin, USGS GA Coop Unit **Collaborators:** MI State Univ, USGS, GCPO LCC, PFLCC, SALCC **Duration:** Aug 2012 - Jun 2016 **Funding:** \$40,000

> bit.ly/DecisionUncertainty

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A HANDBOOK FOR RESOURCE MANAGERS TO UNDERSTAND AND UTILIZE SEA-LEVEL RISE AND COASTAL WETLAND MODELS



Coastal managers and planners will appreciate this condensed resource guide of sea-level rise science and models for predicting impacts on coastal ecosystems.

The goal of this project was to collate science and models pertaining to the effects of sea level on coastal wetlands into a format that would be accessible and useful to resource managers. Researchers conducted training sessions with coastal managers at federal agencies to evaluate managers' needs and understanding of concepts, data, and modeling tools for projecting sea-level rise and its impact on coastal habitats and wildlife. Based on this feedback, researchers developed a handbook summarizing existing information and tools and their respective characteristics, uses, and limitations. The resulting handbook provides a user-friendly guide to understanding the current state of knowledge and tools suitable for managing coastal wetlands.

Investigator: Thomas Doyle, USGS WARC **Collaborators:** NOAA, NPS **Duration:** May 2012 - Mar 2015 **Funding:** \$50,000

> bit.ly/SLRModelHandbook

28

SCIENCE TO SUPPORT ADAPTIVE LANDSCAPE PLANNING AND DECISION MAKING FOR GOPHER TORTOISE CONSERVATION



Statewide tortoise population will be supported by decision support tool to efficiently guide conservation actions and reserve design.

The goal of this project is to develop a decision support system for the iterative selection of conservation actions that leads to a viable landscape supporting the statewide gopher tortoise population and associated species and communities of interest. This work will result in an integrated system of databases, computer algorithms, and monitoring designs that provides a mostly automated process for decision making under uncertainty and for acquiring information to reduce uncertainty. Researchers will incorporate elements of the structured decision-making process around predictive models of habitat suitability and population connectivity to guide the design of conservation reserves that promote persistence of the tortoise within Georgia.

Investigator: Clinton Moore, USGS GA Coop Unit **Collaborators:** GA DNR, UGA, FL FWC, AL DCNR, USFWS, Jones Center **Duration:** Sep 2013 - Jun 2018 **Funding:** \$352,000

> bit.ly/GopherTortoiseCons

Consulting Activities

GULF OF MEXICO AVIAN MONITORING NETWORK

Mitch Eaton facilitated development of a Structured Decision Making framework to identify a set of agreed-upon core values and fundamental objectives among conservation partners representing >20 agencies and organizations. Global Change Fellow Michael Just assisted in the project, which will underpin avian monitoring needs in the Gulf of Mexico.

> bit.ly/GOMAvianMonitoring

CLIMATE VOYAGER

SE CSC consulted with NC State Climate Office to develop this suite of tools designed to inform decision making related to agriculture, land management, and other long-term planning purposes. The tools in Climate Voyager use climate model projections to show the range of possible future outcomes for various climate features that can affect the growth and viability of plants, animals, and humans.

