

Action Plan for the Shenandoah & Nathaniel Mountains Conservation Focus Area



West Virginia Division of Natural Resources

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ACRONYMS USED

ACEP- Agricultural Conservation Easement Program
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 Warbler
CREP- Conservation Reserve Enhancement Program
CRP- Conservation Reserve Program
CSP- Conservation Stewardship Program
EQIP- Environmental Quality Improvement Program
FSA- Farm Service Agency
G Rank- Global Rank
GWWA- Golden-winged Warbler
HUC- Hydrologic Unit Code
NRCS- Natural Resources Conservation Service
NWTF- National Wild Turkey Foundation
R8- Region 8
RGS- Roughed Grouse Society
SGCN- Species of Greatest Conservation Need
S Rank- State Rank
SWAP- State Wildlife Action Plan
TNC- The Nature Conservancy
TU- Trout Unlimited
USDA- United States Department of Agriculture
USFWS- United States Fish and Wildlife Service
WMA- Wildlife Management Area
WVACS- West Virginia Association for Cave Studies
WVCA- West Virginia Conservation Agency
WVCC- West Virginia Cave Conservancy
WVDEP- West Virginia Department of Environmental Protection
WVDHHR- West Virginia Department of Health and Human Resources
WVDNR- West Virginia Division of Natural Resources
WVDOF- West Virginia Division of Forestry
WVU- West Virginia University

Executive Summary

In 2015 the West Virginia Division of Natural Resources (WVDNR) completed 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 this Action Plan for the Shenandoah Mountain and Nathaniel Mountain CFA. This Action 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, karst and cave habitats, and developed and agricultural habitats. It also identifies 157 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 Action 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. A plan for implementation for each major habitat type lists partners and programs available to assist with each of the actions and 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 Action 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 this CFA.

Conserving wildlife species and their habitat within this 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 the plan, implement, and monitor conservation actions, facilitate stakeholder collaboration, and update the Action 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 also function as a blueprint for conservation that other natural resource agencies, local governments, non-governmental organizations, and the general public can use and apply (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 nineteen 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 three anthropogenic habitats that represent map classes of the National Land Cover Database (Homer et al. 2004). In addition, the SWAP classified and mapped eighteen 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 effect 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 this model. The characteristics, distribution, trends, and threats associated with each of the terrestrial and aquatic habitats are described in the 2015 SWAP. This Conservation Focus Area Action Plan uses those same habitat classifications.

For those SGCN listed in the SWAP 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 disease, or indirectly, by affecting the quality or quantity of available habitat. In this CFA Action Plan, WVDNR staff identified the perceived direct and indirect stresses specifically affecting SGCN at the local level in the CFA, as well as targeted conservation actions to address those stresses.

Conservation Actions

The purpose of stress assessment and prioritization in the 2015 SWAP was to identify statewide conservation actions that could 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 intention of the SWAP was to promote voluntary collaboration with landowners, corporations, and other partner organizations and agencies to reduce stresses on wildlife species and their habitats.

