# Action Plan for the Cumberlands East Conservation Focus Area

May 5, 2023

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# List of Acronyms Used

ACEP- Agricultural Conservation Easement Program
AFF- American Forest Foundation
AMJV- Appalachian Mountain Joint Venture
ATFS- American Tree Farm System
BMPs- Best Management Practices
B-Rank- Biodiversity Rank
CFA- Conservation Focus Area
CCV- Cave Conservancy of the Virginias
CCVI- Climate Change Vulnerability Index
CERW- Cerulean Winged Warbler
CREP- Conservation Reserve Enhancement Program
CRP- Conservation Reserve Program
CSP- Conservation Stewardship Program
EQIP- Environmental Quality Improvement Program
ESH- Early Successional Habitat
FSA- Farm Service Agency
FSC- Forest Stewardship Council
G Rank- Global Rank
GWWA- Golden-winged Warbler
HUC- Hydrologic Unit Code
NRCS- Natural Resources Conservation Service
NSS- National Speleological Society
NWTF- National Wild Turkey Foundation
OHCF- Outdoor Heritage Conservation Fund
OSMRE- Office of Surface Mining and Reclamation
RGS- Roughed Grouse Society
SFI- Sustainable Forestry Initiative
SGCN- Species of Greatest Conservation Need
S Rank- State Rank
SWAP- State Wildlife Action Plan
TCF- The Conservation Fund
TNC- The Nature Conservancy
TU- Trout Unlimited
USDA- United States Department of Agriculture
USDOI- United Stated Department of Interior
USFWS- United States Fish and Wildlife Service
WMA- Wildlife Management Area
WVACS- West Virginia Association for Cave Studies
WVASS- West Virginia Speleological Survey
WVCA- West Virginia Conservation Agency
WVCC- West Virginia Cave Conservancy
WVDA- West Virginia Department of Agriculture
WVDHHR- West Virginia Department of Health and Human Resources
WVDNR- West Virginia Division of Natural Resources
WVDEP- West Virginia Department of Environmental Protection
WVDOF- West Virginia Division of Forestry
WVDOH- West Virginia Division of Highways
WVLT- West Virginia Last Trust
WVU- West Virginia University

# Executive Summary

In 2015 the West Virginia Division of Natural Resources (WVDNR) completed the first revision to the State Wildlife Action Plan (SWAP) with the input of numerous stakeholders from across the state, including public agencies and land managers, researchers, local and regional conservation organizations, volunteer groups, private landowners and members of the public. The 2015 SWAP identified 21 Conservation Focus Areas (CFAs), each with a distinctive set of Species of Greatest Conservation Need (SGCN), wildlife habitats, stresses that can adversely affect those species and conservation opportunities to address those stresses. In 2018 the WVDNR and The Nature Conservancy (TNC) began convening a working group of local stakeholders including public agencies and land managers, watershed groups, cave interest groups and other non-profit conservation organizations working in the area to develop the Action Plan for the Cumberlands East CFA. The plan addresses the eight essential elements required in the SWAP. It provides an overview of the landscape and major habitat types within this CFA, including forest and woodland habitats, rock outcrop, cliffs and talus and shale barren habitats, aquatic, floodplain and riparian habitats, and developed and agricultural habitats. It also identifies 57 plant and animal SGCN that are priorities for conservation within this CFA based on factors such as their abundance, distribution, population trends and opportunities for conservation. For each major habitat type the plan lists the priority species, stresses and voluntary actions that can be taken by private landowners, public land managers and partner organizations for the conservation of wildlife species and their habitats. Climate stresses impacting each major habitat type and potential actions to boost their resilience are also listed. An implementation plan for each major habitat type lists partners and programs available to assist with each of the actions as well as metrics for monitoring conservation success. There is also a summary of other human benefits that may be generated by the proposed conservation actions in each major habitat type. The plan also describes a regional network of resilient and connected landscapes within which wildlife species can adapt and shift to a changing climate, identifies high integrity as well as resilient and connected landscapes within the CFA and provides an implementation plan for landscape resilience and connectivity. The plan concludes with a summary of the priority habitats for conservation, describes the importance of combining conservation actions for greater impact and connecting them across the landscape for climate resilience and outlines next steps in plan implementation.

Local stakeholders can use this plan to identify priority species, the habitats and stresses within the CFA, as well as partners who can assist with planning, implementation and monitoring of conservation actions to conserve wildlife and enable climate adaptation. The information in this plan can also be used to inform conservation projects being planned by partners and provide justification for grant applications and other proposals seeking to conserve priority species and habitats. Local stakeholders can also work with relevant agencies to develop strategies to avoid, minimize and mitigate impacts to priority species, their habitats and the resilient and connected landscapes within the CFA.

Conserving wildlife species and their habitat within the CFA will rely upon the voluntary actions of local landowners, public agencies and partner organizations, with support from the WVDNR. WVDNR will convene a working group of local stakeholders on a regular basis to provide guidance, assistance and support; implement and monitor conservation actions; facilitate stakeholder collaboration; and update the plan every 10 years or sooner if needed.

# Introduction to the State Wildlife Action Plan & Conservation Focus Areas

The West Virginia Division of Natural Resources (WVDNR) manages the state's wildlife resources as part of the public trust. A goal of the WVDNR is to support and promote a sense of ownership in the conservation community and the public for the unique habitats and wildlife resources in West Virginia. The 2015 WV State Wildlife Action Plan (SWAP) was therefore developed to function as a blueprint for conservation for use by other natural resource agencies, local governments, non-governmental organizations and the general public (WVDNR 2015). The SWAP is intended to have a ten-year timeframe and will be updated by 2025.

## Species of Greatest Conservation Need, Habitats and Stresses

The 2015 SWAP identified 681 wildlife Species of Greatest Conservation Need (SGCN) across the state. Because plants are a fundamental element of habitat for wildlife SGCN, a list of SGCN plants was also developed, including 482 plant species.

The SWAP classified and mapped 19 terrestrial habitats across the state. These include 16 natural or semi-natural habitats that are derived from NatureServe's Ecological Systems (Comer et al., 2003, Gawler 2008) and 3 anthropogenic habitats that represent map classes of the National Land Cover Database (Homer et al., 2004). In addition, the SWAP classifies and maps 18 aquatic habitat types. These are GIS-derived types based on a simplification for West Virginia of the Northeast Aquatic Habitat Classification System (Anderson et al., 2013). Stream size is considered the most influential variable on determining biological assemblages at the reach scale and is divided into four primary classes: headwaters and creeks, small rivers, medium rivers and large rivers. Stream slope, or gradient, affects aquatic communities at the reach scale due to its influence on stream bed morphology, water velocity and sediment dynamics. Three relative classes (low, moderate, high) of gradient are used to define West Virginia's streams. Water temperature in streams is a key physiological characteristic determining where different stream organisms may persist. Temperature affects seasonal migrations, growth rates, body condition and fecundity of biota. Three temperature classes (cold, cool, warm) based on continuously recorded data and modeled environmental variables were used to determine biological constraints on stream communities in the model. The characteristics, distribution, trends and threats associated with each of the terrestrial and aquatic habitats are described in the 2015 SWAP.

For those SGCN listed in the SWAP as and their associated habitats, WVDNR staff developed a statewide stress assessment using the classification system of the International Union for Conservation of Nature. Terrestrial stresses were addressed at the habitat level within ecoregions. Aquatic stresses were addressed at the HUC 8 watershed level within ecoregions. The resulting analysis identified 21 major statewide stresses affecting terrestrial SGCN and habitats and 21 major stresses that affect aquatic SGCN and habitats. Stresses exerted on SGCN populations and habitats can reduce species populations either directly, by causes such as disease, or indirectly, by affecting the quality or quantity of available habitat.

## Conservation Actions

The purpose of stress assessment and prioritization in the 2015 SWAP is to identify statewide conservation actions that can reduce stress on SGCN populations and their habitats. Most stresses are the result of the lawful activities of people, corporations and public agencies. Rather than seeking a regulatory approach to

restrict lawful activities, the intent of the SWAP is to promote collaboration with landowners, corporations and other partner organizations and agencies to reduce stresses on wildlife species and their habitats.

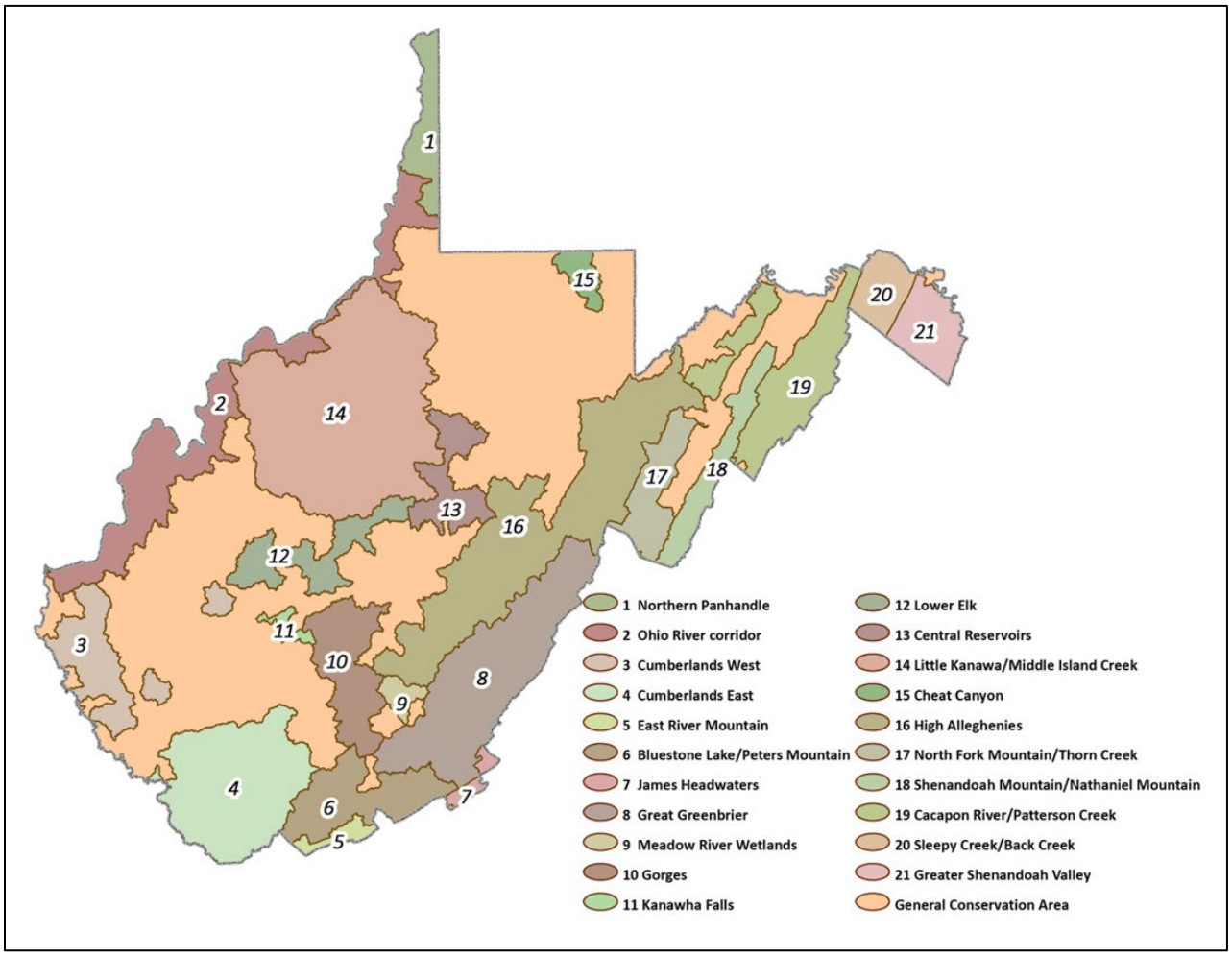
Conservation actions vary according to the species and the specific stresses; actions can take many forms. A lack of information on the status of a species or understanding of a threat may indicate a need for actions such as baseline inventory, research, or data acquisition. Direct action may involve directly protecting or restoring habitats or even restoring populations. Conservation easements are a form of habitat protection that preserves habitat in its current state or can include land management plans that benefit wildlife. It is likely that a suite of actions is required depending on the identified stress and the opportunities available. Ideally, actions are designed to address the source of the stress (AFWA 2011). Conservation actions must also address habitat integrity and ecosystem processes. This includes conserving or preserving intact and functional habitats, protecting or restoring aquatic resources and maintaining and restoring connectivity between habitats (AFWA 2012, Byers and Norris, 2011).

## Conservation Focus Areas and Action Plans

The SWAP provides a broad framework for conservation across West Virginia. However, wildlife species are concentrated in different parts of the state and exposed to multiple stresses at state, regional and local scales. Conservation Focus Areas (CFAs) are specific regions in the state where SGCNs are concentrated, addressable threats are identified and where feasible opportunities exist for focused actions that will achieve success. In completing the 2015 SWAP, WVDNR defined 21 CFAs across the state based on these factors. Map 1 on the following page illustrates the CFAs in West Virginia.

In addition to conservation actions at the statewide level, the 2015 SWAP envisioned that planning at the CFA level would be necessary to fully implement successful conservation and to further define conservation actions and measurable outcomes for most SWAP-based activities. The SWAP also notes that investing conservation resources in the CFAs could increase the potential for collaboration with partners and landowners, as well as the efficiency and effectiveness of conservation on the ground. CFA Action Plans have been developed to identify priority SGCN from each taxa group in each major habitat type, key stresses in those habitats and actions that will effectively secure or protect priority species and their habitats within the CFA. The Plans also identify public lands that can provide opportunities for conservation in collaboration with public land managers. Because many SGCN and their habitats occur on private property within CFAs, conservation actions will require collaboration with private landowners, as well as partner organizations and stakeholder groups. Many local partners have relations with landowners as well as the expertise, capacity, resources and funding to plan and implement the actions listed in CFA Action Plans. CFA planning engages local partners and stakeholders at a scale where collaboration can increase resources (funding, capacity) available for conservation action. WVDNR has engaged a working group of local partners in developing each CFA Action Plan and intends to facilitate, guide and support partner efforts in planning, implementation and evaluation of conservation actions to implement the plans.

*Map 1. Conservation Focus Areas in West Virginia.*




## Climate Change and Resilience

The 2015 SWAP lists climate change as a substantial threat to wildlife and plant populations, noting several recent studies. For example, an assessment of the relative vulnerability to climate change of 185 animal and plant species in West Virginia (Byers and Norris, 2011) identified natural and anthropogenic barriers to movement and dispersal, and physiological thermal and hydrological niches occupied by some species as risk factors correlated with vulnerability to climate change. Over half of the species assessed were determined to be vulnerable to climate change. Both this study and the SWAP identify climate change as a stressor particularly for cool and coldwater fish, mollusks, plants, terrestrial salamanders and many species associated with wetlands and high elevation ecosystems. The SWAP lists habitat shifts and alterations as statewide stresses for terrestrial SGCNs and it lists increasing frequency and severity of droughts, storms and flooding and temperature extremes as statewide stresses for aquatic SGCN and habitats. The SWAP notes that even within taxonomic and habitat groupings, species may respond differently to climate change based on their sensitivity to factors such as temperature, moisture and seasonal triggers. Because climate change acts in tandem with other stresses on wildlife and habitat, the SWAP suggests that actions to address those other stresses could decrease their vulnerability to climate change. Varying conditions among CFAs means actions to address climate impacts should be tailored to each CFA, emphasizing

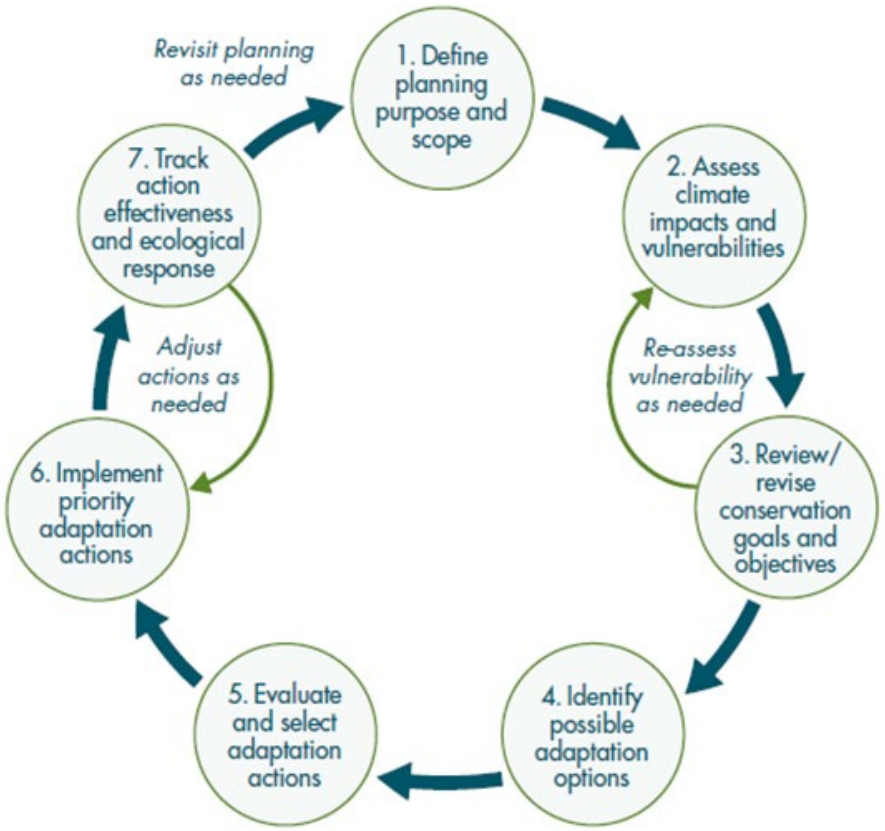
restoration and expansion of vulnerable habitat types in some areas, or reducing habitat fragmentation in others. The SWAP suggests that efficient approaches to maintaining broad suites of species include maintaining functioning ecological systems, landscapes that are resilient to the effects of climate change and ecological connectivity within and between landscapes. Rather than a species-specific approach, the SWAP therefore seeks to address climate change broadly through additional vulnerability assessments for select species, statewide actions to reduce additional stresses on SGCNs and their habitats, and more geographically focused actions in Conservation Focus Areas (CFAs). CFAs are an appropriate scale to promote climate resilience by identifying local actions to relieve stresses on SGCN, restore or expand vulnerable habitats, and maintain ecosystems process, landscape resilience and habitat connectivity.

## Monitoring and Adaptive Management

Monitoring of SGCNs and their habitat is essential to establish better baseline data about species distribution, abundance and population trends. The SWAP calls for monitoring of species and habitat trends across the state, along with more-intensive monitoring within CFAs through collaboration with local partners to gain more area-specific data and to address local threats with targeted conservation actions.

Beyond monitoring SGCNs and their habitat, successful wildlife conservation in CFAs will require monitoring the effectiveness of conservation actions and adapting those actions accordingly. The SWAP envisions monitoring the results of conservation actions at the CFA level, and that CFA-level plans should incorporate measurement and monitoring protocols integrated with conservation actions themselves. Effectiveness measures indicate progress to date and whether the expected results are being realized. Conservation actions should be designed with enough specificity that project impacts and performance can be measured but broadly enough to benefit multiple species and engage partners. Success may be measured by the amount of protected or restored habitat, by stability or increase in populations, or by the acquisition of the information required to make informed conservation decisions. Another measure of success is the amount of "buy-in" or participation by conservation partners in the public and private sectors. Conservation partners, especially those operating through grant funding or those following conservation agency protocols, may already have metrics for accomplishment/success that are used for their own reporting requirements. Furthermore, accountability and transparency to funding sources, partners and the public are essential for program success.

Adaptive management also requires monitoring of climate change impacts on species and their habitats, as well as the success of conservation actions. In common terms, climate adaptation may be thought of as preparing for, coping with, or adjusting to climatic changes and their associated impacts (Stein et al., 2014). Frameworks such as the Climate Smart Conservation Cycle illustrated below (from Stein et al., 2014) can be used to plan, implement and monitor conservation actions to enable wildlife to adapt to a changing climate. Planning  conservation actions to implement this plan should consider climate impacts to species and habitats, WVDNR's ongoing vulnerability assessments and field surveys to further document population trends, distribution and abundance of priority species and the options to build the resilience of each major habitat type listed in this Action Plan. Information on site conditions and project plans provided by partners and landowners should also be considered. This will require careful coordination among WVDNR and local stakeholders.




**Climate-Smart Conservation Cycle**
A General Framework for Adaptation Planning and Implementation
**Stein et. al, 2014**

## Organization of this Action Plan

This CFA Action Plan will begin by introducing the CFA, including an overview of the landscape, terrestrial and aquatic habitats, species of greatest conservation need, distinctive stresses and broad conservation actions, potential partners and lands protected by public ownership or conservation easements. The plan then reviews the conservation goals and lists priority species identified by WVDNR specialists based on factors such as their abundance, population trends and opportunities for conservation within the CFA. The plan is then divided by major habitat type, including forest and woodland habitats, rock outcrops, cliffs and talus and shale barren habitats, aquatic, floodplain and riparian habitats, karst and cave habitats, and developed and agricultural habitats. For each major habitat type the plan lists priority species, stresses effecting those species and actions to alleviate those stresses. The plan also identifies climate stresses impacting each major habitat type and lists potential actions to boost their resilience. The plan provides a roadmap for implementation and monitoring of conservation actions for each major habitat type and brief statements about other human benefits that may be generated by the proposed actions. The plan also describes a regional network of resilient and connected landscapes spanning multiple habitat types that enable wildlife species to adapt and shift to a changing climate and provides an implementation plan for landscape resilience and connectivity. The conclusion provides a summary of the priority habitats for

conservation, describes the importance of integrating conservation for greater impact, connecting conservation actions for climate resilience and outlines next steps in plan implementation.

## How to use this plan

Implementation of this Action Plan will rely upon voluntary actions by local stakeholders including landowners, public agencies and partner organizations, and collaboration between them to conserve wildlife species and their habitat. The role of WVDNR in implementing this plan is to provide local stakeholders with information, guidance, assistance and support to develop, implement and monitor conservation actions and facilitate stakeholder collaboration.

Local stakeholders can use this plan for many purposes, including the following:

- Identify priority wildlife species, rare plant communities and their habitats and the resilient and connected landscapes that can enable species to shift in response to changing conditions.
- Work with relevant agencies to develop strategies to avoid, minimize and mitigate for impacts to priority species, their habitats and the resilient and connected landscapes.
- Identify stresses on priority species in specific habitats, conservation actions that can alleviate those stresses, monitoring protocols to evaluate success, and partners who can provide assistance.
- Understand climate impacts on wildlife habitat and actions to boost habitat resilience.
- Plan and implement conservation actions to boost habitat resilience and enable wildlife to adapt to climate change.
- Design and implement monitoring protocol to evaluate the success of conservation actions.
- Inform and provide rationale for activities being proposed in grant or permit applications.
- Integrate priority species, habitat and climate resilience into other local project plans.

The information provided in this Action Plan is constantly evolving. Local stakeholders are encouraged to seek additional information and assistance from WVDNR to:

- Confirm whether specific priority wildlife species and habitats are present at specific sites
- Understand species and habitat vulnerability to climate change
- Further define or confirm stresses on wildlife species and habitats
- Tailor proposed wildlife conservation actions to alleviate stresses
- Consider adaptation options to boost habitat resilience to climate change
- Develop effective strategies to monitor and evaluate project success

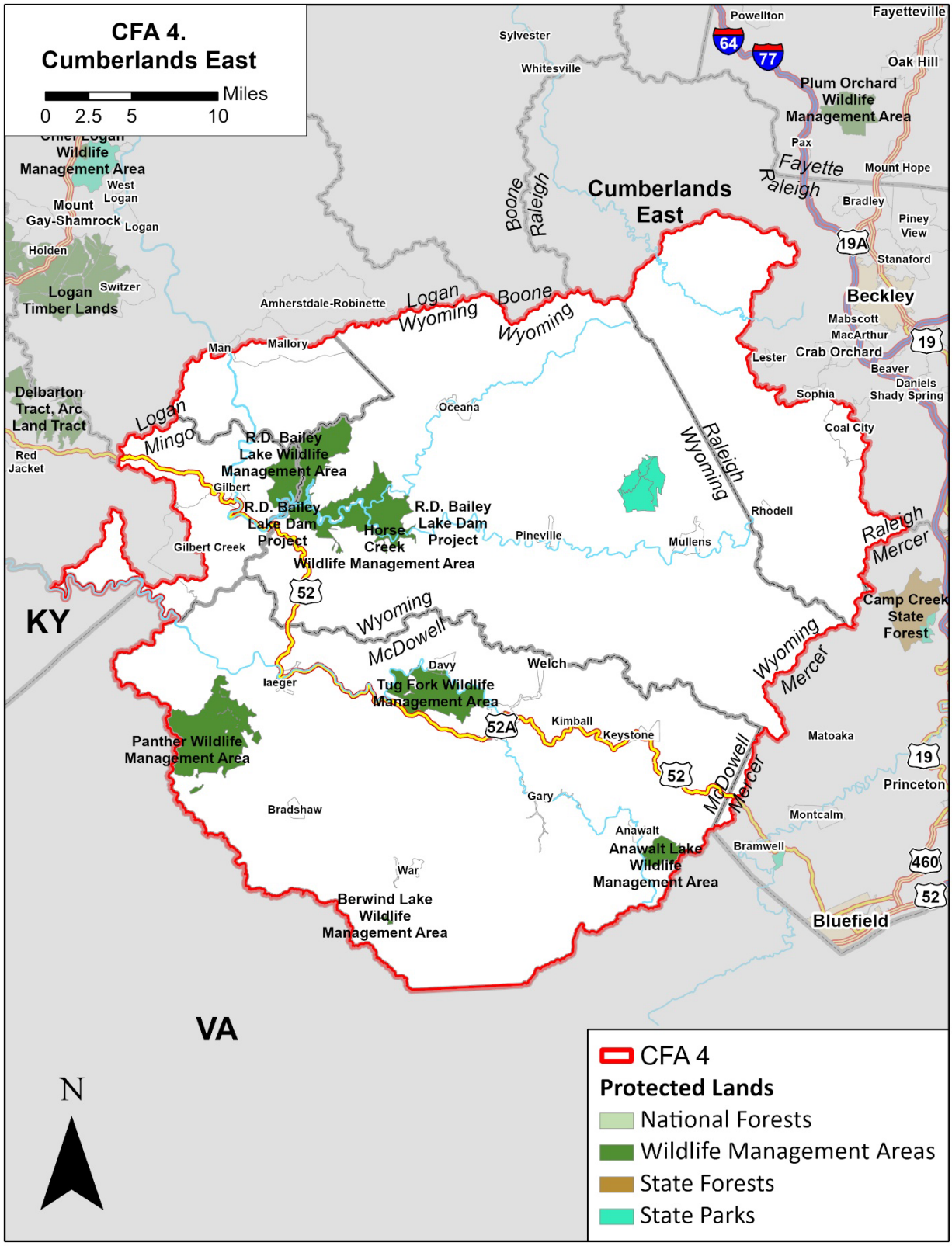
# Cumberlands East Conservation Focus Area

## Overview

This Cumberlands East Conservation Focus Area (CFA) in the Cumberland Mountain Ecoregion is dominated by very rugged, steep, and highly dissected topography at the headwaters of the Tug Fork and Guyandotte Rivers. Much of the area is low to mid-elevation, although some mountains rise to over 3,000 feet, on top of primarily shale and sandstone geology. Ridgetops in the CFA are dominated by Dry Oak-Pine and Dry-Mesic Oak Forests and lower slopes and valleys are typically composed of Mixed Mesophytic Forests.

Mixed Mesophytic Forests, while still common in the CFA, have been significantly displaced in many areas by oak forests due to repeated human-caused fires. The landscape is still mostly forested, with a number of small to medium-sized blocks of relatively unfragmented forest remaining primarily on public land. The area is sparsely settled with a declining population which is largely restricted to (often narrow) valleys. There is substantial acreage in large corporate land holdings. Extensive surface and deep mine complexes and reclaimed and abandoned mines exist throughout the area.

*Map 2. Overview*



## Habitats

The Cumberlands East CFA includes a variety of terrestrial, aquatic and subterranean habitat types.

