



CHAPTER 2

TENNESSEE STATE ACCOMPLISHMENTS UNDER THE 2015 SWAP

2.1. How the 2015 SWAP Guided Conservation Efforts

SINCE ITS INCEPTION, TENNESSEE'S STATE WILDLIFE ACTION PLAN has guided many agencies and organizations in conducting habitat and nongame species conservation throughout Tennessee. One theme heard consistently from wildlife conservation partners is the utility of the Conservation Opportunity Areas. Additionally, the State Wildlife Grant program (SWG) has provided critical investments that have sustained conservation progress across Tennessee.

These grants were created by Congress to help keep species off state and federal Threatened and Endangered (T&E) Species Lists, but to do so, they must be applied strategically, and that is the role of the State Wildlife Action Plan. The 2005 SWAP identified incompatible land use and development as the primary problem facing the widest variety of species and habitats statewide (TWRA 2005). Alteration of streams and rivers, degraded water quality, poor land management practices, natural fire suppression, and invasive exotic species were other priority problems linked to species and habitat declines in the 2005 SWAP. These threats remained at the top of the list in the 2015 SWAP.

To meet these challenges, SWG funding from 2015 through 2024 has supported habitat restoration, dam and culvert removal, prescribed fire, and species reintroductions aimed at increasing populations of key Species of Greatest Conservation Need (SGCN). SWG funds have also helped to leverage the conservation expenditures of other organizations.

Photo credit: Yellowfin Madtom (*Noturus flavipinnis*) Evan Poellinger, Conservation Fisheries Inc.; Tennessee silhouette - gograph.com

Research and monitoring of a wide variety of species has resulted in vastly improved understanding of the distribution and needs of Tennessee’s SGCN, which in turn results in improved management and conservation planning. Research projects are also pioneering ways of combatting white-nose syndrome, which threatens bat populations across the state, and highlighting emerging threats such as Snake fungal disease, chytrid fungus, and Ranavirus—all of which threaten Tennessee’s reptile and amphibian populations. Finally, the extensive SWAP spatial data analysis, combined with strategic granting of SWG dollars, have informed local and state land protection efforts aimed at promoting ecotourism and protecting local heritage and natural areas. (See Appendix C for a list of 2015-2024 SWAP-guided projects submitted by partners).

2.1.1. Restoring and Managing Habitat to Benefit Wildlife

The 2005 SWAP identified “Priority Terrestrial Restoration Portfolios” for six ecoregions of Tennessee, and the 2015 SWAP mapped areas of semi-natural habitat restoration priority in relation to existing priority natural habitats. Both SWAPs also recognized the importance of restoring natural grassland and woodland systems, which would increase overall value to SGCN, since very few good examples of these vegetation types remain. A recommended strategy was to address areas degraded by altered fire regimes through the application of prescribed fire management.

Bringing back oak savanna

At Catoosa Wildlife Management Area (WMA), a project to restore oak savanna and open woodland habitats has been ongoing since 1999. Canopy reduction plays a crucial role in the restoration process. To date, more than 5,800 acres of mixed pine forest has been cleared or thinned. Prescribed fire is applied regularly in the understory to promote native grasses such as big bluestem (*Andropogon gerardii*) and wildflowers such as rattlesnake master (*Eryngium yuccifolium*) and blazing star (*Liatris* sp.) – species that thrive in more open conditions. The new growth provides abundant food in the form of seeds, sprouts, and legumes for birds, deer, and many other species. Native grasses benefit Northern Bobwhite Quail (*Colinus virginianus*), an SGCN whose populations have been in decline for decades, and the scrub-shrub habitat attracts songbirds such as Hooded Warblers (*Setophaga citrina*), Common Yellowthroat (*Geothlypis trichas*), Yellow-breasted Chat (*Icteria virens*), Eastern Towhee (*Pipilo erythrophthalmus*), Field Sparrow (*Spizella pusilla*), and Red-



Keeping common species common: four species from Catoosa that are not SGCN, clockwise from upper left - [Rattlesnake Master](#) / j van cise photos; [Common Yellowthroat](#) / Christina Butler; [big bluestem](#) / Nick Varvel; [Eastern Towhee female](#) / Shawn Taylor

headed Woodpeckers (*Melanerpes erythrocephalus*). This project has received support from at least 14 different agencies, organizations, and funders, while also hosting a wide variety of researchers helping to catalog the response of wildlife and plants to the restoration (Woody 2011). This support reflects the urgency of conservation for oak savannas and other open woodland and grassland community types. The Southeastern Grassland Institute (SGI) is a leader in education and outreach concerning the importance of these habitats in Tennessee and across the Southeast. According to SGI, “Our precious Southern grasslands are nearly extinct and the species that depend on them are fading fast. Many of our Southern grasslands that managed to persist through the past 200 years have disappeared in the past quarter-century.”

The reasons for these losses are many, interrelated, and complex. They include:

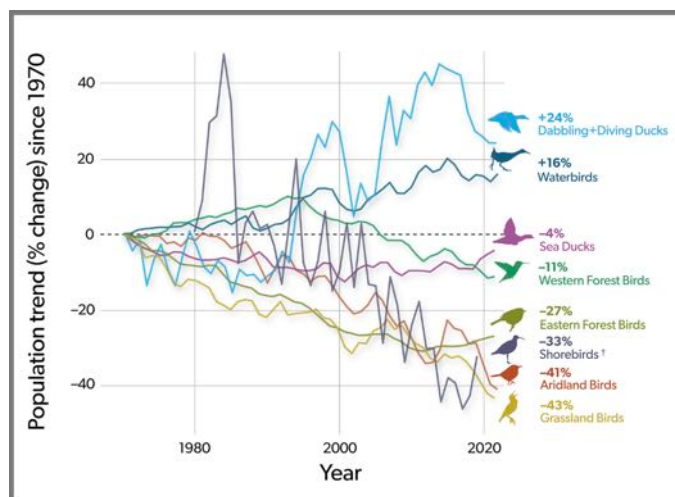
- Grasslands and woodlands were some of the most desirable areas to EuroAmericans who settled these areas for agriculture.
- Agricultural activities could transform woodlands into pine plantations, and grasslands into row crops or pastures planted with European grass species.
- Many of these habitats relied on regular fire and/or disturbance by large herbivores (bison). As lands were settled, fire suppression increased and by the early 1800s, wild bison had disappeared from Tennessee.
- Because of these changes, management of open habitats often requires prescribed fire, mowing, chemical control, and/or periodic thinning of trees (in woodland habitats). Without this stewardship, woodlands that allow plentiful sunlight into their diverse understories become closed canopy and dark. Light-loving plants no longer thrive. In grasslands, prairies, and glades, cedars and other trees can invade—along with invasive