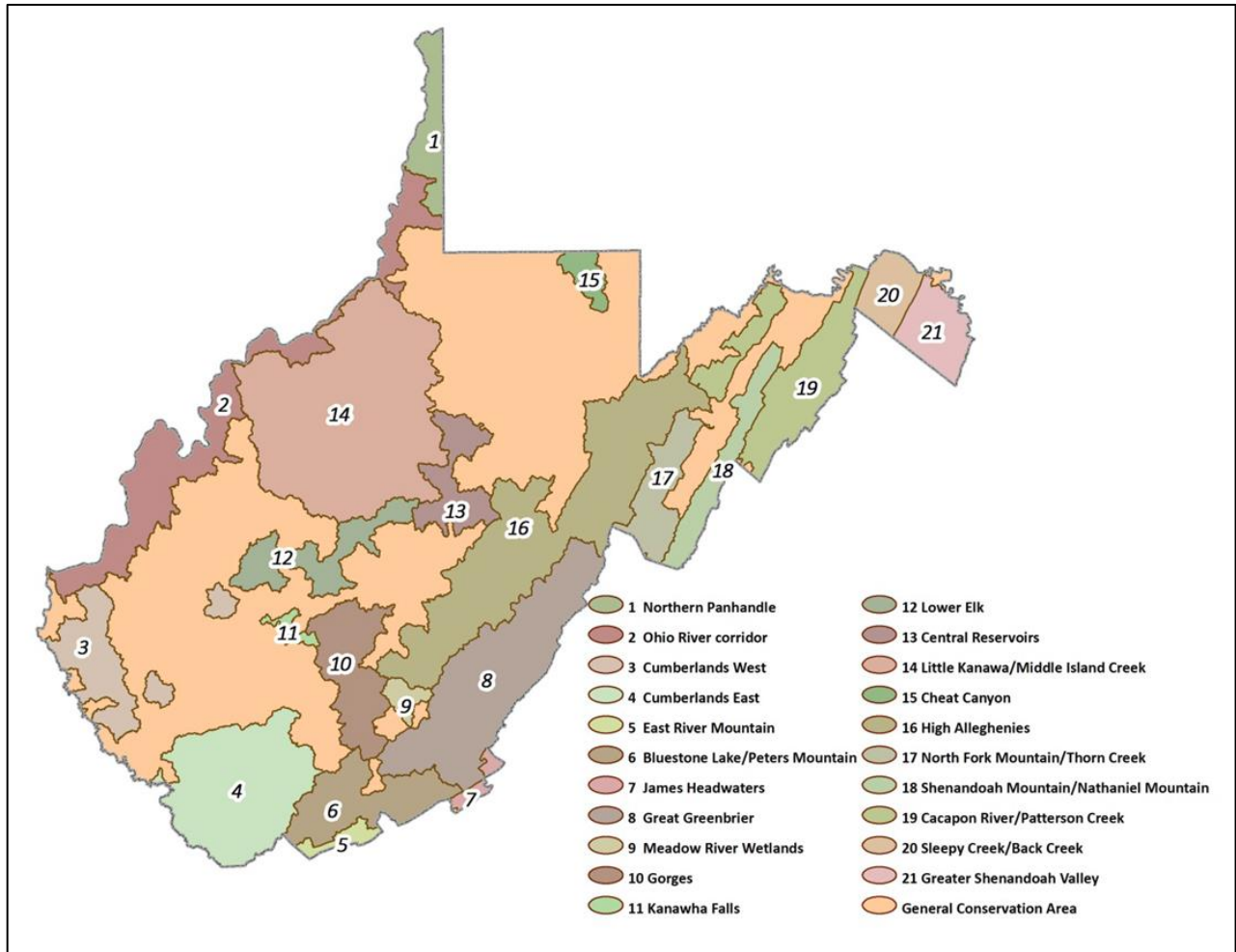
Conservation actions vary according to the species and the specific stresses. Actions can manifest themselves in many forms. A lack of information on the status of a species or understanding of a threat may indicate a need for actions such as baseline inventory, research, or data acquisition. Direct 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, and often similar, 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. The map 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 noted 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 and actions that will effectively secure or protect priority species and their habitats within the CFA. The Action Plans also identify public lands that can provide opportunities for conservation in collaboration with public land managers. And 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.

Conservation Focus Areas in West Virginia.



Climate Change and Resilience

The 2015 SWAP listed 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. This study and the SWAP identified 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 listed habitat shifts and alterations as statewide stresses for terrestrial SGCN and it listed increasing frequency and severity of drought, storms and flooding and temperature extremes as statewide stresses for aquatic SGCN and habitats. The SWAP observed 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. Furthermore, climate change acts in tandem with other stresses on wildlife and habitat, and actions to address those other stresses could decrease their vulnerability to climate change. And actions to address climate impacts would vary between CFAs, emphasizing restoration and expansion of

vulnerable habitat types in some areas, or reducing habitat fragmentation in others. The SWAP further stated 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 sought to address climate change broadly through additional vulnerability assessments for select species, statewide actions to reduce additional stresses on SGCN 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 vulnerably habitats, and maintain ecosystems process, landscape resilience and connectivity.