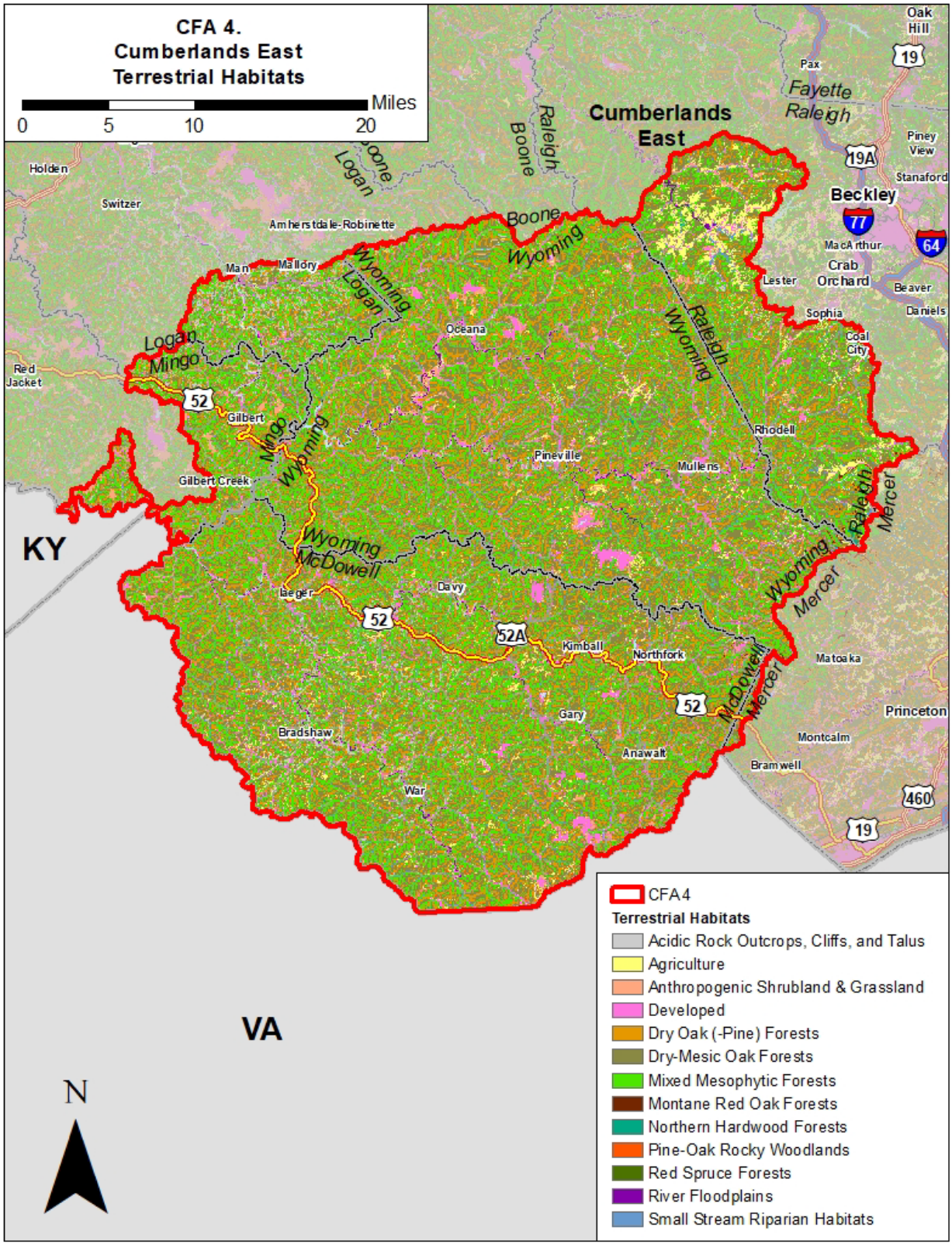
### Terrestrial Habitats

Twelve of the habitat types described in the SWAP are present in this CFA. These include over a quarter of the state's Acid Rock Outcrops, Cliffs and Talus, and over 10% of the state's Anthropogenic Shrubland and Grassland. Terrestrial habitats are described in Chapter 3 of the 2015 SWAP.

Table 1. Terrestrial Habitat Summary

| Habitat Type | Acres in CFA | % of CFA Area | % of WV Total for Habitat Type |
|---|---|---|---|
| Acidic Rock Outcrops, Cliffs, and Talus | 22,997 | 2.71% | 25.61% |
| Agriculture | 22,872 | 2.70% | 1.59% |
| Anthropogenic Shrubland & Grassland | 18,813 | 2.22% | 11.82% |
| Calcareous Cliffs and Talus | 0 | 0.00% | 0.00% |
| Developed | 58,860 | 6.94% | 5.17% |
| Dry Calcareous Forests, Woodlands, and Glades | 0 | 0.00% | 0.00% |
| Dry Oak (-Pine) Forests | 164,745 | 19.44% | 6.67% |
| Dry-Mesic Oak Forests | 273,425 | 32.26% | 5.48% |
| Heath-Grass Barrens | 0 | 0.00% | 0.00% |
| High Allegheny Wetlands | 0 | 0.00% | 0.00% |
| Mixed Mesophytic Forests | 255,936 | 30.19% | 8.69% |
| Montane Red Oak Forests | 894 | 0.11% | 4.23% |
| Northern Hardwood Forests | 494 | 0.06% | 0.05% |
| Pine-Oak Rocky Woodlands | 695 | 0.08% | 0.91% |
| Red Spruce Forests | 16 | 0.00% | 0.01% |
| River Floodplains | 3,490 | 0.41% | 2.90% |
| Shale Barrens | 0 | 0.00% | 0.00% |
| Sinkhole and Depression Ponds | 0 | 0.00% | 0.00% |
| Small Stream Riparian Habitats | 21,446 | 2.53% | 4.34% |
| Unresolved | 2,946 | 0.35% | 2.52% |
| Totals | 847,629 | 100.00% | |

*Map 3. Terrestrial Habitats*



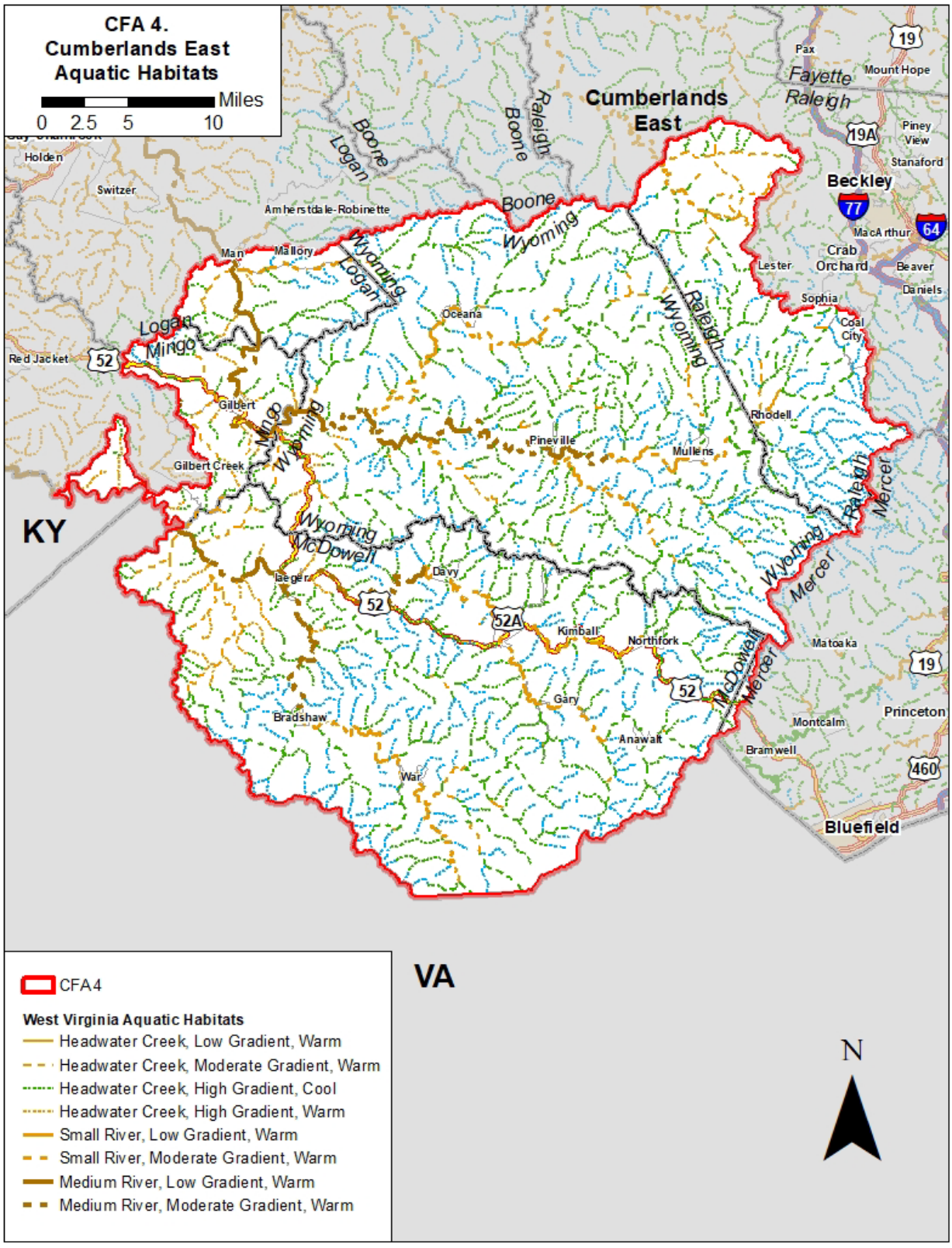
## Aquatic Habitats

Thirteen of the aquatic habitat types described in the SWAP are present within the Cumberlands East CFA, including almost 20% of the state's Moderate Gradient, Cool, Headwater Creeks and Moderate Gradient, Warm, Small Rivers. Over 30% of the aquatic habitat in the CFA is High Gradient, Cold, Headwater Creeks.

Table 2. Aquatic Habitat Summary

| Habitat Type | Acres in CFA | % of CFA Area | % of WV Total for Habitat Type |
|---|---|---|---|
| Headwater Creek,Low Gradient,Cool | 1 | 0.06% | 7.61% |
| Headwater Creek,Low Gradient, Warm | 19 | 1.06% | 3.35% |
| Headwater Creek,Moderate Gradient,Cool | 308 | 17.54% | 14.03% |
| Headwater Creek,Moderate Gradient,Warm | 110 | 6.28% | 2.82% |
| Headwater Creek,High Gradient,Cold | 557 | 31.72% | 18.99% |
| Headwater Creek,High Gradient,Cool | 474 | 27.02% | 7.57% |
| Headwater Creek,High Gradient,Warm | 51 | 2.92% | 6.76% |
| Small River,Low Gradient, Warm | 26 | 1.50% | 5.74% |
| Small River,Moderate Gradient,Cool | 4 | 0.25% | 0.93% |
| Small River,Moderate Gradient,Warm | 99 | 5.64% | 18.25% |
| Small River,High Gradient,Warm | 0 | 0.00% | 0.55% |
| Medium River, Low Gradient,Warm | 47 | 2.68% | 9.88% |
| Medium River,Moderate Gradient,Warm | 58 | 3.30% | 16.69% |
| Medium River,High Gradient,Warm | 0 | 0.02% | 8.73% |
| Totals | 1,755 | 100.00% | |

*Map 4. Aquatic Habitats*



## Species of Greatest Conservation Need

Table 3 lists the number of SGCN in each taxa listed in the SWAP for the Cumberlands East CFA.

Table 3. Species Summary by Taxa

| Taxa | # SGCN |
|---|---|
| Amphibians | 19 |
| Birds | 27 |
| Butterflies and Moths | 7 |
| Crayfish | 3 |
| Dragonflies and Damselflies | 12 |
| Fish | 8 |
| Mammals | 5 |
| Mussels | 3 |
| Plants | 28 |
| Reptiles | 12 |
| Snails | 11 |
| Tiger Beetles | 2 |
| Totals | 137 |

Although heavily degraded, streams in the CFA remain biologically significant, especially for species with small, regionally restricted ranges, and include significant amounts of headwater stream habitats. Two crayfishes listed for protection under the Endangered Species Act occur here:

- Big Sandy Crayfish – listed as endangered under the Endangered Species Act
- Guyandotte River Crayfish – listed as threatened under the Endangered Species Act

The only known populations of the Guyandotte River Crayfish occur here. Streams in the CFA also support half of the state's distribution of the regionally endemic Coalfields Crayfish and about half of the state's range for the regionally endemic Black Mountain Salamander. The relatively intact blocks of deciduous forests in this CFA are the northern portion of a series of forest blocks extending southward through the Cumberland Mountains Ecoregion into Tennessee and which collectively are globally-significant, including some of the most diverse temperate deciduous forest examples known. Forests in this CFA are critically important to a number of forest interior breeding birds especially:

- Wood Thrush
- Swainson's Warbler
- Cerulean Warbler
- Kentucky Warbler

The CFA is also important to salamanders and regionally endemic species. A number of Southern Appalachian endemics at or near the northernmost limit of their ranges and have all or nearly all of their known West Virginia occurrences in this CFA such as land snails including:

- Brown Spot snail
- Hollow Dome snail

The CFA also supports:

- Diana Fritillary butterfly
- Carolina Saxifrage
- Red- Twig Doghobble
- Yellow Mandarin

This Action Plan will list the priority SGCN in each major habitat type in the CFA.

## Distinctive Stresses

The 2015 SWAP identifies several general stresses affecting SGCN and habitat in this CFA:

Upland forest habitats are impacted by

1. Coal mining including legacy mine sites
2. Private road development
3. Energy Development - Gas well and pipelines development fragments intact forests habitats

Aquatic habitats are impacted by

1. Runoff (sediment, acid mine drainage nutrients, other pollution)
2. Water pollution and sedimentation from mining, other resource development, residential use, and ATV recreation all impact aquatic habitats

In addition to this list of general stresses, this Action Plan will list more specific local stresses affecting priority SGCN in each major habitat type.

## Conservation Actions

To address these stresses, the 2015 SWAP recommended these main types of actions in the CFA, listed below.

- Land Protection - Protect remaining intact forests (need to consider land and mineral rights).
- Aquatic Habitat Restoration - Direct mitigation resources to restoring key aquatic systems.
- Terrestrial Habitat Restoration – Work with conservation agencies to restore legacy mined lands.
- Terrestrial Habitat Conservation - Work with mine and gas companies to reduce forest habitat loss and fragmentation when planning mine and gas well development and associated infrastructure.
- Terrestrial Habitat Management - Provide guidance to corporate landowners on practices benefiting forest interior songbirds and land snails.
- Conservation Partnerships – Work with ATV groups to establish guidelines for ATV parks and trail systems that protect both the terrestrial and aquatic habitats.

This Action Plan will also list more specific conservation actions to address the stresses affecting priority SGCN in each major habitat type.

## Potential Partners

The 2015 SWAP lists many potential partners for landowners and others interested in wildlife conservation in the CFA, including:

- WV Division of Forestry
- Appalachian Mountains Joint Venture

- WV Department of Environmental Protection
- Natural Resources Conservation Service
- US Fish and Wildlife Service
- West Virginia Land Trust

With an established "constituency", many conservation partners can provide direct outreach to landowners and key stakeholders interested in wildlife conservation. The WVDNR will engage with these and other partners in regular face-to-face meetings and planning workshops during CFA planning, planning and implementation of conservation actions, and monitoring effectiveness. In many cases partners may assume a lead role in implementing the conservation actions. Appendix 4 lists the types of programming and assistance each partner provides to landowners. Specific partners are also listed along with conservation actions supported through their programs in the implementation plan for each habitat type.

## Protected Lands

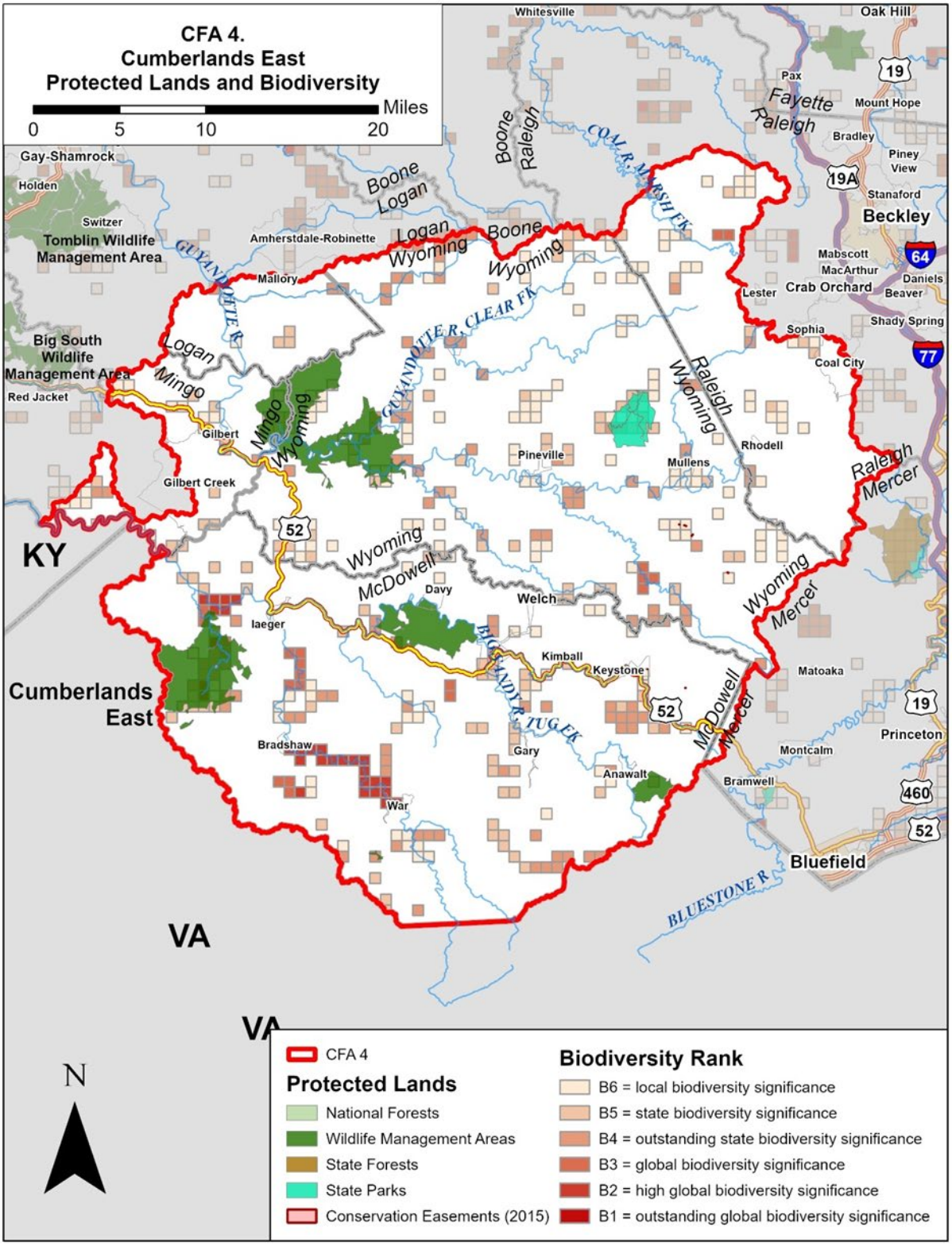
Public lands that may provide significant opportunities for wildlife conservation include:

- Panther State Forest
- Berwind Lake WMA
- RD Bailey Lake WMA
- Tug Fork WMA
- Anawalt WMA
- Twin Falls State Park

These public lands provide important wildlife habitat and are managed for conservation or other compatible goals. Appendix 3 lists habitat types occurring in each of the public lands within this CFA. WVDNR will work with public land managers to identify opportunities to plan and implement conservation actions that address stresses in these habitats and support priority SGCN. On state lands, this can include protection of important ecosystems, habitats, SGCN populations or plant communities through designation as State Natural Areas. City and county-owned public lands may also be managed to benefit wildlife and habitat.

Map 5 shows the location of public lands and conservation easements in the CFA, based on data provided in 2015 by The Conservation Fund (TCF), USGS Gap Analysis Program (GAP), The Nature Conservancy (TNC) and the National Conservation Easement Database (NCED). It also shows known occurrences of SGCNs and rare plant communities over a 1-kilometer grid and the biodiversity rank (including global, state, or local significance) of those occurrences, as generated by WVDNR in 2017. This map illustrates that many SGCN and rare plant communicates occur on public lands in the CFA and there may be opportunities for WVDNR and public land managers to protect them there. Many SGCN and rare plant communicates also occur on private land outside of public lands and conservation easements. This indicates how important it is for WVDNR and other partners to work with landowners to restore and protect biodiversity on private lands. There are no documented conservation easements in this CFA. Appendix 4 lists partners and programs that provide assistance to private landowners in wildlife conservation.

*Map 5. Protected Lands and Biodiversity*



# Action Plan for the Conservation Focus Area

## Conservation Goals

This CFA Action Plan is an extension of the State Wildlife Action Plan. While it is driven by local issues, the overarching goals remain the same. These include:

1. Halt the decline of at-risk species and thus avoid the need for federal listing as threatened or endangered
2. Assist with the recovery of federally listed species
3. Keep the common species common
4. Conserve the full array of habitat types and biological diversity in the state

The WVDNR will collaborate with agency partners, non-governmental organizations and the public to address threats to Species of Greatest Conservation Need, key habitats and unique communities.

## Priority Species

Effectiveness and efficiency are paramount in targeting actions in CFAs and specifically addressing every SGCN present in the CFA is not feasible. From the list of SGCNs documented in the CFA as provided in the SWAP, WVDNR biologists selected priority species for conservation action that represent the best opportunity for successful conservation based on:

- Their conservation status and known trends globally, across the state and in the CFA;
- The degree of dependence of each species on habitats within the CFA;
- The degree to which conservation activities to protect targeted species will also benefit a suite of other species occupying the same habitat or niche;
- Conservation opportunities and likelihood of conservation success in the CFA;
- And other factors.

Table 4 lists SGCNs that were selected as priorities within the CFA based on the above criteria.

Additional field surveying and information is needed to document and monitor the distribution, abundance and population trends of these priority species in the habitats where they occur, and to assess their vulnerability to climate change. This work is ongoing.

Table 4. Priority Species in the CFA

| Taxa | Scientific Name | Common Name | S Rank | G Rank |
|---|---|---|---|---|
| Amphibians | Aneides aeneus | Green Salamander | S3 | G3G4 |
| Amphibians | Desmognathus welteri | Black Mountain Salamander | S2 | G4 |
| Amphibians | Plethodon kentucki | Cumberland Plateau Salamander | S3 | G4 |
| Amphibians | Plethodon wehrlei | Yellow-spotted Woodland Salamander | S4 | G4 |
| Amphibians | Pseudotriton montanus diastictus | Midland Mud Salamander | S1 | G5T5 |
| Birds | Antrostomus vociferus | Eastern Whip-poor-will | S3B | G5 |
| Birds | Bonasa umbellus | Ruffed Grouse | S3B,S3N | G5 |
| Birds | Buteo platypterus | Broad-winged Hawk | S3B | G5 |
| Birds | Chaetura pelagica | Chimney Swift | S3B | G5 |
| Birds | Geothlypis formosa | Kentucky Warbler | S3B | G5 |
| Birds | Helmitheros vermivorum | Worm-eating Warbler | S3B | G5 |
| Birds | Hylocichla mustelina | Wood Thrush | S3B | G5 |
| Birds | Icteria virens | Yellow-breasted Chat | S3B | G5 |
| Birds | Limnothlypis swainsonii | Swainson's Warbler | S3B | G4 |
| Birds | Parkesia motacilla | Louisiana Waterthrush | S3B | G5 |
| Birds | Setophaga cerulea | Cerulean Warbler | S2B | G4 |
| Birds | Setophaga discolor | Prairie Warbler | S3B | G5 |
| Birds | Spizella pusilla | Field Sparrow | S3B | G5 |
| Birds | Vermivora chrysoptera | Golden-winged Warbler | S1B | G4 |
| Birds | Vermivora cyanoptera | Blue-winged Warbler | S3B | G5 |
| Butterflies and Moths | Argynnis diana | Diana Fritillary | S2S3 S2 | G3G4 |
| Butterflies and Moths | Pieris virginiensis | West Virginia White | S3 S2 | G3? |
| Butterflies and Moths | Telegonus cellus | Golden-banded Skipper | S1S2 S1 | G4 |
| Crayfish | Cambarus callainus | Big Sandy Crayfish | S1 | G2 |
| Crayfish | Cambarus hatfieldi | Tug Fork Valley Crayfish | S2 | G2G3? |

| Taxa | Scientific Name | Common Name | S Rank | G Rank |
|---|---|---|---|---|
| Crayfish | Cambarus veteranus | Guyandotte River Crayfish | S1 | G1 |
| Dragonflies and Damselflies | Celithemis fasciata | Banded Pennant | S3 | G5 |
| Dragonflies and Damselflies | Cordulegaster obliqua | Arrowhead Spiketail | S2 | G4 |
| Dragonflies and Damselflies | Cordulia shurtleffi | American Emerald | S4 | G5 |
| Dragonflies and Damselflies | Gomphus quadricolor genus Phanogomphus | Rapids Clubtail | S3 | G3G4 |
| Dragonflies and Damselflies | Lestes forcipatus | Sweetflag Spreadwing | S3 | G5 |
| Dragonflies and Damselflies | Macromia illinoiensis | Illinois Swift River Cruiser | S3 | G5 |
| Dragonflies and Damselflies | Progomphus obscurus | Common Sanddragon | S2S3 | G5 |
| Dragonflies and Damselflies | Somatochlora linearis | Mocha Emerald | S3 | G5 |
| Dragonflies and Damselflies | Tachopteryx thoreyi | Gray Petaltail | S3 | G4 |
| Fish | Carpiodes velifer | Highfin Carpsucker | S1 | G4G5 |
| Fish | Ichthyomyzon bdellium | Ohio Lamprey | S2S3 | G3G4 |
| Fish | Macrhybopsis hyostoma | Shoal Chub | S2 | G5 |
| Fish | Moxostoma carinatum | River Redhorse | S3 | G4 |
| Fish | Percina phoxocephala | Slenderhead Darter | S1 | G5 |
| Fish | Percina sciera | Dusky Darter | S3 | G5 |
| Fish | Phenacobius mirabilis | Suckermouth Minnow | S3 | G5 |
| Fish | Polyodon spathula | Paddlefish | S1 | G4 |
| Plants | Arundinaria gigantea ssp. gigantea | Giant Cane | S2 | G5T5? |
| Plants | Cleistes bifaria | Small Rosebud Orchid | S1 | G4? |
| Plants | Gentiana austromontana | Appalachian Gentian | S1 | G3 |
| Plants | Leucothoe recurva | Red-twig Doghobble | S1 | G4G5 |
| Plants | Listera smallii | Kidneyleaf Twayblade | S2 | G4 |
| Plants | Lysimachia tonsa | Southern Loosestrife | SH | G4 |
| Plants | Potamogeton pulcher | Spotted Pondweed | S1 | G5 |
| Plants | Prosartes maculata | Yellow Mandarin | S1 | G3G4 |

| Taxa | Scientific Name | Common Name | S Rank | G Rank |
|---|---|---|---|---|
| Plants | Saxifraga caroliniana | Carolina Saxifrage | S1 | G3 |
| Plants | Solidago faucibus | Gorge Goldenrod | S1 | G2G4 |
| Plants | Spiraea virginiana | Virginia Spiraea | S1 | G2 |
| Plants | Taxus canadensis | Canada Yew | S2S3 | G5 |
| Plants | Thuja occidentalis | Northern White-cedar | S2 | G5 |
| Reptiles | Terrapene carolina carolina | Eastern Box Turtle | S5 | G5T5 |

S Rank (State Rank) and G Rank (Global Rank) Conservation Status: 1= Critically Imperiled, 2 = Imperiled, 3 = Vulnerable, 4 = Apparently Secure, 5 = Secure, NR = Not Ranked, T = Subspecies or Varieties, B = Breeding, N = Non-breeding, S#S# or G#G# indicates range of uncertainty of conservation status.

## Forest and Woodland Habitats

Dry-Mesic Oak Forests and Mixed Mesophytic Forests each cover around 30% of the CFA and represent the largest proportion of forest habitat types in this CFA, followed by Dry Oak-Pine Forests covering about 20% of the CFA. These forest types are found throughout the CFA. There are also less than a thousand acres each of Montane Red Oak forests, Northern Hardwood Forests and Pine-Oak Rocky Woodlands. Maps 6 and 7 display forest habitat types and intact forest patches (based on the Appalachian and Mid-Atlantic Forest Patch Dataset compiled by The Nature Conservancy in 2011) with biodiversity within the CFA. The diversity of forest types across elevational gradients provides great opportunities for their conservation within larger forest patches and requires careful management tied to specific site conditions and forest stand characteristics. There are around a dozen large forest patches of 5,000 – 25,000 acres surrounded my smaller patches of more fragmented forests in this CFA. Intact forest patches provide core habitat for a significant proportion of SGCN and rare communities, as well as a matrix of forest habitat types and large corridors within which forest species may shift and adapt to climate change.

## Priority Species

The table below lists priority species in the CFA associated with forest and woodland habitats.