Northern Bobwhite, an SGCN / James Childress (bv permission)

plant species that may outcompete rare plant SGCN. Areas transformed in this way can result in the loss of critical habitat to SGCN such as the Northern Bobwhite.

For all of the above reasons, grasslands are commonly recognized as the world’s most endangered biome, and in North America, grassland birds have experienced the greatest



Long-term decline of birds since 1970; ducks have received the greatest conservation investments and show the greatest increase; all other guilds aside from waterbirds have declined. From [2025 State of the Birds Summary](#) / NABCI

population declines (43%) over the past 50 years compared to all other guilds of birds (NABCI 2025).

Aquatic restoration through small dam removal

The 2005 and 2015 SWAPs highlighted existing impoundments and dam construction as a priority source of stress affecting aquatic habitats throughout much of Tennessee. Since 2005, SWG funds and other partnership efforts have focused on piloting small dam removals to improve stream habitat, water quality, and recreational opportunities.

A relatively new tool now available to select the best dams for removal is the **National Aquatic Barrier Inventory & Prioritization Tool**. Begun as a Southeast Aquatic Resources Partnership (SARP) project, it has been expanded, with support from the USFWS, to cover the nation. Data from this tool, augmented by habitat and species occurrences from the 2015 SWAP database, were key in identifying potential dam removals with the greatest benefits. Harm's Mill ranks in the top five out of 2,000 dam removal priorities identified in Tennessee. As of summer 2025, conservation partners including SARP, Tennessee Wildlife Resources Agency (TWRA), The Nature Conservancy (TNC), Tennessee Dept. of Environment and Conservation (TDEC), Tennessee Valley Authority (TVA) and the US Fish and Wildlife Service (USFWS) have planned and permitted the removal of Harm's Mill Dam on the Elk River in Lincoln County. According to the Aquatic Barrier Inventory, as of spring 2025, 38 dams have been or are actively being removed or mitigated in Tennessee, gaining 1,652 miles of reconnected rivers and streams.

2.1.2. Controlling Destructive Invasive Species

Invasive Carp

The species Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*H. Nobilis*), Black Carp (*Mylopharyngodon piceus*), and Grass Carp (*Ctenopharyngodon idella*)—also noted in Tennessee's Aquatic Nuisance Species (ANS) Plan—are a problem for big river SGCN. Invasive nonnative populations escaped or were released from captivity, and in some instances (i.e., Grass Carp) have been stocked for management purposes. Silver Carp and Bighead Carp compete for food with native plankton-eating species including Paddlefish (*Polyodon spathula*), Bigmouth Buffalo (*Ictiobus cyprinellus*), Gizzard Shad (*Dorosoma cepedianum*); the larval fishes of many species; and freshwater mussels.

The noise of boat motors can cause Silver Carp to leap out of the water, creating the potential for human injury or fatality. Commercial fishermen have abandoned fishing sites on the Missouri



Silver Carp, a highly abundant invasive species that is also dangerous to boaters / Invasive Carp Regional Coordinating Committee

River due to the high numbers of invasive carp in their nets (TANSTF 2008), though in recent years,

commercial fishermen have become an important component of efforts to control these invasive species. Black Carp are molluscivores that pose a significant threat to the many threatened and endangered freshwater mussels and snails in Tennessee.

Tennessee's management of invasive carp is part of a broader national effort by state and federal agencies throughout the Mississippi River basin, for which federally appropriated funding has been critical. Tennessee has established ongoing monitoring efforts to track population expansion to new waters, document recruitment events, evaluate population characteristics in invaded waters, and understand behavior of invasive carp to inform prevention and control. In September 2018, Tennessee established the Tennessee Carp Harvest Incentive Program (TCHIP), which has resulted in commercial fishermen removing more than 36 million pounds of invasive carp from the Tennessee and Cumberland rivers as of December 31, 2024!

Tennessee and partners recognize that removal alone is not a long-term solution to prevention and control of invasive carp. Deterrents are needed at locks to further restrict the movement of carp, and Tennessee has been a strong supporter and advocate for implementation of deterrents at priority locations.

Feral Swine

Feral Swine (*Sus scrofa*), also called feral hogs, were introduced to North America by European settlers and have become extremely destructive to the habitats of native wildlife and agriculture. Feral swine can carry at least 30 diseases (including Brucellosis) and nearly 40 types of parasites that may affect people, pets, livestock, and wildlife (USDA APHIS 2024a). Feral Swine can also transmit foodborne illnesses, such as *E. coli*, toxoplasmosis, and trichinosis. In some areas, feral swine have been the cause of elevated waterborne bacteria levels in streams and irrigation canals, which is another risk for human health (USDA APHIS 2024a).

Feral Swine are prolific reproducers and do massive damage to the land through feeding and wallowing. They are also omnivorous and will eat just about anything they can find. Feral Swine depredation can cause turkeys, ground-nesting birds, amphibians, and reptiles to suffer population decreases (Cox 2014). Feral Swine also root up acres of land, including native plant populations, which requires significant time and money to repair.