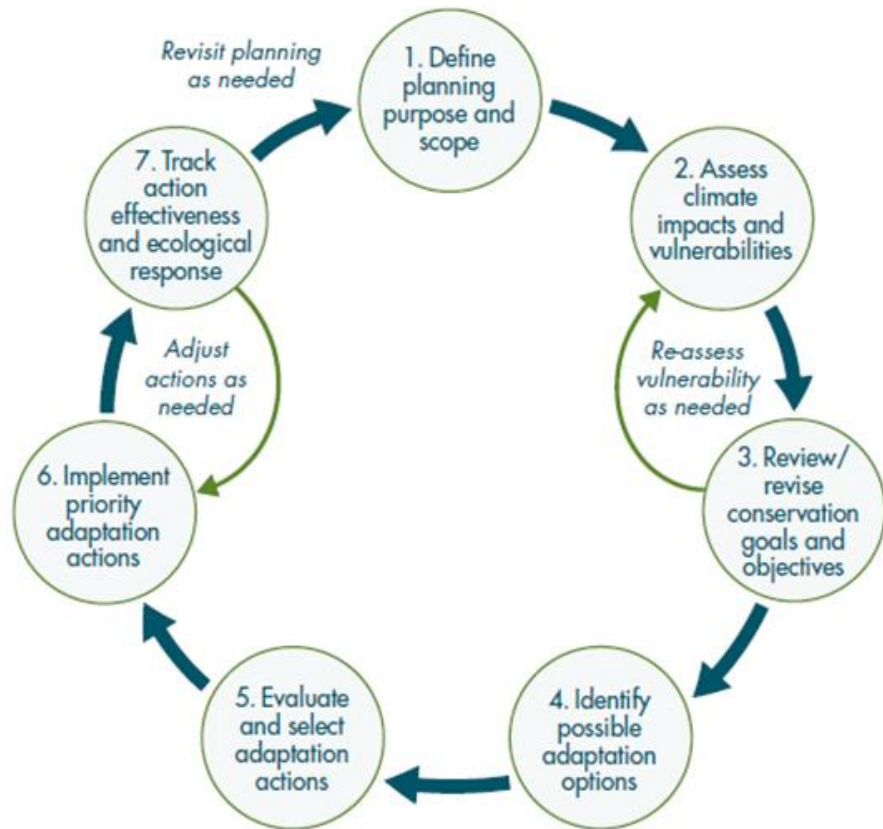
Monitoring and Adaptive Management

Monitoring of SGCN and their habitat is essential to establish better baseline data about species distribution, abundance, and population trends. The SWAP envisioned 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 SGCN and their habitat, successful wildlife conservation in CFAs will require monitoring the effectiveness of conservation actions and adapting those actions accordingly. The SWAP envisioned monitoring the results of conservation actions at the CFA level, and that CFA-level plans would 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 stable or increasing populations, or by acquiring a more complete understanding of species and threats in order 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, their habitats, and the success of conservation actions. Conservation actions are intended to reduce stresses on SGCN and their habitats, and to enable species to adapt to changing conditions. 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). Planning conservation actions for climate adaptation will require consideration of climate impacts, vulnerabilities and adaptation options, and careful monitoring of project effectiveness and ecological response. 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 and monitoring conservation actions may be informed by the climate impacts to species and habitats, WVDNR’s ongoing vulnerability assessments and field surveys to further document the distribution, abundance, and population trends 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

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 Action 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 Action Plan is then divided by major habitat type, including forest and woodland habitats, rock outcrop, 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 Action Plan lists priority species, stresses effecting those species, and actions to alleviate those stresses. The Action Plan also identifies climate stresses impacting each major habitat type and lists potential actions to boost their resilience. The Action Plan provides a plan for implementation and monitoring of conservation actions for each major habitat type, and a brief statement about other human benefits that may be generated by the proposed actions. The Action Plan also describes a regional network of resilient and connected landscapes

spanning multiple habitat types to 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 actions for greater impact and connecting conservation actions for climate resilience, and outlines next steps in plan implementation.

