CHAPTER 5

CONSERVATION STRATEGIES AND ACTIONS

5.1. Defining Conservation Actions

THE 2015 SWAP PLANNING TEAM identified statewide conservation action priorities by reviewing the 2005 SWAP strategy hierarchy and the 2006-12 TWRA Nongame and Endangered Species Operational Plan (NGESOP), which was used by TWRA to begin implementation of the 2005 SWAP (TWRA 2006). The 2005 planning team used a standardized hierarchy to organize and define strategies, an approach now recognized as a Best Practice (AFWA 2012). The 2005 hierarchy was adapted from a format available at that time from the Conservation Measures Partnership and consisted of 2 broad categories, 6 major classes, 22 general actions and over 90 specific conservation actions. The Specific Conservation Actions were evaluated for their capacity to abate problems as determined through an expert-derived ranking process (see TWRA 2005, pp. 75-80).

The 2005 strategy ranking information, compiled in the SWAP database, allowed for a general determination of which Specific Actions could be most appropriate to abate problems for terrestrial, aquatic, and subterranean species (see TWRA 2005, pp. 147-178). This ranking system alone, however, did not allow for the identification of geographically specific strategies, as major problems were not mapped during the 2005 effort. The 2006-12 NGESOP took the summary information on strategies in the 2005 SWAP and applied it to identify projects and outcomes for TWRA to achieve across the different ecoregions of the state, organized by the agency's administrative regions. A majority of these projects were successfully implemented during the last

Pogue Wilderness, Cumberland Plateau - Byron Jorjorian

decade, and these experiences gave the 2015 planning team a foundation for understanding the relative applicability and success of various conservation actions in different places across the state.

The 2015 planning team determined that the 2005 strategy hierarchy, including all the General and Specific Actions, remains applicable to GCN statewide conservation efforts moving forward (Appendix G). The team chose to address General and Specific Actions that are most commonly implemented by TWRA in detail in the 2015 SWAP (see Table 15). Several other General Action categories -- particularly formal education and training, conservation finance, conservation enterprises, market forces, institutional improvements, and legislation -- can improve conditions for achieving conservation outcomes on the ground in meaningful ways. These types of enabling actions are successful most often in collaboration with a variety of partners and stakeholders, many times with these external partners in a leadership role. Therefore, the team determined that the specifics of when and how to execute these strategies is best addressed independently by partners or in collaboration with partners when appropriate. All SWAP partners and stakeholders

Summary: 2015 process for identifying and prioritizing conservation strategies and actions to benefit GCN species and habitats

1. Identify statewide conservation action priorities. Referring to the actions identified in both the 2005 SWAP and the 2006-2012 TWRA Nongame and Endangered Species Operational Plan, the SWAP planning team determined that the 2005 strategy hierarchy, including all the General and Specific Actions, remained applicable to GCN statewide conservation efforts.
2. Focus on a subset of the most important actions for addressing major problems identified in Chapter 4. In the 2015 SWAP, the team chose to elaborate in detail on 16 General Actions (in 5 Classes) that are most commonly implemented by TWRA and which address the major problems affecting species of Greatest Conservation Need and their habitats.
3. Define Conservation Opportunity Areas, a new approach in the 2015 update for focusing conservation efforts. The planning team considered three major attributes in designing COAs: GCN habitat priority, the problems affecting the habitats, and on-the-ground opportunities to implement conservation actions. The team stresses that COAs are not intended to artificially constrain decisions about what strategic actions are needed and where they apply.
4. Conduct vulnerability assessments and develop adaptation strategy approaches for GCN species and habitats in Tennessee. This is a new focus in the 2015 SWAP. The planning team identified which goals and strategies of the National Fish, Wildlife, and Plants Conservation Adaptation Strategy best align with TWRA's mission and expertise. The team worked with the National Wildlife Federation (NWF) to complete a "Climate-Smart" vulnerability assessment for Tennessee species and habitats and began the process of identifying the adaptation options for addressing key vulnerabilities.

TWRA's Watchable Wildlife website provides education tools and informas and promotes public engagement in wildlife conservation.

are encouraged to engage in these types of enabling strategies as best fits their organizational mission or individual expertise.

Table 15 provides a summary of the 16 General Actions (in 5 Classes) most commonly implemented by TWRA in a project leadership or funding role to achieve GCN species or habitat conservation outcomes since 2005. Under the General Actions listed in Table 15, the 2015 planning team also selected a total of 41 Specific Actions from the overall hierarchy as those most connected with TWRA's operational mission, capacity, and funding allocations for GCN management and assistance with federally-listed species recovery (Appendix H).

Table 15. Summary of conservation actions generally led and/or funded by TWRA in collaboration with partners to support GCN species and habitat conservation

Class	General Action
Habitat acquisition	Fee-title ownership Permanent protective easements
Information collection and dispersal	Communications and public relations Conservation planning Monitoring Research
Management and restoration of species and habitats	Compatible resource use Conservation area management Control/prevention of invasive exotic species and pathogens Habitat/Natural process restoration Species restoration
Capacity building	Alliances and partnerships
Law and policy	Compliance and enforcement Land use planning and zoning Policies and regulations Standards

The SWAP conservation actions, individually and collectively, will focus on addressing the major problems affecting species of conservation need and their habitats, as outlined in Chapter 4. These problems include addressing impacts from a wide variety of land and water uses; improving habitat quality and quantity; restoring species populations; and management to abate the negative effects of invasive species, pathogens, and climate change.

Successful conservation actions necessarily involve an emphasis on partnerships to achieve

- well-coordinated land and water management planning at a variety of spatial scales (i.e., regional, state, and local);
- effective environmental review and regulatory programs;
- expanded habitat acquisition and management;

- greater incentives for private landowner engagement in conservation;
- and education, research, and monitoring that fosters learning and improves our adaptive management capacity.

5.2. Conservation Opportunity Areas

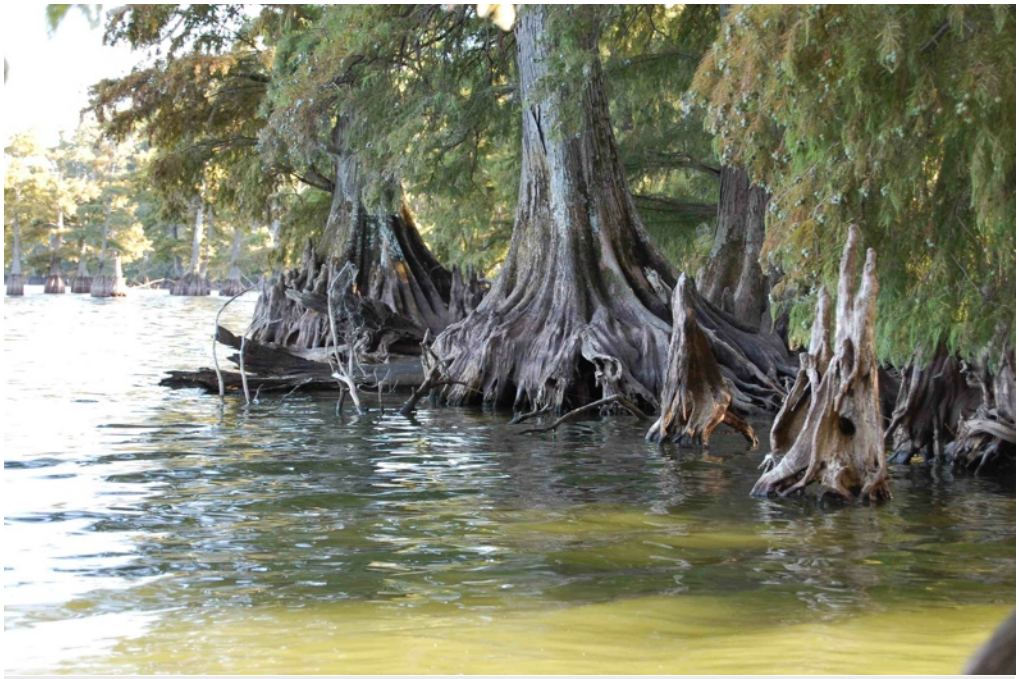
Chapter 3 described the process for updating the SWAP terrestrial, aquatic, and subterranean habitat priorities. These habitat priorities are the most current geographic representation of the lands and waters across the state that are significant for protecting and restoring GCN species populations. Determining where and how to implement conservation actions involves many additional considerations including the problems affecting different places on the ground, the resources available to address the problems, and developing shared outcomes with conservation partners.

5.2.1. Designation Process for Conservation Opportunity Areas

For the 2015 update, the designation of "Conservation Opportunity Areas" (COAs) is a new approach to help focus the conservation efforts, not only of TWRA, but also of a wide range of other agency and nongovernmental partners. The identification of COAs is a recommended best practice for SWAP updates (AFWA 2012).

Unlike the standard lexicon for classifying problems and conservation actions, COA designations vary from state to state and do not follow a specific method. Each state designates COAs in a manner consistent with its data availability, planning process, and priorities.

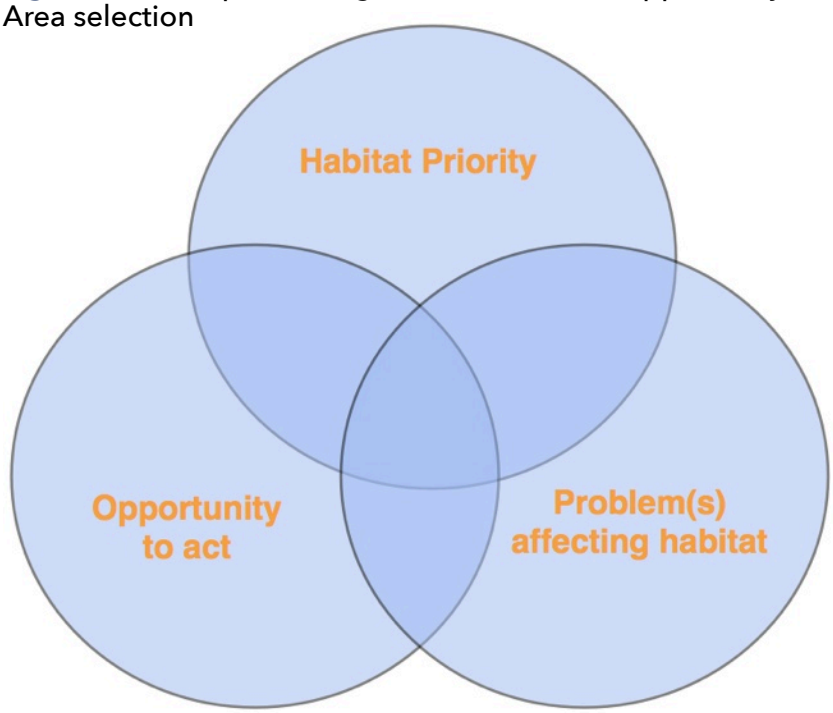
"Spatially depict priority areas on the landscape that offer the best opportunities for GCN conservation and call them Conservation Opportunity Areas (COAs)." - AFWA Best Practices for SWAPs



Reelfoot Lake in west Tennessee, internationally recognized for its wildlife diversity, scenery, and recreational opportunities, is a designated Conservation Opportunity Area. - Rob Colvin, TWRA

While designing the COAs for Tennessee, the planning team considered three major attributes: GCN habitat priority, the problems affecting the habitats, and the on-the-ground opportunities to implement conservation actions (Figure 9). The planning team used the GCN habitat priority maps (see Chapter 3, maps 5.1, 5.2 and 5.3) as the background data for identifying COAs. The boundary outlines of the COAs were then drawn to capture a geographic footprint where one or more conservation actions are needed to address a specific issue (e.g. agricultural best management practices, expanded conservation areas, urban stormwater management, or habitat restoration). The planning team also used expert knowledge on partnerships which are active and working in different areas to inform the boundaries, and capture the list of partners in each Conservation Opportunity Area Summary (see Appendix I).

Figure 9. Conceptual design of Conservation Opportunity Area selection



Several regional and statewide conservation planning efforts have been completed by other agencies since 2005. Many of these agencies collaborated with TWRA and used the 2005 habitat priorities to help inform their designations of significant conservation areas. In designing the COAs, the 2015 SWAP team referenced the following documents:

- Tennessee Heritage Conservation Trust Fund Act of 2005 analysis (TWRA, TDEC and TDA 2006);
- Tennessee Department of Environment and Conservation's **Tennessee 2020** plan (TDEC 2009);
- Tennessee Division of Forestry's **Tennessee Forest Resource Assessment & Strategy** (TDF 2010);
- **TWRA Strategic Plan 2014-2020** (TWRA 2014);
- West Tennessee Resources Conservation Plan (TWRA & USFWS 2004)

The COAs for Tennessee capture populations of GCN species and high quality habitats, and as appropriate, define the geographically relevant framework for achieving conservation outcomes. The COAs currently designed for Tennessee are large geographies, with the expectation that further prioritization and goal setting for specific habitat outcomes can be achieved within them through collaborations with partners on shared objectives. For those COAs containing GCN habitats for which major problems have been mapped (see Chapter 4), this spatial data can also be utilized at different scales to target appropriate conservation actions or interventions in collaboration with partners (see Table 15).