Nationwide, Feral Swine's range increased from 17 to 39 states over the last 30 years (Bevins and Franklin 2014). The damage from Feral Swine was likewise increasing until concerted management efforts to control swine began in 2014, when US APHIS established the National Feral Swine Damage Management Program to protect agricultural and natural resources, property, animal health, and human health and safety. Using a One Health approach, multiple APHIS agencies collaborate with other pertinent federal, state, territorial, tribal, and local agencies (including TWRA), as well as private organizations to achieve these goals. The program focuses on minimizing Feral Swine damage, eliminating emergent populations, and controlling populations in urban areas where they pose a danger to people and property (USDA APHIS 2024b). The program's success shows in the maps below. The year 2013 is when TWRA closed Feral Swine hunting (Fig.

2.1), and the Feral Swine Management Program began the next year. After having spread from approximately 15 Tennessee counties in 1982 (TWRA unpublished data) to 89 counties in 2013 (Jerrolds & Derroch 2014), control efforts have reduced the range of feral swine in Tennessee significantly (Fig. 2.2) to approximately 40 counties!

Figure 2.1 Feral Swine range in 2013

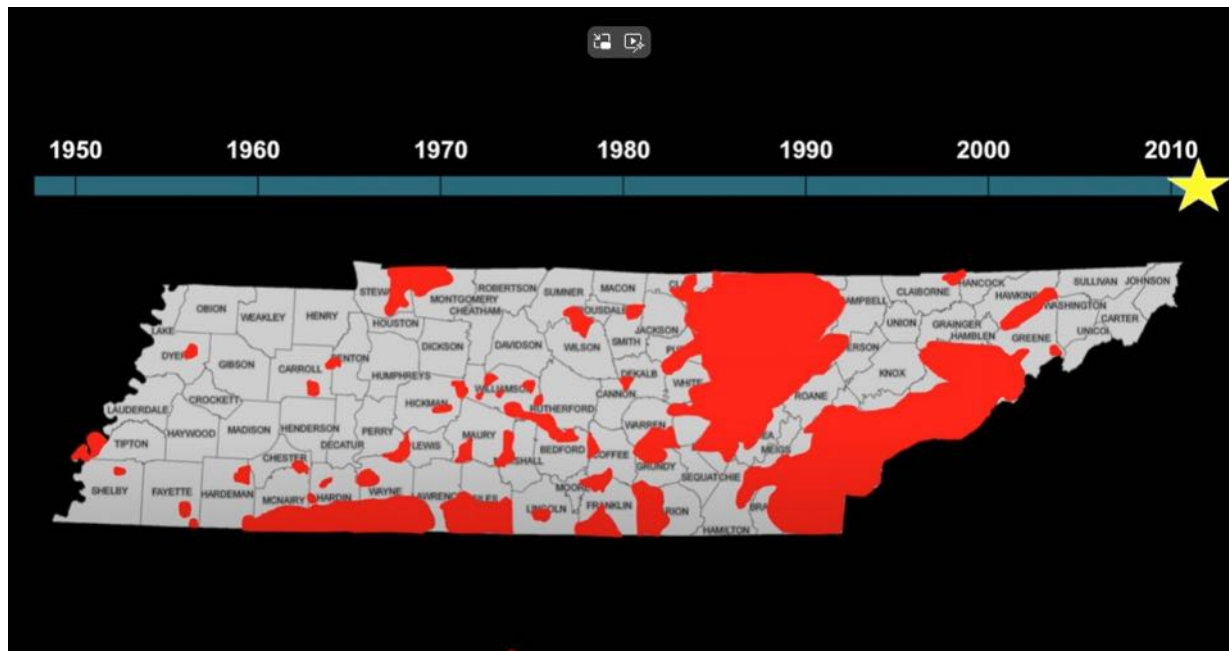
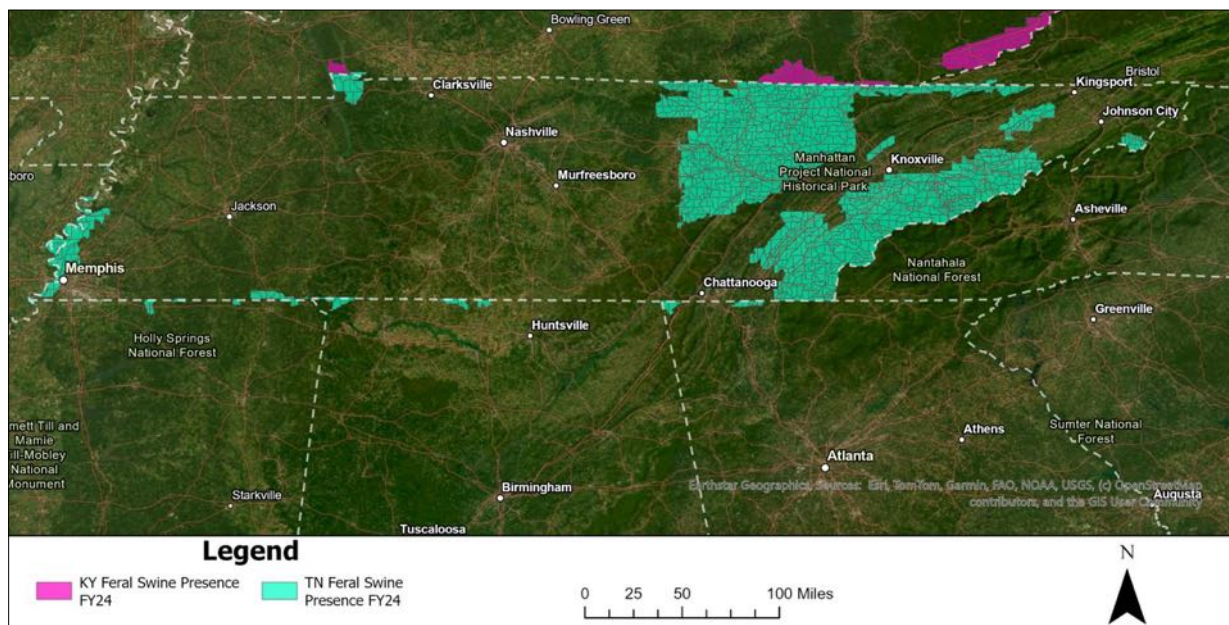


Figure 2.2 Feral Swine range in 2024



2.1.3. Improving Decisions through Data Collection and Analysis

In two TWRA strategic plans issued subsequent to the 2005 SWAP, the lack of information on (1) the status of nongame species populations, (2) their ecological limiting factors, and (3) needed management were identified as priority issues. Since implementation of the 2015 State Wildlife

Action Plan began, TWRA Wildlife Diversity staff have conducted surveys on 51 Wildlife Management Areas (WMAs), three refuges, six wetlands, and six state natural areas/state parks, as well as other key areas across the state.