How to use this plan

Implementation of this 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 Action Plan is to provide local stakeholders with information, guidance, assistance and support to plan, 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 alleviate stresses on wildlife species in specific habitat, 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 their 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

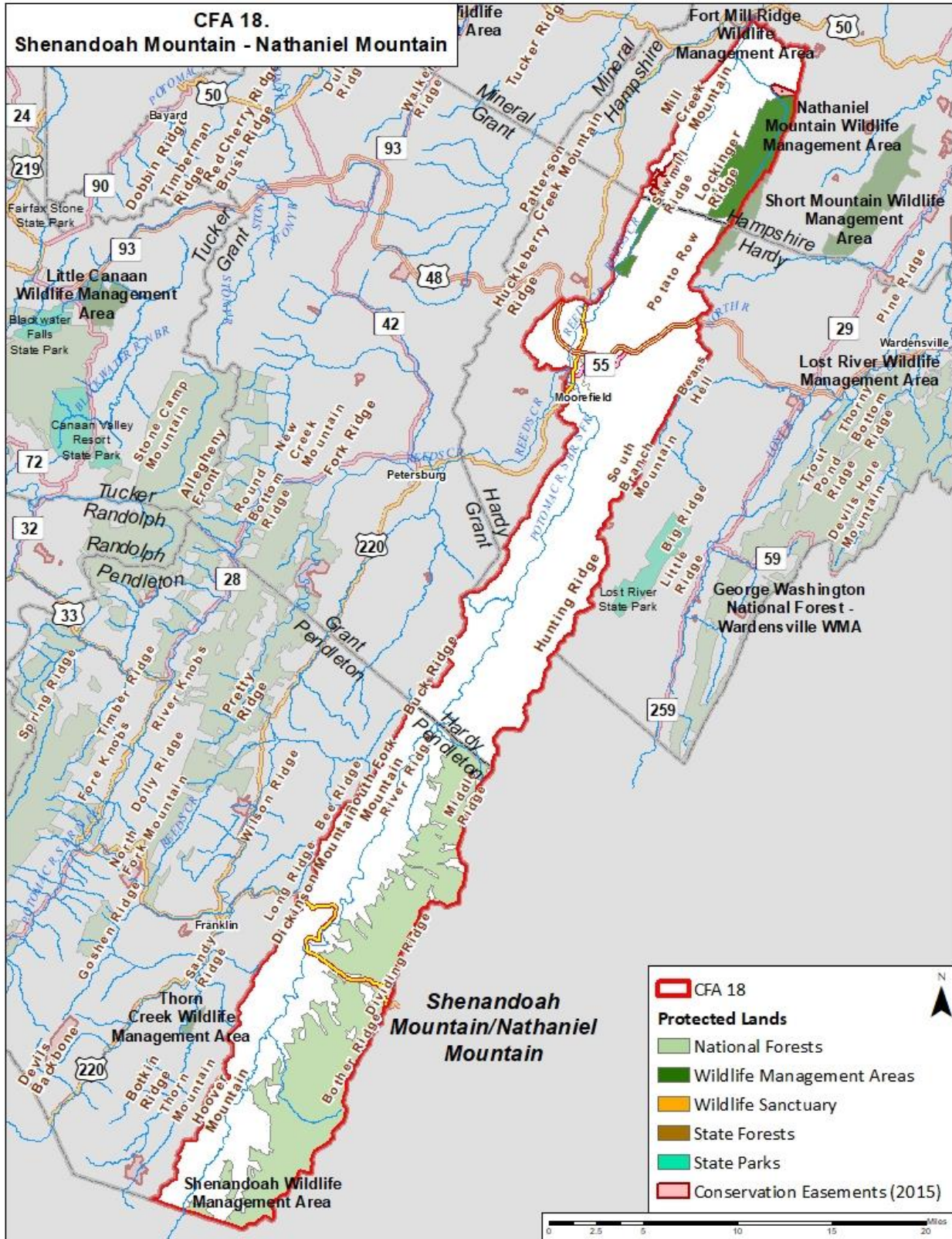
Shenandoah & Nathaniel Mountains Conservation Focus Area