> bit.ly/ClimateVoyager

Organization Abbreviations

AL DCNR = Alabama Department of Conservation and Natural Resources

AppLCC = Appalachian Landscape Conservation Cooperative

CLCC = Caribbean Landscape Conservation Cooperative

Coop Unit = Cooperative Fish and Wildlife Research Unit

DoD = US Department of Defense

FL FWC = Florida Fish and Wildlife Commission

FL State Univ = Florida State University

GA DNR = Georgia Department of Natural Resources

GCJV = Gulf Coast Joint Venture

GCP LCC = Gulf Coast Prairie Landscape Conservation Cooperative

GCPO LCC = Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative

MBL = Marine Biological Laboratory

MI State Univ = Michigan State University

NCSU = North Carolina State University

NE CSC = Northeast Climate Science Center

NPS = National Park Service

NRCS = Natural Resources Conservation Service

NWF = National Wildlife Federation

OR State Univ = Oregon State University

PFLCC = Peninsular Florida Landscape Conservation Cooperative

PRDNER = Puerto Rico Department of Natural and Environmental Resources

SALCC = South Atlantic Landscape Conservation Cooperative

SC CSC = South Central Climate Science Center

SEAFWA = Southeastern Association of Fish and Wildlife Agencies

UGA = University of Georgia

UNC-CH = University of North Carolina at Chapel Hill

Univ of FL = University of Florida

Univ of LA = University of Louisiana at Lafayette

Univ of ID = University of Idaho

Univ of PR = University of Puerto Rico

Univ of SC = University of South Carolina

USFS = US Forest Service

USFWS = US Fish and Wildlife Service

USGS = US Geological Survey

WARC = Wetland and Aquatic Research Center

Partnerships

HOW WE BUILD COLLABORATIONS AND PARTNERSHIPS

- Initial development of a Partner website and introductory Story Map for Tribes & Indigenous Peoples in our region.
- Distribute monthly Newsletters with information about SE CSC and partner news, upcoming events, and relevant publications.
- Coordinate with regional partners at monthly Triangle Land Use and Climate Researcher Brown Bags and regional coordination calls.
- Provide connections and support to facilitate SE CSC principal investigators in engaging stakeholders in co-developing science.

PARTNERSHIP SPOTLIGHT

A research team led by Clint Moore, USGS Georgia Coop Unit, is developing models of range-wide species status – distribution, occupancy, and persistence as they relate to landscape features – for 5 animal species in the longleaf pine ecosystem under review for protection: gopher tortoise, striped newt, gopher frog, southern hognose snake, and Florida pine snake. The project is taking advantage of knowledge and data on these species from a large network of conservation partners across the Southeast, including many of the state and federal partners who will use the models to make conservation decisions. Core partners in the effort are: USFWS, NRCS, NPS, USFS, DoD, SEAFWA (states of AL, FL, GA, MS, NC, SC), SALCC, GCPO LCC, PFLCC. These groups are actively contributing data to the project and participating in workshops to inform model development and outputs. Several other non-profit organizations are contributing supplementary knowledge and perspectives as well as data on species.

The partner network will serve as a mutual resource for sharing knowledge about species, habitats, and management actions, ensuring that management or research initiatives across boundaries are complementary, and promoting robust conservation planning within and across jurisdictions. This collaborative partnership will maximize the co-production of science relevant for listing and management decisions and inform where and how to invest conservation resources in the longleaf system to protect and restore it.

LEARN MORE > bit.ly/LongleafAtRiskSpecies

Capacity Building

How We Are Building Capacity to Conduct, Apply, and Communicate Science

TRIBES:

We assisted the United South and Eastern Tribes (USET) in planning a tribal climate workshop as part of the Bi-Coastal Climate Planning workshops funded by the BIA Climate Program.



“We highly value our partnership with the University and SE CSC, and the tremendous resources provided by their staff in climate science education, insightful research, and innovative assessment tools and decision-making guides, for climate change adaptation planning.”

– JERRY PARDILLA, UNITED SOUTH AND EASTERN TRIBES

MEDIA PROFESSIONALS:

We partnered with NC Coastal Federation, Climate Central, and Climate Communication to hold a Climate and Coastal Impacts Workshop for Media Professionals.

> bit.ly/ClimateChangeforMedia

GRADUATE STUDENTS:

Our Global Change Fellows Program trains the next generation of global change scientists by providing financial, scientific, and professional development support for multi-disciplinary graduate students.

TRAINING IN COMMUNICATIONS

- Science videomaking principles and methods
- Science communication workshops (also open to external partners)

TRAINING IN STRUCTURED DECISION MAKING

- Applied decision science workshops at National Conservation Training Center (NCTC)
- Management decision case studies as part of seminar coursework

TRAINING IN CLIMATE SCIENCE, ECOSYSTEM VULNERABILITY, AND ADAPTATION

- Climate Adaptation and Conservation Biology seminar course
- Global Change Seminar Series

> bit.ly/GlobalChangeSeminar

PROFESSIONAL DEVELOPMENT OPPORTUNITIES

- Structured decision project internships & NCTC coach assistantships
- Climate Boot Camp & National CSC Student and Early Career Training
- Practitioner Career Path Panel with federal and university scientists

“We need two primary things: ready access to experts in climate science who can help us directly incorporate climate data and modeling into analyses that inform decision making and message training on how to talk productively about these topics with our staff, partners, and the public. We need thoughtful analysis and communication that focuses the discussion on likely impacts and appropriate management responses.”