These surveys have determined the presence, absence, and habitat preferences of SGCNs and have produced over 82,000 observations of herpetofauna and mammals (both volant and non-volant), including 2,735 captures of SGCN. TWRA maintains all survey data, and these data significantly increased occurrence records in the 2015 SWAP Geographic Information Systems (GIS) relational database. Data collected through these and partner survey efforts are incorporated into management plans developed for WMAs and have helped to inform the development of habitat management or restoration projects to directly benefit SGCN. Additional monitoring projects have incorporated the ability to track species' response to management activities.

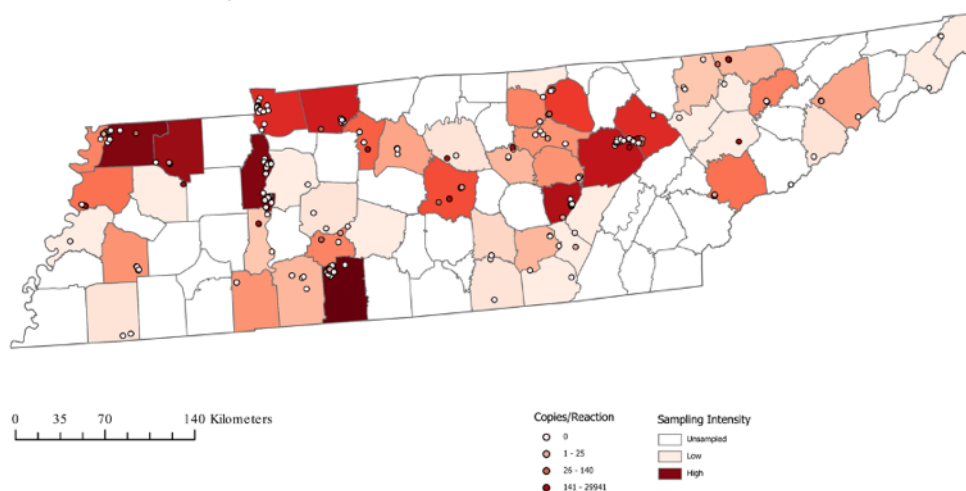


Silver-haired Bat (*Lasionycteris noctivagans*) / Michaela Bass, TWRA

Tracking the effects of a deadly disease

Emerging infectious diseases are increasingly recognized as a significant threat to global biodiversity conservation, leading to an increasing number of studies that quantify how these diseases influence wildlife health. Recent research conducted by Romer et al. (2024) indicates that Snake fungal Disease (Ophidiomycosis or SFD) is an emerging pathogen that may alter the host microbiome by inducing dysbiosis, an ecological state characterized by a reduction in “good” bacteria and an increase in pathobionts (microorganisms that are normally harmless in healthy

Figure 2.3 Sampling intensity for SFD within Tennessee Counties



individuals, but which can become pathogenic under specific circumstances, such as changes in the host's environment, immune system, or diet). The maps below show the results of surveys conducted by Dr. Donald Walker's Microbiome Ecology Lab at Middle Tennessee State University. The maps show where snakes were sampled for the presence of disease (Fig.2.3), based on a predictive model of disease occurrence, which counties were positive for the presence of SFD (Fig. 2.4), and the percent of positive detections (Fig. 2.5).

Figure 2.4 Map showing counties in which SFD was detected, and the types of detections

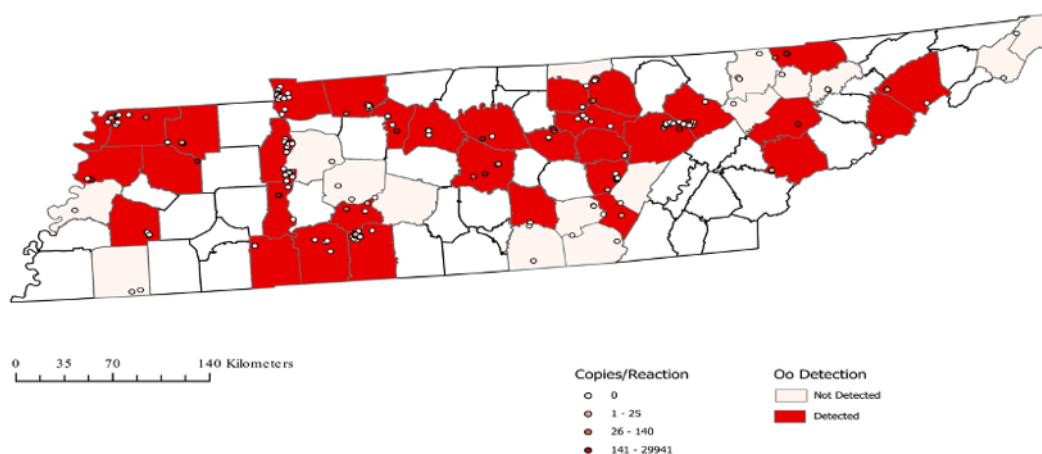
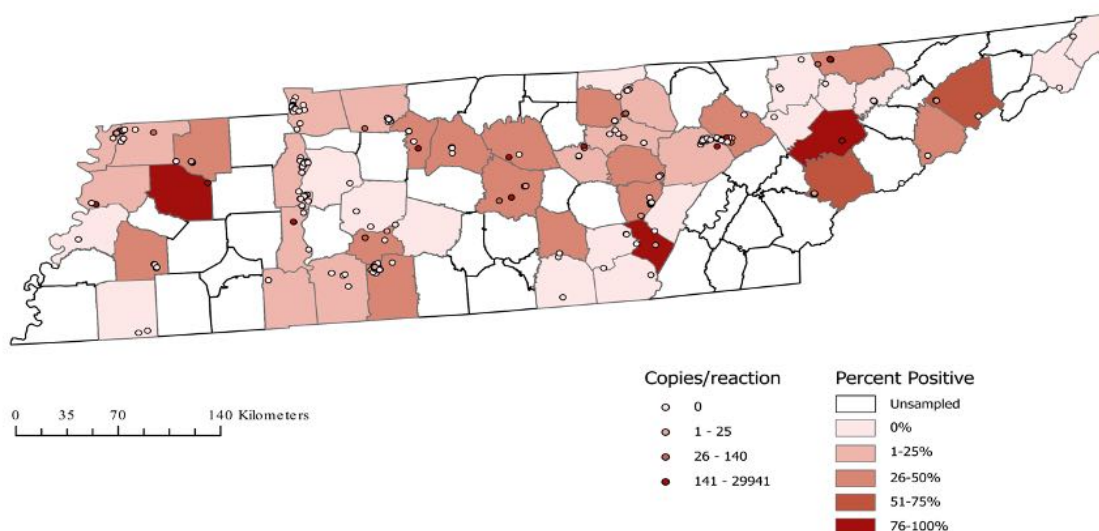