The COA boundary designations do not carry any new legal, regulatory, or jurisdictional authorities, nor do they place any restrictions on land uses or activities occurring within these areas. COAs are intended to foster partnership collaborations, investments and voluntary actions to conserve habitat within a given region of the state. This general approach to COA development is consistent with other states such as Illinois, Missouri, and Pennsylvania.

Another important consideration is that COAs are not intended to be fixed, limiting geographic boundaries. As more projects are designed and executed with partners, changes to the COA designations may be useful to better represent new information or the footprint of a particular project opportunity. In addition, achieving habitat conservation objectives will require adequate consideration of all terrestrial, aquatic, and subterranean priorities regardless of whether they are physically located within a COA boundary at this time. Finally, other wide-ranging collaborations on issues such as maintaining forest health can potentially benefit many different geographies and COAs at once.

Table 16 summarizes the Tennessee COAs within their respective ecoregions, and Map 15 shows the locations of COAs in reference to statewide habitat priorities, while Maps 16-19 show the locations of COAs in relation to public lands and major cities (dividing the state into four sections west to east).

Appendix I provides summary information in the form of a stand-alone factsheet for each Conservation Opportunity Area across the state. This information includes a description of the area, lists of species and habitats, general desired conservation outcomes and associated monitoring strategies, as well as ongoing or proposed conservation partnerships.

Hellbender conservation takes place both within and outside of COAs - Joshua A. Miller

5.2.2. Taking Action Outside of Conservation Opportunity Areas

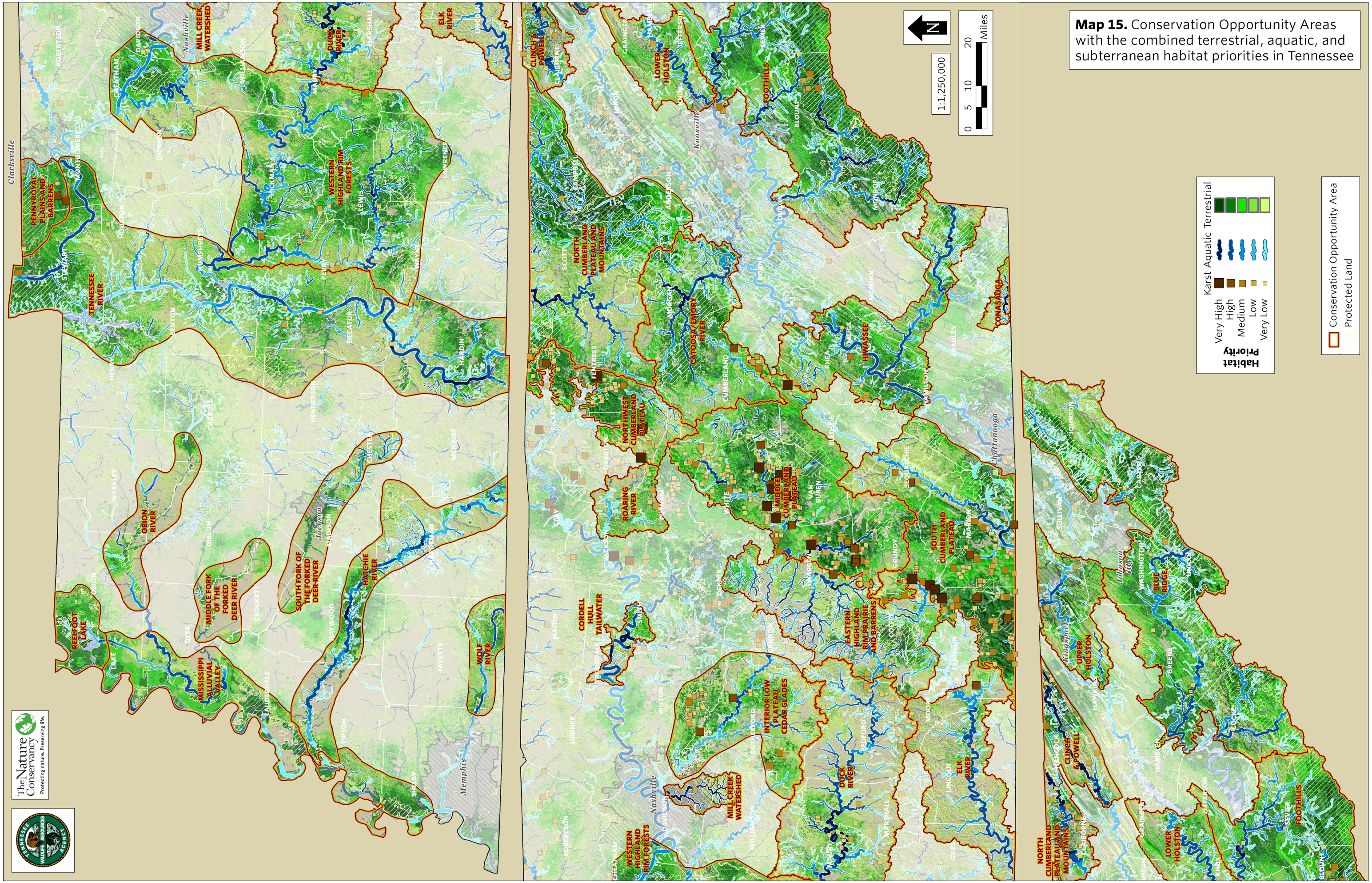
The identification of Conservation Opportunity Areas helps define important geographies across the state where focused collaborations can improve outcomes for GCN species and habitats. However, not all populations of GCN species fall within COAs, and several types of significant conservation actions – such as land use planning, environmental reviews, and research – address issues that affect species and habitats across many different geographies.

Other actions taken outside COA boundaries, such as stream barrier removals or using best practices for stormwater management, can show significant net benefits in both the local project area and for downstream aquatic habitats. Many of Tennessee's existing public lands contain one or more habitat types important

Table 16. Summary of Conservation Opportunity Areas and their location within terrestrial ecoregions and aquatic subregions

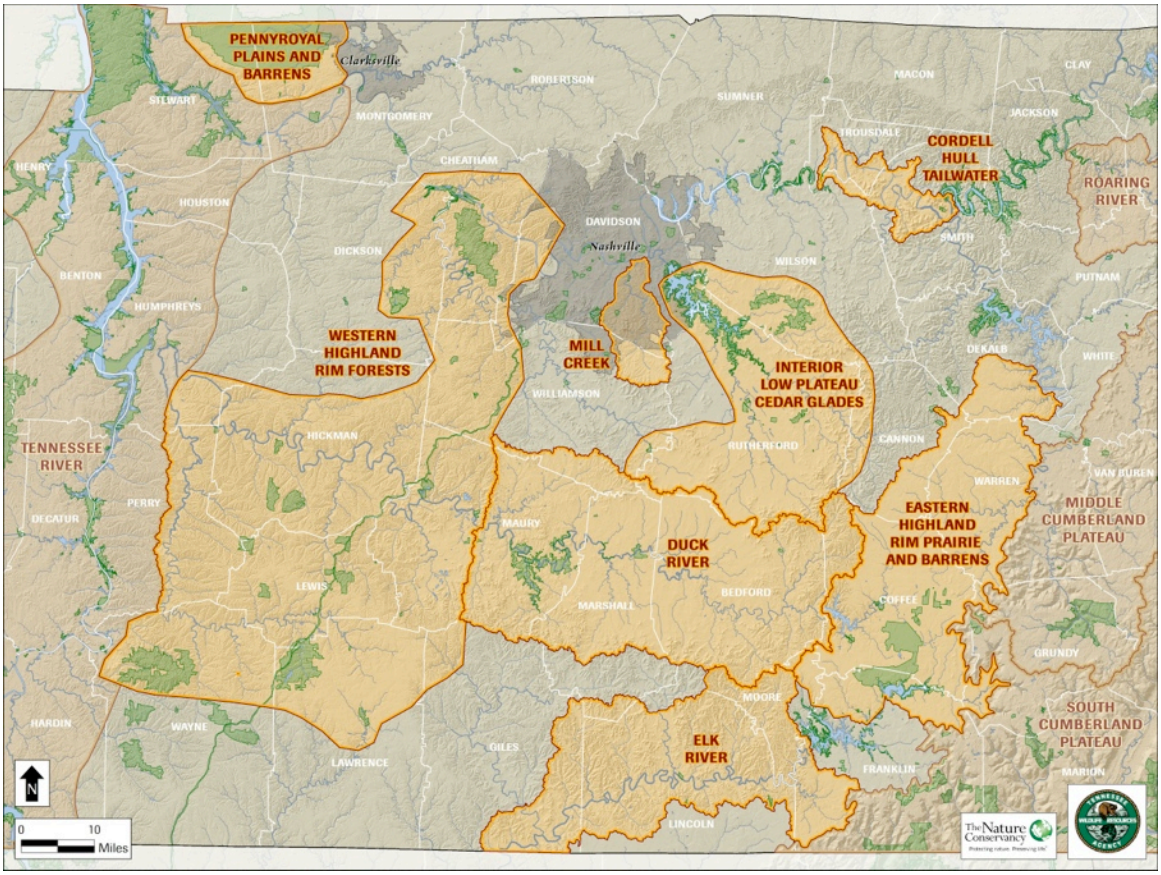
Conservation Opportunity Area	Terrestrial Ecoregion(s)	Aquatic Subregion(s)	Number of GCN species	Acres of very high, high, & medium ranked habitat (natural ecological systems only)	Stream miles of very high, high, and medium ranked habitat
Reelfoot Lake	Mississippi River Alluvial Plain	Mississippi	63	35,884	15
Mississippi Alluvial Valley	Mississippi River Alluvial Plain	Mississippi	77	132,323	117
Obion River	Upper Gulf Coastal Plain	Mississippi	51	33,696	20
Middle Fork of the Forked Deer River	Upper Gulf Coastal Plain	Mississippi	36	23,150	1
South Fork of the Forked Deer River	Upper Gulf Coastal Plain	Mississippi	45	36,352	45
Hatchie River	Upper Gulf Coastal Plain	Mississippi	77	105,444	267
Wolf River	Upper Gulf Coastal Plain	Mississippi	57	19,756	52
Tennessee River	Interior Low Plateau	Lower Tennessee, Lower Cumberland	191	573,176	421
Pennyroyal Plains and Barrens	Interior Low Plateau	Lower Cumberland	111	85,421	2
Western Highland Rim Forests	Interior Low Plateau	Lower Tennessee, Lower Cumberland	162	636,364	626
Mill Creek Watershed	Interior Low Plateau	Cumberland River-Nashville Basin	68	2128	87
Interior Low Plateau Cedar Glades	Interior Low Plateau	Cumberland River-Nashville Basin; Upper Cumberland River	152	116,874	59
Duck River	Interior Low Plateau	Tennessee River-Nashville Basin	148	61,922	278
Elk River	Interior Low Plateau	Tennessee River-Nashville Basin	115	28,552	167
Eastern Highland Rim Prairie and Barrens	Interior Low Plateau	Tennessee River-Nashville Basin; Upper Cumberland River	249	130,721	550
Cordell Hull Tailwater	Interior Low Plateau	Upper Cumberland River	62	22,674	60
Roaring River	Interior Low Plateau	Upper Cumberland River	102	39,154	1

Conservation Opportunity Area	Terrestrial Ecoregion(s)	Aquatic Subregion(s)	Number of GCN species	Acres of very high, high, & medium ranked habitat (natural ecological systems only)	Stream miles of very high, high, and medium ranked habitat
South Cumberland Plateau	Cumberland Plateau & Mountains	Tennessee River-Cumberland Plateau	308	473,060	104
Middle Cumberland Plateau	Cumberland Plateau & Mountains	Tennessee River-Cumberland Plateau; Upper Cumberland River	277	484,626	194
Northwest Cumberland Plateau	Cumberland Plateau & Mountains	Upper Cumberland River	161	204,339	28
Catoosa/Emory River	Cumberland Plateau & Mountains	Tennessee River-Cumberland Plateau	138	312,275	239
Hiwassee	Cumberland Plateau & Mountains, Ridge and Valley	Tennessee River-Blue Ridge; Tennessee River-Cumberland Plateau	172	215,602	237
Conasauga	Ridge & Valley, Southern Blue Ridge	Conasauga River	68	6,547	48
North Cumberland Plateau and Mountains	Cumberland Plateau & Mountains	Cumberland River-Cumberland Mountain; Upper Cumberland River	188	509, 412	445
Clinch and Powell	Ridge & Valley	Tennessee River-Ridge & Valley	138	116,652	211
Upper Holston	Ridge & Valley	Tennessee River-Ridge & Valley	73	81,893	83
Lower Holston	Ridge & Valley	Tennessee River-Ridge & Valley	69	56,682	79
Blue Ridge	Southern Blue Ridge; Ridge & Valley	Tennessee River-Blue Ridge; Tennessee River-Ridge & Valley	231	648,864	262
Foothills	Southern Blue Ridge; Ridge & Valley	Tennessee River-Blue Ridge	202	664,547	411