Table 5. Priority Species in Forest and Woodland Habitats.

| Taxa | Scientific Name | Common Name |
|---|---|---|
| Amphibians | Aneides aeneus | Green Salamander |
| Amphibians | Plethodon kentucki | Cumberland Plateau Salamander |
| Amphibians | Plethodon wehrlei | Yellow-spotted Woodland Salamander |
| Amphibians | Pseudotriton montanus diastictus | Midland Mud Salamander |
| Birds | Antrostomus vociferus | Eastern Whip-poor-will |
| Birds | Bonasa umbellus | Ruffed Grouse |
| Birds | Buteo platypterus | Broad-winged Hawk |
| Birds | Geothlypis formosa | Kentucky Warbler |
| Birds | Helmitheros vermivorum | Worm-eating Warbler |
| Birds | Hylocichla mustelina | Wood Thrush |
| Birds | Icteria virens | Yellow-breasted Chat |
| Birds | Limnothlypis swainsonii | Swainson's Warbler |
| Birds | Setophaga cerulea | Cerulean Warbler |
| Birds | Setophaga discolor | Prairie Warbler |

| Taxa | Scientific Name | Common Name |
|---|---|---|
| Birds | Vermivora chrysoptera | Golden-winged Warbler |
| Birds | Vermivora cyanoptera | Blue-winged Warbler |
| Butterflies and Moths | Argynnis diana | Diana Fritillary |
| Butterflies and Moths | Pieris virginiensis | West Virginia White |
| Butterflies and Moths | Telegonus cellus | Golden-banded Skipper |
| Plants | Gentiana austromontana | Appalachian Gentian |
| Plants | Leucothoe recurva | Red-twig Doghobble |
| Plants | Lysimachia tonsa | Southern Loosestrife |
| Plants | Prosartes maculata | Yellow Mandarin |
| Plants | Solidago faucibus | Gorge Goldenrod |
| Plants | Taxus canadensis | Canada Yew |
| Plants | Thuja occidentalis | Northern White-cedar |

Large, intact forest blocks support many forest interior breeding birds, including Broad-winged Hawk, Cerulean Warbler (CERW), Wood Thrush and Worm-eating Warbler. Early-successional forest habitats support Golden-winged Warbler (GWWA) and Prairie Warbler. Many of the rare plant species associated with forests require additional surveying to further evaluate their status and distribution.

## Rare Plant Communities

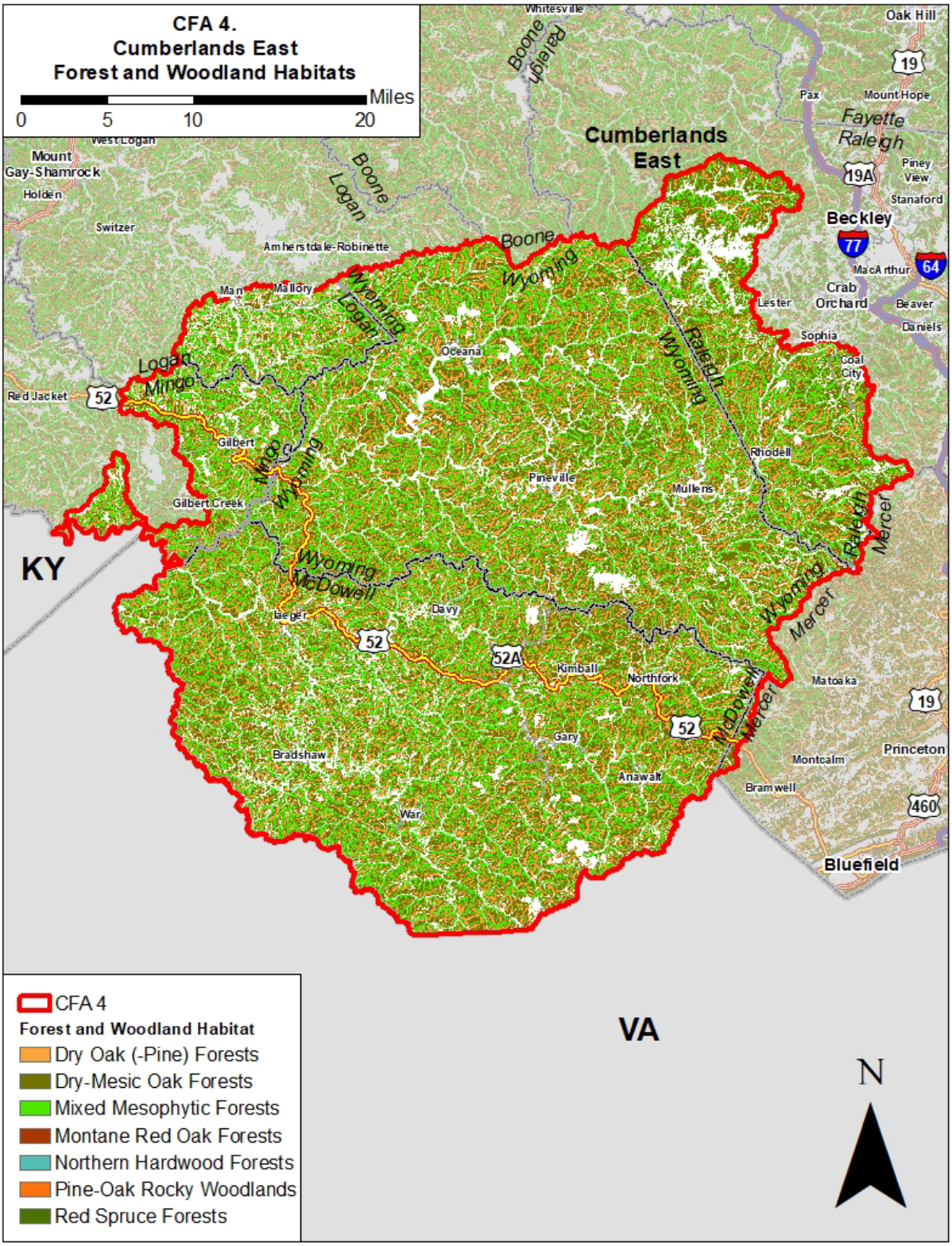
The following rare plant community is found in Forest and Woodland habitats in this CFA. More research is needed on how its regeneration is related to fire, currently and historically. It may be impacted by both unmanaged fire, and lack of carefully managed, prescribed burning.

Table 6. Rare Plant Communities in Forest and Woodland Habitats.

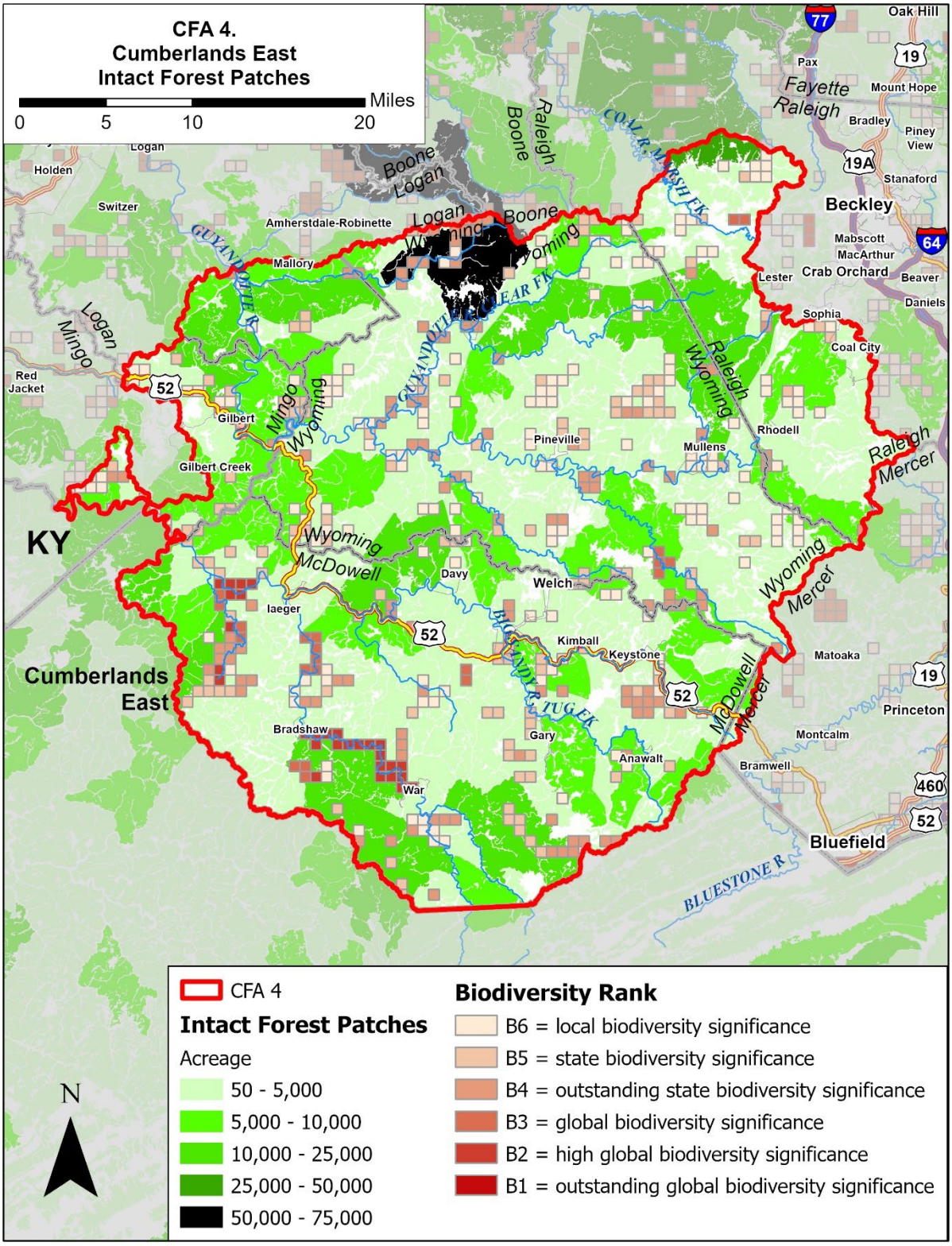
| Common Name | Relative Abundance | G Rank | S Rank |
|---|---|---|---|
| Short Leaf Pine - Oak Forest | 0.33 | G2 | S2 |

S Rank (State Rank) and G Rank (Global Rank) Conservation Status: 1= Critically Imperiled, 2 = Imperiled, 3 = Vulnerable, 4 = Apparently Secure, 5 = Secure, NR = Not Ranked, T = Subspecies or Varieties, B = Breeding, N = Non-breeding, S#S# or G#G# indicates range of uncertainty of conservation status.

*Map 6. Forest and Woodland Habitats*



*Map 7. Intact Forest Patches and Biodiversity*



## Habitat Stresses and Conservation Actions

Table 7 lists stresses impacting species in forest and woodland habitats, and conservation actions landowners and partners can take to address those stresses. Worm-eating Warbler and Wood Thrush suffer from brood parasitism in fragmented forests.

Table 7. Stresses and Actions in Forest and Woodland Habitats:

| **Habitat Stress** | **Conservation Action** |
|---|---|
| Poor forest structure | Maintain forest structural complexity and habitat diversity |
| Deforestation, forest fragmentation, climate change and disturbance of rock outcrops, springs, streams and wetlands | Maintain and protect forest cover and hydrology, especially around rock outcrops, springs, streams, stream valleys and wetlands |
| Invasive plants: forest fragmentation, climate change | Maintain forest cover and control invasive plants, especially around rare habitat features |
| Early-successional habitat: poor forest structure, forest maturation, fire suppression | Use forest management and prescribed fire to promote early-successional habitat across 15-20% of forested landscapes and structural complexity, including gaps with healthy native grasses, forbs, vegetative cover and snags |
| Mature forest: deforestation, fragmentation, poor forest structure | Protect mature forest and promote structural complexity: old growth, small openings with well-developed understories, snags and decaying logs |
| Deer browse impacting forest structure and understory | Manage local deer populations where abundant |
| Loss of nectar resources for Lepidoptera | Alter roadside mowing regimes, manage deer populations, install pollinator habitat using cost share programs |
| Fragmentation of core forests from surface coal mining and other development | Develop state-level guidance on siting and construction of surface mines to avoid fragmentation of core forests |
| Incompatible utility corridor management | Improve vegetation management practices in utility corridors to provide shrub habitat with minimal overstory |

| Habitat Stress | Conservation Action |
|---|---|
| Fire management/Research | Research role of fire in maintaining rare plant communities |
| Logging and habitat destruction around rare plants | Avoid & minimize logging impacts around rare plants, implement forestry BMPs |
| Forest pests and pathogens including Hemlock Woolly Adelgid, Emerald Ash Borer | Monitoring and treatment of target tree species in select priority areas |

In addition to the habitat-linked stresses listed above, direct stresses to priority species include collision mortality on roads (Eastern Whip-poor-will, Broad-winged Hawk and Eastern Box Turtle), disease (Ruffed Grouse and Eastern Box Turtle) and illegal collection (Eastern Box Turtle).

Maintaining diverse populations of forest birds and other priority species requires dynamic forest landscapes with mosaics of age classes, structural and spatial complexity. Efforts to manage and restore both early-successional and late-successional, interior forest habitats are needed for priority SGCN.

## Climate Change and Habitat Resilience

The Central Appalachian Forest Ecosystem Vulnerability Assessment (Butler et al., 2015) describes many potential impacts of climate change on forests in the region. Likely impacts include increased temperatures (especially during the summer and fall), a decrease in winter snowpack, longer growing seasons, increased precipitation during spring and even greater decreases in precipitation during summer and fall, more frequent heavy precipitation events and increasing frequency and severity of storms. These impacts will likely lead to changing soil moisture patterns, increased risk of wildfire, increased damage from pests and pathogens, and increased extent and abundance of invasive plants. Habitat for northern species is likely to decline. Tree seedlings will likely be more vulnerable to climate change impacts than mature trees. Forest ecosystems lacking a diversity of species, age classes and genotypes may be more susceptible to climate change than those with greater diversity. Forest species in fragmented landscapes will have less opportunity to migrate across the landscape in response to changing conditions. Ecological communities tied to specific hydrological conditions or geologic features may also be unable to migrate. Urban areas and impervious cover can exacerbate the effects of increasing temperatures and heavier precipitation. However, ecosystems within areas of high landscape complexity, including a diversity of topography and microhabitats, may be more able to persist and adapt in response to climate change.

The 2015 assessment also described likely impacts to specific forest types. Dry-Mesic Oak Forests support of large number of tree species over a diversity of terrain and many of the tree species are tolerant of drought and fire, providing some resilience to climate change. However, drought may increase susceptibility to forest pests and pathogens, and drought as well as disturbances from stronger

storms may enable the spread of nonnative invasive plants. Intense fires or droughts, combined with other stressors, could increase mortality of some species.

Mixed Mesophytic Forests may be vulnerable to increasing disturbance by wildfire, drought and invasion by nonnative plants. These ecosystems may decline in some areas, while sheltered sites in areas of complex topography may provide some refuge from climate change. Drought may increase the susceptibility of these forests to hemlock woolly adelgid, forest tent caterpillar, beech bark disease and other insect pests and diseases. Invasive plants may outcompete native species as conditions change and drought may increase the risk of wildfire, to which these forests are not well adapted.

Dry Oak-Pine Forests and Pine-Oak Rocky Woodlands are adapted to heat, drought and fire, and may benefit from climate change. However, droughts may increase susceptibility to forest pests and pathogens, and enable nonnative invasive plants to outcompete native herbs and shrubs, providing additional fuel for fires and increasing fire intensity. Forest pests, pathogens and invasive plants need to be carefully managed to build resilience to climate change.

The small areas of red spruce and northern hardwood forests may be particularly impacted by climate change. Increased heat and moisture stress in summer and fall may interact with acid deposition as well as increases in insect pests and pathogens, storm disturbance and wildfires to stress these forests, reducing species diversity and coverage. Cool, moist sites within areas of complex topography may provide some refuge and buffer the effects of climate change.

Some changes in forest composition and structure are likely to occur over time as these different forest types adapt and adjust in response to changes in climate. Conservation actions to reduce existing stresses on forests will aid in building their resilience. Protecting large forest blocks in areas with complex topography and maintaining natural cover linkages between them, may further enable their adaptation and shifting distribution across the landscape.

Table 8 provides a summary of climate stresses on forest habitats and actions which could boost their resilience (Swanston et al., 2016). While climate stresses are listed separately, forest and woodland habitats are often impacted by multiple climate stresses occurring simultaneously and actions to boost habitat resilience are intended to address multiple climate stresses. Many of these actions resemble previously listed conservation actions to reduce stress on priority species, meaning that they could have positive outcomes for priority species as well as habitat resilience. WVDNR, land managers, landowners and partners can select the actions best suited to their specific site conditions, management goals and objectives, from the list below or other sources.

Table 8. Climate Stresses and Resilience Actions in Forest and Woodland Habitats

| Climate Stresses | Habitat Resilience Actions |
|---|---|
| • Increased spring and summer temperatures<br>• Increased risk of drought and wildfire<br>• Increased frequency and severity of storms<br>• Increased competition from nonnative invasive species, pests and pathogens | • Restore or maintain fire in fire-adapted ecosystems<br>• Manage deer populations to promote regeneration<br>• Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plants and remove existing invasive plants<br>• Promote diversity of native species and age classes through planting and silviculture<br>• Protect habitat refugia for rare plant communities and forest types dependent on unique soils, such as calcareous forests, woodlands and glades<br>• Protect forest reserves in areas of high biological diversity or priority species<br>• Reduce forest fragmentation<br>• Maintain or restore large patches and corridors of forest habitat<br>• Restore native forest vegetation on degraded lands within and adjacent to forested areas |

## Implementation Plan

WVDNR will work with interested partners and landowners to plan, implement and measure the effectiveness of conservation actions to benefit priority species in forest and woodland habitats.

Table 9. Implementation Plan for Forest and Woodland Habitats

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Develop and Implement Plans to Manage Forest Habitats<br>• Land Use Plans<br>• Forest Management Plans<br>• Forest Carbon Programs<br>• Cost-Share Programs<br>• Sustainable Forestry Certification Programs<br>• USDA NRCS Climate Smart Forestry Activities | • AMJV<br>• AFF<br>• AFTS, FSC, SFI<br>• Consulting Foresters<br>• Mountain RCD<br>• Planning Commissions<br>• Public Land Managers<br>• USDA NRCS<br>• WVDOF<br>• Forest Carbon Programs | • Acres of habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Forest Habitat, Reserve and Corridor Protection:<br>• Conservation Easements<br>• Land Acquisition<br>• Natural Area designation | • County Farmland Protection Boards<br>• OHCF, TCF, TNC, WVLT<br>• WVDOF Forest Legacy<br>• WVDNR | • Acres of habitat protected<br>• Abundance and diversity of priority species and habitats |
| Manage forests at landscape scale for diversity of native species and age classes, structural and spatial complexity appropriate for the forest type | • AMJV<br>• Consulting Foresters<br>• Forest Certification Programs: AFTS, FSC, SFI<br>• NWTF and RGS<br>• USDA NRCS<br>• WVDOF<br>• WVU Extension<br>• Public Land Managers | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance and diversity of priority species |
| Create or maintain early-successional habitat (ESH) to benefit wildlife species through forest management on appropriate sites.<br><br>GWWA guidelines for large forest patches with > 70% forest cover:<br>• Maintain ESH on 15-20% of forest at any one time, as part of shifting mosaic<br>• ESH should include irregular, interspersed clumps of shrubs and/or saplings, grasses and forbs, and widely spaced overstory trees (10-30% canopy cover or 20-40 ft2 residual basal area) | • Consulting Foresters<br>• NWTF and RGS<br>• USDA NRCS<br>• WVDOF<br>• WVU Extension<br>• Public Land Managers | • Acres of habitat restored<br>• Before and after comparison: abundance and diversity of priority species |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Improve or maintain interior forest habitat to benefit wildlife species through forest management activities on appropriate sites<br><br>CERW guidelines for large forest patches with > 70% forest cover:<br>• Provide heterogenous stand structure and species diversity with 40-90 ft2 residual basal area of well-spaced, large diameter trees (favor white oak, hickory, sugar maple) with canopy gaps and well-developed understory vegetation. Mesic north- and east-facing slopes optimal. | • Consulting Foresters<br>• WVU Extension<br>• USDA NRCS<br>• WVDOF<br>• Public Land Managers | • Acres of habitat restored<br>• Before and after comparison: abundance and diversity of priority species |
| Restore mined lands using Forest Reclamation Approach. | • Mine owners<br>• Mountain RCD<br>• USDOI OSMRE<br>• WVDEP DMR | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance and diversity of priority species |
| Provide pollinator habitat through mine reclamation using Forest Reclamation Approach with native wildflowers, and work with WV DOH to maintain roadside wildflowers and nectar resources. | • WVDOH<br>• WVDEP DMR<br>• USDOI OSMRE | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance, diversity, and distribution of priority species |
| Provide guidance to corporate landowners on practices benefitting forest interior birds | • AMJV<br>• USDA NRCS<br>• WVDNR<br>• WVDOF<br>• WVFA/SFI<br>• Public Land Managers | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance, diversity, and distribution of priority species |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Manage utility corridors to reduce wildlife impacts (implement BMPs promoted by the Wildlife Habitat Council, NRCS and other organizations) | • Landowners, partners, and utility companies | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance and diversity of priority species |
| Monitor and control invasive plants, promptly revegetate disturbed sites | • WVDOF<br>• WVCA and GVCD<br>• USDA NRCS<br>• Public Land Managers | • Acres of habitat protected or restored<br>• Before and after comparison: abundance and diversity of priority species |
| Monitor and treat pests and pathogens targeting specific trees and plant communities in priority sites, including ash and hemlock | • Public Land Managers<br>• WVDA, WVDOF, WVDNR | • Acres of habitat maintained for priority species<br>• Before and after comparison: abundance, diversity and distribution of priority species |
| Manage deer population where abundant | • WVDNR (hunting licenses)<br>• Private landowners<br>• Public Land Managers | • Change in deer population or forest structure<br>• Acres of habitat restored<br>• Before and after comparison: abundance and diversity of priority species |
| Controlled burning by public agencies in fire adapted ecosystems | • Public Land Managers | • Acres of habitat restored<br>• Before and after comparison: abundance, diversity and distribution of priority species |
| Avoid & minimize logging impacts around rare plants, implement forestry BMPs | • Consulting Foresters<br>• WVU Extension<br>• USDA NRCS<br>• WVDNR, WVDOF<br>• Public Land Managers | • Acres of habitat protected around rare plants<br>• Status and distribution of rare plants |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Fire management/research | • Public Land Managers<br>• WVDNR and partners | • Role of fire in maintaining rare plant communities understood<br>• Before and after comparison: abundance and distribution of rare plant communities maintained through prescribed fire |
| Install highway signage to avoid collisions with priority species in high density areas | • WVDOH<br>• WVDNR | • Install highway signage to avoid collisions with priority species in high density areas |
| Establish guidelines for ATV parks and trail systems to protect important forest habitat | • WVDNR<br>• Public Lands Managers<br>• Trail System Managers | • Miles or acreage of trails with habitat protections in place<br>• Before and after comparison: abundance, diversity, and distribution of priority species |
| Public & Landowner Outreach and Demonstration | • Mountain RCD<br>• WVU Extension<br>• WVDNR, WVDOF<br>• WVDEP, WVCA and Conservation Districts<br>• WVDNR<br>• USDA NRCS<br>• Public Land Managers | • # Landowners engaged<br>• # Landowners implementing actions |

## Human Benefits

Actions to restore and protect forest and woodland habitat may provide human health and economic benefits for local residents and communities. These benefits include protection of water ways, water quality and drinking water sources, reduced flood damages, long-term timber production, forest carbon sequestration opportunities and hunting, wildlife viewing, tourism and recreational opportunities.

## Acid Rock Outcrops, Cliffs and Talus Habitats

There are two priority salamander species in this CFA associated with acidic rock outcrops, cliffs and talus habitats. While these rare habitats occupy less than 3% of the CFA, they represent over 25% of the acid rock habitat in the state. As illustrated by map 8, acid rock outcrops, cliffs and talus occur scattered across the CFA, with the highest concentration in the northwest portion. Acid rock habitats are threatened impacts from adjacent land use. Those outside of the larger forest patches may be more vulnerable to habitat disturbance and degradation.

### Priority Species

The table below lists priority species in the CFA associated with Acid Rock Outcrops, Cliffs and Talus Habitats.

Table 10. Priority Species in Acid Rock Outcrops, Cliffs and Talus Habitats

| Taxa | Scientific Name | Common Name |
|---|---|---|
| Amphibians | Aneides aeneus | Green Salamander |
| Amphibians | Plethodon wehrlei or pauleyi | Yellow-spotted Woodland Salamander |
| Plants | Saxifraga caroliniana | Carolina Saxifrage |

Climate change and the increasing occurrence of disturbances could lead to further endangerment of Green Salamanders. Additional surveying is required to further evaluate the status and distribution of rare plants.

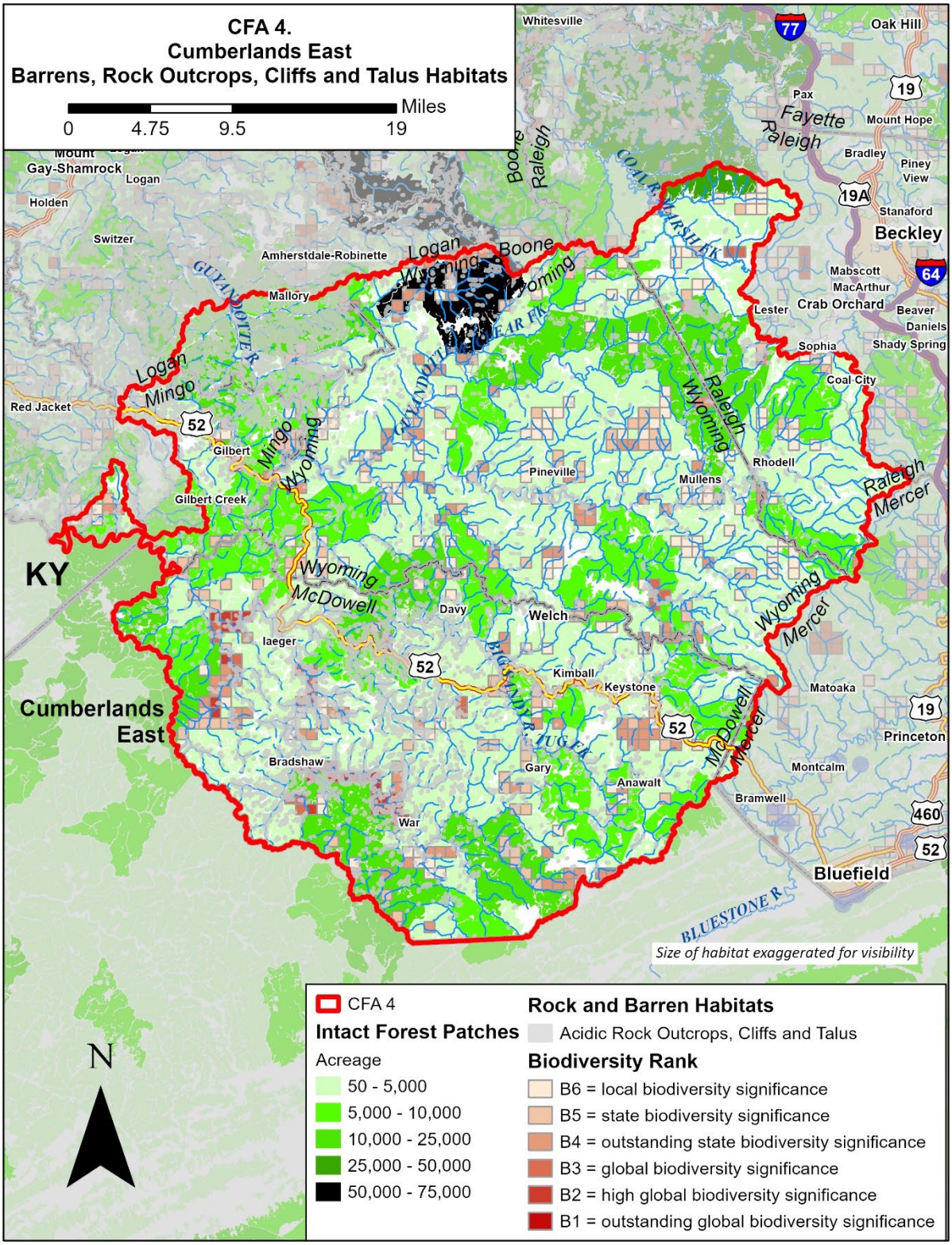
### Habitat Stresses and Conservation Actions

The following stresses to these sensitive habitats may be addressed through the actions below. Plethodon Pauleyi is a newly identified salamander species formerly considered the same as Plethodon Wehrlei (Wehrlei's Salamander), but more data is need to manage its habitat.