Figure 2.5 Percent of samples testing positive for SFD by county across the state



White-nose Syndrome (WNS)

WNS is a disease impacting some species of cave hibernating bats in North America. The fungal pathogen that causes WNS (*Pseudogymnoascus destructans*) was introduced into North America in 2006, and it has spread across the continent from the epicenter in New York (White-nose syndrome 2025). The disease was discovered in Tennessee in 2010 and has since decimated populations of Northern Long-eared Bats, Tricolored Bats, Indiana Bats, and Little Brown Bats in the state (see photo at right).

Part of the national response to WNS has been the development and implementation of the North American Bat Monitoring Program (NABat; Loeb et al. 2015). The program provides detailed protocols to collect acoustic bat data and serves as a database for a variety of bat data from organizations across the continent. Data submitted to NABat is used to analyze bat population trends and occupancy (where bat species occur on the landscape) at range-wide scales and helps inform conservation management.



Five bat SGCN in Tennessee that are vulnerable to WNS, clockwise from upper left: Tricolored Bat (on top) (*Perimyotis subflavus*) and Little Brown Bat (*Myotis lucifugus*); Northern Long-eared Bat (*Myotis septentrionalis*); Gray Bat (*Myotis grisescens*); Indiana Bats (*Myotis sodalis*) / all photos by Daniel Istvanko, TWRA

With funding support from the USFWS's WNS grants to states and tribes, TWRA has implemented an annual stationary and mobile acoustic bat monitoring program. Bat acoustic data is collected by deploying ultrasonic recording devices to record the high frequency echolocation calls from bats. The calls are analyzed with automated software that can often identify which species were recorded based on the frequency and structure of the echolocation calls. Bat stationary acoustic data is recorded each year at 60 sites across the state by TWRA. The data is then analyzed and uploaded to the NABat database. Additionally, TWRA coordinates bat winter colony count surveys across the state each year. These surveys are critical to understanding the population trend of cave hibernating bats and impacts from WNS. Since the discovery of WNS in Tennessee, TWRA and partners have increased capacity, and an average of 98 bat winter colony count surveys have been completed each year in the state since 2015 (Thames 2025).

With support from USFWS WNS grants, TWRA has harnessed the Tennessee Bat Working Group's network of bat biologists to host a bat blitz each summer since 2021. A bat blitz is an event where bat biologists come together and conduct mist net surveys over a couple nights in a small geographic area. The bat captures from these events provide critical species and relative abundance data that inform management and conservation. These data allow biologists to assess bat communities on the landscape, providing more reliable information than acoustic monitoring.

Monitoring newly discovered bat colonies

Tennessee is home to 16 species of insectivorous bats. Bats provide critical ecosystem services by consuming insects and, therefore, saving farmers across the US billions annually and helping to maintain balance in the ecosystems that humans depend on (Boyles et al. 2011).

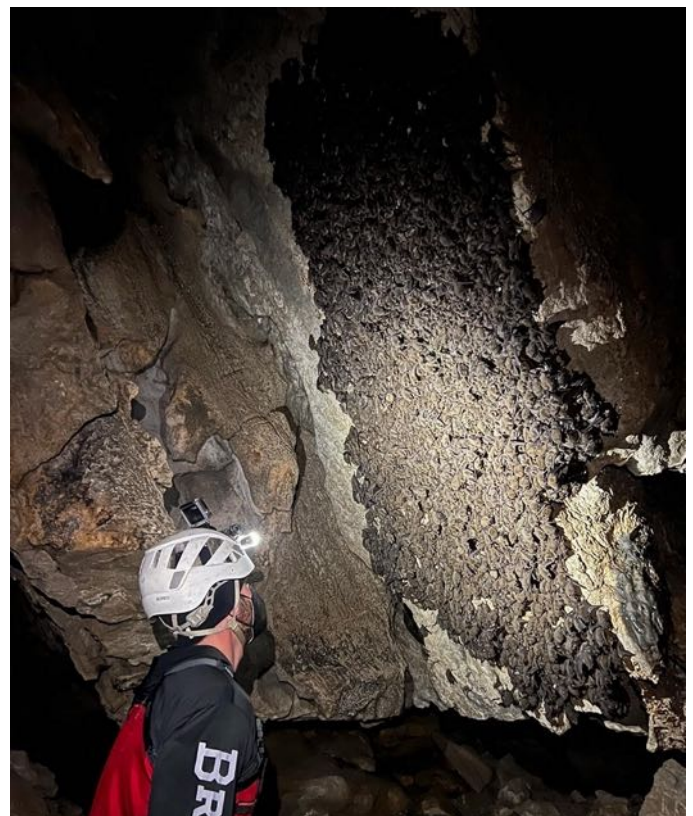
Unfortunately, ten of the 16 species are SGCNs due primarily to declining populations from a variety of threats. Additionally, the basic life history of many species is poorly understood, making conservation challenging. TWRA initiated a spring migration study in 2009 on federally endangered Indiana Bats. Indiana Bat hibernacula are generally well known in Tennessee and have been monitored for decades. However, prior to a spring migration study that was conducted annually from 2009-2018, it was unknown where the Indiana Bats that hibernate in Tennessee migrate to form maternity colonies.