– DR. THOMAS EASON, FLORIDA FISH & WILDLIFE COMMISSION



Global Change Fellows

To view more information on fellows' research and find out where their paths have taken them, follow their linked name or visit bit.ly/SECSCGlobalChangeFellows

2016-17 FELLOWS

[KARLY BITSURA MESZAROS](#) Parks, Recreation and Tourism Management
[GABRIELLE CORRADINO](#) Marine, Earth, and Atmospheric Sciences
[SHILO FELTON](#) Applied Ecology
[JESSICA KETTENBACH](#) Applied Ecology
[ELSITA KIEKEBUSCH](#) Applied Ecology
[DOMINIC LIBERA](#) Civil Engineering
[LARRY LONG](#) Entomology
[LINDSAY MAUDLIN](#) Marine, Earth, and Atmospheric Sciences
[WILMER REYES](#) Forestry and Environmental Resources
[RYANN ROSSI](#) Applied Ecology
[PAUL TAILLIE](#) Forestry and Environmental Resources

2015-16 FELLOWS

[RACHEL ATKINS](#) Marine, Earth, and Atmospheric Sciences,
[KRISTI BACKE](#) Entomology
[SEAN GIERY](#) Applied Ecology
[GENEVA GRAY](#) Marine, Earth, and Atmospheric Sciences
[ERICA HENRY](#) Applied Ecology
[AMIR MAZROOEI](#) Civil Engineering
[GABRIELLA PARDEE](#) Applied Ecology
[PHIL PATTON](#) Applied Ecology
[GEORGINA SANCHEZ](#) Forestry and Environmental Resources
[MEGAN THOEMMES](#) Applied

Ecology

[RENE VALDEZ](#) Forestry and Environmental Resources
[LAURA VILLEGAS](#) Agricultural and Resource Economics

2014-15 FELLOWS

[ADAM DALE](#) Entomology
[LILIANA VELASQUEZ MONTOYA](#) Civil Engineering
[MICHAELA FOSTER](#) Forestry and Environmental Resources
[NITIN SINGH](#) Forestry and Environmental Resources
[MARKETA ZIMOVA](#) Forestry and Environmental Resources

2013-14 FELLOWS

[CARLOS BOTERO](#) Post-doc, Genetics
[STEVEN GRODSKY](#) Forestry and Environmental Resources
[MICHAEL JUST](#) Plant Biology
[AYSE KARANCI](#) Civil Engineering
[JENNIFER NIEMUTH](#) Veterinary Sciences, Fisheries, Wildlife & Conservation Biology

[KARA SMITH](#) Marine, Earth, and Atmospheric Sciences

[TYSON WEPPRICH](#) Applied Ecology
[DAVID ZIETLOW](#) Forestry and Environmental Resources

2012 - 2013 FELLOWS

[CARLOS BOTERO*](#) Post-doc, Genetics
[LAUREN CHARLES SMITH](#) Veterinary Sciences, Fisheries, Wildlife & Conservation Biology
[SARAH FRITTS*](#) Forestry and Environmental Resources
[STEVE GRODSKY](#) Forestry and Environmental Resources
[ERNEST HAIN*](#) Forestry and Environmental Resources
[GUOFANG MIAO](#) Forestry and Environmental Resources
[JESSICA OSBORNE*](#) Anthropology/ Archaeology
[AARON POTEATE*](#) Anthropology/ Archaeology
[KARA SMITH*](#) Marine, Earth, and Atmospheric Sciences
[ELIZABETH WARREN](#) Anthropology/ Archaeology
[TYSON WEPPRICH*](#) Applied Ecology
[ADRIENNE WOOTTEN](#) Marine, Earth, and Atmospheric Sciences