Table 11. Habitat Stresses and Conservation Actions in Acid Rock Outcrops, Cliffs and Talus Habitats

| Habitat Stress | Conservation Action |
|---|---|
| Impacts from deforestation, fragmentation and other impacts on adjacent forests, and climate change | Maintain and manage use of forested buffers around occupied habitat |
| Data Gaps | Determine current extent of Plethodon pauleyi and Saxifraga Caroliniana, especially on public lands to better inform future management decisions. |

*Map 8. Acid Rock Outcrop, Cliffs & Talus Habitats and Biodiversity*



## Climate Change and Habitat Resilience

As described in The Central Appalachians Forest Ecosystem Vulnerability Assessment (Butler et al., 2015), ecosystems that are limited by geological features may be restricted from shifting across the landscape in response to climate change. These habitat types are dependent on underlying geology, so their ability to shift across the landscape in response to climate change is very limited. While they are usually adapted to extreme conditions, they may be vulnerable to increased disturbance from drought, fire and storms and from invasion by nonnative invasive plants. Maintaining intact forest ecosystems around these rare habitats and controlling invasive species may help maintain resilience to a changing climate.

Table 12. Climate Stresses and Resilience Actions in Acid Rock Outcrop, Cliffs and Talus Habitats

| **Climate Stresses** | **Habitat Resilience Actions** |
|---|---|
| • Increased risk of drought and wildfire<br>• Increased frequency and severity of storms<br>• Increased competition from nonnative invasive species | • Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species<br>• Protect rare habitats and refugia for rare plant communities<br>• Maintain intact, resilient forest habitat in surrounding areas |

## Implementation Plan

WVDNR will work with interested partners and landowners to plan, implement and measure the effectiveness of conservation actions to benefit priority species in acid rock outcrops, cliffs and talus.

Table 13. Implementation Plan for Acid Rock Outcrop, Cliffs and Talus Habitats

| **Action** | **Partners** | **Effectiveness Measures** |
|---|---|---|
| Habitat Protection:<br>• Conservation Easements<br>• Land Acquisition<br>• Natural Area designation | • County Farmland Protection Boards<br>• OHCF, TCF, TNC, WVLT<br>• WVDOF Forest Legacy<br>• WVDNR | • Acres of habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Habitat Protection:<br>• Land use planning | • Mountain RCD<br>• Planning Commissions | • Acres of habitat protected through land use planning for development around cliffs, steep slopes and fragile soils |
| Habitat Protection<br>• Incentive Programs | • USDA NRCS | • Acres of habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |
| Re-vegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species | • WVDOF<br>• WVCA and GVCD<br>• NRCS CSP<br>• Public Land Managers | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance, diversity and distribution of priority species |
| Controlled burning by public agencies | • Public Land Managers | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance, diversity and distribution of priority species |
| Manage recreation on sensitive sites | • Mountain RCD<br>• Public Land Managers | • Acres of habitat restored for priority species<br>• Before and after comparison: abundance, diversity and distribution of priority species |
| Minimize impact on fragile habitat | • Quarries and developers<br>• WVDEP<br>• Public Land Managers | • Acres of habitat protected for priority species<br>• Before and after comparison: abundance, diversity and distribution of priority species |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Public & Landowner Outreach and Demonstration | • Mountain RCD<br>• WVU Extension<br>• WVDNR, WVDOF<br>• WVDEP, WVCA and Conservation Districts<br>• WVDNR<br>• USDA NRCS<br>• Public Land Managers | • # Landowners engaged<br>• # Landowners implementing actions |

## Human Benefits

Actions to restore acid rock outcrop, cliffs and talus habitat may provide human health and economic benefits for local residents and communities, including hunting, wildlife viewing, tourism and recreational opportunities.

## Aquatic, Floodplain and Riparian Habitats

A diversity of aquatic habitats in the CFA range from high gradient, cold, headwater creeks, which represent over 30% of the aquatic habits in the CFA, to low gradient, warm, medium rivers. A map of aquatic habitat types is included in the introduction to the CFA. These streams and river habitats are tightly connected with their adjacent floodplains, wetlands and riparian habitats. Many plant and animal species rely on aquatic habitats such as streams, rivers and wetlands, as well as their adjacent terrestrial habitats, especially riparian areas and forests. The loss of natural floodplain habitats and riparian corridors often impacts water quality and adjacent aquatic habitat. Improving wildlife habitat in streams and rivers often requires conservation actions to improve adjacent floodplain and riparian habitats. Therefore aquatic, floodplain, wetland and riparian habitats will be addressed together.

### Priority Species

Table 14 lists priority species in the CFA that occur in aquatic, riparian and floodplain and wetland habitats. Like other aquatic environments, ponds and wetland habitats are influenced by land use practices in adjacent lands and waters.

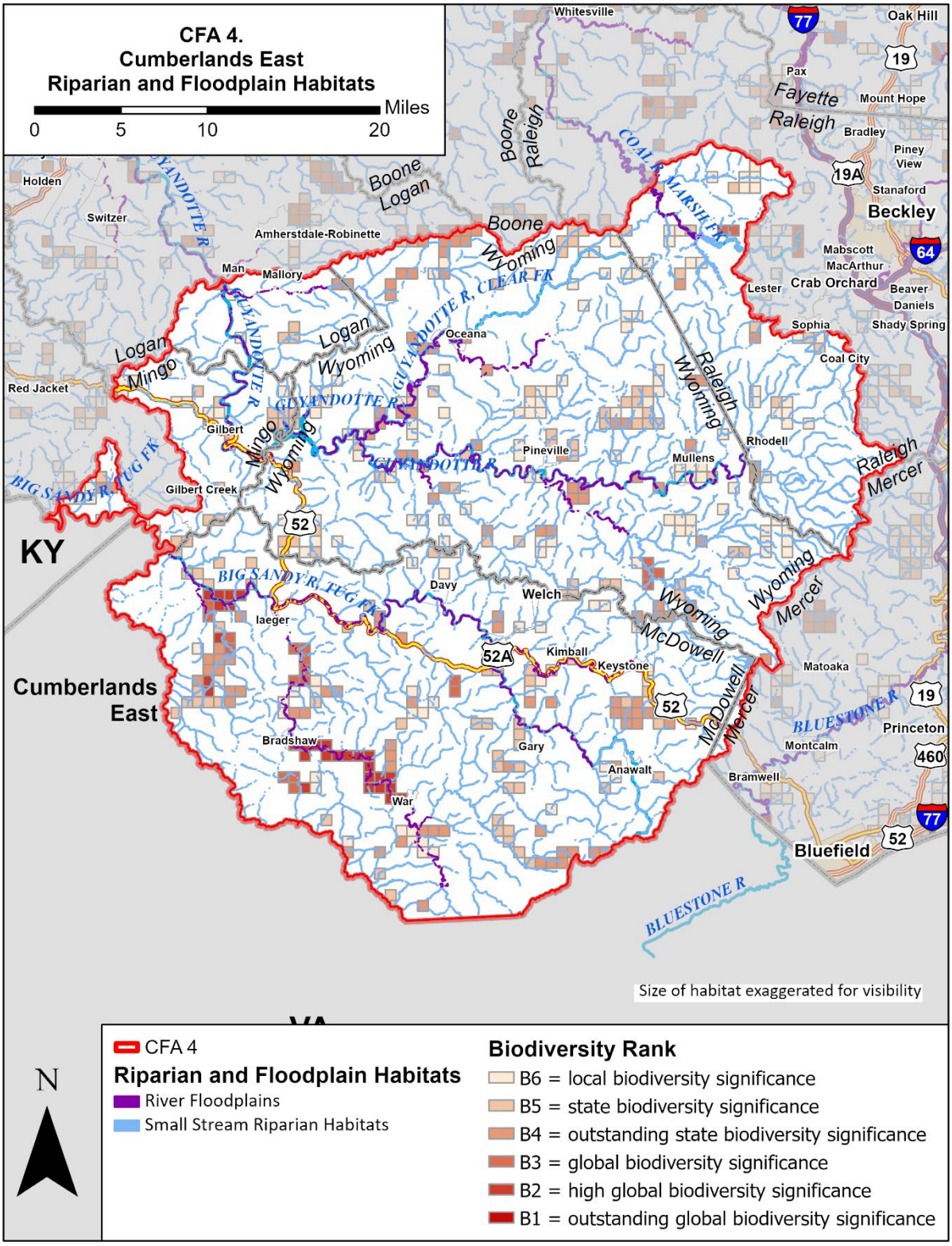
Table 14. Priority Aquatic, Floodplain and Riparian Species

| Taxa | Scientific Name | Common Name |
|---|---|---|
| Amphibians | Desmognathus welteri | Black Mountain Salamander |
| Amphibians | Pseudotriton montanus diastictus | Midland Mud Salamander |
| Birds | Parkesia motacilla | Louisiana Waterthrush |
| Butterflies and Moths | Argynnis diana | Diana Fritillary |
| Butterflies and Moths | Pieris virginiensis | West Virginia White |
| Butterflies and Moths | Telegonus cellus | Golden-banded Skipper |
| Crayfish | Cambarus callainus | Big Sandy Crayfish |
| Crayfish | Cambarus hatfieldi | Tug Fork Valley Crayfish |
| Crayfish | Cambarus veteranus | Guyandotte River Crayfish |
| Dragonflies and Damselflies | Celithemis fasciata | Banded Pennant |
| Dragonflies and Damselflies | Cordulegaster obliqua | Arrowhead Spiketail |
| Dragonflies and Damselflies | Cordulia shurtleffi | American Emerald |
| Dragonflies and Damselflies | Gomphus quadricolor genus Phanogomphus | Rapids Clubtail |
| Dragonflies and Damselflies | Lestes forcipatus | Sweetflag Spreadwing |
| Dragonflies and Damselflies | Macromia illinoiensis | Illinois Swift River Cruiser |
| Dragonflies and Damselflies | Progomphus obscurus | Common Sanddragon |
| Dragonflies and Damselflies | Somatochlora linearis | Mocha Emerald |

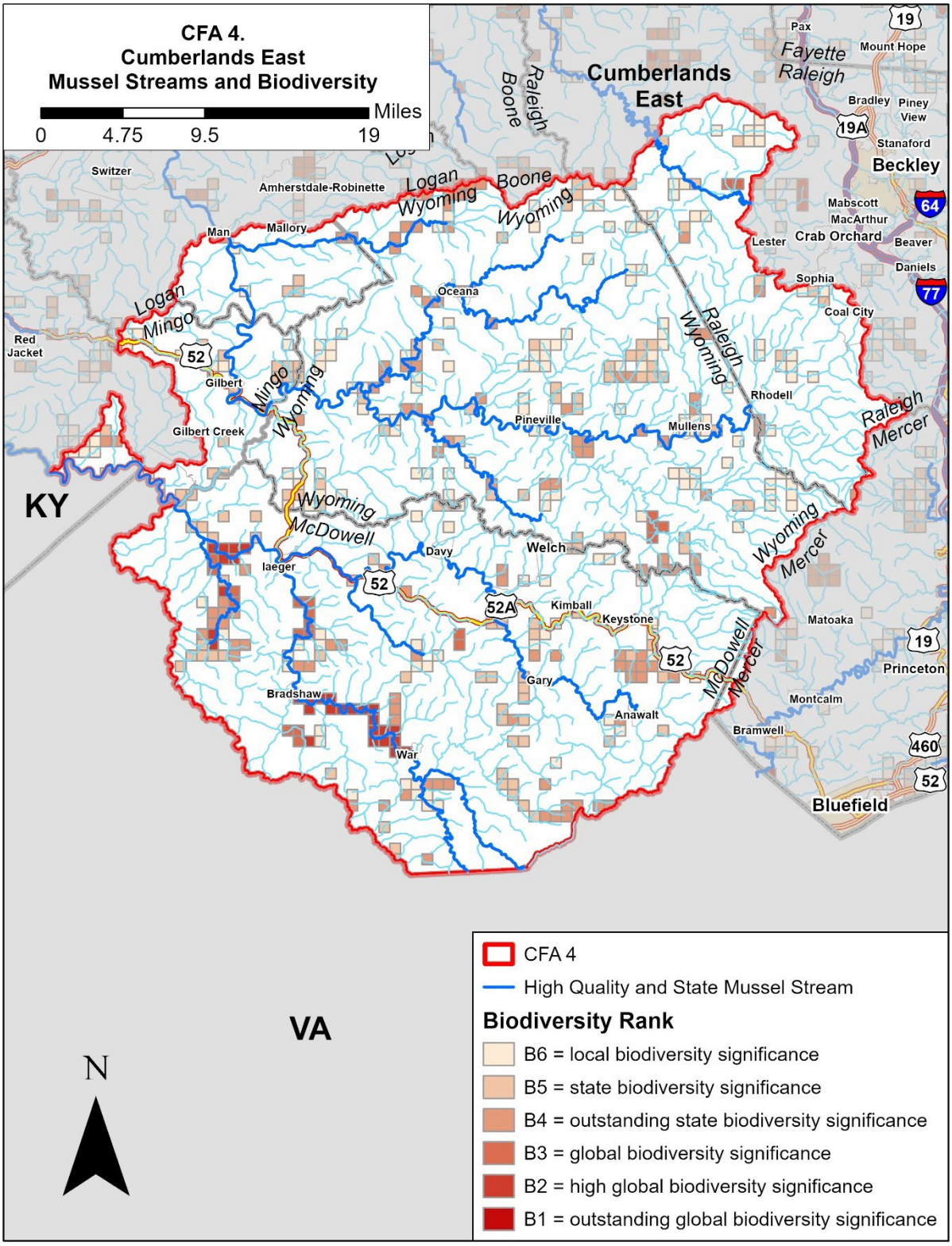
| Taxa | Scientific Name | Common Name |
|---|---|---|
| Dragonflies and Damselflies | Tachopteryx thoreyi | Gray Petaltail |
| Fish | Carpiodes velifer | Highfin Carpsucker |
| Fish | Ichthyomyzon bdellium | Ohio Lamprey |
| Fish | Macrhybopsis hyostoma | Shoal Chub |
| Fish | Moxostoma carinatum | River Redhorse |
| Fish | Percina phoxocephala | Slenderhead Darter |
| Fish | Percina sciera | Dusky Darter |
| Fish | Phenacobius mirabilis | Suckermouth Minnow |
| Fish | Polyodon spathula | Paddlefish |
| Plants | Arundinaria gigantea ssp. gigantea | Giant Cane |
| Plants | Cleistes bifaria | Small Rosebud Orchid |
| Plants | Listera smallii | Kidneyleaf Twayblade |
| Plants | Potamogeton pulcher | Spotted Pondweed |
| Plants | Spiraea virginiana | Virginia Spiraea |
| Reptiles | Terrapene carolina carolina | Eastern Box Turtle |

Map 9 illustrates riparian and floodplain habitats along with biodiversity. The largest corridors of river floodplain habitat occur along the Big Sand, Tug Fork, Guyandotte and Clear Fork Rivers. Riparian corridors exist throughout the CFA but are interrupted in many places by development and land use activities. Map 10 illustrates mussel streams (mapped by WVDNR in 2018) and biodiversity in the CFA. The Tug Fork and Guyandotte River and several of their main tributaries are recognized as state mussel streams and provide important habitat for mussel species. There are many instances of biodiversity along mussel streams, floodplain and riparian habitats, which provide core habitat and movement corridors for many of the priority species listed above and are priority habitats. The Biodiversity Rank occurrences indicate that numerous SGCN and rare communities occupy stream, floodplain and riparian habitats.

*Map 9. Riparian and Floodplain Habitats, and Biodiversity*



*Map 10. Mussel Streams, Wetlands and Biodiversity*



## Habitat Stresses and Conservation Actions

Protecting and restoring streamside riparian buffers is an important conservation action that improves water quality as well as both in-stream and riparian habitat for priority aquatic, floodplain and riparian species. Salamanders also suffer from collection activities and contaminated gear and equipment, and rare crayfish species suffer from the introduction of non-native crayfish. Additional surveying is required to further understand the status and distribution of rare plant species.

Map 11 shows stream impairments, along with biodiversity. There Guyandotte, Tug Fork and numerous tributaries are impaired by fecal bacteria, aluminum, iron, manganese or selenium, as well as biological impairments (WVDEP, 2016). Many of these impaired streams nonetheless host concentrations of biodiversity and provide habitat for mussels and other priority species. Improving water quality in these impaired streams is an important conservation action, especially where priority SGCN are present. Appendix 5 provides a listing of impaired streams in the CFA.

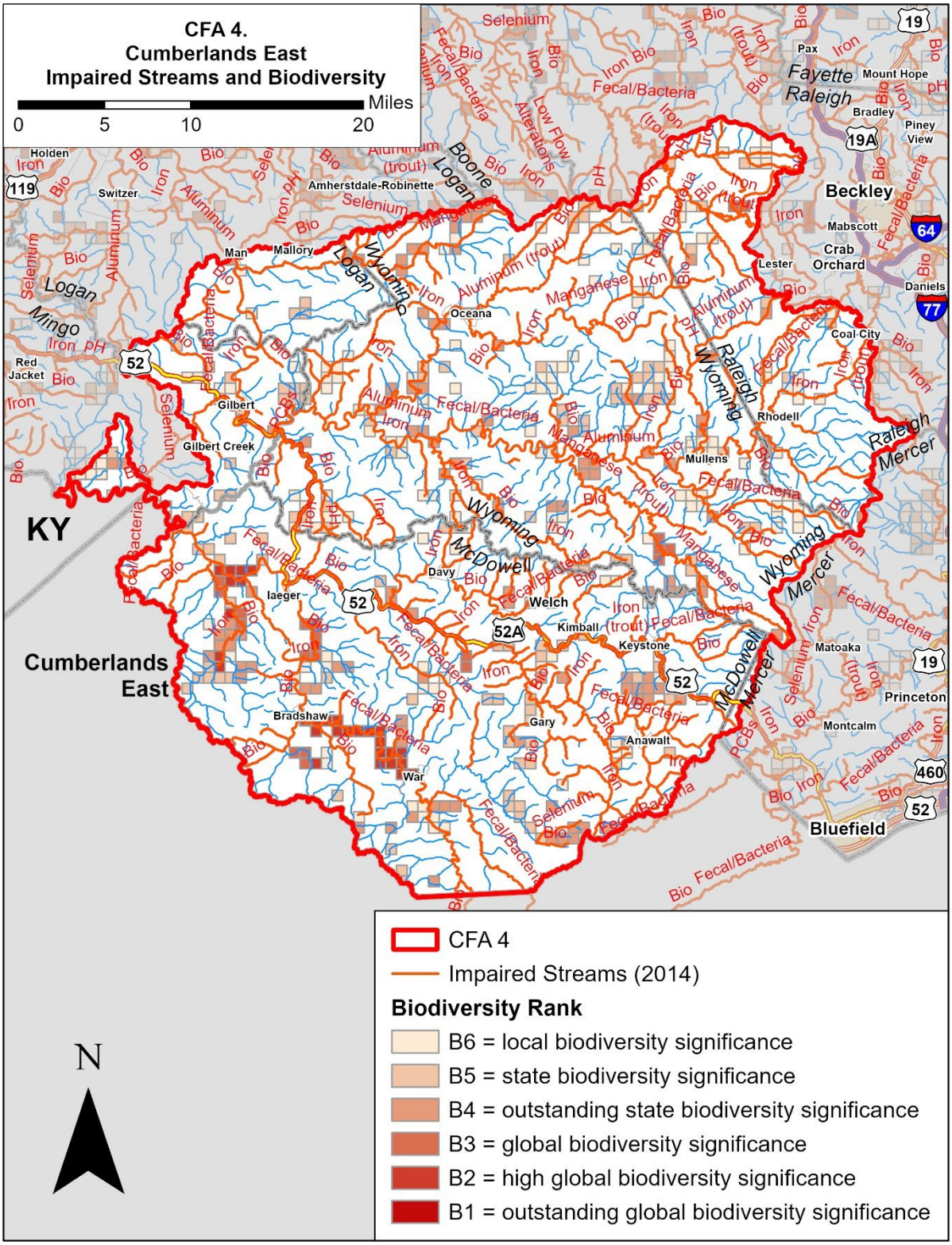
In addition to the habitat-linked stresses listed above, direct stresses to Eastern Box Turtle include collision mortality on roads, disease and illegal collection.

Table 15. Habitat Stresses and Conservation Actions for Aquatic, Floodplain and Riparian Habitat

| **Habitat Stress** | **Conservation Action** |
|---|---|
| Habitat loss of floodplains, riparian corridors, ponds, seeps, stream and wetland habitats from application of chemicals, mineral extraction, road building, timber harvesting and development activities | Habitat protection through land use planning, conservation easements, forestry BMPs and stream buffers<br><br>Avoid and reduce chemical applications in and around water bodies<br><br>Maintain emergent vegetation in and around ponds and wetlands |

| Habitat Stress | Conservation Action |
|---|---|
| Water quality degradation and sedimentation from roads and development, inadequate wastewater treatment, uncontrolled ATV access, logging and resource extraction and run-off | Identify and treat sources of pollution: improved sewage treatment, storm water management, run-off and sediment load reductions, and water quality from surface coal mines.<br><br>Implement Forestry BMPs<br><br>Maintain forested riparian corridors<br><br>Manage ATV access in and around streams, wetlands, floodplains and riparian area to reduce runoff and sedimentation<br><br>Increased coordination with WVDNR |
| Altered hydrology, increased flooding, runoff and stream temperatures, climate change | Landowner outreach<br><br>Restore and maintain forested riparian corridors around streams, ponds and wetlands<br><br>Minimize disturbance |
| Invasive plants | Identify and carefully treat invasive plants; replace with native plants |
| Introduction of non-native crayfish | Prevent introduction of non-native crayfish |
| Aquatic passage barriers (dams and road crossings) | Identify, modify or remove barriers to aquatic organism passage and high flows |
| Degradation of springs, ponds and wetlands | Restore and maintain forested buffers and minimize disturbance |
| Habitat degradation and fragmentation, isolated populations, climate change | Protect isolated populations of rare species and refugia; Habitat restoration |

*Map 11. Impaired Streams and Biodiversity*



## Climate Change and Habitat Resilience

As noted in the Central Appalachians Forest Ecosystem Vulnerability Assessment (Butler et al., 2015), riparian forests are vulnerable to climate change stressors including increased flood frequency and severity and resulting erosion and sedimentation. Impervious cover may exacerbate these impacts. Drought may stress plants and increase their susceptibility to forest pests and pathogens. Warming temperatures and increased disturbances may enable nonnative invasive plant species to outcompete native species. Although riparian forests are adapted to some level of disturbance and variable conditions, habitat alterations and invasive species may limit the ability of riparian forests to adapt to climate change. Restoring and maintaining the health, acreage and connectivity of native riparian forests along streams and rivers will build their resilience to climate change.

The Assessment also describes how instream habitats and associated plant and animal species may be stressed by climate change-related increases in temperature, droughts, flood frequency and severity, and resulting erosion and sedimentation. Low flow events may also become more frequent and severe. Warming surface waters is likely to result in water quality degradation and eutrophication. Many aquatic species and life stages are adapted to specific timing and ranges of flow and temperature, as well as water quality variables. Climate change may impact different species and life stages in different ways. Cold water habitats and aquatic communities may be at particular risk. Areas within a watershed may be more or less sensitive to increases in air temperature, depending on local factors such as watershed characteristics, position within the watershed, upstream land uses, groundwater contributions, forest cover and shading.

Restoring and maintaining the health, size and connectivity of native riparian forests along streams and rivers can provide riparian habitat, shade and cooling, organic matter, structure and debris, protect stream banks and in-stream habitat during high flows and maintain water quality. Stabilizing eroding stream banks using natural channel design techniques and reconnecting streams with their floodplains can restore fluvial processes and floodplain habitats. Cleaning and enlarging culverts and stream crossings to accommodate increased peak flows and aquatic organism passage can reduce flood damage to infrastructure and habitat and allow aquatic organisms to reach additional habitat as they adapt to changing conditions.

Below is a summary of climate stresses on aquatic, floodplain and riparian habitat, and actions to boost their resilience (Swanston et al., 2016). While climate stresses are listed separately, aquatic, floodplain and riparian habitats are often impacted by multiple climate stresses occurring simultaneously and actions to boost habitat resilience are intended to address multiple climate stresses. Many of these actions reiterate previously listed conservation actions to reduce stress on priority species and could have positive outcomes for priority species as well as habitat resilience. WVDNR, land managers, landowners and partners can select the actions best suited to their specific site conditions, management goals and objectives, from the list below or other sources.

Table 16. Climate Stresses and Resilience Actions in Aquatic, Floodplain and Riparian Habitat

| Climate Stresses | Habitat Resilience Actions |
|---|---|
| • Increased flood frequency and severity, erosion and sedimentation<br>• Increased surface water temperatures, low-flow events and water quality degradation<br>• Increased risk of drought and wildfire<br>• Increased competition from nonnative invasive species, pests and pathogens | • Restore and maintain the health, diversity and connectivity of riparian forests<br>• Stabilize eroding streambanks and reconnect stream hydrology to floodplains<br>• Clean and enlarge culverts and stream crossings to accommodate peak flows and aquatic organism passage<br>• Minimize disturbance to riparian forests, promptly revegetate after disturbance, prevent the introduction and establishment of invasive plant species and remove existing invasive species<br>• Protect refugia for cold water habitat |

## Implementation Plan

WVDNR will work with interested partners and landowners to plan, implement and measure the effectiveness of conservation actions to benefit priority species in aquatic, floodplain and riparian habitats.

Table 17. Implementation Plan for Aquatic, Floodplain and Riparian Habitats

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Habitat Protection:<br>• Conservation Easements<br>• Land Acquisition<br>• Natural Area designation | • County Farmland Protection Boards<br>• OHCF, TCF, TNC, WVLT<br>• WVDEP ILF<br>• WVDNR<br>• USDA Natural Resource Conservation Service ACEP | • Acres of aquatic and riparian habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |
| Habitat Protection<br>• Incentive Programs | • USDA | • Acres of aquatic and riparian habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Habitat Protection:<br>• Land Use Planning | • County Planning Commissions | • Acres of habitat protected through land use planning, floodplain and stormwater regulations |
| In-stream habitat restoration | • Mountain RCD<br>• Public Land Managers<br>• Trout Unlimited<br>• USDA FSA & NRCS<br>• USFWS<br>• WVDEP and WVCA | • Acres or linear feet of in-stream and riparian habitat restored for priority species<br>• Before and after comparison: abundance and diversity of priority species |
| Restore and maintain stream buffer zones | • Public Land Managers<br>• Trout Unlimited<br>• USDA FSA & NRCS<br>• USFWS<br>• WVDEP and WVCA<br>• WVDOF | • Acres or linear feet of stream buffer zones planted and fenced to protect priority species<br>• Before and after comparison: abundance and diversity of priority species |
| Identify and improve aquatic passage barriers, increase aquatic connectivity | • Trout Unlimited<br>• USFWS<br>• WVDEP<br>• WVDOH | • # barriers enlarged or removed<br>• # miles stream opened<br>• Before and after comparison: abundance and diversity of priority species |
| Identify and treat sources of water pollution/improve water quality | • Consulting Foresters<br>• County governments<br>• Mountain RCD<br>• Municipalities<br>• Trout Unlimited<br>• WVDEP & WVCA<br>• WVDHHR<br>• WVDOF<br>• WV Rivers Coalition | • # water treatment systems installed or improved<br>• Change in fecal, sediment and other water quality measurements<br>• Before and after comparison: abundance & distribution of priority species |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Work with regulatory agencies to improve stream and wetland mitigation measures to protect and restore important habitat | • US Army Corps of Engineers<br>• WVDEP<br>• WVDNR | • Acres or linear feet of in-stream and riparian habitat restored for priority species<br>• Before and after comparison: abundance and diversity of priority species |
| Establish guidelines for ATV parks and trail systems to protect important stream, wetland, floodplain and riparian habitats | • WVDNR<br>• Public Lands Managers<br>• Trail System Managers | • Miles or acreage of trails with habitat protections in place<br>• Before and after comparison: abundance, diversity, and distribution of priority species |
| Monitor and treat invasive plants around streams and wetlands | • Public Land Managers<br>• USDA FSA & NRCS<br>• USFWS Partners for Fish and Wildlife<br>• WVDEP<br>• WVDOF<br>• Consulting Foresters | • Acres treated<br>• Treatment success rate<br>• Before and after comparison: abundance and diversity of priority species |
| Prevent introduction of non-native crayfish and collection/contamination of salamanders and turtles | • WVDNR<br>• Landowners<br>• Public Land Managers | • Abundance and distribution of priority species in target areas |
| Public & Landowner Outreach and Demonstration | • Mountain RCD<br>• WVU Extension<br>• WVDNR, WVDOF<br>• WVDEP, WVCA and Conservation Districts<br>• WVDNR<br>• USDA NRCS<br>• Public Land Managers | • # Landowners engaged<br>• # Landowners implementing actions |

## Human Benefits

Actions to restore and protect aquatic, floodplain and riparian habitat may have numerous health and economic benefits for local residents and communities, including absorption and reduction of pollution in water ways and drinking water sources, absorption and reduction of flood waters and reduced flood damages, soil conservation and improved agricultural productivity, and improved hunting, fishing and recreational opportunities.