Overview

Shenandoah Mountain is the largest massif in the Ridge and Valley Ecoregion, rising dramatically above the valley of the South Fork of the South Branch Potomac River to elevations above 4000 feet. The Virginia state line follows the crest of the mountain for much of its length in West Virginia. The CFA extends northward, into West Virginia, where it encompasses South Branch Mountain and eventually Nathaniel Mountain. River valleys are low in elevation. The South Fork of the South Branch Potomac River (South Fork) valley tends to be narrow with a well-developed floodplain that quickly gives way to foothills. North of the confluence of the South Fork and mainstem South Branch, the CFA includes The Trough, a narrow, steep canyon along the South Branch. Mountains tend to be sandstone, the valleys shale. Small areas of limestone also occur in the valleys.

This landscape is almost entirely forested, with large blocks of forest remaining. Several hunt clubs own large, forested parcels including one 11,000+ acre property which is the largest private tract in the Potomac Watershed of West Virginia. Farmland (mostly poultry, livestock pasture, hay, and corn) occurs primarily in the river bottom along the South Fork River, on top of South Branch Mountain and Shenandoah Mountains in Hardy County, and in an area east of Nathaniel Mountain. Low density residential and second home development is occurring throughout the area north of Pendleton County. There is substantial public land in the southern and northern thirds, but none in the middle third of this landscape.

Overview



Habitats

The Shenandoah & Nathaniel Mountains CFA includes a variety of terrestrial, subterranean, and aquatic habitat types.