The project resulted in the discovery of maternity colonies at six sites in Tennessee, and numerous sites out-of-state, including Chattahoochee National Forest in Georgia, Holly Springs National Forest in Mississippi, and Talladega National Forest in Alabama. The most populous maternity sites in Tennessee are located in Wilson County and, unlike the sites out-of-state, the Wilson County colonies are on private property.

To conserve and protect these populations, TWRA harnessed grant funding from TVA to develop license agreements with landowners. These



BrandenBark (left) and Rocket Box installed on private property in Wilson County, TN / Dustin Thames, TWRA



Gray Bats at Pearson Cave / Mallory Tate Cogburn, TWRA

agreements provide TWRA with access to the property and rights to install artificial roosting structures for the bats. In exchange, the private landowners get an annual monetary payment. Approximately 1,300 acres are currently held in license agreement and 36 artificial roosts were installed on the properties in 2020. The first spring after installation, Indiana Bats formed a maternity colony in one of the artificial roosts. The population using the roost has increased each year with the highest count of 53 Indiana Bats being documented in 2024 (see White-nose Syndrome Highlight).

The success of this project provides a framework for conserving endangered bats on private property. More funding is needed to purchase property in the area to ensure the protection of this maternity colony in perpetuity. TWRA has developed strong relationships with landowners in the area, and these relationships have been critical in educating landowners on the life history and conservation needs of bats.

2.1.4. Protecting Lands and Waters in Perpetuity

Priority bat caves in Tennessee

The previous iterations of Tennessee's SWAP have consistently highlighted the importance of land acquisition in protecting populations of SGCN. SWG funding, along with other funding sources, has been used to protect numerous tracts of land across the state of Tennessee. For example, since 2005 TWRA has purchased property surrounding two of the three largest bat caves in Tennessee: Bellamy Cave in Montgomery County (34 acres in 2007, and 5 acres added in 2013 with a State Wildlife Grant) and Pearson Cave in Hawkins County (102 acres in 2009, and 46 acres added in 2013 with SWG funding).

Bellamy and Pearson Caves are winter hibernacula and summer maternity sites for federally endangered Gray Bats. The number one priority recovery action listed in the Gray Bat recovery plan is the protection of roosts from human disturbance (USFWS 1982). Following TWRA's acquisition of Bellamy Cave and the construction of a gate to protect the site from human disturbance, the winter Gray Bat population increased from 91,000 in 2002 to 348,871 in 2024! The winter population of Gray Bats at Pearson also increased following protection. In 1978 the winter population of Gray Bats at Pearson Cave was estimated to be only 100,000. In 2024, the population was up to 256,202, and the highest number was estimated in 2015 at 431,020. The population at Pearson fluctuates, and over the past 15 years declines at Pearson have corresponded with increases at other sites.

In 2018, TWRA harnessed SWG and other funding sources to purchase Whiteside Cave in Marion County. The site is a winter hibernaculum for Tricolored Bats and receives substantial human disturbance due its accessibility and reputation with cavers and

Following TWRA's acquisition of Bellamy Cave and the construction of a gate to protect the site from human disturbance, the winter Gray Bat population increased from 91,000 in 2002 to 348,871 in 2024!

locals. Prior to the acquisition, TNC and partners constructed a cave gate at the site. Conservation of Tricolored Bats has become a high priority for conservation groups due to population declines from WNS. Prior to WNS Tricolored Bats were among the most common species in Tennessee, and the protection of Whiteside Cave represents a shift in priorities from federally listed bats to WNS-impacted bats.

Additionally, the agency began gating high priority bat caves in the state to reduce human disturbance. TWRA has gated or constructed

Powers-style exclusion fencing at Grassy Cove Saltpeter Cave (Cumberland County), Carlton Cave (Franklin County), Keith Cave (Franklin County), a civil war bunker (Tipton County), and Jolley Saltpeter Cave (Union Cave). These efforts reduce anthropogenic disturbance to Tricolored Bats, Indiana Bats, Northern Long-eared Bats, and Little Brown Bats using these caves.



Tricolored Bat at Whiteside Cave / Daniel Istvanko, TWRA

Specialized habitats for SGCN

Many other acquisitions of land or conservation easements have occurred since 2015, almost all of which were informed by information provided in the 2015 SWAP, particularly the Conservation Opportunity Areas. For example, TennGreen Land Conservancy completed 62 total acquisitions (fee title or conservation easements) from 2015 to 2024. These acquisitions were often carried out in concert with other partners, such as The Nature Conservancy, The Conservation Fund, or local conservancies (e.g., Wolf River Conservancy, Swan Conservation Trust, etc.). All of these acquisitions address threats to the species posed by development, incompatible forestry, and or protection of priority wildlife habitat or high-value recreational land. The 2025 SWAP Steering Committee is seeking to collect comprehensive data on land acquisitions that have occurred across the state since 2015. That process is ongoing.