## Anthropogenic Habitats

Several priority species rely on developed and anthropogenic shrubland and grassland habitats in this CFA, which include reclaimed mine areas, and occur throughout the CFA. There are also small areas of agricultural habitats, which are concentrated on the north end of the CFA in Raleigh County. These priority species rely on grasslands, shrubland, early successional forest habitat in reclaimed mine areas and pastures and woody vegetation in fallow areas, abandoned fields, field borders, wetlands and riparian corridors within the smaller pockets of agricultural habitat. Chimney Swifts depend on habitats in residential and urban areas. Map 12 shows the locations of anthropogenic habitats and highlights biodiversity occurrences in and around these areas. Restoring and maintaining compatible habitat and native vegetation is a priority for SGCNs in anthropogenic habitats.

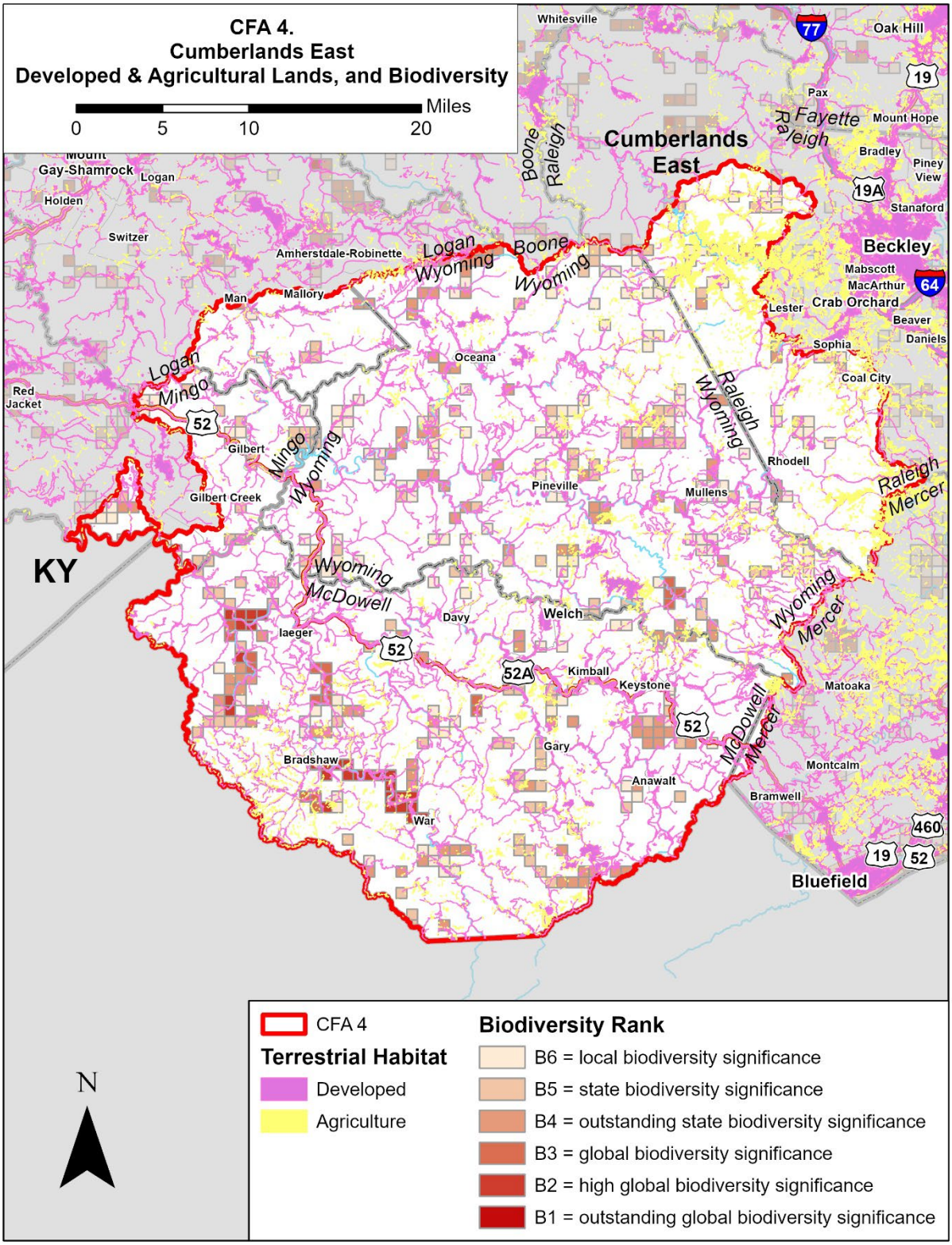
## Priority Species

Table 18 provides a list of priority SGCN associated with anthropogenic habitats in the CFA.

Table 18. Priority Species in Anthropogenic Habitats

| Taxa | Scientific Name | Common Name |
|---|---|---|
| Birds | Chaetura pelagica | Chimney Swift |
| Birds | Icteria virens | Yellow-breasted Chat |
| Birds | Spizella pusilla | Field Sparrow |
| Birds | Vermivora cyanoptera | Blue-winged Warbler |
| Butterflies and Moths | Argynnis diana | Diana Fritillary |
| Reptiles | Terrapene carolina carolina | Eastern Box Turtle |

*Map 12. Anthropogenic Habitat and Biodiversity*



## Habitat Stresses and Conservation Actions

While surface mining and residential develop are stresses to many priority species, they create compatible habitat for several others. Table 26 lists stresses to wildlife habitat in agricultural areas and conservation actions to address them.

Table 19. Habitat Stresses and Conservation Actions in Anthropogenic Habitats:

| **Habitat Stress** | **Conservation Action** |
|---|---|
| Loss of pollinator habitat | Restore and maintain pollinator habitat |
| Loss of early-successional habitat | Retain early-successional habitat with healthy grasses and forbs |
| Chimney capping | Uncap chimneys, install towers for chimney swifts, retain hollow snags and logs |
| Non-native invasive species | Monitoring and careful treatment, replace with native plantings |

## Climate Change and Habitat Resilience

The Central Appalachian Forest Ecosystem Vulnerability Assessment (Butler et al., 2015) describes many potential impacts of climate change on forested ecosystems in the region, and some of these may apply to the early successional forests and scrub/shrub habitats on reclaimed mine lands and other anthropogenic habitats. Likely impacts include increased temperatures (especially during the summer and fall), a decrease in winter snowpack, longer growing seasons, increased precipitation during spring and even greater decreases in precipitation during summer and fall, more frequent heavy precipitation events and increasing frequency and severity of storms. These impacts will likely lead to changing soil moisture patterns, increased risk of wildfire, increased damage from pests and pathogens, and increased extent and abundance of invasive plants. Tree seedlings may be more vulnerable to climate change impacts than mature trees. Drought may stress plants and increase their susceptibility to forest pests and pathogens. Warming temperatures and increased disturbances may enable nonnative invasive plant species to outcompete native species. As conditions change, forest species in fragmented landscapes will have less opportunity to migrate across the landscape in response.

Impervious cover and compacted soil associated with anthropogenic habitats can exacerbate the effects of increasing temperatures and heavier precipitation, which may impact downstream aquatic and riparian habitats. Low flow events may also become more frequent and severe. Warming surface waters is likely to result in water quality degradation and eutrophication. Many aquatic species and life stages are adapted to specific timing and ranges of flow and temperature, as well as water quality variables. Climate change may impact different species and life stages in different ways. Cold water habitats and aquatic communities may be at particular risk. Restoring and maintaining the health, size and connectivity of native riparian forests along streams and rivers can provide riparian habitat, shade and cooling, organic matter, structure and debris, protect stream banks and in-stream habitat during high flows and maintain water quality. Stabilizing eroding stream banks using natural channel design techniques and reconnecting streams with their floodplains can restore fluvial processes and floodplain habitats. Cleaning and enlarging culverts and stream crossings to accommodate increased peak flows and aquatic organism passage can reduce flood damage to infrastructure and habitat and allow aquatic organisms to reach additional habitat as they adapt to changing conditions.

Table 20 provides a summary of climate stresses on wildlife habitat in anthropogenic habitat, and actions to boost their resilience. Climate stresses are listed separately, but agricultural habitats are often impacted by multiple climate stresses occurring simultaneously. Therefore, actions to boost habitat resilience are intended to address multiple climate stresses. These actions reinforce conservation actions to reduce stress on priority species in agricultural and developed habitats. WVDNR, partners and landowners can collaborate to select the habitat resilience actions best suited to site conditions, conservation goals and land management objectives.

Table 20. Climate Stresses and Resilience Actions for Anthropogenic Habitats

| Climate Stress: | Habitat Resilience Action: |
|---|---|
| • Increased spring and summer temperatures<br>• Increased risk of drought and wildfire<br>• Increased competition from nonnative invasive species, pests and pathogens<br>• Increased frequency and severity of storms, floods, erosion and sedimentation<br>• Increased surface water temperatures, low-flow events and water quality degradation | • Manage deer populations to promote regeneration<br>• Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plants and remove existing invasive plants<br>• Promote diversity of native species and age classes through planting and silviculture<br>• Maintain soil health and water quality<br>• Create pollinator habitat<br>• Reduce forest fragmentation<br>• Maintain or restore large patches and corridors of forest habitat<br>• Restore native forest vegetation on degraded lands within and adjacent to forested areas<br>• Maintain, restore and connect aquatic, riparian and forest habitats to buffer against hydrological impacts<br>• Adapt infrastructure and land uses to changing conditions<br>• Reduce and buffer impervious surfaces and use green infrastructure to absorb runoff and mitigate hydrological impacts |

## Implementation Plan

WVDNR will seek to engage the following partners and programs in implementing and measuring the effectiveness of conservation actions in agricultural habitats.

Table 21. Implementation Plan for Anthropogenic Habitats.

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Habitat Protection:<br>• Conservation Easements<br>• Land Acquisition | • County Farmland Protection Boards<br>• OHCF, TCF, TNC, WVLT<br>• USDA NRCS<br>• WVDNR | • Acres of habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Habitat Protection<br>• Incentive Programs | • USDA FSA<br>• WVCA and WVDEP | • Acres of habitat protected for priority species<br>• Abundance and diversity of priority species and habitats |
| Create and maintain pollinator habitat and nectar resources, including diverse native and non-invasive flowering forbs, shrubs, trees, larval host plants and undisturbed nesting and overwintering areas on appropriate sites. | • Consulting Foresters<br>• USDA NRCS<br>• USFWS Partners for Wildlife Program<br>• WVDOH<br>• Public Land Managers | • Acres or linear feet of pollinator habitat created or maintained<br>• Change in abundance, diversity and distribution of priority species and habitats |
| Maintain or restore aquatic, riparian and forest habitat as well as species and structural diversity across anthropogenic and adjacent natural habitats | • Trout Unlimited<br>• USDA FSA & NRCS<br>• WVCA and GVCD<br>• Public Land Managers | • Acres of habitat restored<br>• Abundance & distribution of priority species and habitats |
| Create and maintain early-successional habitat | • USDA NRCS<br>• WVCA and WVDEP<br>• WVDOF<br>• Public Land Managers | • Acres of habitat created<br>• Change in abundance, diversity and distribution of priority species and habitats |
| Monitoring and careful treatment of nonnative invasive species, replace with native plantings | • USDA FSA & NRCS<br>• WVCA and GVCD<br>• WVU Extension | • Acres of habitat maintained or restored<br>• Before and after comparison: abundance and diversity of priority species |
| USDA NRCS Climate Smart Agricultural Mitigation Activities and Plans to adapt farm practices and infrastructure to changing conditions | • USDA FSA & NRCS<br>• Public Land Managers | • # practices or acres adapted<br>• Change in abundance, diversity and distribution of priority species |

| Action | Partners | Effectiveness Measures |
|---|---|---|
| Landowner outreach, uncapping chimneys, install swift towers | • Brooks Bird Club<br>• WVU Extension<br>• Landowners and volunteer groups | • # chimneys uncapped<br>• # swift towers installed<br>• Change in abundance, diversity and distribution of chimney swifts |
| Public & Landowner Outreach and Demonstration | • Mountain RCD<br>• WVU Extension<br>• WVDNR, WVDOF<br>• WVDEP, WVCA and Conservation Districts<br>• WVDNR<br>• USDA NRCS<br>• Public Land Managers | • # Landowners engaged<br>• # Landowners implementing actions |

## Human Benefits

Actions to restore and protect wildlife habitat within agricultural areas and developed lands may provide benefits including erosion control and improved water quality, improved hunting, fishing and recreational opportunities, and conservation of native pollinators for crop production.

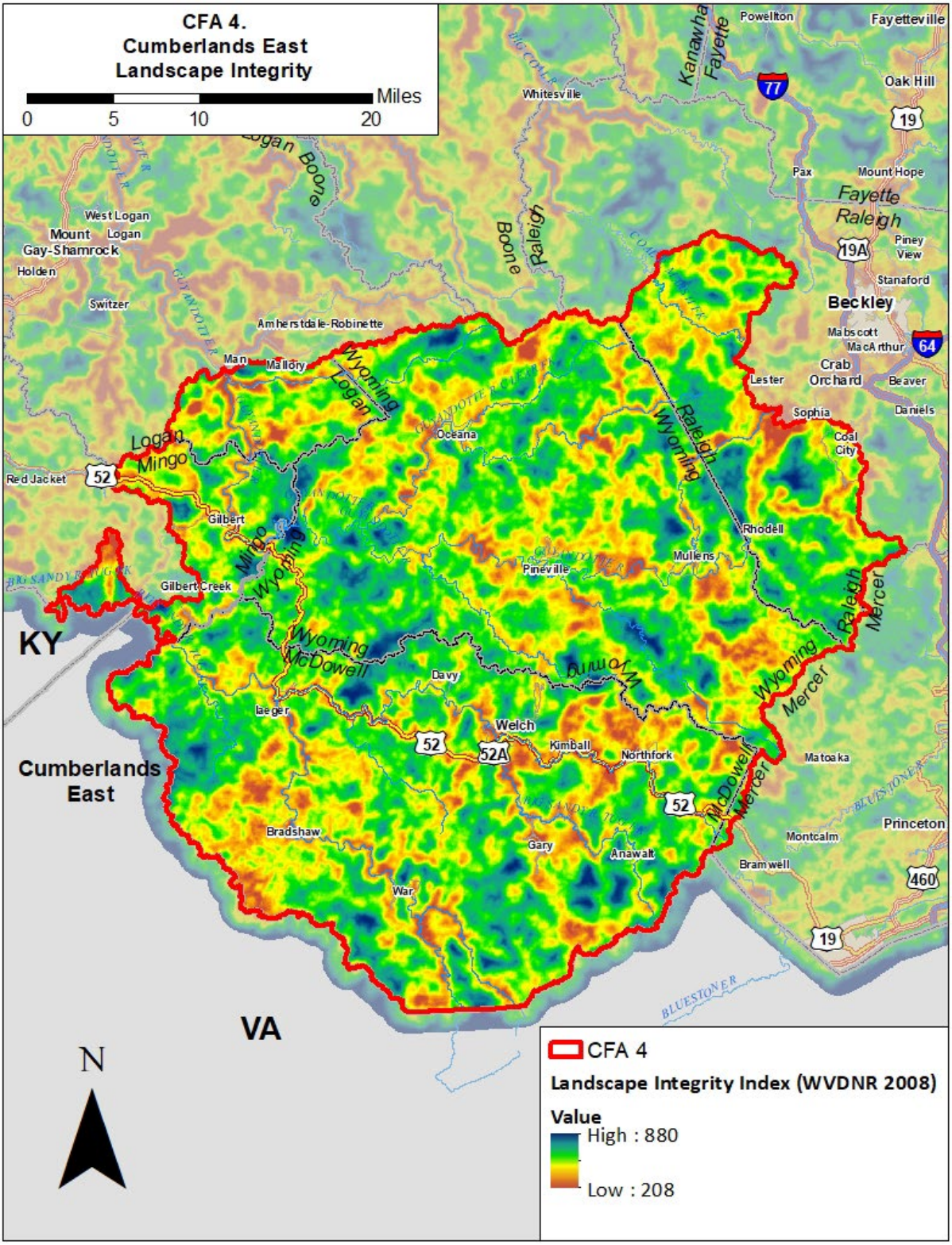
## Landscape Resilience and Connectivity

The conservation and resilience actions described previously in this action plan aim to reduce stressors on priority species in each major habitat type and enhance the resilience of those habitats to climate change. Some of those actions include protecting refugia, core areas of intact habitats and habitat corridors. Habitat cores are patches of high-quality habitat for priority species surrounded by areas with a different community structure, and they serve as nodes in a connected ecological network (Harrison and Odell, 2016; USDA Natural Resources Conservation Service, 2004). Habitat cores identified for protection in this CFA include large forest blocks, wetlands, habitats limited to specific soil types and geology such as shale barrens, cliffs and talus, biologically significant caves and their buffer zones, and core aquatic habitat such as mussel streams. Important habitat corridors identified for protection include connected forest patches, intact river floodplains and small stream riparian forests. Protecting corridors of terrestrial and aquatic habitat connected to habitat patches and larger core areas may allow for species movement and enhance the flow of genetic material in response to climate change (Butler et al., 2015; Anderson et al., 2016a).

Wildlife conservation in changing climate may require conservation actions at a landscape level, across habitat types and beyond individual habitat cores and corridors. Anderson (2016b) summarized a wealth of current research demonstrating how the increasing frequency and severity of storms, floods, droughts and fires may cause species to respond by shifting location or behavior within their existing habitat, evolving to adapt to new conditions, or shifting their distributions across the landscape. Evidence has been documented for over 1000 species currently shifting one of four ways: locally toward suitable microclimate, upslope to higher elevations, downslope towards moist riparian areas and northward toward cooler latitudes. However, landscape fragmentation has been shown to slow movement in response to climate change. Enabling wildlife to shift and adapt to climate change will require the conservation of a network of unfragmented landscapes within which species can shift their range to more suitable local microclimates or upslope, downslope or northward.

In 2008 the WVDNR developed a model of landscape integrity to identify unfragmented landscapes. Map 13 on the subsequent page illustrates areas of high landscape integrity in the CFA. Landscape integrity is estimated to increase with distance from roads, powerlines, surface mines, development and other features that fragment the landscape. There are some high integrity areas stretching across the eastern and western portions of the CFA, and in southern end, which tend to correspond to larger forest patches within public lands including State Parks and Wildlife Management Areas. These areas are surrounded by more fragmented landscapes with lower landscape integrity. Restoration in these landscapes will be critical for enabling the movement of priority species in response to changing climate conditions.

*Map 13. Landscape Integrity*



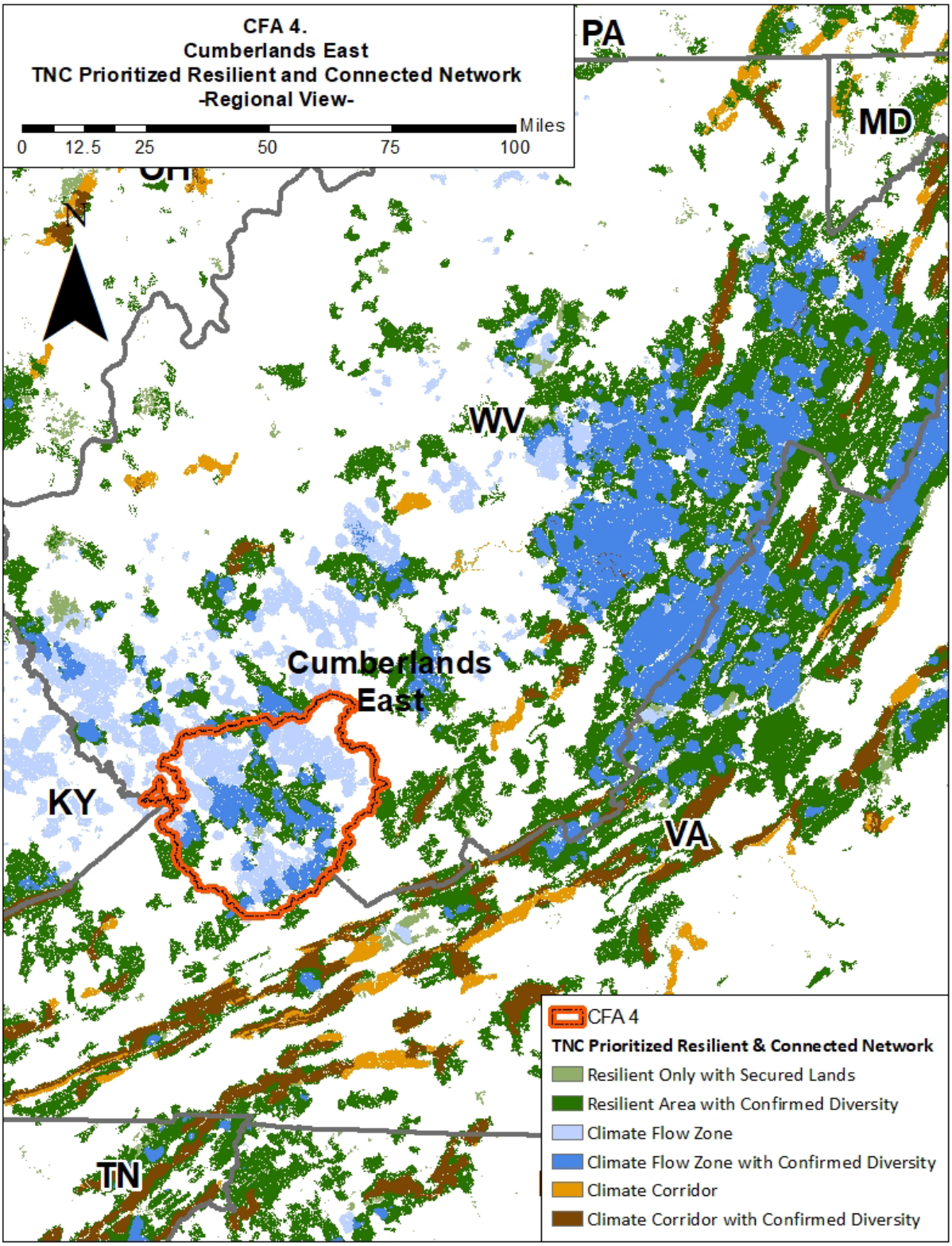
Building on the concept of landscape integrity, The Nature Conservancy (TNC) led a team of 60 scientists to identify areas representing all geophysical settings, with varied microclimates and natural cover, that were most likely to sustain native plants and animals and natural processes into the future and be resilient to climate change. The team identified resilient sites as those with topographic and elevation diversity that offer a range of habitat types and microclimates for species and ecosystems to adapt to climate change, along with high landscape integrity or local connectedness where species could move locally and disperse in response to climate change, and where natural processes like fire and floods could continue unimpeded. These are core areas for species movement and adaptation at a local level. They then modeled the movement or flow of species across the landscape over time in response to climate change, as constrained by natural and human-caused barriers. This led to the identification of corridors of constrained movement and flow zones of dispersed movement. These are corridors and core areas for species movement and adaptation at a landscape level. Lastly the team developed models that integrated landscape resilience, connectivity and the flow of species and populations across the landscape to identify a connected network of sites that represents the full suite of geophysical settings, includes known records of biological diversity and has the configuration and connections necessary to support the continued movement of species in response to change conditions. To identify the subset of places most essential for sustaining biodiversity in a changing climate and aligned to the natural flow patterns across the region, the team then identified the most resilient and diverse lands representing all of the region's geophysical settings, recorded occurrences of biological diversity, resilient lands already secured through public ownership or conservation easements, and the riparian corridors and other landscape linkages with the most concentrated movement of species. This prioritized network covers 23% of the land in the Eastern United States.

This work is documented in Resilient Sites for Terrestrial Conservation in Eastern North America (Anderson et al., 2016a) and Resilient and Connected Landscapes for Terrestrial Conservation (Anderson et al., 2016b). The studies produced a series of maps (see http://maps.tnc.org/resilientland/) that identified the following areas:

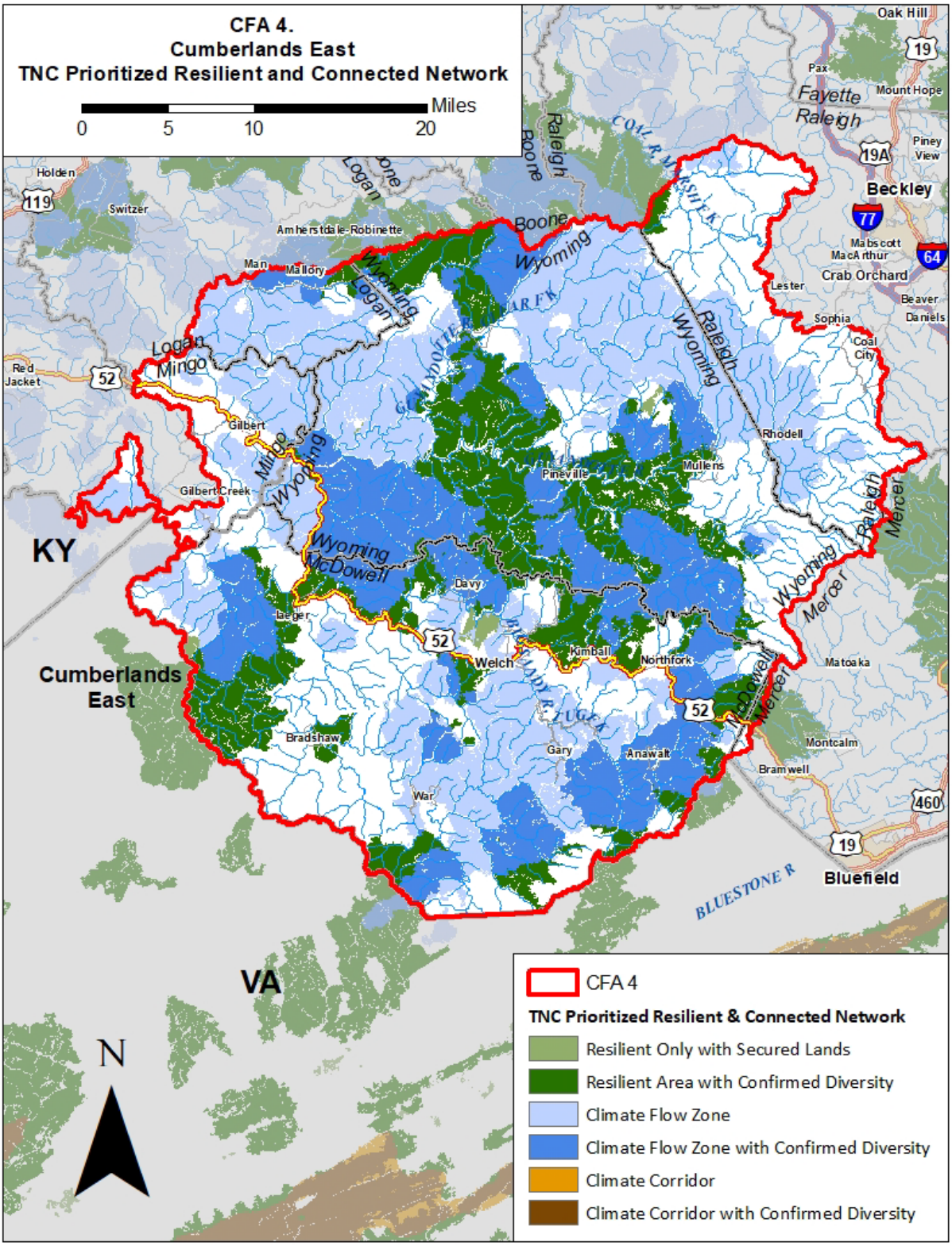
- Resilient area: a place buffered from climate change because it contains diverse, complex, connected landscapes with many micro-climates that create options for species adapting to climate change
- Climate corridor: a narrow conduit of natural cover in which the movement of plants and animals becomes concentrated, often along a stream corridor or ridgeline
- Climate flow zone: areas with high levels of plant and animal movement that is less concentrated than in a corridor, such as an intact forest patches and areas of high integrity

Map 14 illustrates that the climate flow zones and resilient areas within this CFA are part of the large hub of resilient landscapes on the southern side of the state. They are loosely connected to the larger hub of resilient, connected landscapes in the eastern portions the state and stretching along the Appalachians. The resilient, connected landscapes in this CFA are part of a connected network that is critical to species adapting to climate change across the Eastern United States.