2011 - 2012 FELLOWS

[NATHAN PUTMAN](#) Post-doc, Marine, Earth, and Atmospheric Sciences
[COREY DAVIS](#) Marine, Earth, and Atmospheric Sciences
[ANGELA HARRIS](#) Anthropology/ Archaeology
[DANIELA MAGDALENA SORGER](#) Biology
[SIYAO ZHANG](#) Forestry and Environmental Resources

**(also funded in 2011-12)*



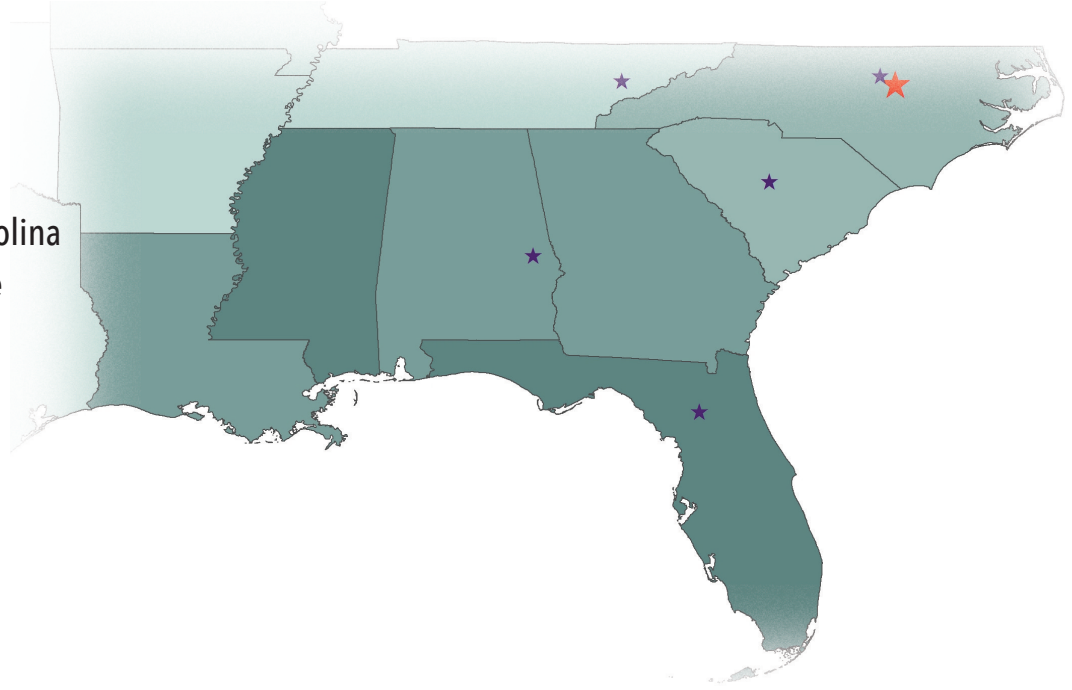
"The fellowship provided many networking opportunities with the SE CSC team, other students, and scientists and practitioners and made me as a student more comfortable interacting with scientiststhese courses provided a foundation of knowledge on decision making and climate change that I've used to frame how I think about resource management challenges in my research."

—GLOBAL CHANGE FELLOW

Looking Ahead

PHOTO BY ALAN CRESSLER, USGS

- ➔ Listening Tours being held in states across the SE CSC region.
- ➔ Launch of new Strategic Plan development and revamped Science Advisory Committee.
- ➔ Anticipating work with new BIA Tribal Liaison for Northeast and Southeast regions.
- ➔ 2017 National Adaptation Forum cross-CSC special session, Teaching Climate Adaptation: Regional Climate Science Center Network Activities on Education and Training.
- ➔ Hiring of two new post doctoral scholars, in partnership with US EPA and with National Park Service.
- ➔ NCSU is excited to continue as lead host institution for Phase Two of the hosting agreement for the Southeast Climate Science Center beginning in 2017. We're engaging new consortium partners:
 - Auburn University
 - Duke University
 - University of Florida
 - University of South Carolina
 - University of Tennessee



NC STATE UNIVERSITY



Get more info and keep up with our work
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