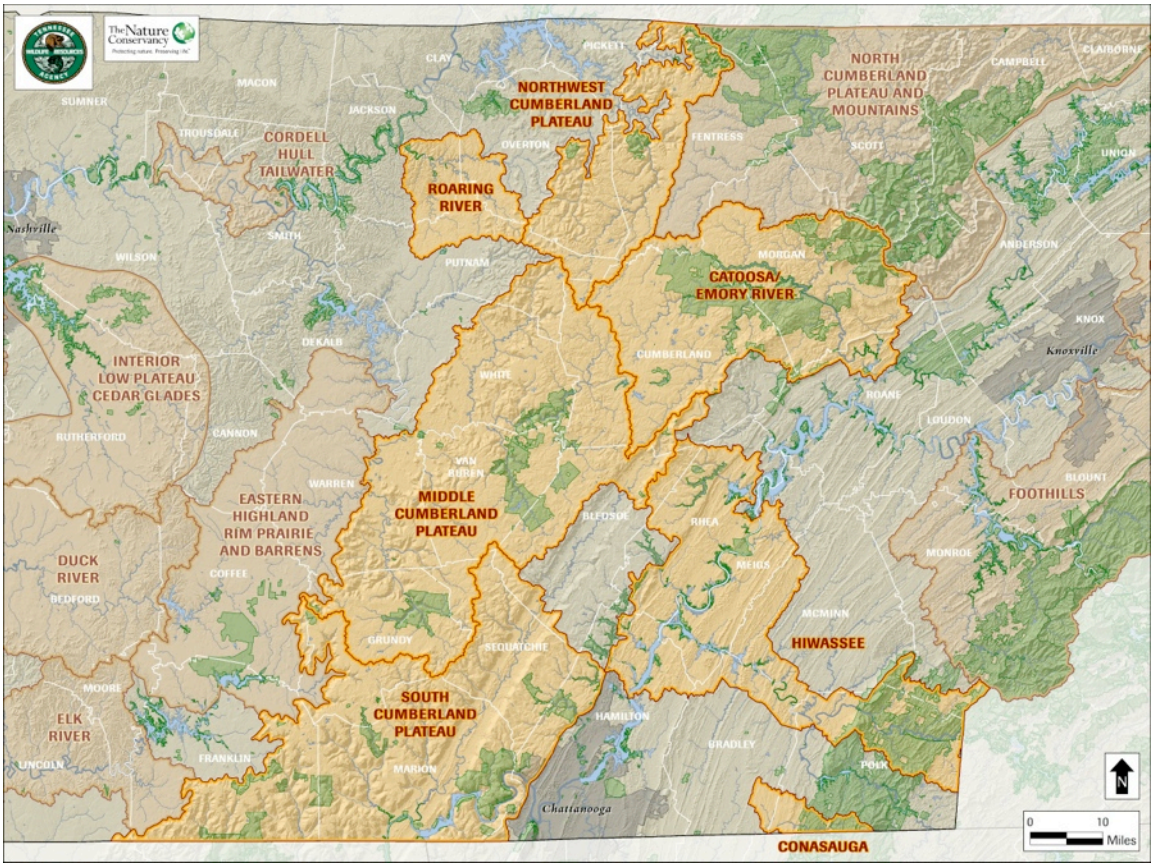

Map 15. Conservation Opportunity Areas with the combined terrestrial, aquatic, and subterranean habitat priorities in Tennessee
N
1:1,250,000
0 5 10 20 Miles
Habitat Priority
Very High
High
Medium
Low
Very Low
Karst Aquatic Terrestrial
Conservation Opportunity Area
Protected Land
The Nature Conservancy
Protecting nature. Preserving life.
TENNESSEE WILDLIFE RESOURCES AGENCY
Clarksville
Nashville
Knoxville
Chattanooga
Kingsport
Jackson
Memphis
PENNYROYAL PLAINS AND BARRENS
TENNESSEE RIVER
MISSISSIPPI ALLUVIAL VALLEY
OBION RIVER
REELFOOT LAKE
MIDDLE FORK OF THE FORKED DEER RIVER
SOUTH FORK OF THE FORKED DEER RIVER
HATCHIE RIVER
WOLF RIVER
WESTERN HIGHLAND RIM FORESTS
MILL CREEK WATERSHED
DUCK RIVER
ELK RIVER
CORDELL HULL TAILWATER
ROARING RIVER
NORTHWEST CUMBERLAND PLATEAU
NORTH CUMBERLAND PLATEAU AND MOUNTAINS
CLINCH & POWELL
CATOOSA & EMORY RIVER
HIWASSEE
CONASAUGA
LOWER HOLSTON
FOOTHILLS
MIDDLE CUMBERLAND PLATEAU
SOUTH CUMBERLAND PLATEAU
EASTERN HIGHLAND RIM PRAIRIE AND BARRENS
INTERIOR LOW PLATEAU CEDAR GLADES
UPPER HOLSTON
BLUE RIDGE
WASHINGTON
SEVIER

Map 16. West Tennessee COAs, Public Lands, and Major Cities

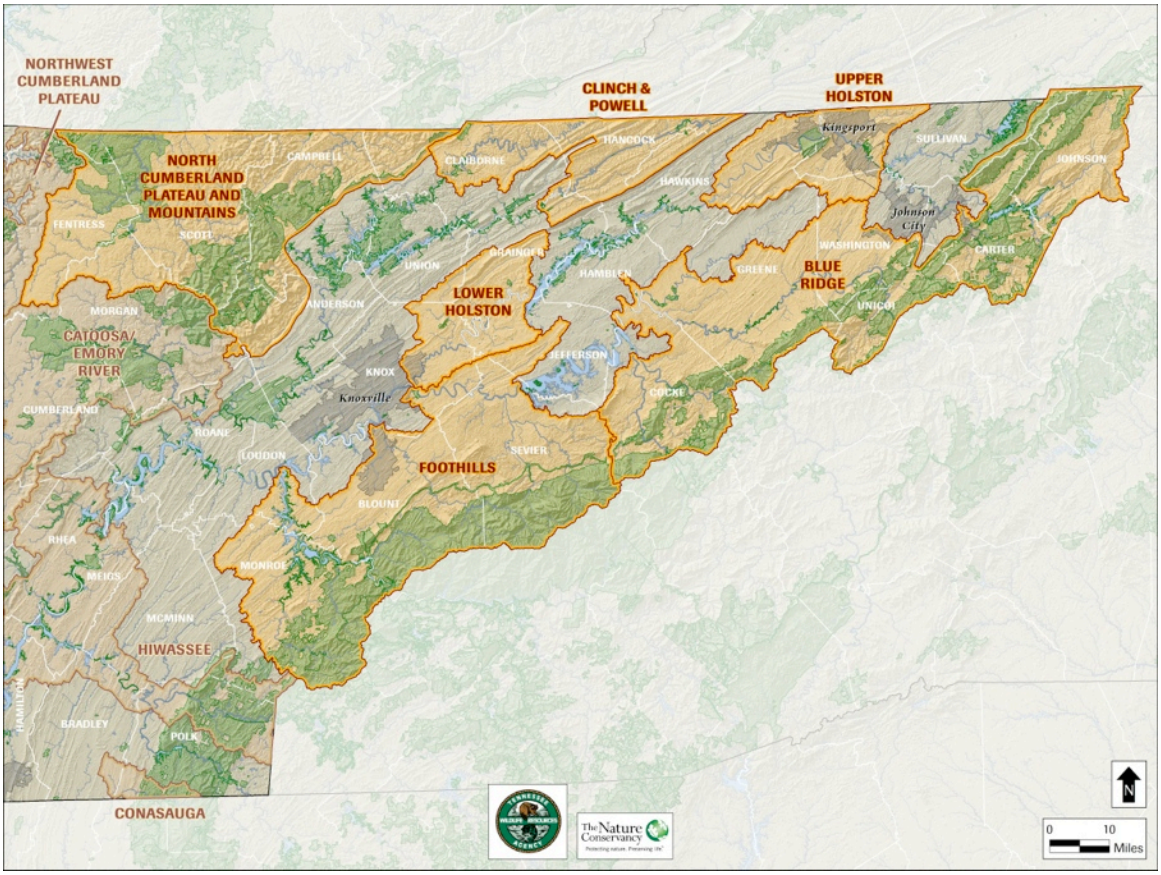
Map 17. Central Tennessee COAs, Public Lands, and Major Cities



Map 18. Cumberland Region COAs, Public Lands, and Major Cities



Map 19. East Tennessee COAs, Public Lands, and Major Cities



for GCN species, and while most public lands are captured within COAs, some are not. As the assessment of potential climate vulnerabilities demonstrates, vegetation types may change over time, resulting in habitat type and distribution shifts from what are identified as priorities on the landscape today.

COAs, therefore, are not intended to artificially constrain decisions about what strategic actions are needed and where they apply. The information on GCN species, habitats, and major problems in the SWAP GIS database can be used in a variety of different decision-making contexts to help determine where a project or strategy may be of benefit in any location across Tennessee.

Accordingly, the 2015 SWAP update articulates those conservation actions that are recommended to be employed statewide to benefit GCN species and their habitats, irrespective of COA boundaries. The overview of strategies in the following section highlights examples of general and specific conservation actions, organized by the SWAP hierarchy, which can be employed to address the major issues affecting species and habitats – whether within or outside COA boundaries.

COAs are not intended to artificially constrain decisions about what strategic actions are needed and where they apply.

These actions include efforts that could be best deployed at a statewide scale (e.g., policy or standards development) and others that must be tailored to habitat protection or restoration outcomes in specific locations (e.g., application of prescribed fire). The project examples demonstrate the importance of conservation activities for species and habitats both within and outside the current Conservation Opportunity Areas.

5.3. Overview of Priority Conservation Strategies in Tennessee

This section on priority conservation strategies is organized according to the Class level of the SWAP conservation strategy hierarchy (see Table 15 and Appendix H). The project examples are intended to illustrate the application of general and specific conservation actions both within and outside Conservation Opportunity Areas.

5.3.1. Habitat Acquisition

Habitat acquisition for conservation purposes continues to be a major need in Tennessee. Strategies for improving public and private funding for land acquisition statewide are important. A primary tenet guiding many, though not all, conservation acquisitions is to build upon and connect the existing public lands base. Conservation Opportunity Areas highlight geographies

where this type of focus may be successful. Another major tenet is to help private land owners and local governments who are already engaged in conservation to retain their land ownership and manage their resource values through education, technical assistance, or financial support.

In many cases where limited or highly dispersed priority habitats remain, or where land use threats are high, acquisition may be the primary and most effective strategy for preventing further habitat destruction and achieving conservation goals. The cedar glades and barrens of middle Tennessee are a prime example of acquisition helping to protect both rare and highly dispersed habitats. Two successful examples of how the 2005 SWAP helped to guide acquisition strategies for conservation are provided in this chapter.

Landscape-scale habitat conservation

In June 2007, the state of Tennessee and the Nature Conservancy, teaming with the timber companies Conservation Forestry and Lyme Timber, completed the largest land protection deal in Tennessee since the creation of Great Smoky Mountains National Park. A total of $82 million in state funding, $13 million from TNC – with financial assistance from the Doris Duke Charitable Foundation and the Tucker Foundation – and $40.2 million from the two timber companies was combined to protect 127,854 acres on the Cumberland Plateau.

Sandy Gap, a part of the 127,854-acre Cumberland Plateau acquisition - David Engebretson

This purchase connects the forestlands in Scott, Campbell, Anderson, and Morgan counties with 66,000 acres of existing public lands, creating a protective corridor for wildlife as well as preserving a natural sanctuary for the public. Ranked as globally significant for its diversity of plant and animal species, the area harbors increasingly rare species of bats, salamanders, fish, and other creatures. Migratory songbirds rely on the forestlands of this region for habitat in spring and summer, and large, wide-ranging mammals such as elk and black bear are sheltered on the Plateau.

A sophisticated mix of fee title, conservation easements, and timber rights were combined to close the deal, in which innovative working forest conservation easements, crafted by the

Tennessee Department of Environment and Conservation and The Nature Conservancy, keep 42,075 acres open to the public for recreation and guide sustainable forest management.