*Map 14. Priority Resilient and Connected Network: Regional View*



*Map 15. Priority Resilient and Connected Network – Detailed View*



Map 15 provides a detailed view of the resilient, connected landscapes in the Cumberlands East CFA. There are large resilient areas and flow zones with confirmed biological diversity stretching from east to west across the middle of the CFA, and smaller ones on the northern and southern ends, loosely connected by flow zones in between them. These priority, resilient and connected landscapes contain the CFA's larger forest patches, high integrity areas and a substantial portion of its biodiversity.

Protecting and maintaining these areas of high landscape integrity and the resilient areas, climate corridors and climate flow zones within the region's priority resilient and connected network is critical to enable priority SGCN and their habitat to adapt to climate change and persist in this CFA. These areas are priorities for conservation action within the CFA.

The table below summarizes conservation actions for climate resilience to address stresses from climate change at a landscape level.

Table 22. Climate Stresses and Actions for Landscape Resilience and Connectivity

| Climate Stress | Conservation Action |
|---|---|
| • Changing conditions exacerbating existing stresses on species and habitat<br>• Species responding to climate change by shifting locally as well as across the landscape<br>• Landscape fragmentation that prevents or constrains species movement | • Protect and maintain a connected network of resilient landscapes, flow zones and climate corridors across the landscape for species to adapt and shift locally and regionally in response to climate change |

## Implementation Plan

The resilient and connected landscapes in this CFA provide critical links to the larger network of resilient and connected landscapes in West Virginia, Maryland, Virginia, the Central Appalachians and Eastern North America. They provide a blueprint of habitat cores and corridors where conservation actions to restore, maintain and protect natural habitat and remove barriers to movement will be crucial to enabling priority species and habitats to shift and adapt to climate change at both local and regional scales. The following implementation plan lists specific actions to protect, maintain and restore the network of resilient, connected lands within the CFA.

Table 23. Implementation Plan for Landscape Resilience and Connectivity

| **Action** | **Partners** | **Effectiveness Measures** |
|---|---|---|
| Protection of Resilient, Connected Landscapes and migratory corridors<br>• Conservation Easements<br>• Land Acquisition | • County Farmland Protection Boards<br>• OHCF, TCF, TNC, WVLT<br>• USDA NRCS<br>• WVDNR | • Acres of habitat protected for priority species in resilient landscapes and climate corridors<br>• Abundance & distribution of priority species and habitats |
| Protection of Resilient, Connected Landscapes<br>• Land use planning | • County Planning Commissions | • Acres of habitat protected through land use planning in resilient, connected landscapes |
| Protection of Resilient, Connected Landscapes<br>• Incentive Programs<br>• Forest Carbon projects<br>• Forest Certification Programs | • USDA FSA & NRCS<br>• Consulting Foresters<br>• AFF, TNC<br>• ATFS, FSC, SFI | • Acres of habitat protected for priority species in resilient landscapes and climate corridors<br>• Abundance & distribution of priority species and habitats |
| Protection of Resilient, Connected Landscapes<br>• Conservation and Management | • AFF, AMJV, NWTF, RGS, TNC<br>• Forest Certification Programs: ATFS, FSC, SFI<br>• WVDNR<br>• WVDOF<br>• Private Landowners<br>• Public Land Managers<br>• Partner Organizations | • Acres of habitat protected, restored and maintained in resilient landscapes and climate corridors<br>• Abundance & distribution of priority species and habitats |

# Conclusion

## Habitat Conservation Priorities

This action plan lists priority species and rare plant communities targeted for conservation action on public and private land and within each major habitat type. The major habitat types include forests and woodlands, acid rock outcrops, cliffs and talus, aquatic, riparian, floodplain, and anthropogenic habitats. For each major habitat type the plan identifies stresses that affect priority species, conservation actions to reduce those stresses, climate stresses on those habitats, actions to boost resilience, partners that can assist with conservation actions to implement the plan and the human benefits of conservation.

Below is a list of the priority habitats identified by this Action Plan for conservation action.

- Large, intact forest patches, including interior forest habitat
- Early-successional forest habitat
- Acidic rock outcrops, cliffs and talus
- Mussel streams, riparian and river floodplain habitats
- High integrity, resilient and connected landscapes and migratory corridors.

These priority habitats include habitat cores and corridors that are critical for maintaining wildlife populations in this CFA. To protect priority SGCN and enable them to adapt to changing conditions within these priority habitats, landowners and partner organizations are encouraged to plan and implement conservation actions to alleviate stresses on priority species and boost habitat resilience, and carefully monitor the results using an adaptive management framework such as the Climate Smart Conservation Cycle included in the introduction. Stakeholders are also encouraged to coordinate with relevant agencies to develop strategies to avoid, minimize and mitigate for impacts to these priority habitats.

## Integration of Conservation Actions

Integration of conservation actions within the above priority habitats, such as projects to improve mussel stream habitat by improving wastewater treatment, enlarging stream crossings and planting riparian stream buffers may benefit multiple plant communities and wildlife species. Coordinating actions across multiple habitats, such as protecting large patches of diverse forest habitats that also include acid rock outcrops may benefit additional species. Private landowners, public land managers and conservation partners are encouraged to focus resources across priority habitats to maximize benefits to multiple species.

## Connecting Conservation Actions for Climate Resilience

As we have seen, conservation actions to relieve stresses on priority species and efforts to boost the resilience of wildlife habitat are essential for enabling climate adaptation. Protecting areas of high landscape integrity as well as the regional network of resilient lands, climate corridors and flow zones is also critical for enabling wildlife species to adapt to changing conditions and shift across the landscape.

Furthermore, creating local networks of connected habitat cores and corridors will enhance their resilience and connectivity, and the ability of wildlife species to adapt to changing conditions within this CFA. Connected local networks of headwater streams and larger rivers, their riparian corridors, floodplains and wetlands enhances the stability of these habitats and enables fish, reptiles, birds and other priority wildlife species that depend on those habitats to move across the landscape as conditions change. Maintaining connections between patches of diverse forest habitat and with acid rock outcrops, cliff and talus enhances the resilience of these habitats and enables forest species to move to optimal sites as conditions change. Conservation of aquatic, riparian and floodplain corridors along with areas of native vegetation in and around agricultural areas, small forest patches and larger blocks of forest habitat can create a local network of resilient, connected lands that merges into the larger regional network. In this CFA in particular, restoring and connecting a diversity of natural forest and aquatic habitats in and around reclaimed mine areas will increase the connectivity and resilience of these landscapes. Beyond undertaking conservation actions in the priority habitats listed above and protecting the regional network of resilient and connected lands, stakeholders are encouraged to restore and protect the connections between these areas in order to maintain an interwoven fabric of natural systems for native plants and animals to thrive long into the future.

## Next Steps in Implementation

WVDNR engaged a working group of partner organizations and public land managers in developing this Action Plan and will seek to remain engaged by convening semi-annual meetings with the working group to collaborate on actions including the following:

- Planning, implementing and evaluating ongoing field surveys of priority species to document and monitor their abundance, distribution, population trends, vulnerability and range shifts
- Planning, implementing, monitoring and evaluating the results of the conservation actions
- Engaging and supporting private landowners in this work.

WVDNR may lead some of these efforts but will most often play the role of supporting efforts by the many partners active in this CFA with ongoing projects, established programs and connections with landowners. In the case of public lands, WVDNR will also seek to incorporate conservation actions targeting priority species, habitats and priority areas for conservation action into agency planning processes and support those actions. WVDNR will also work with state agencies and other authorities to promote avoidance, minimization and mitigation for development impacts to priority habitats and other priority areas for conservation action.

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## Appendix 1. SGCN in the Cumberlands East CFA

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Amphibians | Ambystoma jeffersonianum | Jefferson Salamander | | S2 | G4 | | |
| Amphibians | Aneides aeneus | Green Salamander | | S3 | G3G4 | | |
| Amphibians | Cryptobranchus alleganiensis | Eastern Hellbender | | S2 | G3G4 | | |
| Amphibians | Desmognathus kanawha | Black-bellied Salamander | | S3 | G5 | | |
| Amphibians | Desmognathus welteri | Black Mountain Salamander | | S2 | G4 | | |
| Amphibians | Necturus maculosus | Mudpuppy | | S4 | G5 | | |
| Amphibians | Plethodon kentucki | Cumberland Plateau Salamander | | S3 | G4 | | |
| Amphibians | Plethodon wehrlei | Yellow-spotted Woodland Salamander | | S4 | G4 | | |
| Amphibians | Pseudotriton montanus diastictus | Midland Mud Salamander | | S1 | G5T5 | | |
| Amphibians | Pseudotriton ruber ruber | (northern) Red Salamander | | S3 | G5 | | |
| Birds | Actitis macularius | Spotted Sandpiper | | S2B | G5 | | |
| Birds | Ammodramus savannarum | Grasshopper Sparrow | | S3B | G5 | | |
| Birds | Antrostomus vociferus | Eastern Whip-poor-will | | S3B | G5 | | Conserv |
| Birds | Bonasa umbellus | Ruffed Grouse | | S3B,S3N | G5 | | |
| Birds | Buteo platypterus | Broad-winged Hawk | | S3B | G5 | | |
| Birds | Cardellina canadensis | Canada Warbler | | S3B | G5 | | |
| Birds | Catharus fuscescens | Veery | | S3B | G5 | | |
| Birds | Chaetura pelagica | Chimney Swift | | S3B | G5 | | |
| Birds | Falco sparverius | American Kestrel | | S3B | G5 | | |
| Birds | Geothlypis formosa | Kentucky Warbler | | S3B | G5 | | |
| Birds | Helmitheros vermivorum | Worm-eating Warbler | | S3B | G5 | | |
| Birds | Hylocichla mustelina | Wood Thrush | | S3B | G5 | | Conserv |

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Birds | Icteria virens | Yellow-breasted Chat | | S3B | G5 | | |
| Birds | Limnothlypis swainsonii | Swainson's Warbler | | S3B | G4 | | |
| Birds | Parkesia motacilla | Louisiana Waterthrush | | S3B | G5 | | |
| Birds | Piranga rubra | Summer Tanager | | S3B | G5 | | |
| Birds | Podilymbus podiceps | Pied-billed Grebe | | S2B,S4N | G5 | | |
| Birds | Scolopax minor | American Woodcock | | S3B | G5 | | |
| Birds | Setophaga cerulea | Cerulean Warbler | | S2B | G4 | | Conserv |
| Birds | Setophaga discolor | Prairie Warbler | | S3B | G5 | | |
| Birds | Spizella pusilla | Field Sparrow | | S3B | G5 | | |
| Birds | Sturnella magna | Eastern Meadowlark | | S3B, S2N | G5 | | |
| Birds | Vermivora chrysoptera | Golden-winged Warbler | | S1B | G4 | | Conserv |
| Birds | Vermivora cyanoptera | Blue-winged Warbler | | S3B | G5 | | |
| Butterflies and Moths | Argynnis diana | Diana Fritillary | | S2S3 | G3G4 | | |
| Butterflies and Moths | Calycopis cecrops | Red-banded Hairstreak | | S3 | G5 | | |
| Butterflies and Moths | Cyllopsis gemma | Gemmed Satyr | | S3 | G4G5 | | |
| Butterflies and Moths | Phyciodes cocyta diminutor | Summer Crescent | | SNR | GNR | | |
| Butterflies and Moths | Pieris virginiensis | West Virginia White | | S3 | G3? | | |
| Butterflies and Moths | Syngrapha rectangula | Salt & Pepper Looper Moth | | S1 | G5 | | |
| Butterflies and Moths | Telegonus cellus | Golden-banded Skipper | | S1S2 | G4 | | |
| Crayfish | Cambarus hatfieldi | Tug Fork Valley Crayfish | | S2 | G2G3? | | |
| Crayfish | Cambarus theepiensis | Coalfields Crayfish | | S3 | GNR | | |
| Crayfish | Cambarus veteranus | Guyandotte River Crayfish | | S1 | G1 | E | |

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Crayfish | Camberus callainus | Big Sandy Crayfish | | S1 | G3 | T | |
| Dragonflies and Damselflies | Celithemis fasciata | Banded Pennant | | S3 | G5 | | |
| Dragonflies and Damselflies | Cordulegaster obliqua | Arrowhead Spiketail | | S2 | G4 | | |
| Dragonflies and Damselflies | Cordulia shurtleffi | American Emerald | | S4 | G5 | | |
| Dragonflies and Damselflies | Dromogomphus spoliatus | Flag-tailed Spinyleg | | SH | G4G5 | | |
| Dragonflies and Damselflies | Gomphus quadricolor | Rapids Clubtail | | S3 | G3G4 | | |
| Dragonflies and Damselflies | Lanthus parvulus | Northern Pygmy Clubtail | | S3 | G4 | | |
| Dragonflies and Damselflies | Lestes forcipatus | Sweetflag Spreadwing | | S3 | G5 | | |
| Dragonflies and Damselflies | Macromia alleghaniensis | Allegheny River Cruiser | | S2S3 | G4 | | |
| Dragonflies and Damselflies | Macromia illinoiensis | Swift River Cruiser | | S3 | G5 | | |
| Dragonflies and Damselflies | Progomphus obscurus | Common Sanddragon | | S2S3 | G5 | | |
| Dragonflies and Damselflies | Somatochlora linearis | Mocha Emerald | | S3 | G5 | | |
| Dragonflies and Damselflies | Tachopteryx thoreyi | Gray Petaltail | | S3 | G4 | | |
| Fish | Ameiurus nebulosus | Brown Bullhead | | S2 | G5 | | |
| Fish | Carpiodes velifer | Highfin Carpsucker | | S1 | G4G5 | | |
| Fish | Ichthyomyzon bdellium | Ohio Lamprey | | S2S3 | G3G4 | | |

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Fish | Macrhybopsis hyostoma | Shoal Chub | | S2 | G5 | | |
| Fish | Moxostoma carinatum | River Redhorse | | S3 | G4 | | |
| Fish | Percina copelandi | Channel Darter | | S2S3 | G4 | | |
| Fish | Percina phoxocephala | Slenderhead Darter | | S1 | G5 | | |
| Fish | Percina sciera | Dusky Darter | | S3 | G5 | | |
| Fish | Phenacobius mirabilis | Suckermouth Minnow | | S3 | G5 | | |
| Fish | Polyodon spathula | Paddlefish | | S1 | G4 | | |
| Mammals | Lasiurus borealis | Eastern Red Bat | | S4 | G5 | | |
| Mammals | Lasiurus cinereus | Hoary Bat | | S3 | G5 | | |
| Mammals | Myotis leibii | Eastern Small-footed Bat | | S1 | G3 | | |
| Mammals | Myotis lucifugus | Little Brown Myotis | | S2* | G3 | | |
| Mammals | Myotis septentrionalis | Northern Myotis | | S2* | G2G3 | | |
| Mammals | Neotoma magister | Allegheny Woodrat | | S3 | G3G4 | | |
| Mammals | Ochrotomys nuttalli | Golden Mouse | | S2 | G5 | | |
| Mammals | Perimyotis subflavus | Tricolored Bat | | S2* | G3 | | |
| Mammals | Sorex dispar | Long-tailed Shrew | | S2S3 | G4 | | |
| Mammals | Spilogale putorius | Eastern Spotted Skunk | | S1 | G5 | | |
| Mammals | Synaptomys cooperi | Southern Bog Lemming | | S3 | G5 | | |
| Mussels | Elliptio dilatata | Spike | | S3 | G5 | | |
| Mussels | Lampsilis cardium | Plain Pocketbook | | S3 | G5 | | |
| Mussels | Lampsilis fasciola | Wavy-rayed Lampmussel | | S3 | G5 | | |
| Plants | Agalinis auriculata | Earleaf False Foxglove | | SH | G3 | | |
| Plants | Anemone quinquefolia var. minima | Dwarf Anemone | | S2 | G5T3 | | |
| Plants | Arundinaria gigantea ssp. gigantea | Giant Cane | | S2 | G5T5? | | |
| Plants | Calycanthus floridus var. glaucus | Carolina Allspice, Strawberry-shrub | | SH | G5T5 | | |
| Plants | Carex pedunculata | Longstalk Sedge | | S2 | G5 | | |

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Plants | Carex tonsa var. tonsa | Shaved Sedge | | S1 | G5T5 | | |
| Plants | Cleistes bifaria | Small Rosebud Orchid | | S1 | G4? | | |
| Plants | Coeloglossum viride var. virescens | Long-bracted Green Orchid, Satyr Orchid | | S1 | G5T5 | | |
| Plants | Gentiana austromontana | Appalachian Gentian | | S1 | G3 | | |
| Plants | Heuchera americana var. hispida | Rough Alumroot, Rough Heuchera | | S2 | G5T3? | | |
| Plants | Heuchera longiflora | Long-flower Alumroot | | S2 | G4 | | |
| Plants | Juglans cinerea | Butternut | | S3 | G4 | | |
| Plants | Juncus dichotomus | Forked Rush | | S1 | G5 | | |
| Plants | Leucothoe recurva | Red-twig Doghobble | | S1 | G4G5 | | |
| Plants | Liatris scariosa var. nieuwlandii | Devil's-bite | | S1 | G5?T3T5 | | |
| Plants | Lilium michauxii | Carolina Lily | | S1 | G4G5 | | |
| Plants | Liparis loeselii | Yellow Wide-lip Orchid | | S3 | G5 | | |
| Plants | Listera cordata var. cordata | Heartleaf Twayblade | | S2 | G5T5 | | |
| Plants | Listera smallii | Kidneyleaf Twayblade | | S2 | G4 | | |
| Plants | Lygodium palmatum | American Climbing Fern | | S3 | G4 | | |
| Plants | Lysimachia tonsa | Southern Loosestrife | | SH | G4 | | |
| Plants | Marshallia grandiflora | Monongahela Barbara's-buttons | | S2 | G2 | | |
| Plants | Myosotis macrosperma | Large-seed Forget-me-not | | S3 | G5 | | |
| Plants | Platanthera psycodes | Lesser Purple Fringed Orchid | | S1 | G5 | | |
| Plants | Polygala curtissii | Curtiss' Milkwort | | S2 | G5 | | |
| Plants | Potamogeton pulcher | Spotted Pondweed | | S1 | G5 | | |
| Plants | Prosartes maculata | Yellow Mandarin | | S1 | G3G4 | | |
| Plants | Saxifraga caroliniana | Carolina Saxifrage | | S1 | G3 | | |
| Plants | Scutellaria saxatilis | Rock Skullcap | | S2 | G3 | | |

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Plants | Solidago faucibus | Gorge Goldenrod | | S1 | G2G4 | | |
| Plants | Spiraea virginiana | Virginia Spiraea | | S1 | G2 | | |
| Plants | Spiranthes tuberosa | Little Ladies'-tresses | | S3 | G5 | | |
| Plants | Taxus canadensis | Canada Yew | | S2S3 | G5 | | |
| Plants | Thuja occidentalis | Northern White-cedar | | S2 | G5 | | |
| Plants | Viola nephrophylla | Northern Bog Violet | | SH | G5 | | |
| Plants | Vitis rotundifolia var. rotundifolia | Muscadine | | SH | G5T5 | | |
| Reptiles | Agkistrodon contortrix mokasen | Northern Copperhead | | S5 | G5T5 | | |
| Reptiles | Apalone spinifera spinifera | Eastern Spiny Softshell | | S4 | G5T5 | | |
| Reptiles | Carphophis amoenus | Wormsnake | | S3 | G5 | | |
| Reptiles | Coluber constrictor constrictor | Northern Black Racer | | SNR | G5T5 | | |
| Reptiles | Crotalus horridus | Timber Rattlesnake | | S3 | G4 | | |
| Reptiles | Heterodon platirhinos | Eastern Hog-nosed Snake | | S2 | G5 | | |
| Reptiles | Liochlorophis vernalis | Smooth Greensnake | | S5 | G5 | | |
| Reptiles | Opheodrys aestivus | Rough Greensnake | | S2 | G5 | | |
| Reptiles | Plestiodon anthracinus anthracinus | Northern Coal Skink | | S2 | G5T5 | | |
| Reptiles | Regina septemvittata | Queen Snake | | S4 | G5 | | |
| Reptiles | Terrapene carolina carolina | Eastern Box Turtle | | S5 | G5T5 | | |
| Snails | Anguispira mordax | Appalachian Tigersnail | | S2 | G4 | | |
| Snails | Carychium nannodes | File Thorn | | S3 | G5 | | |
| Snails | Gastrodonta fonticula | Appalchia Bellytooth | | S2 | G3G4 | | |
| Snails | Glyphyalinia cumberlandiana | Hill Glyph | | S3 | G4 | | |
| Snails | Hawaiia alachuana | Southeastern Gem | | S3 | G4G5Q | | |
| Snails | Paravitrea bellona | Club Supercoil | | S1 | G1 | | |
| Snails | Paravitrea bellona | Club Supercoil | | S1 | G1 | | |

| Taxa | Scientific Name | Common Name | | S Rank | G Rank | Federal Status | USFWS at Risk |
|---|---|---|---|---|---|---|---|
| Snails | Paravitrea reesei | Round Supercoil | | S2 | G3 | | |
| Snails | Stenotrema edvardsi | Ridge-and-valley Slitmouth | | S3 | G4G5 | | |
| Snails | Stenotrema macgregori | Fraudulent Slitmouth | | S2 | GNR | | |
| Snails | Stenotrema macgregori | Fraudulent Slitmouth | | S2 | GNR | | |
| Snails | Striatura ferrea | Black Striate | | S3 | G5 | | |
| Snails | Striatura ferrea | Black Striate | | S3 | G5 | | |
| Snails | Triodopsis tennesseensis | Budded Threetooth | | S3 | G4 | | |
| Snails | Triodopsis tennesseensis | Budded Threetooth | | S3 | G4 | | |
| Snails | Ventridens collisella | Sculptured Dome | | S3 | G4G5 | | |
| Snails | Vertigo parvula | Smallmouth Vertigo | | S2 | G3 | | |
| Snails | Vertigo parvula | Smallmouth Vertigo | | S2 | G3 | | |
| Tiger Beetles | Cicindela ancocisconensis | Appalachian Tiger Beetle | | S3 | G3 | | |
| Tiger Beetles | Cicindela unipunctata | A Tiger Beetle | | S3 | G4G5 | | |

S Rank (State Rank) and G Rank (Global Rank) Conservation Status: 1= Critically Imperiled, 2 = Imperiled, 3 = Vulnerable, 4 = Apparently Secure, 5 = Secure, NR = Not Ranked, T = Subspecies or Varieties, B = Breeding, N = Non-breeding, S#S# or G#G# indicates range of uncertainty of conservation status.

Federal Status (2021): T= Threatened, E = Endangered.

USFWS Priority At Risk (2021): Conserv = need management attention, Science = need more research.

## Appendix 2. Priority SGCN, Known Stresses and Actions

| Forests and Woodlands | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Green Salamander | • Habitat degradation | • Buffer rocky outcrops and known occupied habitat |
| Cumberland Plateau Salamander | • Habitat degradation | • Implement forestry BMPs |
| Midland Mud Salamander | • Habitat degradation<br>• Water quality | • Protection of springs and palustrine wetlands |
| Eastern Whip-poor-will | • Collision mortality<br>• Incompatible forest structure<br>• Possible declines in prey | • Erect road signage in high density areas<br>• Develop and implement BMPs |
| Ruffed Grouse | • Insufficient habitat<br>• West Nile Virus | • Assess prevalence of West Nile Virus in population<br>• Implementation of BMPs at landscape scale. |
| Broad-winged Hawk | • Collision mortality | • Erect road signage in high density areas |
| Kentucky Warbler | • Local understory impacts from deer overabundance | • R3 initiatives. |
| Worm-eating Warbler | • Local understory impacts from deer overabundance<br>• Brood parasitism and nest predation in forest fragments<br>• Landscape-scale forest homogeneity | • R3 initiatives<br>• Forest stand improvement<br>• Development of forest habitat mosaics |
| Wood Thrush | • Local understory impacts from deer overabundance<br>• Brood parasitism and nest predation in forest fragments<br>• Landscape-scale forest homogeneity | • R3 initiatives<br>• Forest stand improvement<br>• Development of forest habitat mosaics |

| Forests and Woodlands | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Yellow-breasted Chat | • Insufficient habitat supply | • Forest and utility corridor management for shrubby habitats with minimal overstory |
| Swainson's Warbler | • Habitat degradation and forest loss in stream bottoms and adjacent slopes | • Improve implementation and enforcement of mitigation measures |
| Cerulean Warbler | • Forest fragmentation and loss from residential development and industrial activities<br>• Incompatible forest structure | • Implement BMPs on public and private lands |
| Prairie Warbler | • Insufficient habitat supply. | • Forest and utility corridor management for shrubby habitats with minimal overstory |
| Golden-winged Warbler | • Forest maturation, incompatible forest structure<br>• Habitat loss on wintering grounds | • Implement BMPs on public and private lands |
| Blue-winged Warbler | • Forest maturation, incompatible forest structure<br>• Habitat loss on wintering grounds | • Implement BMPs on public and private lands |
| Golden-banded Skipper | • Invasive plant species out-competing larval host (Phaseolus polystacios - wild bean) | • WVDNR should develop plans to control invasive plant species on their properties and implement them |
| West Virginia White | • Ovipositing by females onto invasive garlic mustard leading to death of larvae<br>• Loss of toothworts (Cardamine) from legacy land uses | • Promote and implement invasive species management including garlic mustard pulls |

| Forests and Woodlands | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Diana Fritillary | • Habitat loss from mineral extractions especially surface coal mining<br>• Loss of nectar resources from mowing and deer browse | • Improve management and restoration of surface coal mining<br>• Encourage reduced mowing and other actions to promote abundant native nectar sources<br>• Reduce deer numbers through hunting and special seasons |
| Eastern Box Turtle | • Habitat degradation | • Outreach to spread awareness about illegal trade in turtles and regulations regarding taking box turtles and other WV amphibians and reptiles<br>• Create wildlife corridors in high impact areas |

| Acid Rock Outcrops, Cliffs and Talus | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Green Salamander | • Habitat degradation | • Buffer rocky outcrops and known occupied habitat |
| Yellow-spotted Woodland Salamander | • Data Gaps | • Determine current extent of Plethodon pauleyi, especially on public lands<br>• Collect baseline population data to better inform future management decisions. |

| Anthropogenic Habitats | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Chimney Swift | • Breeding season chimney capping<br>• Illegal removal of breeding birds and nests | • Distribute management guidelines to landowners and industry |
| Yellow-breasted Chat | • Insufficient habitat supply | • Forest and utility corridor management for shrubby habitats with minimal overstory |
| Field Sparrow | • Nest destruction from mowing/brush hogging | • Develop and distribute educational materials to private landowners |
| Blue-winged Warbler | • Forest maturation, incompatible forest structure<br>• Habitat loss on wintering grounds | • Implement BMPs on public and private lands |
| West Virginia White | • Ovipositing by females onto invasive garlic mustard leading to death of larvae<br>• Loss of toothworts (Cardamine) from legacy landuses | • Promote and implement invasive species management including garlic mustard pulls |
| Diana Fritillary | • Habitat loss from mineral extractions especially surface coal mining<br>• Loss of nectar resources from mowing and deer browse | • Improve management and restoration of surface coal mining<br>• Encourage reduced mowing and other actions to promote abundant native nectar sources<br>• Reduce deer numbers through hunting and special seasons |
| Chimney Swift | • Breeding season chimney capping<br>• Illegal removal of breeding birds and nests | • Distribute management guidelines to landowners and industry |
| Eastern Box Turtle | • Illegal Collection<br>• Road Mortality<br>• Disease | • Outreach to spread awareness about illegal trade in turtles and regulations regarding taking box turtles and other WV amphibians and reptiles<br>• Create wildlife corridors in high impact areas |

| Aquatic, Floodplain and Riparian Habitats | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Black Mountain Salamander | • Collection for fishing bait<br>• Disease<br>• Water Quality | • Implement BMPs on private and public lands to reduce impacts to water quality<br>• Follow appropriate gear and equipment (recreational, construction) decontamination protocols<br>• Restrict collection |
| Midland Mud Salamander | • Habitat degradation<br>• Water quality | • Protection of springs and palustrine wetlands |
| Louisiana Waterthrush | • Water quality degradation from development, resource extraction, and runoff events | • Improve implementation and enforcement of mitigation measures |
| Golden-banded Skipper | • invasive plant speciies out-competing larval host (Phaseolus polystacios - wild bean) | • WVDNR should develop plans to control invasive plant species on their properties and implement them |
| West Virginia White | • Ovipositing by females onto invasive garlic mustard leading to death of larvae<br>• Loss of toothworts (Cardamine) from legacy land uses | • Promote and implement invasive species management including garlic mustard pulls |
| Diana Fritillary | • Habitat loss from mineral extractions especially surface coal mining<br>• Loss of nectar resources from mowing and deer browse | • Improve management and restoration of surface coal mining<br>• Encourage reduced mowing and other actions to promote abundant native nectar sources<br>• Reduce deer numbers through hunting and special seasons |
| Big Sandy Crayfish | • AMD/mountain top mining<br>• Sedimentation<br>• Timbering | • Mitigating siltation, reduce off trail use, prevent non-native crayfish introductions |

| Aquatic, Floodplain and Riparian Habitats | | |
|---|---|---|
| **Common Name** | **Local Stress** | **Action** |
| Tug Fork Valley Crayfish | • AMD/mountain top mining<br>• Sedimentation<br>• Timbering | • Mitigating siltation<br>• Reduce off-trail use of ATVs<br>• Prevent non-native crayfish introductions |
| Guyandotte River Crayfish | • AMD/mountain top mining<br>• Sedimentation<br>• Timbering | • Mitigating siltation<br>• Reduce off-trail use of ATVs<br>• Prevent non-native crayfish introductions |
| Eastern Box Turtle | • Illegal Collection<br>• Road Mortality<br>• Disease | • Outreach to spread awareness about illegal trade in turtles and regulations regarding taking box turtles and other WV amphibians and reptiles<br>• Create wildlife corridors in high impact areas |