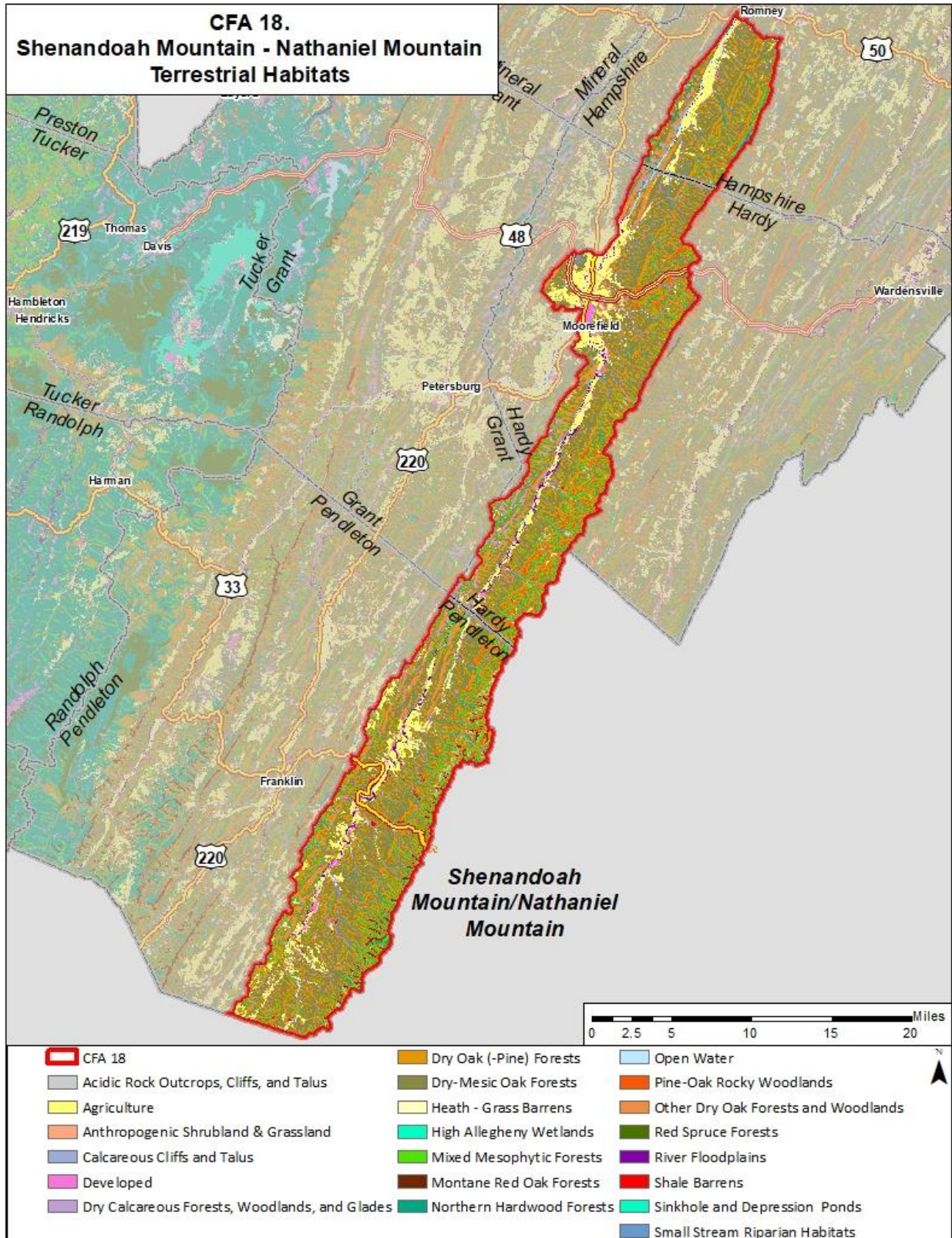
Terrestrial Habitats

Fifteen of the habitat types described in the SWAP are present in this CFA. Dry Oak-Pine Forests and Dry-Mesic Oak Forests cover majority of the CFA and only represent over 2% of the state's total habitat. Shale Barrens and Calcareous Cliffs and Talus represent a tiny portion of the terrestrial habitats in this CFA yet represent over 18% of the state's total shale barren habitat.

Terrestrial Habitat Summary

HABITAT TYPE	ACRES IN CFA	PERCENT OF CFA AREA	PERCENT OF WV TOTAL FOR TYPE
Acidic Rock Outcrops, Cliffs, and Talus	1,545	0.61%	1.72%
Agriculture	25,331	9.98%	1.76%
Anthropogenic <u>Shrubland</u> & Grassland	0	0.00%	0.00%
Calcareous Cliffs and Talus	1,660	0.65%	18.03%
Developed	9,228	3.63%	0.81%
Dry Calcareous Forests, Woodlands, and Glades	3,317	1.31%	4.64%
Dry Oak (-Pine) Forests	59,172	23.31%	2.39%
Dry <u>Mesic</u> Oak Forests	105,238	41.45%	2.11%
Heath-Grass Barrens	0	0.00%	0.00%
High Allegheny Wetlands	0	0.00%	0.00%
Mixed <u>Mesophytic</u> Forests	15,474	6.09%	0.53%
<u>Montane</u> Red Oak Forests	2,274	0.90%	10.76%
Northern Hardwood Forests	2,003	0.79%	0.20%
Pine-Oak Rocky Woodlands	5,885	2.32%	7.70%
Red Spruce Forests	117	0.05%	0.07%
River Floodplains	2,424	0.95%	2.02%
Shale Barrens	387	0.15%	21.61%
Sinkhole and Depression Ponds	0	0.00%	0.00%
Small Stream Riparian Habitats	9,267	3.65%	1.87%
Unresolved	10,563	4.16%	9.05%
Totals	253,887	100.00%	