State Natural Areas and rare species protection

Tennessee Department of Environment and Conservation's Natural Areas Division has added four new designated State Natural Areas (SNAs) over the last decade, including Window Cliffs SNA, which protects populations of the rare Plains muhly grass (*Muhlenbergia cuspidata*) and Eastern white cedar (*Thuja occidentalis*); Lost Creek (SNA), which is home to a number of biodiverse caves and karst features; Sherwood Forest SNA, which protects the Painted Snake–coiled Forest Snail (*Anguispira picta*) along with numerous rare plant species; and Walnut Knob SNA, which was designated to protect the Braun's rock cress (*Borodinia perstellata*). In total the division has added more than 6,500 acres of protected state natural area lands since 2015.

Since the 2015 Tennessee State Wildlife Action Plan was published, TNC has used the SWAP to prioritize and complete over 93,000 acres of land acquisition projects statewide. TNC did not do

this alone. State and federal agencies, including TWRA, TDEC, Tennessee Division of State Parks/Natural Areas, the USDA Forest Service (USFS), and the US National Park Service (NPS), as well as other nonprofit land trusts, such as The Conservation Fund and TennGreen Land Conservancy, coordinate together to identify, purchase, and manage critical wildlife habitats and the SGCN that rely upon them.

Otey Mills Refuge Unit, located within North Cumberland Wildlife Management Area in Claiborne County,

is a recent (2022-24) land protection collaboration between TWRA and TNC that exemplifies the SWAP's informative power. The refuge's 3,464 acres match multiple SWAP ranking criteria:

- Both open and forested habitat are used by a monitored elk herd.
- Subterranean karst features support rare and endemic cave invertebrates.
- Native hardwood forest connects to other state and federally-owned public land.
- The unit provides habitat for rare, threatened, and endangered bats and migratory songbirds.
- It provides public access for multi-use outdoor recreation.

2.1.5. Data-driven Planning

The 2005 SWAP recognized sprawl as the single greatest threat to Tennessee's remaining natural landscapes. To address this threat, it provided maps and data that could be used to identify critical watersheds for protection.

Improved agency planning and coordination

Beyond TWRA, organizations and agencies that protect or manage land in perpetuity, such as land trusts, TDEC, USFWS, NPS, and the USFS use the SWAP to identify and justify the protection of critical wildlife tracts. By working with TNC and TWRA GIS staff, species and their associated habitats can be identified for potential protection (See SWAP Relational Database Highlight). Other agencies such as the USDA Natural Resources Conservation Service and Tennessee Division of Forestry can use the current and future plans to identify watersheds and specific sites where improved land management will benefit SGCN and their habitats.



Window Cliffs Class II Natural Scientific State Natural Area / TDEC

Planning for habitat conservation

TWRA's SWAP has supported local and regional planning initiatives:

- A Gray Bat migration analysis was conducted by TNC in 2021 using updated SWAP data from 2015. TN data was combined with data on all Gray Bat sites across its entire known range (nine Southeast states) to model movement and create a heat map demonstrating the likelihood of landscape use by Gray Bats (Holliday et al. 2023). The study identified two major areas of use during spring and fall migration, as well as four likely movement pathways, which can be used to anticipate bat presence and optimize wind turbine siting to avoid impacts.
- Rural and scenic Cheatham County, located adjacent to the growing metropolis of Nashville, created a Sustainable Tourism Plan by assessing its natural and cultural resources to highlight, among other values, its ecotourism potential (Tennessee Regions' Roundtable Network 2013)
- Cumberland Region Tomorrow used the SWAP GIS database to create "GIS Greenprint Tools" for a 10-county region using SWG funding. The tools highlight critical lands for conservation in open space and transportation planning (Elliott 2010).

2.1.6. Saving Species through Reintroductions

Species reintroductions occur both as a means of preventing listing under the Endangered Species Act and to bring back populations of rare species where they have declined or disappeared. Stocking programs in Tennessee are part of a long-term program designed to restore reproducing populations of native species to Tennessee waters.

Eastern Hellbender

Since the 2015 Tennessee SWAP was completed, conservation for Hellbenders ramped up to include several new species restoration efforts statewide. Two head-start programs, one at the Nashville Zoo and the second at Chattanooga Zoo, along with studies to determine feasibility of releasing head-started hellbenders and translocating them, are taking place to restore this species in several Tennessee watersheds.

The Eastern Hellbender (*Cryptobranchus alleganiensis*) is Tennessee's largest salamander with adults reaching a total length exceeding 24 in and some exceeding 25 years of age.

The scientific name is derived from "Cryptobranchus" which uses the Greek words *kryptos* meaning hidden, concealed, secret, i.e. cryptic and *branchion* meaning gill; together the name



Eastern Hellbender held by TWRA Biologist Chris Ogle / Scott Dykes, TWRA



Hellbender compared to a Common Mudpuppy (*Necturus maculosus*) / Chris Simpson, TWRA

refers to the absence of external gills. Similarly, “alleganiensis” refers to the Allegheny Mountains, where it was first discovered (Niemiller and Reynolds 2011). The Eastern Hellbender is also referred to as the “snot otter,” “devil dog,” and “lasagna lizard.” Since 2000, the Eastern Hellbender in Tennessee has been listed as a species deemed in need of management. By 2013, an imminent potential for federal listing and a need to better understand the status of hellbenders in Tennessee led TWRA to fund surveys through its SWG program.

Based on surveys conducted by Middle Tennessee State University (Moonshiner 2013), it was determined that hellbenders in the state were likely undergoing declines, and likely extirpations in some watersheds had occurred since the 1990s (Miller and Miller 2005). Surveys indicated many middle Tennessee populations lacked multiple age classes, as juveniles and smaller individuals were not observed, and populations were limited to just a few older individuals. Current science indicates the juvenile stage after hatching appears to be a critical point for recruitment, as very few larvae are found in the wild.