Conservation on this scale ensures that:
✦working forestland is protected, sustaining forest-based jobs and the industry around them well into the future;
✦current and future generations will continue to enjoy access to the property for recreation;
✦ forests are well-managed, remaining healthy and intact, which will help maintain water quality in local communities that depend upon these watersheds and deter floods and erosion;
✦rare ecological lands are added to state ownership and protected for future generations.

Conservation in Developing Areas

In areas of rapid urban/suburban development where land values are increasingly high, permanent conservation easements can provide an excellent alternative to fee title purchase. One such easement – purchased through private philanthropy in partnership with the Tennessee Parks and Greenways Foundation and $12,500 in federal funds through TWRA – occurred in 2013, permanently protecting 1,363 acres of mixed forest/grasslands on the Western Highland Rim in Williamson County.

Partnering with a landowner seeking to conserve property in the area, the easement conserves land near the headwaters of the Harpeth River, which is crucial to downstream habitat and aquatic biodiversity. It is also located adjacent to the Natchez Trace Parkway, with high connectivity to other protected lands. The SWAP GIS database model shows the habitat priority for this property is medium to high for terrestrial species. A survey of the property documented 22 species of reptiles and amphibians, including the Eastern Box Turtle. The tract also contains habitat for interior forest birds.

Conservation easement purchases such as this provide the following benefits:
✦Habitat for uncommon and rare species;
✦Public value in the form of scenic quality (in this case, viewable from the Natchez Trace Parkway);
✦High connectivity to other protected lands, which increases habitat functionality and security on a landscape scale;
✦Protection from encroaching suburban development.

5.3.2. Information Collection and Dispersal

The information collection and dispersal class of strategies includes the following types of General Conservation Actions: improved communications and public relations, conservation planning, monitoring, and research. Improved communications include a focus on raising awareness of stewardship issues on public lands, specific GCN conservation issues, and opportunities to partner in private lands conservation. TWRA also will

continue and seek to expand engagements in joint planning efforts with a variety of partners.

This approach includes the use of new conservation planning data in the 2015 SWAP GIS model to help identify and implement a variety of projects. The agency will also continue to invest in monitoring GCN species, habitats, and particular problems that threaten them. Such monitoring can often best be accomplished through investments and collaborations with researchers. Teaching and engaging the public and volunteers in monitoring activities, sometimes called citizen science, also is growing in popularity and can be helpful to achieving a variety of monitoring objectives. Wildlife diversity staff also will take advantage of new collaborations (e.g. with Landscape Conservation Cooperatives) to improve capabilities for both monitoring and planning at landscape and regional scales.

Communications & Public Relations

Partnerships among agencies and other organizations are effective means of increasing public awareness about important stewardship issues where knowledge can translate into conservation results. Good examples of this in Tennessee include the public outreach campaign to "**Buy Firewood Where You Burn It**" and the related **Don't Move Firewood** website designed to help stop the spread of invasive insect pests, as well as **Protect TN Forests**, which has a broader focus on promoting knowledge of practices that benefit forest health.

Monitoring and Research

Since the 2005 SWAP, TWRA wildlife diversity biologists have spent a significant amount of time monitoring GCN species populations and their response to management activities,

Clockwise from upper left: Electroshocking fish on East Fork of the Stones River - Pandy English; Banding a bat - Josh Campbell; Surveying Alligator Snapping Turtles - Rob Colvin; Live trapped woodrat on Kyles Ford WMA - Scott Dykes (photographers and those in photos all TWRA staff).

contributing to the improvements in the GIS and relational database noted in Chapter 3. Citizen science refers to research collaborations between interested citizens and researchers to collect data about the natural world. Citizen science monitoring programs represent an opportunity to expand the agency's capacity for monitoring certain GCN species. The following are current examples of TWRA citizen science, which could be expanded or replicated for different species:

✦The Tennessee Amphibian Monitoring Program, a partnership between TWRA and Middle Tennessee State University, is a good example of citizen science that recruits and trains volunteers to collect data about GCN species of frogs and toads.
✦Another program trains volunteers to recognize and monitor the spread of the destructive Hemlock Woolly Adelgid, an introduced insect pest that kills native hemlocks in east Tennessee's highlands.
✦A number of citizen groups currently monitor bat houses; greater coordination and sharing of Tennessee bat research between scientists and these programs could benefit both researchers and volunteers.

Monitoring on a very large, or landscape, scale requires continuously updating information in a fast-changing world. The U.S. Fish and Wildlife Service Landscape Conservation Cooperatives, which have been organized since the first 2005 SWAP planning effort, provide a major opportunity for states to engage and assist with planning and monitoring at large spatial scales.

By applying the expanded datasets in Tennessee's GIS relational database, TWRA can improve its species and habitat management decisions. For example, data on lowhead dams being compiled in partnership with the Division of Natural Areas and information on riparian zone condition will be useful to Environmental Services when reviewing permit applications submitted to the Tennessee Dept. of Environment and Conservation.

TWRA also supports research by or in collaboration with partners from academia and other institutions. For example, TWRA has worked with researchers from Middle Tennessee State University, University of Tennessee, and the Nashville Zoo to conduct research focused on improving Hellbenders' resistance to both Chytrid fungus and Ranavirus.

TWRA is supporting research on chytrid fungus and ranavirus in Hellbenders, both of which are thought to be associated with missing digits on the salamanders, as with the hind foot shown here, which normally has five toes. - Sherri Reinsch, Nashville Zoo

5.3.3. Management and Restoration of Species and Habitats

Management and restoration of species and habitats includes a number of General Conservation Actions that form the core stewardship practices designed to maintain ecosystem health: compatible resource use on public and private lands, conservation area management, exotic species/pathogen control, habitat and natural process restoration, and species restoration. This class of conservation strategies focuses on better direct resource management and planning on both public and private lands. Compatible resource use also can depend on effective environmental reviews which ensure that species and habitat needs are adequately considered and incorporated into land and water resource use decisions.

To achieve habitat improvements on public and private lands, it is necessary to make use of a variety of funding sources, especially state and federal incentive programs designed to assist landowners with practices that benefit habitat values as well as their own properties and operations.

Shelterwood cut with burning, an example of forestry management to benefit wildlife at North Cumberland WMA - Scott Dykes, TWRA

Habitat restoration can be thought of as two main types: (1) restoring natural processes, such as removal of barriers to restore stream flows or re-introduction of fire, and (2) restoring specific habitat types for species, such as forests, wetlands, and grasslands. Species restoration efforts become necessary in certain cases, such as with several fish and freshwater mussel species, when precipitous declines require direct population recovery strategies. In particular, restoration of habitats for federally-listed (Threatened or Endangered) species – as well as actions to address at-risk species that could result in precluding the need to list them under the ESA – can be supported through the USFWS Recovery and Partners for Fish & Wildlife programs.

Compatible Resource Use

The 2005 SWAP, the updated 2015 SWAP, and the Tennessee Division of Forestry's (TDF) 2010 **Forest Resource Assessment and Strategy** all agree that opportunities exist for collaboration among TWRA, TDF, and private landowners to improve forest management for the benefit of wildlife and plants. The following points, drawn directly from the Forest Assessment, summarize Best Management Practices (BMPs) needed to ensure

healthy forests for Tennessee wildlife and plants:

✦Forest stewardship plans that address forest health, intermediate stand practices, aesthetics, and non-native invasives will assist landowners in achieving multiple management goals, including wildlife conservation.
✦Structure essential to a diverse fauna can be provided by applying intermediate treatments, such as burning or thinning, and by regeneration harvesting in groups or patches.
✦Modification of some forest practices has been identified as an opportunity to aid certain GCN species. For example, habitat fragmentation and nest predation caused by large clearcut areas may be mitigated by using smaller, irregularly shaped, soft-edged interspersed clearcuts.
✦Habitat fragmentation can also be reduced when stand placement is considered in the context of the surrounding forests. Maintaining the connectivity of hardwood stands provides travel corridors for wildlife, and greater interspersion of food and cover resources.
✦Restoration and protection of uncommon forest habitats is also key to supporting many GCN animals and plants. Uncommon forest habitats include savannas, cave openings, wetlands, rock outcrops, bogs, springs, seeps, glades, balds, and vernal pools. Maintaining contiguous, mature forests across the landscape is also critical for conserving many GCN species, and these habitat needs are important to consider as forest management plans are designed.

Private land management is critical to achieving positive, long-term conservation outcomes in Tennessee. More than 90 percent of Tennessee's land is privately owned, and the manner in which private lands are managed significantly affects public environmental benefits, including water quality, habitat quality, the costs of wildlife management, and the long-term sustainability of wildlife populations. In fact, TDF has identified priority watersheds for focused management and outreach to private landowners based on the following:
✦watershed > 50% forested;
✦privately owned;
✦threatened by development;
✦supplies at least one public water intake.

Since 2007, TWRA has cost-shared four Private Lands Biologist positions with the Natural Resources Conservation Service (NRCS), a very important partner in private lands management. TWRA staff will continue to partner with NRCS in outreach to private landowners, the identification

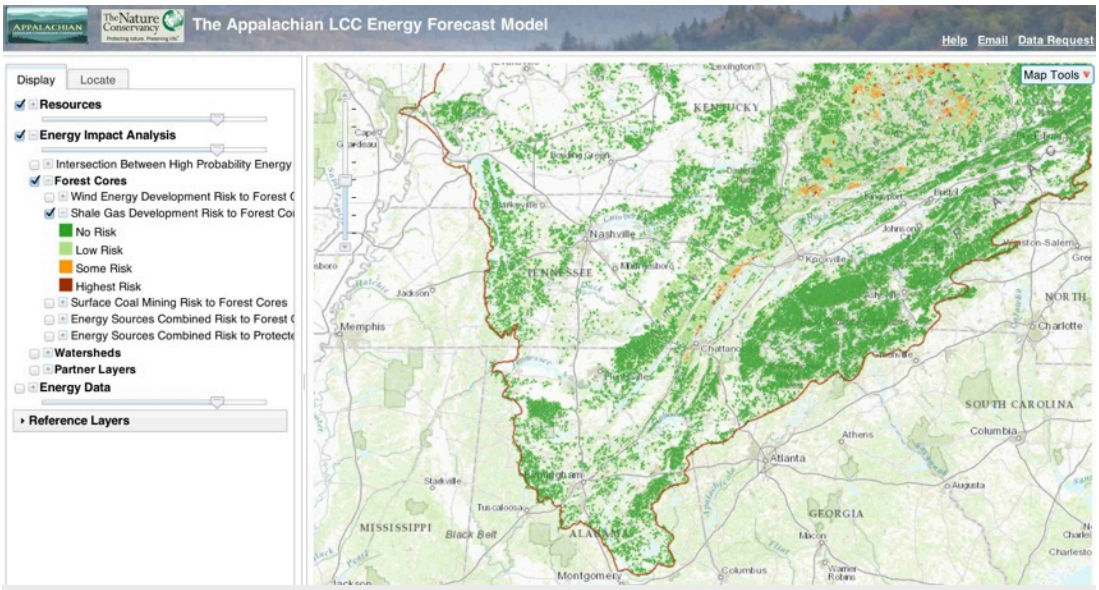
TWRA habitat biologist Wally Akins and a landowner discuss options for improving private property for wildlife. - Robin Mayberry, NRCS

of priority conservation practices for key areas of the state, and the prioritization of incentive program applications based on pressing wildlife conservation needs.

Advance planning and effective environmental reviews to mitigate problems and protect sensitive resources is an important strategy for both public and private lands. For example, the National Park Service developed the Big South Fork National River and Recreation Area/Obed Wild and Scenic River Final Non-federal Oil and Gas Management Plan/ Environmental Impact Statement in 2012. This strategy helps park managers ensure their park units are protected from current as well as potential future issues from new development. The plan provides park-specific guidance for oil and gas owners and operators who wish to establish new oil and gas extraction sites (NPS 2012).

Another example of advance planning at a regional scale is an analysis developed by The Nature Conservancy with support from the Appalachian LCC to assist policy makers, land management agencies, and industry leaders in assessing the overlap between potential future energy development and biological and ecological resource values. Data from the study is hosted on the web-based **Appalachian LCC Energy Forecast Model**, which allows users to query various datasets to see where energy development may likely occur and intersect with important natural values to inform regional landscape planning decisions.