## Appendix 3. Habitats on Public Lands

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| Anawalt Lake Wildlife Management Area | **Forest and Woodland**<br>• Dry-Mesic Oak Forests<br>• Dry Oak (-Pine) Forests<br>• Mixed Mesophytic Forests<br>• Anthropogenic Shrubland & Grassland<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>• Open Water<br>**Agriculture and Developed**<br>• Developed | • Headwaters/Creek, High Gradient, Cold<br>• Headwaters/Creek, Very High Gradient, Cold |
| Berwind Lake Wildlife Management Area | **Forest and Woodland**<br>• Dry Oak (-Pine) Forests<br>• Mixed Mesophytic Forests<br>• Dry-Mesic Oak Forests<br>• Anthropogenic Shrubland & Grassland<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>• Open Water<br>**Agriculture and Developed**<br>• Developed<br>• Agriculture | • Headwaters/Creek, High Gradient, Cold<br>• Headwaters/Creek, Very High Gradient, Cold<br>• Headwaters/Creed, Moderate Gradient, Cold |
| Bright Bridge Park | **Agriculture and Developed**<br>• Developed | • Headwaters/Creek, High Gradient, Cold |
| Captain J.F. Lyttle Jr. Memorial Parks and Playground | **Agriculture and Developed**<br>• Developed | • Small River, Low Gradient, Transitional |
| Helen Park | **Agriculture and Developed**<br>• Developed | • Headwaters/Creek, High Gradient, Cold |

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| Horse Creek Wildlife Management Area | **Forest and Woodland**<br>• Mixed Mesophytic Forests<br>• Dry-Mesic Oak Forests<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>• Open Water<br>• Developed | • Headwaters/Creek, High Gradient, Cold<br>• Headwaters/Creek, Very High Gradient, Cold<br>• Headwaters/Creed, Low Gradient, Cold |
| Lake Stephens Recreation Area | **Forest and Woodland**<br>• Dry Oak (-Pine) Forests<br>• Mixed Mesophytic Forests<br>• Dry-Mesic Oak Forests<br>• Anthropogenic Shrubland & Grassland<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>• Open Water<br>**Agriculture and Developed**<br>• Agriculture<br>• Developed | • Headwaters/Creek, High Gradient, Transitional<br>• Headwaters/Creek, Very High Gradient, Cold<br>• Headwaters/Creed, Very High Gradient, Transitional<br>• Headwaters/Creed, Low Gradient, Transitional |
| Larry Joe Harless Community Center | **Aquatic, Floodplain, and Riparian**<br>• Open Water<br>**Agriculture and Developed**<br>• Agriculture<br>• Developed | |
| Laurel Park | **Forest and Woodland**<br>• Anthropogenic Shrubland & Grassland<br>**Aquatic, Floodplain, and Riparian**<br>• River Floodplains<br>**Agriculture and Developed**<br>• Developed | |

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| Linkous Park | **Forest and Woodland**<br>• Anthropogenic Shrubland & Grassland<br>**Aquatic, Floodplain, and Riparian**<br>• River Floodplains<br>**Agriculture and Developed**<br>• Developed | • Small Rivers, Very High Gradient, Transitional |
| Mullens City Pool | **Forest and Woodland**<br>• Dry-Mesic Oak Forests<br>**Agriculture and Developed**<br>• Developed | |
| Mullins Volunteer Park | **Agriculture and Developed**<br>• Developed | |
| Panther State Forest | **Forest and Woodland**<br>• Mixed Mesophytic Forests<br>• Anthropogenic Shrubland & Grassland<br>• Dry-Mesic Oak Forests<br>• Dry Oak (-Pine) Forests<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>**Agriculture and Developed**<br>• Developed | • Headwaters/Creek, Very High Gradient, Cold<br>• Headwaters/Creed, Low Gradient, Cold<br>• Headwaters/Creed, High Gradient, Transitional |

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| Panther Wildlife Management Area | **Forest and Woodland**<br>• Dry-Mesic Oak Forests<br>• Mixed Mesophytic Forests<br>• Anthropogenic Shrubland & Grassland<br>• Dry Oak (-Pine) Forests<br>• Pine-Oak Rocky Woodlands<br>**Rock Outcrops, Cliffs and Talus, and Shale Barrens**<br>• Acidic Rock Outcrops, Cliffs, and Talus<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>**Agriculture and Developed**<br>• Agriculture<br>• Developed | • Headwaters/Creeks, Transitional, High Gradient<br>• Headwaters/Creeks, Transitional, Very High Gradient<br>• Headwaters/Creeks, Cold, Low Gradient<br>• Headwaters/Creeks, Cold, Very High Gradient<br>• Headwaters/Creeks, Cold, High Gradients<br>• Headwaters/Creeks, Cold, Moderate Gradient |
| Pineville Park | **Agriculture and Developed**<br>• Developed | • Medium Rivers, Transitional, High Gradient |
| R.D. Bailey Lake Wildlife Management Area | **Forest and Woodland**<br>• Dry Oak (-Pine) Forests<br>• Dry-Mesic Oak Forests<br>• Mixed Mesophytic Forests<br>• Anthropogenic Shrubland & Grassland<br>**Rock Outcrops, Cliffs and Talus, and Shale Barrens**<br>• Acidic Rock Outcrops, Cliffs, and Talus<br>**Aquatic, Floodplain, and Riparian**<br>• River Floodplains<br>• Small Stream Riparian Habitats<br>• Open Water<br>**Agriculture and Developed**<br>• Developed<br>• Agriculture | • Headwaters/Creeks, Cold, Very High Gradient<br>• Headwaters/Creeks, Cold, High Gradient<br>• Small Rivers, Transitional, High Gradient<br>• Medium Rivers, Transitional, Low Gradient<br>• Medium Rivers, Transitional, High Gradient<br>• Small Rivers, Transitional, Low Gradient<br>• Headwaters/Creeks, Cold, Moderate Gradient<br>• Headwaters/Creeks, Cold, Low Gradient |

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| R.D. Bailey Recreation Area | **Forest and Woodland**<br>• Anthropogenic Shrubland & Grassland<br>• Dry Oak (-Pine) Forests<br>• Dry-Mesic Oak Forests<br>• Mixed Mesophytic Forests<br>**Rock Outcrops, Cliffs and Talus, and Shale Barrens**<br>• Acidic Rock Outcrops, Cliffs, and Talus<br>**Aquatic, Floodplain, and Riparian**<br>• Open Water<br>• River Floodplains<br>• Small Stream Riparian Habitats<br>**Agriculture and Developed**<br>• Developed<br>• Agriculture | • Headwaters/Creeks, Cold, Very High Gradient<br>• Headwaters/Creeks, Cold, High Gradient<br>• Small Rivers, Transitional, High Gradient<br>• Medium Rivers, Transitional, Low Gradient<br>• Medium Rivers, Transitional, High Gradient<br>• Small Rivers, Transitional, Low Gradient<br>• Headwaters/Creeks, Cold, Moderate Gradient<br>• Headwaters/Creeks, Cold, Low Gradient<br>• Medium Rivers, Transitional, Very High Gradient<br>• Headwaters/Creeks, Transitional, Very High Gradient<br>• Small Rivers, Transitional, Very High Gradient |
| Rhodell Park | **Agriculture and Developed**<br>• Developed | |

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| Tug Fork Wildlife Management Area | **Forest and Woodland**<br>• Mixed Mesophytic Forests<br>• Dry-Mesic Oak Forests<br>• Anthropogenic Shrubland & Grassland<br>• Dry Oak (-Pine) Forests<br>**Rock Outcrops, Cliffs and Talus, and Shale Barrens**<br>• Acidic Rock Outcrops, Cliffs, and Talus<br>**Aquatic, Floodplain, and Riparian**<br>• River Floodplains<br>• Open Water<br>• Small Stream Riparian Habitats<br>**Agriculture and Developed**<br>• Developed<br>• Agriculture | • Headwaters/Creeks, Cold, Very High Gradient<br>• Small Rivers, Transitional, High Gradient<br>• Medium Rivers, Transitional, Low Gradient<br>• Medium Rivers, Transitional, High Gradient<br>• Small Rivers, Transitional, Low Gradient<br>• Medium Rivers, Transitional, Very High Gradient<br>• Small Rivers, Transitional, Very High Gradient<br>• Small Rivers, Transitional, Moderate Gradient<br>• Medium Rivers, Transitional, Moderate Gradient |

| Public Land | Terrestrial Habitat | Aquatic Habitat |
|---|---|---|
| Twin Falls Resort State Park | **Forest and Woodland**<br>• Mixed Mesophytic Forests<br>• Dry Oak (-Pine) Forests<br>• Dry-Mesic Oak Forests<br>• Anthropogenic Shrubland & Grassland<br>• Northern Hardwood Forests<br>**Rock Outcrops, Cliffs and Talus, and Shale Barrens**<br>• Acidic Rock Outcrops, Cliffs, and Talus<br>**Aquatic, Floodplain, and Riparian**<br>• Small Stream Riparian Habitats<br>**Agriculture and Developed**<br>• Agriculture<br>• Developed | • Headwaters/Creeks, Cold, Very High Gradient<br>• Headwaters/Creeks, Cold, High Gradient |

## Appendix 4. Partners and Assistance Provided

The table below lists partners and assistance provided to landowners for wildlife conservation actions in the CFA.

| Partner | Role/Assistance Provided |
|---|---|
| American Forest Foundation (AFF)<br><br>https://www.forestfoundation.org/<br><br>https://www.familyforestcarbon.org/ | • The American Forest Foundation's mission is to deliver meaningful conservation impact through the empowerment of family forest landowners.<br>• The American Tree Farm System (ATFS) recognizes landowners for their good stewardship and adhering to the ATFS Standards of Sustainability while meeting their own goals and objectives for their land.<br>• The Family Forest Carbon Program focuses on two specific practices: Growing Mature Forests (encouraging Forest Management Plans) and Enhancing the Future Forest (control of competing vegetation to improve regeneration before or after a regeneration harvest) |
| Appalachian Mountains Joint Venture (AMJV)<br><br>https://amjv.org/ | • The Appalachian Mountains Joint Venture (AMJV) is a regional partnership of state and federal agencies, conservation organizations, and universities who work to restore and sustain viable populations of native birds and their habitats in the Appalachian Mountains. AMJV works with partners to provide private landowners with guidance and opportunities to improve habitat for birds and other wildlife. |
| Brooks Bird Club<br><br>https://www.brooksbirdclub.org/ | • The Brooks Bird Club, Inc. is an independent, educational, non-profit organization which promotes the study and enjoyment of birds and other elements of the natural world.<br>• Its purpose is to inform members and the public of environmental issues, to encourage intelligent use of our natural resources and preservation of our natural heritage.<br>• Chimney Swift Project: https://www.brooksbirdclub.org/chimney-swift-project.html |

| Partner | Role/Assistance Provided |
|---|---|
| Cave Conservancy of the Virginias (CCV)<br><br>https://caveconservancyofvirginia.org/ | • Promoting conservation, management, knowledge and acquisition of caves and karst resources in Virginia and West Virginia<br>• Contributes to educational, research and environmental protection projects<br>• Funds a variety of cave and karst education, outreach, research, cleanup and acquisition projects.<br>• Provides research scholarships and stipends for graduate and undergraduate students<br>• Supports *Project Underground* environmental education program to promote a better understand of caves and karst lands. |
| Consulting Foresters<br><br>https://wvforestry.com/forestry-consultants/ | • Developing Forest Stewardship Plans<br>• Promoting Forestry BMPs<br>• Designing forest management practices to achieve landowner goals and ecological objectives<br>• Assisting landowners with developing forest carbon projects aimed at achieving verifiable carbon sequestration through improved forest management practices |
| County Farmland Protection Boards<br><br>http://wvfp.org/ | • County Farmland Protection Boards and West Virginia Agricultural Land Protection Authority are authorized through WV Department of Agriculture, under the Voluntary Farmland Protection Act, to<br>• Assist in sustaining the farming community<br>• Provide sources of agricultural products within the state for citizens of the state<br>• Control the urban expansion which is consuming the agricultural land, topsoil and woodland of the state<br>• Curb the spread of urban blight and deterioration<br>• Protect agricultural land and woodland as open-space land<br>• Enhance tourism<br>• Protect worthwhile community values, institutions & landscapes which are inseparably associated with traditional farming |

| Partner | Role/Assistance Provided |
|---|---|
| Forest Certification Programs:<br><br>• American Tree Farm System (ATFS) https://www.treefarmsystem.org/<br>• Sustainable Forestry Initiative (SFI) https://www.forests.org/ https://www.wvfa.org/sfi/<br>• Forest Stewardship Council (FSC) https://fsc.org/en | • Resources, assistance and certification for sustainable forest management on public and private lands |
| Master Naturalists Program<br><br>http://mnofwv.org/ | • Training interested people in the fundamentals of natural history, nature interpretation and teaching.<br>• Instilling an appreciation of the importance of responsible environmental stewardship.<br>• Providing a corps of highly qualified volunteers to assist government agencies, schools and non-government organizations with research, outdoor recreation development, and environmental education and protection |
| Mountain RCD (Resource Development Council)<br><br>https://www.mtnrcd.com/ | • Assists with identification, planning, and implementing natural resource related projects that protect the resource base, maintain environmental quality and increase community development opportunities |
| National Speleological Society (NSS)<br><br>https://caves.org/ | • Promotes safe and responsible caving practices, effective cave and karst management, speleology, and conservation.<br>• Members work together in NSS grottos (i.e, chapters), regions, surveys, and sections to develop ideas and pursue projects in the areas of speleology, as well as cave conservation, management, preservation, restoration, exploration, surveying, rescue, equipment, techniques, and education. |
| National Wild Turkey Federation (NWTF)<br><br>https://www.nwtf.org/ | • Provides information to landowners on hunting and habitat management for wild turkey and other wildlife<br>• Partners with state and federal agencies on hunting access and habitat management for wild turkey and other wildlife species |

| Partner | Role/Assistance Provided |
|---|---|
| Outdoor Heritage Conservation Fund (OHCF) https://commerce.wv.gov/boards-commissions/outdoor-heritage-conservation-fund/ | • The Outdoor Heritage Conservation Fund (OHCF) protects lands that host West Virginia's wild and wonderful natural resources. The OHCF's land-protection projects can include important wildlife habitats, working forests and farmlands, as well as hunting, fishing, and outdoor recreational areas. The OHCF is working to protect the best of our natural resources for all West Virginians. |
| Ruffed Grouse Society/American Woodcock Society (RGS) https://ruffedgrousesociety.org/# | • Creates healthy forest habitat for the benefit of ruffed grouse, American woodcock and other forest wildlife<br>• Works with landowners and government agencies to develop critical habitat using scientific management practices<br>• RGS works with the forest product industry, including landowners, foresters, loggers, and forest product manufacturers, to scale up capacity building, investment and conservation benefits from working forests to the landscape scale. https://ruffedgrousesociety.org/the-ruffed-grouse-society-model-of-working-forests/ |
| The Conservation Fund (TCF) https://www.conservationfund.org/where-we-work/west-virginia | • Works with public, private and nonprofit partners to protect America's legacy of land and water resources through land acquisition, sustainable community and economic development, and leadership training, emphasizing the integration of economic and environmental goals. |
| The Nature Conservancy (TNC) https://www.nature.org/en-us/about-us/where-we-work/united-states/west-virginia/ | • Assist public land managers with land protection, management and restoration to maintain landscape resilience and connectivity<br>• Assist private landowners with land protection and improved management, including conservation easements and forest carbon projects<br>• Manages a network of nature preserves and conservation easements for conservation and recreation |

| Partner | Role/Assistance Provided |
|---|---|
| Trout Unlimited (TU)<br><br>• http://www.wvtu.org/<br>• http://www.tu.org/ | • Plans and implements restoration projects with landowners and in coordination with USFWS Partners program and USDA Natural Resource Conservation Service and Forest Service and other partners<br>• Projects focus on riparian corridor and in-stream habitat restoration, invasive weed treatment and aquatic passage barrier removal/replacement to benefit brook trout and other wildlife species |
| USDA Farm Service Agency (FSA)<br><br>https://www.fsa.usda.gov/state-offices/West-Virginia/programs/index<br><br>• Conservation Reserve Program (CRP)<br>• Conservation Reserve Enhancement Program (CREP)<br>• State Acres for Wildlife Enhancement (SAFE)<br>• Farmable Wetlands Program (FWP)<br>• Grasslands Reserve Program (GRP) | • CRP provides rental payments to agricultural producers participating voluntarily to safeguard environmentally sensitive land, conserve water quality, control soil erosion and enhance wildlife habitat, including floodplain wetlands.<br>• CREP provides extra incentives and payments to eligible producers to reduce soil erosion and pollution, improve water quality and enhance terrestrial and aquatic wildlife habitat through practices such as riparian buffers and wetland restoration<br>• The State Acres for Wildlife Enhancement (SAFE) Initiative provides farmers and landowners with assistance to establish wetlands, grasses and trees to enhance important wildlife populations by creating critical habitat and food sources, while protecting soil and water health.<br>• The Farmable Wetlands Program (FWP) provides farmers and ranchers annual rental payments in return for restoration wetlands and wetland buffers zones.<br>• The Grassland Reserve Program (GRP) provides farmers a rental payment to voluntarily prevent grazing and pasture land from being converted into cropland or urban development. |

| Partner | Role/Assistance Provided |
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| USDA Natural Resources Conservation Service (NRCS):<br><br>https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/programs/financial/<br><br>• Environmental Quality Incentive Program (EQIP)<br>• Conservation Stewardship Program (CSP)<br>• Agricultural Management and Assistance Program (AMA)<br>• Agricultural Conservation Easement Program (ACEP)<br>• Climate-Smart Agriculture and Forestry Mitigation Activities | • EQIP provides cost-share to forest and agricultural landowners targeting for activities such as forestry and grazing BMPs, reduction of nutrient, sediment and pesticide pollution, stream restoration and wildlife habitat enhancement, including stream buffers<br>• Working Lands for Wildlife is a partnership between NRCS and USFWS to work with agricultural producers and forest land managers on habitat conservation for seven at-risk species, including Golden-winged Warbler<br>• The RCPP-EQIP Cerulean Warbler Initiative is designed to enhance Cerulean Warbler habitat and increase their populations<br>• The RCPP-EQIP WV Aquatic Passage-Working Farms project is a partnership between NRCS, TU and USFWS designed to improve fish and aquatic wildlife habitat, reduce infrastructure risk and increase flood resiliency.CSP provides payments to farm and forest landowners for actively managing, maintaining and expanding conservation activities to enhance natural resources and improve their business operations. Priority resource concerns for funding include terrestrial habitat for wildlife and invertebrates.<br>• AMA provides technical and financial assistance to agricultural producers on a voluntary basis to address issues such as water management, water quality and erosion control by incorporating conservation into their farming operations.<br>• ACEP is a voluntary program providing technical and financial assistance to landowners for both agricultural land easements and wetland reserve easements to protect farmland and wetland habitat.<br>• Climate-Smart Agriculture and Forestry Mitigation Activities may deliver quantifiable reductions in greenhouse gas emissions and/or increases in carbon sequestration. Many offer co-benefits that help operations build climate change resilience while addressing other natural resource concerns such as soil health, water quality, pollinator and wildlife habitat, and air quality. |

| Partner | Role/Assistance Provided |
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| US Fish and Wildlife Service (USFWS)<br><br>Partners for Fish and Wildlife Program<br><br>https://www.fws.gov/northeast/ecologicalservices/partners.html | • Provides technical and financial assistance to private landowners for restoration and enhancement of fish and wildlife habitat for the benefit of Federal Trust species (Migratory Birds, Threatened and Endangered and At-Risk Species)<br>• Efforts focus on controlling nonnative invasive plants, managing livestock access to forests, wetland restoration, riparian buffer planting and fencing, in-stream habitat improvement, aquatic passage barrier removal and creating pollinator habitat<br>• Works in coordination with the USDA Natural Resources Conservation Service farm bill programs, Trout Unlimited and other partners |
| US DOI Office of Surface Mining Reclamation and Enforcement (OSMRE)<br><br>https://www.osmre.gov/index.shtm<br><br>Appalachian Regional Reforestation Initiative (ARRI)<br><br>https://arri.osmre.gov/About/AboutARRI.shtm | • OSMRE is the primary regulator of coal mining under the Surface Mining Control and Reclamation Act (SMCRA) of 1977 until a State or Indian Tribe develops its own regulations to meet SMCRA and OSMRE requirements.<br>• OSMRE partners with States to regulate mining on Federal lands and to support States' regulatory programs with grants and technical assistance<br>• Abandoned Mine Land (AML) Reclamation Program addresses the hazards and environmental degradation posed by mines abandoned before the SMCRA<br>• The Appalachian Regional Reforestation Initiative (ARRI) is a coalition of groups, including citizens, the coal industry, and government dedicated to restoring forests on coal mined lands in the Eastern United States |
| West Virginia Association for Cave Studies (WVACS)<br><br>https://www.wvacs.org/ | • Contributes to cave surveys and research<br>• Hosts cave scientists and graduate students pursuing cave research at field stations in Greenbrier County |

| Partner | Role/Assistance Provided |
|---|---|
| West Virginia Cave Conservancy<br><br>https://wvcc.net/ | • Manages caves to protect sensitive cave resources and environments<br>• Educates and provides expertise to landowners, developers, local governments and the public on the value of cave and karst resources<br>• Organizes cave and karst conservation projects including sinkhole cleanups and livestock barrier fences.<br>• Preserves access to significant caves through ownership and management agreements<br>• Sponsor research and survey projects on WVCC caves |
| WV Conservation Agency (WVCA) and Southern Conservation District<br><br>https://www.wvca.us/district/scd.cfm<br><br>• Ag Enhancement Program (AgEP)<br>• Non-Point Source Program<br>• Stream Partners Program | • The Ag Enhancement Program (AgEP), administered by Conservation Districts and the WVCA, offers technical and financial assistance to implement conservation best management practices for the reduction of nutrients and sediment entering waterways and increasing farm profitability and sustainability. Practices may include invasive species management and exclusion fencing to protect streams, wetlands and other environmentally sensitive areas.<br>• Through Conservation Districts, the statewide Non-Point Source Program uses federal Clean Water Act, Section programs to reduce nonpoint source pollution related to agriculture, construction and urban stormwater management.<br>• Through the Stream Partners Program, WVDNR, WVCA, WVDOF and WVDEP provide grants up to $5,000 to citizens' groups who want to improve, restore, protect, study or celebrate the state's rivers and streams. |

| Partner | Role/Assistance Provided |
|---|---|
| WV Department of Environmental Protection (WVDEP)<br><br>• Nonpoint Source Program https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx<br>• Watershed Based Plans https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Pages/WBP.aspx<br>• Save Our Streams Program https://dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx<br>• In Lieu Fee (ILF) Stream and Wetland Mitigation Program https://dep.wv.gov/wwe/programs/pages/in-lieu-fee.aspx<br>• Division of Mining and Reclamation (DMR) https://dep.wv.gov/dmr/Pages/default.aspx<br>• Rehabilitation Environmental Action Plan (REAP) https://dep.wv.gov/environmental-advocate/reap/Pages/default.aspx<br>• WVDEP Youth Environmental Program (YEP) https://dep.wv.gov/environmental-advocate/yep/Pages/default.aspx | • Supports partners and citizen-based watershed organizations in restoring impaired watersheds<br>• Provides assistance in proper installation and maintenance of Best Management Practices<br>• Provides funding for projects by watershed groups and partners to improve water quality in watersheds listed as impaired, including the Greenbrier River and many tributaries<br>• Practices include wastewater treatment, agricultural BMPs, rain gardens for stormwater runoff, streambank restoration and community outreach<br>• Save our Streams provides training for volunteers to monitor local wadable streams and rivers<br>• REAP provides communities with technical, financial and resource assistance in cleanup efforts.<br>• YEP organizes youth and volunteer groups for hands-on conservation projects |
| WV Department of Health and Human Resources (WVDHHR)<br><br>• On-Site Sewage Program<br><br>https://www.wvdhhr.org/phs/sewage/index.asp | • Provides rule interpretation and technical assistance on conventional and non-conventional on-site sewage systems, including information on septic systems, installers, permits, fees and loan programs. |

| Partner | Role/Assistance Provided |
|---|---|
| WV Division of Forestry (WVDOF)<br><br>http://www.wvforestry.com/ | • Oversees the Managed Timberland Program to provide tax incentives for landowners who manage their forest land sustainably according to a management plan<br>• Oversee timber sales and Best Management Practices<br>• Provides training workshops for loggers on safety and Best Management Practices<br>• Maintains list of consulting foresters who can help landowners with Forest Stewardship Plans to enhance wildlife habitat<br>• Protection of large private forest tracts through Forest Legacy Program |
| WV Division of Natural Resources (WVDNR)<br><br>https://wvdnr.gov/ | • Identification of SGCN and rare communities<br>• Education, outreach and teaching resources<br>• Field guides, Landscaping and Management guidelines<br>• Fish and game management<br>• Habitat restoration assistance<br>• Natural Areas Program |
| West Virginia Land Trust (WVLT)<br><br>https://www.wvlandtrust.org/ | • WVLT's mission is to protect land with significant conservation values through the use of conservation easements and real estate acquisitions, and by working with a statewide network of partners to build a passionate land conservation movement in the state. |
| West Virginia Scenic Trails Association (WVSTA)<br><br>https://www.wvscenictrails.org/ | • Serves the outdoor community by building and maintaining the Allegheny Trail and other trails in partnership and cooperation with landowners, managers, and others.<br>• Maintains, preserves, protects, and promotes this challenging and scenic foot trail (that will exceed 300 miles) running southward from the Mason-Dixon Line through WV and VA to the Appalachian Trail.<br>• Furthers the conservation of wild pristine lands and wildlife and protect areas of natural beauty and historic interest through stewardship |

| Partner | Role/Assistance Provided |
|---|---|
| West Virginia University Extension Service (WVU Extension):<br>• Forestry<br>https://extension.wvu.edu/natural-resources/forestry<br>• Wildlife<br>https://extension.wvu.edu/natural-resources/wildlife | • Landowner technical assistance and information on financial assistance for forest and wildlife management<br>• Training workshops and conferences on forestry Best Management Practices and safety practices |