The hellbender was proposed for state listing in 2016 and approved by the Tennessee Wildlife and Fisheries Commission as state endangered in August 2017. In December of 2024, the US Fish and Wildlife Service announced a proposal to list the Eastern Hellbender as an endangered species throughout its range under the Endangered Species Act.

Since 2015, TWRA has been working with the Nashville Zoo to head start Eastern Hellbenders. The Nashville Zoo has been collecting hellbender eggs from nests in the Duck River watershed since 2015 as a part of its head starting program. They have successfully reared more than 200 hellbenders from those eggs in a small trailer behind the scenes at the zoo, allowing them to reach a size that should boost their survival in the wild. Beginning in 2021 and in partnership with Tennessee State University,



Tanks at the Nashville Zoo for head starting Eastern Hellbenders / Chris Simpson, TWRA



TWRA Biologist Kirk Miles and Mark Thurman, TNC with two juvenile hellbenders ready for release / Chris Simpson, TWRA



Biologists measuring and weighing zoo-raised Hellbenders in preparation for release into the wild /Cyna Gehring

24 to 35 hellbenders have been implanted with radio transmitters and released in the Duck River watershed each year. The released individuals have been monitored to check survival, ascertain movement, and to better understand the impacts of releasing the hellbenders back into the watershed. In May 2025 an additional 24 four- to six-year-old hellbenders were released in the Duck River watershed.

In 2020, a new hellbender head-starting project funded by the USFS along with SWG funding supported partners from the Chattanooga Zoo Hiwassee Hellbender Research and Education Facility and Lee University to start the work on hellbenders

in southeast Tennessee. The plan was to collect eggs from the wild, hatch and rear them for three to four years, and release them in the Hiwassee watershed in southeast Tennessee. The Chattanooga Zoo and Lee University had their first initial release in 2024, and monitoring of all the released head-started hellbenders is ongoing to determine the success of these releases.



One of the undisclosed sites where head-started hellbenders were released back into a tributary of the Buffalo River in 2025 / Cyna Gehring

Additionally, in 2022 these partners along with TSU—as part of the hellbender work within the Cherokee National Forest—translocated adult hellbenders from several tributaries to neighboring tributaries where hellbender populations had become isolated due to a loss of connectivity. Monitoring of these populations is primarily through telemetry and physical snorkel surveys. The new technology of eDNA is being used to help determine potential presence of hellbenders and direct future surveys through the collection of water samples.

Yellowfin Madtom

The Yellowfin Madtom is a brightly colored miniature catfish and is one of the first species that Conservation Fisheries Inc. (CFI) began working with in the 1980s (see the CFI “Innovation, Success” Highlight). Due in large part to CFI’s captive breeding and reintroduction program, the Yellowfin Madtom is currently on the USFWS shortlist for delisting as an endangered species! CFI’s program began by reintroducing the madtom into one of its original home streams, Abrams Creek. In the 70s, the species was limited to the Powell River and Citico Creek.

Now, there are established populations in Abrams Creek, Tellico Creek, the North Fork Holston River, the Clinch River, and seven sites in the French Broad River. If all of these populations prove successful, the fish will have met or exceeded the USFWS recovery plan’s criteria for delisting. As Bo Baxter, President and Director of CFI states, “Not many species have come off the endangered species list, but the Endangered Species Act has kept them on the planet.” Programs such as Section 6, through which the USFWS allocates funding to states for rare species conservation work, are critical to this success. Section 6 grants have supported Yellowfin Madtom recovery since the beginning in 1983.



Yellowfin Madtom / Dick Biggins, USFWS

Freshwater mussels

Tennessee has tremendously rich aquatic fauna, particularly when it comes to freshwater mussels. Except for Alabama, the lakes, streams and rivers of Tennessee once harbored the most diverse and abundant assemblage of mussels known: 140 of 300 mussel species recorded in the country are or were known to occur here. However, mussels make up almost half of the state’s federally listed threatened and endangered species. The current level of imperilment of Tennessee’s mussel fauna adds greater importance to conservation efforts for species not yet designated in federal listings.

Mussels are important biological water filters for rivers, are used in research, and provide food for other wildlife. Their shells are **sought commercially** for their nacre used to create nuclei used in the

cultured pearl industry. The Tennessee Freshwater Mollusk Strategic Plan (Medlock et al. 2013) calls for the propagation and reintroduction of important mussel species into priority streams; this program has been augmented through SWG-funded equipment and facilities. An outstanding example is the **Cumberland River Aquatic Center** or CRAC, a unique facility built with the partial support of SWG grants, the full dedication of TWRA staff, and partnerships with TVA and the US Army Corps of Engineers. The CRAC focuses on propagation and reintroduction of aquatic species into the Cumberland River.

There are currently 11 species housed at CRAC, 7 that are federally listed and 4 that are common throughout Tennessee. Some of the rare species include Pink Mucket (*Lampsilis abrupta*), Birdwing Pearly Mussel (*Lemiox rimosus*), and Sheepnose (*Plethobasus cyphus*). Since its establishment in 2015, CRAC has worked with 24 freshwater mussel species including 16 that are federally endangered, one that is federally threatened, and one that is proposed endangered. A major breakthrough at CRAC has been the adoption of in-vitro culture technology for mussel propagation, which began in 2018 (See the Pale Lilliput In-Vitro Fertilization Highlight). This innovative method has proven especially valuable for species that are difficult to propagate using traditional techniques. As a result, CRAC has successfully propagated nine endangered species using this method, including the Cracking Pearlymussel (*Hemistena lata*), Duck River Dartersnapper (*Epioblasma ahlstedti*), Pale Lilliput (*Toxolasma cylindrellus*), and Cumberland Monkeyface (*Theliderma intermedia*). Over 10,000 juvenile mussels have been propagated at CRAC and released out into rivers across the state including the Duck River, Elk River, and Nolichucky River.



Tagging mussels as part of TWRA's Capture-Mark-Recapture mussel monitoring program on the Duck River / Brittany Bajo-Walker, TWRA