Another important approach to ensuring compatible resource use is the advance designation of sites and areas for which particular land or resource utilization would not advance habitat and species conservation goals. An example of this type of determination has been conducted for the North Cumberland Wildlife Management Area (NCWMA) and lands in its vicinity in the Cumberland Plateau and Mountains region. The NCWMA offers one of Tennessee's premier opportunities to protect, manage, conserve, and restore GCN species and their habitats, with special emphases on aquatic, riparian zone, and ridgeline hydrological and ecological



The Appalachian LCC Energy Forecast Model, showing potential risk of shale gas development relative to forest cores in Tennessee and surrounding states.

function. Over 150 wildlife and plant GCN species are dependent upon adequate protection of these habitat features and their ecological function in the landscape.

TWRA has determined that new contour, cross-ridge, or mountain top removal coal mining is wholly incompatible with agency management and restoration for the NCWMA. Re-mining to resolve outstanding water quality and slope stability problems from previous mining and deep-mining, when properly done, are not considered incompatible with TWRA management plans for the NCWMA. For a detailed list of GCN species potentially affected by incompatible mining in the NCWMA and surrounding vicinity defined in a current State of Tennessee Lands Unsuitable for Mining petition, please see Appendix C, Table 5.

Conservation Area Management

TWRA Wildlife Diversity staff strive to work effectively with other TWRA divisions, the Tennessee Department of Agriculture's Forestry Division, and Tennessee Dept. of Environment and Conservation on management issues within Wildlife Management Areas (WMAs). This is a frequent goal of conservation area management in the 2015 SWAP. Collaboration between agencies with different expertise and jurisdictional authorities helps achieve balance between a variety of management objectives and will help improve habitat zones for all GCN species. For example many rare plants occur in rare and/or small patch habitats that also may include GCN wildlife species.

Another example of improving conservation area management comes from the Obed River Gorge, a popular rock climbing destination. Potential impacts to native plant communities and cultural resources from climbers led the National Park Service to develop the Obed Wild and Scenic River Climbing Management Plan (NPS 2002) to manage and decrease impacts. A similar example is the **Rock Climbing Guidelines** developed by the Tennessee Division of Forestry in cooperation with its user group, the Southeastern Climbers Coalition, to manage the impacts of climbing in Prentice Cooper State Forest.

Proactive management to prevent damage by licensed motorized off-highway vehicles (OHVs) and non-licensed All Terrain Vehicles (ATVs) often consists of driver education. TWRA provides **guidance to riders** on where these different vehicles are allowed and not allowed on Wildlife Management Areas. An excellent example of an educational initiative to improve rider safety and help prevent damage to creeks and rivers is provided by the **Iowa ATV Safety Course**.

Control/Prevention of Invasive Exotic Species and Pathogens

When exotic or introduced species threaten GCN species and habitats, a hierarchy of approaches to prevention and control is needed. Over the long-term, the most cost-effective, but also potentially the most labor intensive and difficult approach is to monitor for new outbreaks or invasions.

Often control or even eradication of invasive species is possible before they become well established. After an exotic species has become established, a variety of control mechanisms is available, depending on the species, but eradication is unlikely. Monitoring is appropriate to determine the level of threat and the effectiveness of management actions.

Joe Elkins, TWRA using an injector to apply herbicide to undesirable tree species in Shady Valley bog habitat. - Scott Dykes, TWRA

Arnold Air Force Base in Coffee and Franklin Counties is a good example of integrated pest plant management. The base's invasive pest management strives to:

✦support the maintenance of biodiversity;

✦maintain the structure and function of ecologically significant plant communities;

✦restore a functioning mosaic of barrens habitats;

✦protect high priority sites where plant invasions threaten rare species habitats; and

✦develop monitoring protocols to track management effects, and to detect new pest plant occurrences.

Basal bark treatment of an invasive woody species - Arnold Air Force Base

The Hemlock Woolly Adelgid, *Adelges tsugae*, is an insect that has wreaked havoc on many hemlock forests in the eastern United States. A relatively new biological control, the predatory beetle species called *Laricobius nigrinus* eats Hemlock Woolly Adelgid (HWA). **Experiments are ongoing in the Great Smoky Mountains National Park** and other Tennessee forests to release these beetles and slow down HWA infestations in priority conservation areas. This effort demonstrates the importance of research efforts in determining the best possible responses so that potential unintended consequences from the introduction of biological controls are understood and minimized.

Timely management actions tailored to address a new pathogen's spread are needed to combat emerging infectious diseases of wildlife. Pathogen spread in populations of one or more GCN species may require focused conservation or

research. The Eastern Hellbenders of Tennessee case study describes an example of this type of collaborative effort.

In recent years, TWRA has also seen evidence of the deleterious effects of pathogen infections on various reptile populations in middle and east Tennessee. Through participation in a multi-state State Wildlife Grant, TWRA has partnered with researchers from Cumberland University, Middle Tennessee State University, and University of Tennessee Department of Forestry, Wildlife and Fisheries Center for Wildlife Health to determine the presence of the snake fungal disease (*Ophidiomyces ophiodiicola*) in Timber Rattlesnake populations at Center Hill Lake, Cedars of Lebanon State Forest, and Flat Rock Cedar Glades and Barrens State Natural Area. Non-target species of reptiles are also sampled to determine if species other than rattlesnakes may be impacted.

Researchers have been performing telemetry to determine movement behavior and using special temperature-sensitive radio transmitters to record the body temperature of timber rattlesnakes throughout hibernation. These efforts, combined with observations of winter basking occurrences, allow researchers to gain valuable insights into the impacts of this devastating disease.

Habitat and Natural Process Restoration

Restoration of habitats and the natural processes that maintain their health is an important strategy for a large majority of GCN species. Within Conservation Opportunity Areas, restoration activities may be prioritized to improve or connect existing habitat areas. Important management techniques can include prescribed fire; removal of stream and river barriers; restoration and reconstruction of wetland and stream habitats; and reestablishment and management of native forest conditions. Map 20 provides an overview of where restoration from current semi-natural landcover conditions to the dominant forest type of the region can be most effective for expanding available habitat for GCN species (Wisby and Palmer 2015).

Prescribed fire is a management approach that provides measurable benefits to early successional and fire-adapted habitats in Tennessee, thereby benefiting many wildlife and plant species. TWRA will

Rattlesnake with snake fungal infection - Daniel Bryan, Cumberland University

TENNESSEE CASE STUDY: The Eastern Hellbenders of Tennessee - A species indicative of good water quality provides a focus for conservation statewide

Perhaps no other species in Tennessee is more emblematic of the widespread, interacting, and complex mix of threats posed by society to healthy aquatic systems than the Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*). Picturesquely dubbed "The Last Dragons" in a 2014 film produced by Freshwaters Illustrated and the U.S. Forest Service, this giant salamander subspecies was once distributed throughout most streams in the eastern two-thirds of Tennessee.

With a fascinating life history – including a relatively long life (25 years or more), a fierce attachment to home territory, annual battles by males vying for mates, and males that guard their eggs and young – this species has become a flagship for what is extraordinary about Tennessee and southern Appalachian streams. Hellbenders have experienced precipitous population declines across much of the state in the past several decades, and their plight clearly illustrates an issue for which conservation efforts beyond the boundaries of Conservation Opportunity Areas must and will continue.

> "I did not know then (2001) that that individual would be the last Hellbender I would find in the Collins River." -- Dr. Brian Miller, herpetologist, Middle Tennessee State University

The Hellbenders' descent into rarity

Dr. Brian Miller, a salamander expert who first came to Middle Tennessee State University in 1989 to study Hellbenders, has been observing the species' decline for more than 20 years. He began working with Hellbenders in the Collins and Buffalo Rivers where populations seemed relatively high. After a survey hiatus from 1995 to 2001, he returned to the Collins River to find only one Hellbender. "I did not know then that that individual would be the last Hellbender I would find in the Collins River," says Miller.

Top to bottom: Hellbender in typical habitat at night, Hiwassee River -Dave Herasimtschuk, Freshwaters Illustrated; Small hellbender indicative of a reproducing population, lower Little River - TWRA staff; The Hiwassee River: some of the best remaining Hellbender habitat in Tennessee - LookoutBelle/next page: Hellbender in Tellico River - Dave Herasimtschuk, Freshwaters Illustrated

His assessment after searching numerous middle Tennessee rivers over subsequent years is that populations crashed over a 10-year span, going from low densities to almost non-existent. Miller notes, "In retrospect, I was probably working with an aged and dwindling population in the Collins River in the early 1990s, since I never found small Hellbenders back then."

This picture is complicated by one of the quintessential problems in ecology: a lack of historical information with which to compare current conditions. Miller estimates that the initial decline may have begun as early as the 1970s. However, the lack of data on the original size of Hellbender populations hinders any definitive assessment.

Unraveling Hellbender problems

Hellbenders require extremely good water quality. They need clear swift-flowing streams that keep crevices under streambed rocks open and available for Hellbender lairs. This species also breathes through its skin, making it dependent upon high levels of oxygen in the water. For these reasons, most stream modifications impact Hellbenders, including impoundments, channelization, siltation, acid mine drainage, and thermal pollution.

Increased levels of siltation from agriculture and other forms of runoff essentially bury Hellbender habitat. Silt may often carry with it herbicides and other chemicals, which some research has implicated as a potential contributor to Hellbender reproductive problems (Solis et al. 2007). Further complicating this picture is the fact that streams in Tennessee completely lack historical or current records on the chemical loads they carry. People who move or collect river stones for building often directly destroy Hellbender habitat. Finally, in the early 2000s there was also a question about whether Hellbenders were succumbing to diseases that have been spreading among amphibian populations on a global scale.

Responding to the unnerving decline that Miller had found in middle Tennessee's Hellbenders, in 2010 TWRA provided State Wildlife Grant (SWG) support to a collaborative group of researchers, including the University of Tennessee and the Nashville Zoo, to bring together salamander experts and develop a coordinated program of research aimed at improving Hellbender conservation. The program they developed aimed to achieve four goals:

1. Conduct field surveys of historic Hellbender locations to determine current distribution.
2. Determine the extent to which Hellbenders are susceptible to two widespread diseases affecting amphibians: chytrid fungus and ranavirus.
3. Develop an "e-DNA" (environmental DNA) protocol to allow sampling of Hellbender DNA from the water column to discern presence/absence and genetic differences among populations.

4. Develop techniques to study and boost wild Hellbender populations, including cryopreservation of sperm for captive breeding and development of crèche methods for rearing wild caught Hellbender young to increase their survival rate.

A complicated picture emerges

Research implemented by partners in this effort since 2010 has yielded the following:

- The Upper Tennessee Drainage has some of the best remaining Hellbender populations in the state, and the Middle Tennessee has remnant populations (the Duck and Buffalo watersheds), while the Cumberland Drainage populations are imperiled, with over 140 man hours of search effort yielding 0 Hellbenders. Moreover, moderate to high degrees of siltation were found in all the Cumberland waterways surveyed.
- Hellbenders can contract both chytrid fungus and ranavirus. In captivity, nearly all Hellbenders with ranavirus die when water temperature exceeds 68 degrees Fahrenheit (a common occurrence in streams during Tennessee summers).
- The Buffalo River in Middle Tennessee has a genetically unique strain of Hellbenders, which is different from those found in the Hiwassee and Ocoee Rivers of East Tennessee.
- Researchers successfully collected Hellbender sperm, using cryopreservation to "bank" their genes. Captive breeding of Hellbenders has been largely unsuccessful.
- Placing concrete Hellbender houses in streams has allowed fertilized eggs to be removed and hatched in captivity -- either for study or to improve survival of salamander larvae by growing them out for release back into the environment.

Bringing back Hellbenders: 2015 and beyond

People value rarity, and as Hellbender populations across the state have crashed, support and interest in their conservation has increased. Unfortunately, the level of effort required to assist rapidly declining wildlife populations is often quite high and quite complex.

The status of Hellbenders in Tennessee is inspiring concern and action: to understand where they are still found, what threatens them, and what conservation measures will be most effective.

TWRA and the U.S. Fish and Wildlife Service are supporting efforts aimed at further cataloguing Hellbender populations. In 2015, Dr. Miller at MTSU initiated (with TWRA SWG support) a population survey in the Little Buffalo River, the middle Tennessee stream with the best breeding densities of Hellbender according to a 2012 survey. Meanwhile, additional SWG funds are supporting researchers with the University of Tennessee Forestry, Wildlife, & Fisheries Department who are attempting to develop a means of inoculating Hellbenders against chytrid fungus to create disease-resistant populations in the wild.

The brightest part of the big picture is that steeper gradient rivers like the Hiwassee still have some of the best remaining Hellbender populations and could serve as potential sources for reintroduction efforts. However, if population crashes are associated with a decrease in water quality, then those issues must be remedied prior to any stocking efforts (see the Elk River case study). Dr. Miller sums it up by saying, "Some of these east Tennessee streams appear to have somewhat stable populations. Time will tell."

promote the application of prescribed fire in the COAs where fire suppression has occurred, on both public and private lands.