Terrestrial Habitats



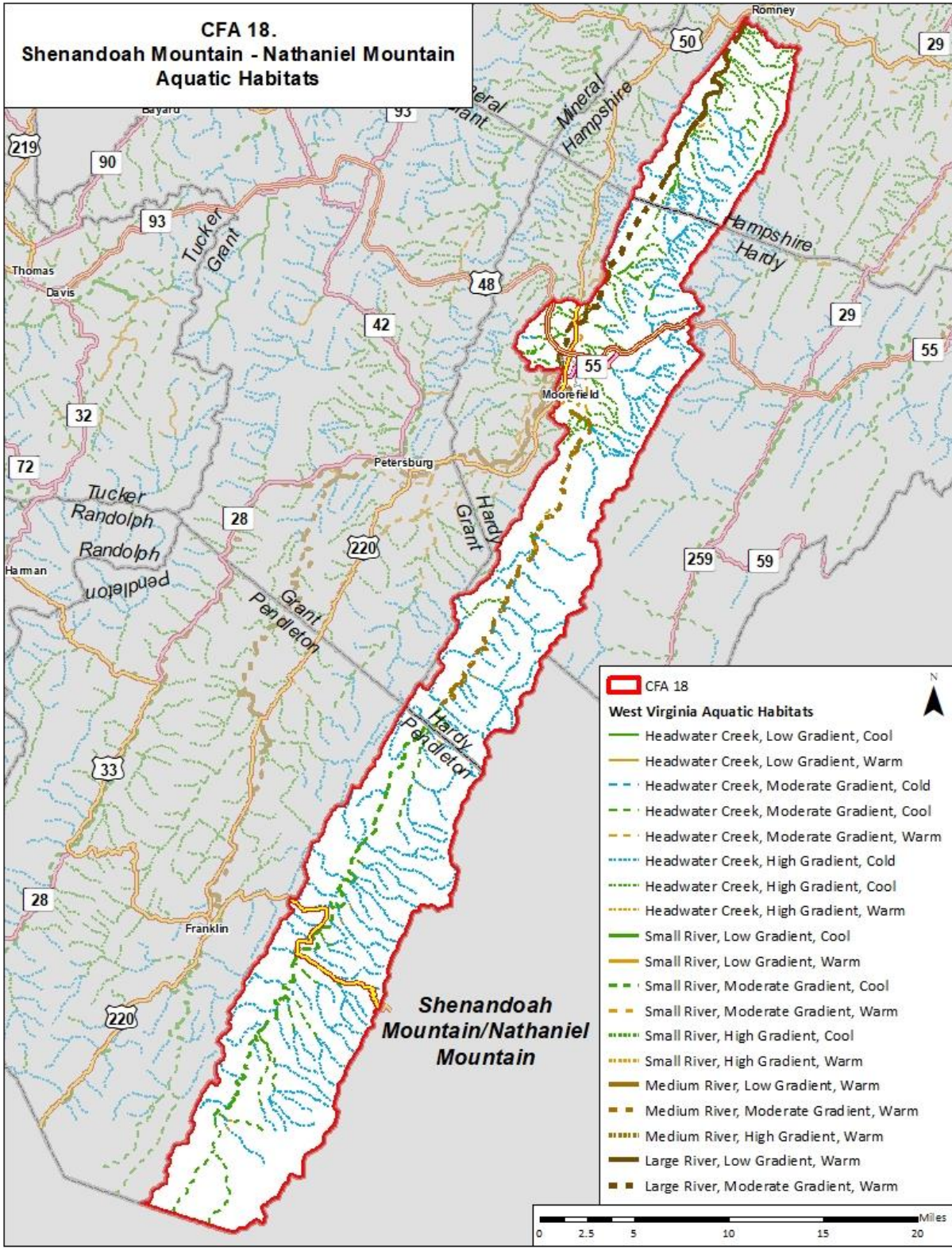
Aquatic Habitats

Fifteen of the aquatic habitat types described in the SWAP are present within the Shenandoah and Nathaniel Mountains CFA, including over 10% of the state's cold, high gradient headwater creek habitat.