## Appendix 5. Impaired Streams.

| Reach Code | AUID | Common Name | Impairments |
|---|---|---|---|
| 05070101000754 | WVOG-89-C.3_00 | AdamsFork | Selenium |
| 05070201001104 | WVBST-110_00 | AdkinBranch | Bio, Iron |
| 05070201001000 | WVBST-70-O_00 | AtwellBranch | Iron |
| 05070201001049 | WVBST-78-G_00 | BadwayBranch | Bio, Iron |
| 05070201001088 | WVBST-122_01 | BallarHarmonBranch | Iron |
| 05070201001088 | WVBST-122_02 | BallardHarmonBranch | Selenium |
| 05070101000119 | WVOG-131_00 | BarkersCreek | Bio, Fecal, Iron |
| 05070201000906 | WVBST-70-I_00 | BeartownBranch | Iron |
| 05070101000279 | WVOG-124-N_00 | BeartownFork | Iron |
| 05070201003370 | WVBST-99-L-2_00 | BearwallowBranch | Selenium |
| 05050009002563 | WVKC-46-J-2_00 | BeeBranch | pH, Aluminum |
| 05070101000418 | WVOG-76-K_01 | BeechBranch | Bio |
| 05070101000418 | WVOG-76-K_02 | BeechBranch | Bio, Selenium |
| 05070201000524 | WVBST-70-AA_00 | BeechFork | Bio |
| 05070201003882 | WVBST-116_00 | BelcherBranch | Iron |
| 05070201001071 | WVBST-111_00 | BelcherBranch | Iron |
| 05070201005349 | WVBST-52_00 | BenCreek | Bio, Selenium |
| 05070101000649 | WVOG-138-A_00 | BerryBranch | Fecal |
| 05070201001005 | WVBST-70-E_02 | BetsyBranch | Iron |
| 05070201000953 | WVBST-70-X_00 | BigBranch | Iron |
| 05070101000602 | WVOG-136_01 | BigBranch | Bio |
| 05070101003342 | WVOG-96_01 | BigCubCreek | Aluminum |
| 05070101000289 | WVOG-96_03 | BigCubCreek | Bio, Aluminum |
| 05070101000288 | WVOG-96_02 | BigCubCreek | Bio, Aluminum |
| 05070201000257 | WVBST-70-M_00 | BradshawCreek | Bio, Fecal |
| 05050009000264 | WVKC-46-L_00 | BreckenridgeCreek | Fecal |
| 05070101000290 | WVOG-110-A_00 | BrierCreek | Bio, Iron |
| 05070101001968 | WVOG-89-B-1_02 | BrowningFork | Bio |
| 05070201001143 | WVBST-98_00 | BrownsCreek | Bio, Fecal |
| 05070101000261 | WVOG-75_01.1 | BuffaloCreek | Al_Trout |
| 05070101000730 | WVOG-92-K_01 | BuffaloCreek | Bio, pH, Iron |
| 05070101000731 | WVOG-92-K_02 | BuffaloCreek | pH, Iron |
| 05070201003357 | WVBST-57_00 | BullCreek | Fecal, Selenium |
| 05070201001133 | WVBST-99-K_00 | BurkCreek | Selenium |
| 05070101000475 | WVOGC-16-C_00 | CabinBranch | Bio |
| 05070101000188 | WVOG-127_00 | CabinCreek | Iron |
| 05070101001870 | WVOGC-16-B-1_00 | ChestnutFlatsBranch | Bio |
| 05070201003453 | WVBST-99-J_00 | ClarkBranch | Selenium |
| 05050009000628 | WVKC-46-N.9_00 | ClaypoolHollow | Fecal |
| 05070201000334 | WVBST-76_00 | ClearFork | Bio, Fecal, Iron |
| 05070101000235 | WVOGC_01 | ClearFork | Bio, Al_Trout, Iron |
| 05070101000237 | WVOGC_02 | ClearFork | Al_Trout, Iron |
| 05070201003977 | WVBST-70-T-2_00 | ClearForkBranch | Bio |
| 05070201001109 | WVBST-99-I_01 | CoalbankBranch | Selenium |
| 05070201001109 | WVBST-99-I_02 | CoalbankBranch | Iron, Selenium |
| 05070201003678 | WVBST-99-I_03 | CoalbankBranch | Selenium |

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|---|---|---|---|
| 05070201004860 | WVBST-78-E_00 | CoontreeBranch | Bio, Iron |
| 05050009003419 | WVKC-46-K_01 | CoveCreek | Fecal, Iron |
| 05050009003430 | WVKC-46-K_02 | CoveCreek | Iron |
| 05070201000581 | WVBST-70-D_01 | CraneCreek | Iron |
| 05070101000301 | WVOGC-26_00 | CraneFork | Bio, Iron |
| 05070201003596 | WVBST-60-D_00 | CubBranch | Iron |
| 05070201001428 | WVBST-85_00 | DavyBranch | Bio, Fecal |
| 05070101000147 | WVOG-137_00 | DevilsFork | Bio, Fecal, Iron |
| 05050009000627 | WVKC-46-O_00 | DingessBranch | Fecal, Iron |
| 05070201003886 | WVBST-119_00 | DryBranch | Iron |
| 05070201000235 | WVBST-70_01.1 | DryFork | Bio, Fecal |
| 05070201005070 | WVBST-70_02 | DryFork | Bio, Fecal |
| 05070201000290 | WVBST-70_01.2 | DryFork | Bio, Fecal, Iron_Trout |
| 05070201000291 | WVBST-70_01.3 | DryFork | Bio, Fecal |
| 05070101001923 | WVOG-96-C_00 | ElkTraceBranch | Iron |
| 05070201000407 | WVBST-99_01 | ElkhornCreek | Bio, Iron_Trout |
| 05070201000415 | WVBST-99_02 | ElkhornCreek | Iron_Trout |
| 05070101000458 | WVOGC-16-U_00 | FranksFork | Bio |
| 05070101000030 | WVOG-89_00 | GilbertCreek | Bio, Aluminum, Selenium |
| 05070101000125 | WVOG-131-F_00 | GooneyOtterCreek | Bio, Al_Trout, Iron |
| 05070201003761 | WVBST-107_00 | GrapevineBranch | Iron |
| 05070201000905 | WVBST-70-F_00 | GrapevineBranch | Bio, Iron |
| 05070201000882 | WVBST-60-A_00 | GreenbrierFork | Bio |
| 05070201004984 | WVBST-70-M-1_00 | GroundhogBranch | Bio |
| 05070101000023 | WVOG-up_01 | GuyandotteRiver(upper) | Fecal, Aluminum, Iron |
| 05070101000158 | WVOG-up_02 | GuyandotteRiver(upper) | Bio, Fecal, Aluminum, Iron |
| 05070201001101 | WVBST-113_00 | HarmonBranch | Bio, Iron, Selenium |
| 05050009002565 | WVKC-46-J-7_00 | HarperBranch | Iron |
| 05070201001106 | WVBST-104_00 | HarrisBranch | Iron |
| 05070101002832 | WVOG-131-B_00 | HickoryBranch | Iron |
| 05070201003497 | WVBST-78-D_00 | HoneycampBranch | Iron |
| 05070201004850 | WVBST-63_00 | HorseCreek | Bio |
| 05070201005056 | WVBST-70-W-6_02 | HorsepenCreek | Selenium |
| 05070101000034 | WVOG-89-B_01 | HorsepenCreek | Selenium |
| 05070101000254 | WVOG-76_01.2 | HuffCreek | Bio, Iron, Selenium, Manganese |
| 05070101000251 | WVOG-76_01.1 | HuffCreek | Bio, Iron, Manganese |
| 05070101001033 | WVOG-76_02.2 | HuffCreek | Iron, Manganese |
| 05070101000255 | WVOG-76_02.1 | HuffCreek | Iron, Selenium, Manganese |
| 05070101000065 | WVOG-110_00 | IndianCreek | Bio, Iron |
| 05070201001094 | WVBST-120-A_02 | IndianGraveBranch | Iron |
| 05070201001094 | WVBST-120-A_01 | IndianGraveBranch | Iron |
| 05070201000303 | WVBST-70-W_02 | JacobsFork | Bio, Fecal |
| 05070201000303 | WVBST-70-W_01 | JacobsFork | Fecal |
| 05070201003611 | WVBST-102_00 | JedBranch | Iron |

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|---|---|---|---|
| 05070101000589 | WVOG-131-F-1_00 | JimsBranch | Iron |
| 05070101002230 | WVOG-128_00 | JoeBranch | Bio, Iron |
| 05070201000998 | WVBST-70-P_00 | JohnnycakeHollow | pH, Aluminum |
| 05070201001083 | WVBST-115-D_00 | JumpBranch | Iron, Selenium |
| 05070101000732 | WVOG-92-K-1_00 | KezeeFork | Iron |
| 05070101000478 | WVOGC-28_00 | KnobFork | Bio |
| 05070101000717 | WVOG-114_00 | LanesBranch | Iron |
| 05070201000602 | WVBST-99-E_03 | LaurelBranch | Bio |
| 05070201000602 | WVBST-99-E_02 | LaurelBranch | Bio, Iron |
| 05070201000600 | WVBST-99-E_01 | LaurelBranch | Bio |
| 05070201001075 | WVBST-115-F_00 | LaurelBranch | Iron |
| 05070101000543 | WVOG-124-H_00 | LaurelBranch/PinnacleCreek | Iron |
| 05070101000230 | WVOGC-16_02.2 | LaurelFork | Iron, Manganese |
| 05070101000221 | WVOGC-16_01 | LaurelFork | Bio, Iron, Manganese |
| 05070101000222 | WVOGC-16_02.1 | LaurelFork | Iron, Manganese |
| 05070101001709 | WVOG-135-A_00 | LeftFork/AllenCreek | Bio, Iron |
| 05070201004845 | WVBST-57-B_00 | LeftFork/BullCreek | Bio, Fecal |
| 05070201001152 | WVBST-85-A_00 | LeftFork/DavyBranch | Iron |
| 05070201004932 | WVBST-109-B_00 | LeftFork/SandlickCreek | Bio, Iron |
| 05070101000766 | WVOG-77-D_01 | LefthandFork/RockhouseCreek | Bio, Iron |
| 05070101000767 | WVOG-77-D_02 | LefthandFork/RockhouseCreek | Bio, pH, Aluminum, Iron |
| 05070201004899 | WVBST-114_01 | LeslieBranch | Iron, Selenium |
| 05070201003716 | WVBST-114_02 | LeslieBranch | Selenium |
| 05070201001167 | WVBST-71_00 | LickBranch | Bio |
| 05070101002750 | WVOG-77-B_01 | LickBranch | Selenium |
| 05070201000606 | WVBST-120_01_r | LittleCreek | Bio, Fecal, Iron |
| 05070201000608 | WVBST-120_02_r | LittleCreek | Fecal, Iron |
| 05070101000307 | WVOG-108_00 | LittleCubCreek | Iron |
| 05070101000726 | WVOG-92-B_00 | LittleCubCreek | Bio |
| 05070101000042 | WVOG-92_01 | LittleHuffCreek | Bio |
| 05070201001059 | WVBST-100_00 | LittleIndianCreek | Bio, Iron |
| 05070101000554 | WVOG-124-P_00 | LittlePinnacleCreek | Bio |
| 05070201000263 | WVBST-70-N_01 | LittleSlateCreek | Bio, Fecal |
| 05070201000265 | WVBST-70-N_02 | LittleSlateCreek | Fecal |
| 05070101000536 | WVOG-124-E_01 | LittleWhiteOakCreek | Bio |
| 05070101000537 | WVOG-124-E_02 | LittleWhiteOakCreek | Bio, Iron |
| 05070101000579 | WVOG-129_00 | LongBranch | Bio, Iron |
| 05070101003352 | WVOG-97_00 | LongBranch | Bio |
| 05070201001096 | WVBST-117_00 | LoopBranch | Bio, Iron |
| 05070101000749 | WVOG-89-B-0.3_00 | LowerPeteBranch | Selenium |
| 05070101001587 | WVOGC-12_00 | LowerRoadBranch | Iron |
| 05050009000603 | WVKC-46-N_01 | MapleMeadowCreek | Bio, Fecal, Iron |
| 05050009000603 | WVKC-46-N_02 | MapleMeadowCreek | Bio |
| 05070101000195 | WVOG-127-D_00 | MarshFork | Bio |
| 05070101000507 | WVOG-110-A-2_00 | MarshFork | Iron |
| 05050009002673 | WVKC-46_02 | MarshFork | Fecal, Iron_Trout |

| | | | |
|---|---|---|---|
| 05050009000630 | WVKC-46_03 | MarshFork | Fecal, Iron_Trout |
| 05050009000200 | WVKC-46_01 | MarshFork | Fecal, Iron |
| 05050009000200 | WVKC-46_04 | MarshFork | Iron_Trout |
| 05070201001085 | WVBST-115-B_00 | McClureBranch | Iron, Selenium |
| 05070101001811 | WVOG-96-H_00 | McDonaldFork | Iron |
| 05070101000311 | WVOG-134-D_00 | MeasleFork | pH, Iron |
| 05070201004496 | WVBST-70-W-1-G_00 | MiddleFork/BigCreek | Bio, Selenium |
| 05070201001084 | WVBST-115-C_00 | MilamBranch | Selenium |
| 05070101000313 | WVOGC-16-M_00 | MilamFork | Bio, Iron |
| 05070201001023 | WVBST-70-C_02 | MileBranch | Iron |
| 05070201003748 | WVBST-118_00 | MillBranch | Iron |
| 05070201001091 | WVBST-121_00 | MillseatBranch | Iron |
| 05070201001105 | WVBST-105_00 | MitchellBranch | Iron |
| 05070201001454 | WVBST-58_00 | MohawkBranch | Bio |
| 05070201003577 | WVBST-78-I_00 | MoorecampBranch | Iron |
| 05070201000621 | WVBST-70-W-1-A_00 | MountainFork | Bio |
| 05070101002610 | WVOG-92-K-2_00 | MudlickFork | Iron |
| 05070101000317 | WVOG-92-I_00 | MuzzleCreek | Bio, Iron |
| 05070201000630 | WVBST-78-H_00 | NewsonBranch | Bio, Iron |
| 05070201004431 | WVBST-70-W-1-F_00 | NorthFork/BigCreek | Selenium |
| 05070201003379 | WVBST-99-L_00 | NorthFork/ElkhornCreek | Bio, Fecal |
| 05070101000587 | WVOG-131-F-2_00 | NosemanBranch | Iron |
| 05070101001702 | WVOG-77-A.5_00 | OldhouseBranch | Bio, pH, Aluminum, Iron, Manganese |
| 05070101000319 | WVOG-92-Q_00 | PadFork | Iron |
| 05070201000208 | WVBST-60_01 | PantherCreek | Iron |
| 05070201000211 | WVBST-60_02 | PantherCreek | Iron |
| 05070101000549 | WVOG-124-J-1_00 | PayneBranch | Iron |
| 05070101000400 | WVOG-76-M_00 | PaynterBranch | Bio |
| 05070101000091 | WVOG-124_01 | PinnacleCreek | Bio, Iron_Trout, Manganese |
| 05070101000093 | WVOG-124_02 | PinnacleCreek | Bio, Iron_Trout, Manganese |
| 05070201000994 | WVBST-70-S_00 | PruettBranch | Bio |
| 05070201003258 | WVBST-98-A_00 | PuncheoncampBranch | Bio, Iron |
| 05070201001093 | WVBST-120-B_00 | PuncheoncampBranch | Iron, Selenium |
| 05070101003353 | WVOG-(L1)_00 | RDBaileyLake | PCBs |
| 05070101000440 | WVOG-99_00 | ReedyBranch | Bio, Iron |
| 05070101000646 | WVOG-139-B_00 | RiffeBranch | Iron_Trout |
| 05070201004924 | WVBST-109-A_00 | RightFork/SandlickCreek | Bio, Iron |
| 05070101000763 | WVOG-78-A_00 | RightFork/SandlickCreek | Bio |
| 05050009000633 | WVKC-46-J-3_01 | RightFork/SandlickCreek | Bio, Fecal |
| 05050009000633 | WVKC-46-J-3_02 | RightFork/SandlickCreek | Bio |
| 05070101002876 | WVOG-92-Q-1_00 | RighthandFork/PadFork | Iron |
| 05070101001976 | WVOG-96-B_00 | RoadBranch | Bio, Iron, Selenium |
| 05070101001327 | WVOG-76-O_00 | RoadBranch | Selenium |

| | | | |
|---|---|---|---|
| 05070201001080 | WVBST-115-G_00 | RoadFork | Iron |
| 05070201004520 | WVBST-70-W-1-G-1_00 | RoadFork | Selenium |
| 05070201001060 | WVBST-103_00 | RockNarrowsBranch | Bio, Iron |
| 05070101000197 | WVOG-123_01 | RockcastleCreek | Bio |
| 05070201001135 | WVBST-99-F_00 | RockhouseBranch | Iron |
| 05070101000765 | WVOG-77_02 | RockhouseCreek | Iron |
| 05050009003451 | WVKC-46-N-1_00 | RockhouseFork | Fecal, Iron |
| 05070201001090 | WVBST-123_00 | SamsBranch | Iron |
| 05070201000373 | WVBST-109_01.1 | SandlickCreek | Bio, Iron |
| 05070201000374 | WVBST-109_02 | SandlickCreek | Bio, Iron, Selenium |
| 05070201000374 | WVBST-109_01.2 | SandlickCreek | Bio, Iron, Selenium |
| 05050009003369 | WVKC-46-J_03 | SandlickCreek | Bio, Iron |
| 05050009000212 | WVKC-46-J_02 | SandlickCreek | Bio, Fecal, Iron |
| 05050009000207 | WVKC-46-J_01 | SandlickCreek | Fecal, Iron |
| 05070201001054 | WVBST-78-B_00 | ShabbyroomBranch | Bio, Iron |
| 05070201001405 | WVBST-94_00 | ShannonBranch | Iron |
| 05070101000183 | WVOG-134_02 | SlabFork | Bio, Al_Trout, Iron |
| 05070101000182 | WVOG-134_01 | SlabFork | Bio, Al_Trout, Iron |
| 05070101000535 | WVOG-124-D_00 | SmithBranch | Bio, Iron |
| 05070201000385 | WVBST-115_01 | SouthFork/TugFork | Iron, Selenium |
| 05070201000391 | WVBST-115_02 | SouthFork/TugFork | Iron, Selenium |
| 05050009000631 | WVKC-46-M_00 | SpankerBranch | Bio, Fecal |
| 05070201000622 | WVBST-78_00 | SpiceCreek | Bio |
| 05070201001072 | WVBST-115-E_01 | SpiceCreek | Iron |
| 05070201001073 | WVBST-115-E_02 | SpiceCreek | Iron, Selenium |
| 05070101001918 | WVOG-82_00 | SpiceCreek | Bio |
| 05070101000568 | WVOG-124-I_00 | SpiderCreek | Iron |
| 05070101001616 | WVOG-77-A_00 | SpringBranch | Selenium |
| 05070101002202 | WVOG-88_00 | StaffordBranch | Bio |
| 05070101000332 | WVOG-130_01 | StillRun | Iron |
| 05070101000335 | WVOG-130_02 | StillRun | Iron |
| 05070201001051 | WVBST-78-F_00 | StonecoalBranch | Iron |
| 05070101000637 | WVOG-139_02 | StonecoalCreek | Bio, Iron |
| 05070101000637 | WVOG-139_01 | StonecoalCreek | Bio, Iron |
| 05070101000438 | WVOG-96-A_00 | SturgeonBranch | Iron |
| 05070101000692 | WVOG-125_00 | SugarRun | Bio |
| 05070201001061 | WVBST-106_00 | SugarcampBranch | Iron |
| 05070101001431 | WVOG-76-J_00 | SugarcampBranch | Bio |
| 05070101000733 | WVOG-92-M_00 | SukeCreek | Bio |
| 05070101000539 | WVOG-124-E-0.5_00 | SulphurBranch | Bio, Iron |
| 05070201001086 | WVBST-115-A_00 | TeaBranch | Iron, Selenium |
| 05070101000434 | WVOG-96-F_00 | TolerHollow | Bio, Iron |
| 05070101000473 | WVOGC-16-J-1_00 | TomBaileyBranch | Bio |
| 05070101000830 | WVOG-139-A_02 | TommyCreek | Iron_Trout |
| 05070101000160 | WVOG-139-A_01 | TommyCreek | Bio, Iron_Trout |
| 05070101000337 | WVOG-76-L_02 | ToneyFork | Bio, pH, Aluminum, Iron |

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|---|---|---|---|
| 05070101000336 | WVOG-76-L_01 | ToneyFork | Bio, pH, Iron |
| 05070101000480 | WVOGC-19_00 | ToneyFork | Bio, Iron |
| 05070201001418 | WVBST-98-B_00 | TrailFork | Fecal |
| 05070101000465 | WVOGC-16-P_00 | Trough Fork | Bio, Iron |
| 05070201002075 | WVBST_03.1 | Tug Fork | Bio, Fecal |
| 05070201000397 | WVBST_03.2 | Tug Fork | Bio, Fecal, Selenium |
| 05070201000401 | WVBST_03.3 | Tug Fork | Bio, Fecal |
| 05070201001103 | WVBST-112_00 | Turnhole Branch | Iron |
| 05070201004337 | WVBST-122-A_00 | UNT/Ballard Harmon Branch RM1.49 | Selenium |
| 05070101001330 | WVOG-76-K-1_00 | UNT/BeechBranchRM0.61 | Bio |
| 05070101002290 | WVOG-120-A_00 | UNT/BigBranchRM1.04 | Iron |
| 05070101002286 | WVOG-120-C_00 | UNT/BigBranchRM1.54 | Bio |
| 05070201000982 | WVBST-70-W-1-0.7A_00 | UNT/BigCreekRM1.98 | Bio |
| 05050009000600 | WVKC-46-L-1_00 | UNT/BreckenridgeCreekRM3.04 | Fecal |
| 05050009003056 | WVKC-46-L-1.8_00 | UNT/BreckenridgeCreekRM3.22 | Iron |
| 05070201003544 | WVBST-57-G_00 | UNT/BullCreekRM4.71 | Selenium |
| 05070201004884 | WVBST-99-I-2_00 | UNT/CoalbankBranchRM1.43 | Selenium |
| 05050009002872 | WVKC-46-K-2_00 | UNT/CoveCreekRM1.22 | Fecal |
| 05070201003217 | WVBST-85-G_02 | UNT/DavyBranchRM3.28 | Iron |
| 05070201003755 | WVBST-99-O.7_00 | UNT/ElkhornCreekRM20.15 | Selenium |
| 05070201004562 | WVBST-70-W-6-0.5A_00 | UNT/HorsepenCreekRM1.48 | Iron |
| 05070201001070 | WVBST-109-B-3_01 | UNT/LeftForkRM0.89/SandlickCreek | Iron, Selenium |
| 05070201001070 | WVBST-109-B-3_02 | UNT/LeftForkRM0.89/SandlickCreek | Iron |
| 05070201000970 | WVBST-70-W-1-F-2_00 | UNT/NorthForkRM1.52/BigCreek | Selenium |
| 05070101002547 | WVOG-124-J-1-C_00 | UNT/PayneBranchRM1.37 | Iron |
| 05070101002001 | WVOG-96-B-2_00 | UNT/RoadBranchRM1.13 | Bio |
| 05070101001444 | WVOG-76-O-3_00 | UNT/RoadBranchRM1.79 | Selenium |
| 05070201001067 | WVBST-109-D_00 | UNT/SandlickCreekRM3.00 | Selenium |
| 05070101001636 | WVOG-134-D.5_00 | UNT/SlabForkRM7.96 | Bio |
| 05070201001076 | WVBST-115-I_00 | UNT/SouthForkRM5.46/TugFork | Selenium |
| 05070101001589 | WVOG-77-A-1_00 | UNT/SpringBranchRM0.56 | Selenium |
| 05070201003929 | WVBST-114.2_00 | UNT/TugForkRM145.75 | Selenium |
| 05070201001098 | WVBST-114.4_00 | UNT/TugForkRM146.21 | Selenium |
| 05070201001087 | WVBST-115.2_00 | UNT/TugForkRM148.42 | Selenium |
| 05070201003939 | WVBST-115.6_00 | UNT/TugForkRM148.86 | Iron, Selenium |
| 05070201003856 | WVBST-118.3_00 | UNT/TugForkRM151.49 | Selenium |
| 05070201003974 | WVBST-118.7_00 | UNT/TugForkRM152.09 | Selenium |
| 05070201004011 | WVBST-120.3_00 | UNT/TugForkRM154.02 | Selenium |
| 05070201004256 | WVBST-124_00 | UNT/TugForkRM157.07 | Selenium |
| 05070201004074 | WVBST-109-B-3-A_00 | UNT/UNTRM0.01/ LeftForkRM0.89/ SandlickCreek | pH, Aluminum, Iron |

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|---|---|---|---|
| 05070201001078 | WVBST-115-J-1_00 | UNT/UNTRM0.15/ SouthForkRM5.85/ TugFork | Iron |
| 05070201001146 | WVBST-95_00 | UpperShannonBranch | Bio, Iron |
| 05070101000172 | WVOG-138-G_02 | WestFork/WindingGulf | pH |
| 05070101000472 | WVOGC-16-N_00 | WhiteOakBranch | Bio |
| 05070101000170 | WVOG-138_02 | WindingGulf | Bio, Fecal, Al_Trout, Iron |
| 05070101000652 | WVOG-138_03 | WindingGulf | Bio, Fecal, Al_Trout, Iron |
| 05070101000167 | WVOG-138_01 | WindingGulf | Bio, Fecal, Al_Trout, Iron |
| 05050009002466 | WVKC-46-J-4_00 | WingroveBranch | Fecal, Iron |
| 05070101002340 | WVOG-110-G_00 | WolfPenBranch | Bio |
| 05070201001404 | WVBST-70-M-3_00 | WolfpenBranch | Bio |

## Appendix 6. Resources

The following resources may provide additional information to landowners and partners seeking to manage habitat for priority SGCN in this CFA.

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| Watershed Based Plans for the Upper Guyandotte River and Tug Fork River/North Fork Elkhorn available at:<br><br>https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Pages/WBP.aspx |
| Long Range Plans for the Guyan and Southern Conservation Districts:<br><br>Summarize natural resources conditions and ranks resource concerns that could be addressed through NRCS technical and financial assistance. Available at:<br><br>https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/wv/programs/financial/eqip/?cid=nrcseprd1167606 |
| Living on Karst- A Reference Guide for Landowners in Limestone Regions<br><br>http://www.livingonkarst.org/living_on_karst.htm |
| Guidelines for Cave and Karst Protection- IUCN<br><br>https://www.iucn.org/content/guidelines-cave-and-karst-protection-0 |
| A Guide to Responsible Caving, by the National Speleological Society<br><br>https://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf |

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| National Wild Turkey Foundation- Landowner's Toolbox<br><br>https://www.nwtf.org/conservation/category/landownershttps://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf-tool-box |
| Cerulean Warbler Management Guidelines for Enhancing Breeding Habitat in Appalachian Hardwood Forests<br><br>http://amjv.org/wp-content/uploads/2018/06/cerulean_guide_1-pg_layout.pdf |
| Best Management Practices for Golden-winged Warbler Habitats in the Appalachian Region: A Guide for Land Managers and Landowners.<br><br>https://www.allaboutbirds.org/bbimages/clo/pdf/GWWA-APPLRegionalGuide_130808_lo-res.pdf |
| Wildlife Habitat Council Integrated Vegetation Management Project Guidance for Infrastructure Corridors: https://www.wildlifehc.org/wp-content/uploads/2015/11/WHC-Integrated-Vegetation-Management-Project-Guidance.pdf |
| West Virginia Pollinator Handbook – A Field Office Technical Guide Reference to management of pollinators and their habitats. Developed by WV NRCS Ecological Sciences in conjunction with WV Division of Natural Resources and the Xerces Society for Invertebrate Conservation.<br><br>http://xerces.org/sites/default/files/publications/12-049.pdf |
| Brochures about Aquatic Invasive Species, Forest Pests and Pathogens, and Invasive Plant Species<br><br>https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/technical/ecoscience/invasive/ |

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| West Virginia Invasive Species Strategic Plan and Voluntary Guidelines, 2014<br><br>https://eos.ucs.uri.edu/seagrant_Linked_Documents/mdu/2014-09_RO_Anderson_M_INV-3b.pdf |
| Fighting Invasive Plants in West Virginia<br><br>http://www.wvnps.org/FightingInvasives.pdf |
| American Forest Foundation: Woodland owners planning tool for forest management<br><br>https://mylandplan.org/ |
| The Nature Conservancy Resilient Land Mapping Tool and Documents:<br><br>http://maps.tnc.org/resilientland/ |
| USDA Forest Service, Northern Research Station's Climate Change Atlas: documentation of current and possible future distribution of 134 tree species and 147 bird species in the Eastern United States<br><br>https://www.fs.fed.us/nrs/atlas/ |

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| USDA NRCS Climate-Smart Forestry and Agriculture Mitigation Practices<br><br>While NRCS offers a broad suite of voluntary conservation activities, the agency identifies a sub-set as critical to climate change mitigation. When applied appropriately, these activities may deliver quantifiable reductions in greenhouse gas emissions and/or increases in carbon sequestration. Many offer co-benefits and ancillary benefits that help operations build climate change resilience while addressing other natural resource concerns such as soil health, water quality, pollinator and wildlife habitat and air quality.<br><br>https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/climate/climate-smart-mitigation-activities |
| Rudnick, D.A. et al. 2012. The Role of Landscape Connectivity in Planning and Implementing Conservation and Restoration Priorities. Ecological Society of America. https://applcc.org/cooperative/our-organization/rudnick-et-al.-2012-the-role-of-landscape-connectivity-in-planning-and-implementing-conservation-and-restoration-priorities |
| Adaptation Workbook: A climate change tool for land management and conservation, created by the Northern Institute of Applied Climate Science:<br><br>https://adaptationworkbook.org/ |
| U.S. Climate Resilience Toolkit, a website designed to help people find and use tools, information and subject matter expertise to build climate resilience. The Toolkit offers information from all across the U.S. federal government in one easy-to-use location.<br><br>https://toolkit.climate.gov/tool/climate-smart-conservation-putting-adaptation-principles-practice |

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| Forest Adaptation Resources: climate change tools and approaches for land managers, 2nd edition, 2016, published by the USDA Forest Service, Northern Research Station<br><br>https://www.nrs.fs.fed.us/pubs/52760 |
| Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. U.S. Department of Agriculture.<br>https://www.climatehubs.usda.gov/sites/default/files/AdaptationResourcesForAgriculture.pdf |