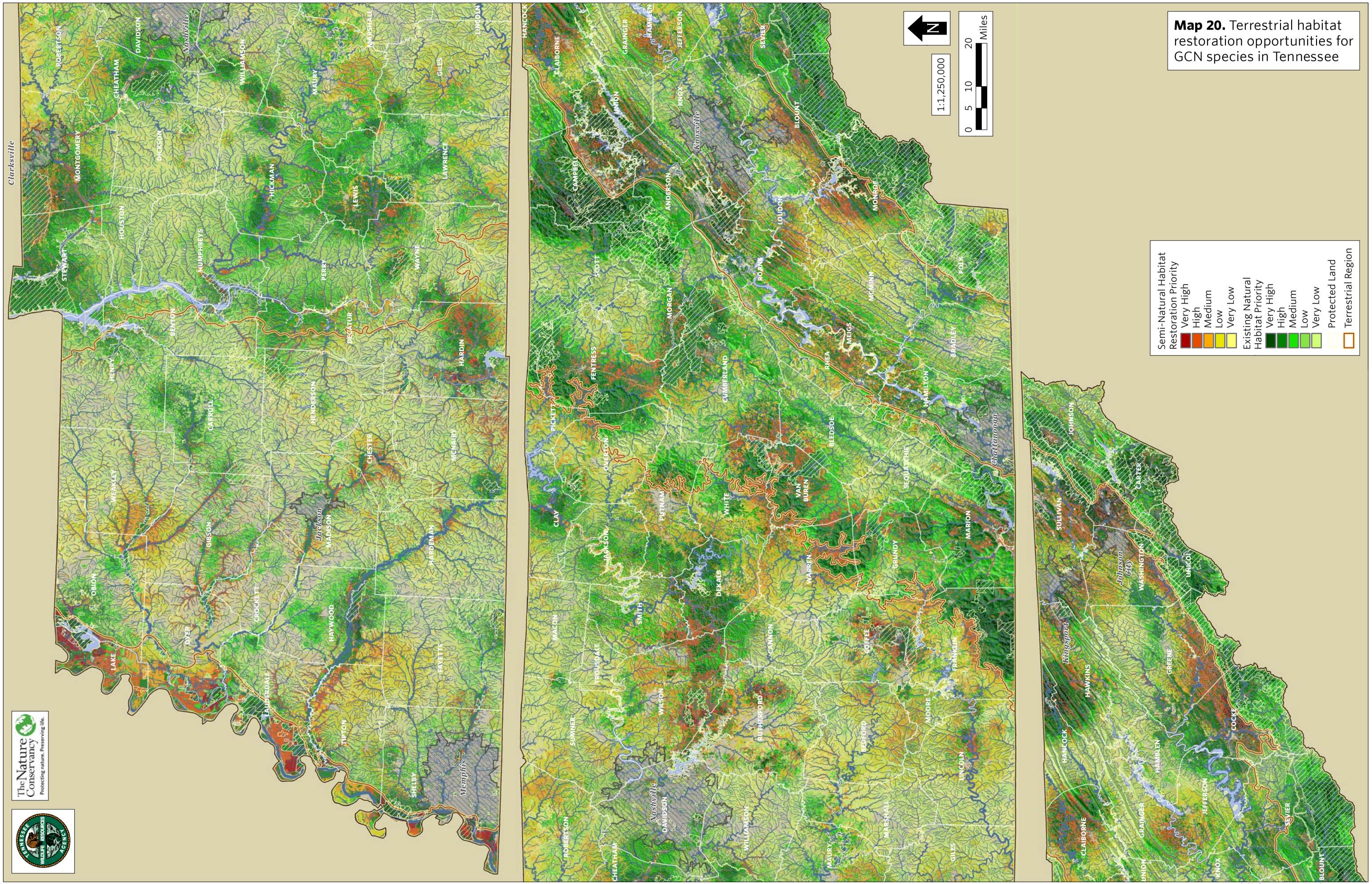
With support from the Tennessee Fire Council and the Tennessee Wildlife Federation, the Tennessee Prescribed Burning Act was signed into law May 10, 2012. This legislation provides liability protection for landowners who use prescribed fire appropriately, and it also authorizes the Tennessee Division of Forestry (TDF) to provide training programs to the public that teach basic fire ecology and the safe and appropriate use of prescribed fire.

The Golden-winged Warbler Case Study demonstrates how early successional habitat management is emerging as a priority for wildlife management in Tennessee. These habitats are by definition constantly changing, as plant colonization and regrowth occur subsequent to a disturbance. Disturbance may be natural, such as lightning-ignited fire and storm damage, or it may occur as a result of human management, such as a prescribed fire or tree harvesting. Early successional habitats are important for a variety of GCN species, such as Prairie Warbler and Spotted Skunk.

As discussed in Chapter 4, managing large dam infrastructure and reservoir releases to improve water quality and habitat conditions for GCN species is critical for conservation efforts in Tennessee. Another type of activity gaining positive momentum is the restoration of stream habitat connectivity and stream flow through small dam removals. Many small dams on streams and rivers no longer serve the purpose for which they were originally built, and many pose public safety hazards.

Since 2012, several dam removals have taken place in Tennessee, with one in the pipeline as of mid-2015. In 2012, a multi-agency and organization coalition removed a lowhead dam on the Harpeth River near Franklin, TN. This project is located outside of any COAs

Above: Catoosa Wildlife Management Area 1 month after a prescribed burn; below: two native early successional species post-burn. - Clarence Coffey, TWRA retired



Map 20. Terrestrial habitat restoration opportunities for GCN species in Tennessee

TENNESSEE CASE STUDY: Intensive management for early successional habitat, guided by the needs of Golden-winged Warbler in the N. Cherokee Conservation Opportunity Area

The birdwatchers and fishermen who visit Hampton Creek Cove State Natural Area in the Southern Appalachians may not realize the degree of collaboration and management that goes into maintaining this ecological gem. Hampton Creek Cove (HCC) is a popular birding destination owned by the Tennessee Department of Environment and Conservation (TDEC) and managed by the Southern Appalachian Highlands Conservancy (SAHC) land trust.

The creek itself supports one of the most productive native trout streams in East Tennessee, while the old field/early forest succession at lower mountain elevation provides excellent nesting habitat for Golden-winged Warblers, a declining neotropical migrant species. The National Audubon Society designated HCC an "Important Bird Area" in 2005, even though it falls at the edge of the species' breeding range. The HCC site supports the highest density of Golden-winged Warblers on the Roan Mountain Massif.

> Due to their marked dependence on early successional habitat, if an area can be maintained for Golden-winged Warblers, it will likely remain suitable for many more species who rely on that habitat type.

Like many warblers, the Golden-winged is suffering a range-wide decline due at least in part to loss of breeding habitat (Schubert 2013). In fall 2007, the Tennessee Wildlife Resources Agency (TWRA) decided to work with TDEC at this 693-acre Natural Area to enhance habitat for Golden-winged Warblers. The scientific literature supports the idea that these warblers can be considered a type of "indicator" species. Because of their marked dependence on early successional habitat, if an area can be maintained as preferred habitat for Golden-winged Warblers, it will likely remain suitable for many more species that rely on that habitat type.

Hampton Creek Cove ranges from 3,000 to 4,800 feet at the higher elevations and is a mix of pasture, shrub-scrub, and mature timber. Golden-winged Warblers prefer scattered

Top to bottom: Forest habitat closing in without disturbance at HCC; Habitat opened up after bulldozing - both photos by Scott Dykes, TWRA; Golden-winged Warbler in the hand - Nora Schubert/next page left: Early successional habitat restoration begins; right: Green-up first spring after restoration - both photos by Scott Dykes, TWRA

shrub habitat with an understory of forbs (wildflowers and other broad-leaved herbaceous plants) and grasses, where they hide their nests. As scrub habitat matures, in the absence of disturbance from fire or storms, the canopy closes in, eventually making the habitat unsuitable for these birds.

In natural cycles, rebirth follows death; the process is no different for habitat restoration. Early successional habitat restoration involved work from 2007 through 2009 to open up 45 acres of forest canopy using heavy equipment, herbicide, and native grass seeding to ensure quick ground cover for the next breeding season. The seed mix included Fowl Bluegrass (found in four Tennessee counties), Little Bluestem and Indian Grass.

To document management at HCC and to assess the effectiveness of their project, TWRA also funded biological surveys of HCC Golden-winged habitat. Field work is documenting the warblers' population and breeding activities post-restoration, including characteristics of the vegetation in preferred nest sites. Ideally, nest monitoring will assess nesting success in restored and natural habitat.

The results of the habitat work speak for themselves. In years prior to restoration, between 16 and 17 Golden-winged Warbler breeding territories were documented. In the first year after restoration work began, territories dropped to 11, but this result was expected due to the large-scale disturbance of the site. By the spring of 2010, the first year without on-the-ground work, surveys showed 21 occupied territories! The 2013 survey showed that early successional habitat restored by TWRA was occupied by relatively high densities of Golden-winged Warblers, with 17 territories overall (Schubert 2013). Future habitat restoration at the site is recommended, including a monitoring design that will measure GWWA population response to habitat modifications.

The immediate result of conservation work to restore early successional habitat can look like the results of a very bad storm, and that is precisely the point. In Tennessee, vegetation regrowth is quick and profuse.

Schubert, N. 2013. 2013 Golden-winged Warbler monitoring at Hampton Creek Cove State Natural Area, Tennessee. Report submitted to Tennessee Wildlife Resources Agency.

designated in the 2015 SWAP, but would still be a priority today for its benefits to GCN species and local community values. In September 2014, the Tennessee Wildlife Resources Agency (TWRA) took down remnants of the Brown's Mill dam on the East Fork of the Stones River, funded in part by a State Wildlife Grant. Also in 2014 an outdated dam on Richland Creek at McCabe Park in Nashville was removed. All of these projects eliminated recreational hazards while improving and increasing habitat for a wide diversity of native fish and mussels.

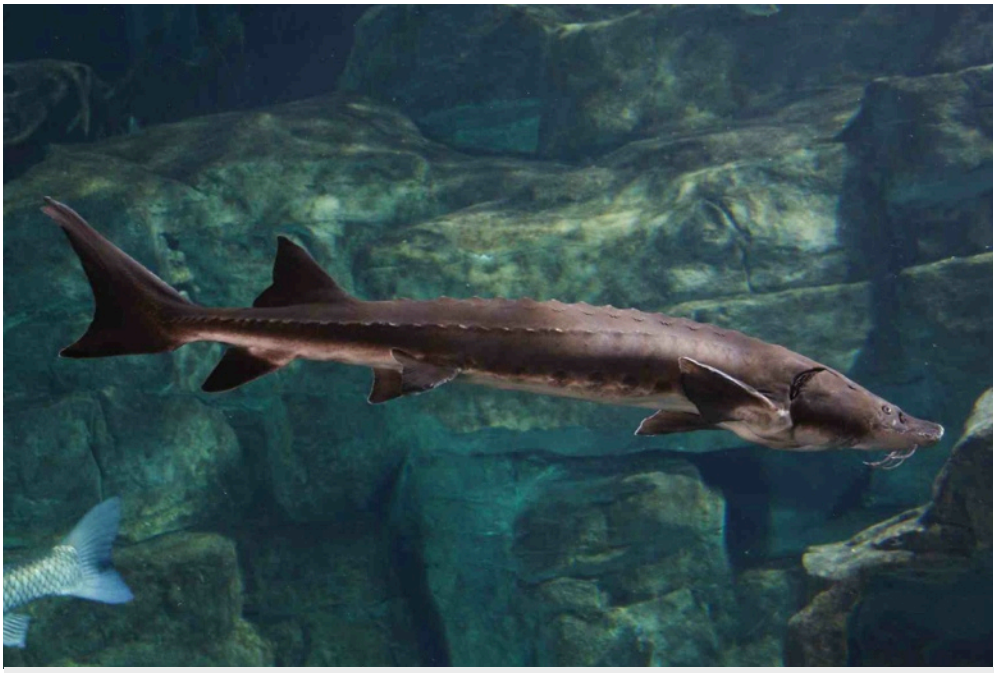
In collaboration with the Tennessee Dam Removal Partnership, TWRA has removed small dams and other river obstructions if they address the following criteria in a thorough planning effort designed to balance all resource values:

- The property owner is agreeable.
- Public safety can be improved.
- River ecology can be improved.
- Funding is available.
- There is support from the public, including but not limited to, local watershed associations and recreational users.
- The dam no longer serves its original or current purpose.

Species Restoration

TWRA and others have undertaken a number of species restoration projects in Tennessee to benefit animals and plants that are rare, declining, or locally extirpated (see Chapter 2). Species restorations occur primarily through one of two means: (1) propagation of plants/captive breeding and release of animals or (2) the transplanting of "seed stock" (both plants and animals). Restoration may occur to augment populations that are in trouble or to reintroduce species to sites where they have been extirpated. For example, a reintroduction and management program for Lake Sturgeon has restored this "fossil" species into several areas of both the Tennessee and Cumberland Rivers since 1998.

As with any complex program, many partners have played an essential role. In this case, the Tennessee Lake Sturgeon Reintroduction Working Group includes the U.S. Fish and Wildlife Service, TWRA, Tennessee Valley Authority, The Tennessee Aquarium, University of Tennessee,



Lake Sturgeon - Todd Stailey, Tennessee Aquarium

Tennessee Technological University, Tennessee Clean Water Network, World Wildlife Fund, and the U. S. Geological Survey (SLSWG 2014).

Lake Sturgeon are large, slow-growing fish that can live to be 150 years old. The cause of their decline was overfishing from the 1940s to 1961, when the last commercial catch took place. Since that time, the species has suffered from the effects of hydroelectric dams and water pollution. However, both the Clean Water Act (passed in 1972) and the Tennessee Valley Authority's Reservoir Release Improvement program contributed to improvements to habitat and prey species populations, making it feasible to consider reintroducing Lake Sturgeon.

Since 2000, more than 120,000 Lake Sturgeon juveniles have been released into both rivers. The program is considered a success by the following measures:

- all suitable habitat within management units is occupied;
- natural reproduction has been observed, with a level of recruitment sufficient to sustain the population;
- the population contains 20+ year classes of adults > 15 years old;
- some level of recreational harvest can be supported.

Although these outcomes have not yet been achieved, monitoring survey results and angler catches have indicated that Lake Sturgeon are persisting in Tennessee waters. These early successes indicate that the working group will be able to meet their long-term goal of Lake Sturgeon restoration.

5.3.4. Capacity Building

Capacity building is essential if governments and organizations are to meet the challenges faced by GCN species and habitats statewide. The problems, and often the solutions, are complex, requiring the intentional development of partnerships. Investments in designing and maintaining successful partnerships are significant conservation strategies that amplify the ability to deliver better on-the-ground outcomes in more places and for more species.

The **Tennessee Bat Working Group** (TNBWG) is an example of one such partnership. The group formed in the summer of 2004 to meet the need for cooperation in the coordination of bat conservation in Tennessee. The goal of the TNBWG is to conserve bats and their habitats in the southeastern United States through collaborative research, education, and management. The scope of the group's efforts is wide-ranging, including research, management, and information exchange concerning bats and their habitats anywhere they occur in the state, regardless of ownership. Members of the TNBWG have played a pivotal role in addressing

An adult Rafinesque's Big-eared Bat in the hand. - Scott Dykes, TWRA

White-nose Syndrome through its collaborative monitoring, research, and public education efforts.

The Tennessee Dam Removal Partnership is a diverse group of individuals from many organizations across several states. There are currently 39 participants representing city, state, and federal entities as well as nongovernmental organizations (NGOs). These include TWRA, TDEC, the Southeast Aquatic Resources Partnership, universities, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, environmental consultants, individual citizens and NGOs such as American Rivers, the Tennessee Clean Water Network, the Cumberland River Compact, and The Nature Conservancy.
The group has held two dam removal workshops facilitated by American Rivers and has supported directly or indirectly the removal of three dams since its creation. Members of the group are actively documenting and mapping obstructions that impact stream health as well as developing prioritization tools to help plan for Tennessee's dam removals in the future.

Like the Tennessee Bat Working Group, which has been invaluable in the fight against White-nose Syndrome, the Tennessee Dam Removal Partnership is organized and poised to deal with dam removal issues and opportunities that will no doubt present themselves in the near future.

Complex solutions to the challenges faced by GCN species often require the intentional development of partnerships.

The **Clinch-Powell Clean Rivers Initiative (CPCRI)** is a two state river coalition including government agencies, research scientists, conservation organizations, and industry leaders. This collaboration works to protect and restore water quality by executing and using high quality river monitoring and science in decision-making; educating key constituencies and raising public awareness; and investing in strategic conservation projects. Since 2007 the CPCRI has led a symposium and collaborative projects that have raised the national profile of these watersheds and elevated the significance of effective environmental management.

A dam under consideration for removal in 2015 - Chris Simpson, TWRA

A critical feature of capacity building efforts is the willingness to invest substantial funding in support of collaborative efforts. Funding from both the public and private sectors, and the sharing of dedicated staff resources whenever possible, are the primary mechanisms which support successful partnerships. State and federal funding resources are regularly matched by private donations and grant funds raised by NGOs, and other private sector actors.

Philanthropic foundations, individual businesses, and corporations often combine to make joint projects successful. Ongoing and future conservation are dependent upon effective relationships supported by intentional funding and commitment of staff.

5.3.5. Law and policy

Some of the problems that GCN species face are statewide in scope. The problems may be quite large, dispersed over vast areas, or accelerated by widespread economic needs and incentives. The major land and water use issues outlined in Chapter 4 – urbanization, agricultural land management, forestry practices, water management, energy development, and transportation and utility corridors – are contributors to these types of wide-ranging problems. Over-collection or illegal collection of several plant and animal species also can be a widespread problem in regions of the state. To address such challenges to GCN species and their habitats, the application of different federal, state, and local policies and regulations often is required. Much can be accomplished through advanced engagement, the identification of shared interests, and cooperative planning. Using these strategies, a variety of objectives may be achieved, including conservation of species and their habitats.

Land Use Planning and Zoning

By promoting and sharing information in the 2015 SWAP with local planning agencies, municipalities, nongovernmental organizations, and many other partners, TWRA will amplify the ability of those groups to effectively plan for the conservation of their community's natural wealth, which underpins quality of life. Information in the 2015 SWAP about priority GCN habitats, Conservation Opportunity Areas, and GCN species can improve planning and provide additional rationale for long-term comprehensive approaches designed to avoid urban sprawl.

Policies and Regulations

Information on GCN species and their priority habitats also can help better inform a variety of existing environmental policies. Similar to the specific partnerships discussed previously as Capacity Building examples, ensuring effective environmental policy and regulatory implementation requires a focus on active collaboration with both public and private sector partners. Protecting GCN species and habitats, in the context of many land and water resource use decisions, requires cooperation and commitment to incorporating available information on species and habitat needs during the process. Several of these types of strategic collaborations are outlined in more detail in Appendix G.

The application of compensatory mitigation approaches at different spatial scales is one area in particular where a variety of expertise and information can be utilized to achieve better outcomes. One example is the application of a "watershed approach" to

compensatory mitigation under the 2008 rule issued under the Clean Water Act by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency (EPA) (see Case Study: Stones River Species of Greatest Conservation Need). The rule emphasizes the need to consider habitats of important species and the long-term sustainability of aquatic resources and their associated uplands.

Compliance and Enforcement

Regulations that limit or prohibit the take of wild animals or plants are written to protect the health of species populations. TWRA law enforcement officers investigate and apprehend violators for wildlife offenses ranging from the illegal sale of certain crayfish species as live bait to the illegal take and commercialization of Common Snapping Turtles. Without enforcement, such illegal activities would continue unabated and possibly increase.

Great Egret, a GCN species dependent on wetlands. - Cynthia Routledge

5.3.6. Develop Climate Adaptation Strategies

Preparing for and coping with current and future climate impacts is an emerging field known as climate change adaptation.

In 2012 a consortium of federal and state agency and tribal leaders released the National Fish, Wildlife, and Plants Climate Adaptation Strategy (NFWPCAS). The national strategy provides a framework of goals and strategies "designed to inspire and enable natural resource managers, elected officials, and other decision makers to take action over the next five to ten years to help our living resources adapt to climate change" (NFWPCAP 2012). The strategy is a complementary effort to a wide variety of ongoing science and conservation efforts across the country.

The NFWPCAS identifies the following seven over-arching national goals:

Goal 1: Conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate.

Goal 2: Manage species and habitats to protect ecosystem functions and provide sustainable cultural, subsistence, recreational, and commercial use in a changing climate.

Goal 3: Enhance capacity for effective management in a changing climate.

Goal 4: Support adaptive management in a changing climate through integrated observation and monitoring and use of decision support tools.

Goal 5: Increase knowledge and information on impacts and responses of fish, wildlife, and plants to a changing climate.

Goal 6: Increase awareness and motivate action to safeguard fish, wildlife, and plants in a changing climate.

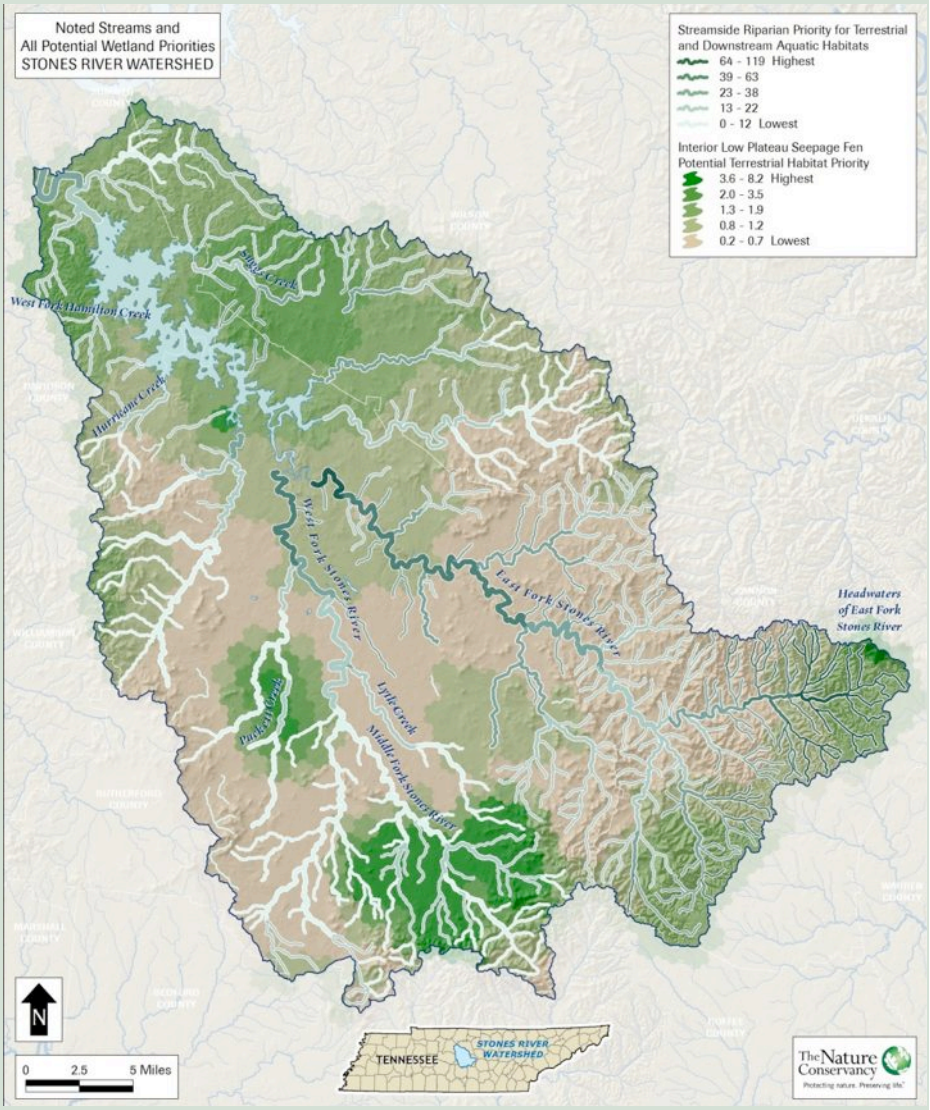
Goal 7: Reduce non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate.

TENNESSEE CASE STUDY: Stones River Species of Greatest Conservation Need and their habitats inform the application of compensatory mitigation for wetlands and streams

From 2009-2011, The Nature Conservancy and the Environmental Law Institute, with support from the Doris Duke Charitable Foundation, worked with the U.S. Army Corps of Engineers, TDEC, EPA, TWRA, and other partners to demonstrate how data on GCN species and their habitats could be utilized as part of the watershed approach framework for wetland and stream mitigation decisions in Tennessee (**Palmer and Wisby 2011**).

The Stones River Watershed map shows the distribution of important stream habitats and potential wetland areas based on known GCN distributions and wetland habitat preferences. The results of this pilot effort demonstrate that proper application of the compensatory mitigation hierarchy within a watershed context can help achieve habitat conservation as well as promote the restoration and protection of other important resource values (Palmer and Wisby 2011). Using the information in the SWAP GIS database, similar watershed maps can now be produced for watersheds across Tennessee, at the preferred spatial scale of the planning effort.

> Application of this compensatory mitigation hierarchy within a watershed context can help achieve habitat conservation as well as promote the restoration and protection of other important resource values.



The Stones River is a significant watershed in Tennessee's history. It contains large expanses of prime farmland; provides drinking water for over 250,000 people and annual recreational opportunities for millions; and provides important habitats for globally rare plant and animal species. Land development patterns and future trends suggest that resource impacts requiring mitigation in the watershed are likely to continue.

The data and methods developed for the Stones River plan mark a major advancement in the application of conservation data to stream and wetland mitigation decision-making in Tennessee. Previously, conservation data was available to decision-makers either as individual species locations or habitat patches, neither of which was related to known wetland occurrences in the National Wetland Inventory. The Nature Conservancy used a variety of different datasets to make these connections more explicit, and to improve our collective understanding of the significance and spatial distribution of plant and animal species habitats throughout the watershed.

The final report provides specific recommendations on how mitigation siting and techniques can be applied to achieve multiple resource benefits. These benefits include the following:

- Improving stream health currently degraded from excess sediment;
- Protecting and restoring species habitat;
- Connecting existing conservation lands in the watershed; and
- Maintaining and improving recreational, historic, and agricultural resources.

With respect to GCN species conservation, the Stones River watershed plan identifies several opportunities to avoid negative impacts and utilize restoration and preservation techniques to improve habitat conditions. These include the following:

- Floodplain sections of the East and West Forks of the Stones River provide significant habitat for rare plant and terrestrial animal species.
- The East Fork of the Stones contains the majority of remaining populations of fish, mussel, and crayfish native to the watershed.
- The upper headwaters of the East Fork provide extremely significant habitat for the Brawley's crayfish, a globally rare and State listed Endangered species.
- Isolated wetland habitats in the Puckett Creek subwatershed occupied by the Streamside Salamander, a State rare species, may be impacted by projected land conversion.
- The limestone glade habitats, including seep zones, are highly significant for many globally rare endemic plant species.

Applying this conservation framework to mitigation decisions in the future may make significant contributions to the long-term sustainability of aquatic resources in the Stones River watershed and the associated benefits they provide.

The data and methods developed for the Stones River plan mark a major advancement in the application of conservation data to stream and wetland mitigation decision-making in Tennessee.

Top to bottom: Gray Bats - USFWS; Louisiana Waterthrush - Andy Reago & Chrissy McClarren; Stones River - Casey Fleser

The strategy calls upon government agencies and non-government partners to incorporate goals, strategies, and actions as appropriate into ongoing planning efforts, particularly State Wildlife Action Plans (NFWPCAP 2012).

As described in Chapter 4, TWRA and TNC worked with the National Wildlife Federation (NWF) to complete an updated vulnerability assessment for species and habitats in Tennessee and begin the process of identifying potential adaptation strategies (Glick et al. 2015). NWF is a national leader in connecting climate science and adaptation principles with on-the-ground management actions. The 2014 publication **Climate-Smart Conservation: Putting Adaptation Principles into Practice**, outlines a planning process that guides the development of many types of conservation actions to address climate change-related management concerns and provides case studies of strategy development and implementation (Stein et al. 2014).

Ephemeral wetlands at Hickory Flats WMA - Josh Campbell, TWRA

For the 2015 SWAP revision, the planning team focused on identifying which NFWPCAS goals and strategies best aligned with TWRA's mission and expertise, the key vulnerabilities facing Tennessee's native species and habitats, and what types of adaptation options might be most applicable for addressing key vulnerabilities.

While TWRA and its conservation partners have a role in achieving all seven national goals, three goals and their accompanying strategies were identified as particularly appropriate and connected to important conservation needs in Tennessee (Table 17).

Focus on key vulnerabilities and general adaptation actions

Effectively designing adaptation actions requires an emphasis on "key vulnerabilities," including an understanding or working hypothesis of the reasons a species or habitat is vulnerable (Stein et al. 2014). The companion report to this 2015 SWAP revision (Glick et al. 2015) provides a discussion of the key vulnerabilities facing Tennessee's species and habitats, which also are summarized in Table 18. The 2015 planning team also took the NWF General Adaptation Strategy system and aligned it with the three main NFWPCAS national

goals chosen as a method of "stepping down" elements of the national strategy into more specific adaptation options (see Table 19).

Identifying preliminary adaption options

Many of the conservation strategies and management actions previously discussed in this chapter are highly relevant for addressing climate change vulnerabilities. However, applying these actions as climate adaptation options requires considering their effectiveness given the potential impacts of climate change at local and landscape scales and in the context of other problems

Table 17. NFWPCAS goals and strategies emphasized in Tennessee's SWAP

Goal	Strategy
Goal 1: Conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate.	***Strategy 1.1:*** Identify areas for an ecologically-connected network of terrestrial, freshwater, coastal, and marine conservation areas that are likely to be resilient to climate change and to support a broad range of fish, wildlife, and plants under changed conditions.
	Strategy 1.2: Secure appropriate conservation status on areas identified in Action 1.1.1 to complete an ecologically connected network of public and private conservation areas that will be resilient to climate change and support a broad range of species under changed conditions.
	Strategy 1.3: Restore habitat features where necessary and practicable to maintain ecosystem function and resiliency to climate change.
	Strategy 1.4: Conserve, restore, and as appropriate and practicable, establish new ecological connections among conservation areas to facilitate fish, wildlife, and plant migration, range shifts, and other transitions caused by climate change.
Goal 2: Manage species and habitats to protect ecosystem functions and provide sustainable cultural, subsistence, recreational, and commercial use in a changing climate.	***Strategy 2.1:*** Update current or develop new species, habitat, and land and water management plans, programs and practices to consider climate change and support adaptation.
	Strategy 2.2: Develop and apply species-specific management approaches to address critical climate change impacts where necessary.
	Strategy 2.3: Conserve genetic diversity by protecting diverse populations and genetic material across the full range of species occurrences.
Goal 7: Reduce non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate.	***Strategy 7.1:*** Slow and reverse habitat loss and fragmentation.
	Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through land/ocean- use planning, water resource planning, pollution abatement, and the implementation of best management practices.
	Strategy 7.3: Use, evaluate, and as necessary, improve existing programs to prevent, control, & eradicate invasive species and manage pathogens.
	Strategy 7.4: Reduce destructive capture practices, over-harvesting and illegal trade to help increase fish, wildlife, and plant adaptation.

Table 18. Key Vulnerabilities of Tennessee Species and Habitats

Climate Change Drivers	Potential Impacts	Key Vulnerabilities
Changes in precipitation timing and duration	• Increased frequency, duration, and intensity of drought •Changes to seasonal timing, frequency, and magnitude of moderate and extreme flood events •Changes to habitat availability for different life history stages •Interactions with water quality conditions •Instream flow management response issues	•Low flow/extreme low flow and base flow alteration could result in reduced habitat quality and connectivity for aquatic species. •Increasingly extreme flood events could lead to habitat destabilization (especially in headwater/smaller order streams), affect spawning cues for some species, and interrupt the availability of feeding and nursery grounds. •Increases in stormwater runoff are likely to exacerbate the input of excess nutrients and toxicity loading and contribute to altered pH and dissolved oxygen levels. •Extreme droughts could alter habitat availability, including breeding habitat and food sources for birds, spawning habitat for mussels and fish, and vernal pools for amphibians.
Increasing temperatures	•Contributions to terrestrial habitat shifts •Relationship to pest and pathogen spread •Changes to freshwater and cave habitat suitability •Interactions with water quality conditions •Contributions to phenological mismatch	• Thermal habitat suitability is likely to be reduced for a number of aquatic species, especially Brook Trout, Hellbenders, and some mussel species. •Increased evaporation could cause drying of vernal pool habitats. •Higher temperatures in caves could harm certain cave fish and bat hibernacula. •Significant shifts in forest habitat types are projected, particularly at higher elevations and in the western portion of the state. •Negative impacts are expected among high-elevation habitat-dependent species such as Rock Vole and Carolina Northern Flying Squirrel. •Spread of pests and pathogens are likely to affect plant and animal species both directly and indirectly. •Phenological mismatch could lead to disruptions in species interactions and mutualisms (e.g., timing of insect emergence and other food sources for birds, fish, and other species).
Altered disturbances (e.g., fire, wind damage, ice storms)	•Contributions to terrestrial habitat shifts •Relationship to spread of invasive species •Damage to habitat	•Increasingly extreme events could have adverse effects on habitat quantity and quality, especially in forest communities. •Altered fire regimes could pose significant challenges for fire management practices.

affecting species and habitats (Stein et al. 2014).

The three elements of Tennessee's vulnerability assessment – priority species, potential vegetation/habitat change, and landscape geophysical settings – as well as the landscape-level assessments of major problems statewide, allow TWRA and conservation partners to examine a variety of specific adaptation actions in different spatial contexts.

The SWAP planning team began this process of identifying preliminary adaptation options for a variety of species, habitats, and their key vulnerabilities. The following themes guided this effort (adapted from NWF 2014):

✦Identify circumstances where managing for habitat and species population changes, rather than persistence, may be appropriate.

✦Consider how conservation goals may need to change over time.

✦Link adaptation concepts to existing management actions.

Table 19. Alignment of NWF general adaptation strategies with three NFWPCAS goals of emphasis in the TN SWAP

NFWPCAS Goal	NWF ClimateSmart General Adaptation Strategy	NWF ClimateSmart General Adaptation Strategy Description
1	Protect Key Ecosystem Features	Focus management on structural characteristics, organisms, or areas that represent important "underpinnings" or "keystones" of the current or future system of interest. This may include protecting features such as the "geophysical settings" (Anderson et al. 2014).
	Ensure Connectivity	Protect, restore, and create landscape features that facilitate movement of organisms (and gene flow) among resource patches.
	Protect Refugia	Protect areas less affected by climate change as sources of "seed" for recovery or as destinations for climate-sensitive migrants.
	Restore Structure & Function	Rebuild, modify, or transform ecosystems that have been lost or compromised, in order to restore or establish desired structures and functions.
2	Support evolutionary potential	Protect a variety of species, populations, and ecosystems in multiple places to bet-hedge against losses from climate disturbances, and where possible manage these systems to assist positive evolutionary change.
	Relocate organisms	Engage in human-facilitated transplanting of organisms from one location to another in order to bypass a barrier.
7	Reduce non-climate stressors	Minimize localized human stressors that hinder the ability of species of ecosystems to withstand or adjust to climatic events.

Tennessee's exposure to climate change and landscape-scale impacts can be summarized in three broad categories: (1) changes in precipitation timing and duration; (2) warming temperatures; and (3) climate effects on the magnitude, severity, and return interval of disturbances (i.e. fire, wind damage, ice storms). These factors, both in isolation and combination, contribute to a variety of natural system vulnerabilities across the state (Table 18).

Appendix J summarizes preliminary adaptation options for different sets of priority species and habitats, all related to shifting precipitation and warming temperatures. These preliminary results focus on the following overarching conservation needs:

✦Maintain and improve hydrologic integrity of aquatic systems to support GCN species populations and habitats.

✦Maintain and improve suitable breeding habitat for migratory birds across their range in Tennessee in collaboration with regional partners.

✦Maintain and increase, as appropriate, the quality and abundance of amphibian breeding habitats.

✦Protect and maintain, where feasible, cold water stream habitat in support of eastern Brook Trout populations.

✦Conserve high elevation (>6000 ft) sites and monitor for potential forest type transition, managing for structure, function, and species migration changes as feasible.

✦Maintain stable populations of GCN species experiencing pathogen outbreaks through protection and management of diverse habitats, monitoring, and addressing the impacts of pathogens.

The planning team generated a variety of appropriate adaptation options designed to achieve

Smoky Mountains: The varied topography of mountainous terrain in east Tennessee has provided a home for many species over the millennium and is a critical region of habitat in the Southern Appalachians – Lee Coursey

these six overarching conservation needs. They are listed in Appendix J, grouped by both NFWPCAS goal (1, 2, or 7) and associated NWF general adaptation strategy. Next steps needed to refine these preliminary adaptation options are to apply them in goal- and outcome-setting exercises for the various species and habitat conservation targets, then evaluate which set of adaptation actions best address the conservation needs and also are feasible to implement (Stein et al. 2014).

Moving forward, TWRA, in collaboration with its conservation partners, will use the vulnerability assessment information and strategy development framework identified in the 2015 SWAP revision to generate additional adaptation options for priority species and habitats. This effort may include, but is not limited to, identification of new priority areas for acquisition and management; strategies for managing current high priority habitats as they transition to new vegetation states; new priorities for aquatic habitat restoration activities; and decisions regarding alternative management approaches to GCN species populations.

Frozen Head Mountain at Frozen Head Natural Area and State Park, TN - Michael Hodge

Northern Gray-cheeked Salamander, a GCN species - Chris Ogle, TWRA