Aquatic Habitat Summary

HABITAT TYPE	MILES IN CFA	PERCENT OF CFA MILES	PERCENT OF WV TOTAL FOR TYPE
<u>Headwater Creek, Low Gradient, Cool</u>	0	0.03%	1.42%
<u>Headwater Creek, Low Gradient, Warm</u>	4	0.61%	0.64%
<u>Headwater Creek, Moderate Gradient, Cool</u>	71	12.00%	3.22%
<u>Headwater Creek, Moderate Gradient, Warm</u>	14	2.40%	0.36%
<u>Headwater Creek, High Gradient, Cold</u>	334	56.78%	11.40%
<u>Headwater Creek, High Gradient, Cool</u>	82	13.87%	1.30%
<u>Small River, Low Gradient, Cool</u>	3	0.45%	6.92%
<u>Small River, Low Gradient, Warm</u>	0	0.01%	0.01%
<u>Small River, Moderate Gradient, Cool</u>	31	5.33%	6.74%
<u>Small River, Moderate Gradient, Warm</u>	1	0.09%	0.10%
<u>Small River, High Gradient, Warm</u>	0	0.00%	0.17%
<u>Medium River, Low Gradient, Warm</u>	4	0.76%	0.94%
<u>Medium River, Moderate Gradient, Warm</u>	21	3.49%	5.92%
<u>Large River, Low Gradient, Warm</u>	13	2.20%	2.23%
<u>Large River, Moderate Gradient, Warm</u>	12	1.98%	10.63%
Totals	589	100.00%	

Aquatic Habitat



Species of Greatest Conservation Need

The table below lists the number of SGCN in each taxa group listed in the SWAP for the Shenandoah & Nathaniel Mountains CFA (see full list in Appendix 1).

Species Summary by Taxa

TAXA	# SGCN
Amphibians	15
Birds	28
Butterflies and Moths	16
Dragonflies and Damselflies	3
Fish	6
Mammals	9
Mussels	6
Plants	52
Reptiles	10
Snails	12
Totals	157

This CFA and its ecological continuation in Virginia include some of the largest intact forest patches between the Adirondacks and Great Smoky mountains, representing regionally significant habitat for several forest interior nesting birds, species of embedded rocky patch habitats such as:

- Allegheny Woodrat
- Timber Rattlesnake
- Appalachian Oak Fern
- Wintering Golden Eagle (one of the highest wintering densities in the eastern United States)

Also found here are globally rare, highly restricted endemic plants. These forest blocks are critical for maintaining embedded patch habitats, regional connectivity, and functional, resilient forest communities. Almost the entire ranges of the Cow Knob and Shenandoah Mountain salamanders are found here and in adjoining Virginia. Along the South Fork is one of the most globally significant assemblages of Shale Barrens, which support many plants and butterflies of concern, including the federally endangered Shale Barren Rockcress. Many species are known in West Virginia only or primarily from here including:

- Olympia Marble
- Turkeybeard
- Dwarf Trillium (*Trillium pusillum*)

Overall, the forests and embedded patch habitats support:

- 16 SGCN moths and butterflies
- 12 SGCN snails
- 52 SGCN plants.

A cave with a significant summer colony and hibernating concentration of Virginia Big-eared Bats and a small population of Indiana Bats occurs along the South Fork. American Eel adults are still commonly found in larger streams. The Trough supports several breeding pairs of Bald Eagles.

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

Distinctive Stresses

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

- Low density housing and second home development has significantly fragmented forest habitat in portions of this CFA, including the largest second home development in West Virginia (which covers 10,000 acres).
- Industrial wind energy projects have been proposed for portions of the area.
- Forest management activities (e.g. timber harvesting, prescribed fire and road construction) perforate intact forest and enable non-native invasive plant species establishment.

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

Conservation Actions

To address these stresses, the 2015 SWAP recommended that four main types of action in the CFA.

1. Cooperative efforts with public landowners to maintain large, intact forest blocks thus protecting many other special habitats.
2. Partner with public landowners so that habitat loss and fragmentation by renewable energy and other development can be avoided on public lands.
3. Implement a comprehensive plan to enhance climate change resiliency through reducing other stressors (such as invasive species), identifying, maintaining, and creating key habitat cores and corridors, and protecting areas of high landscape complexity and integrity.
4. Coordinate with the Potomac Highlands Cooperative Weed Pest management Area to identify habitats impacted by NNIS and coordinate control or eradication efforts.

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:

- George Washington National Forest
- WVDOF
- NRCS
- Potomac Highlands Cooperative Weed and Pest Management Area
- AMJV
- Large hunt clubs

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 1 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

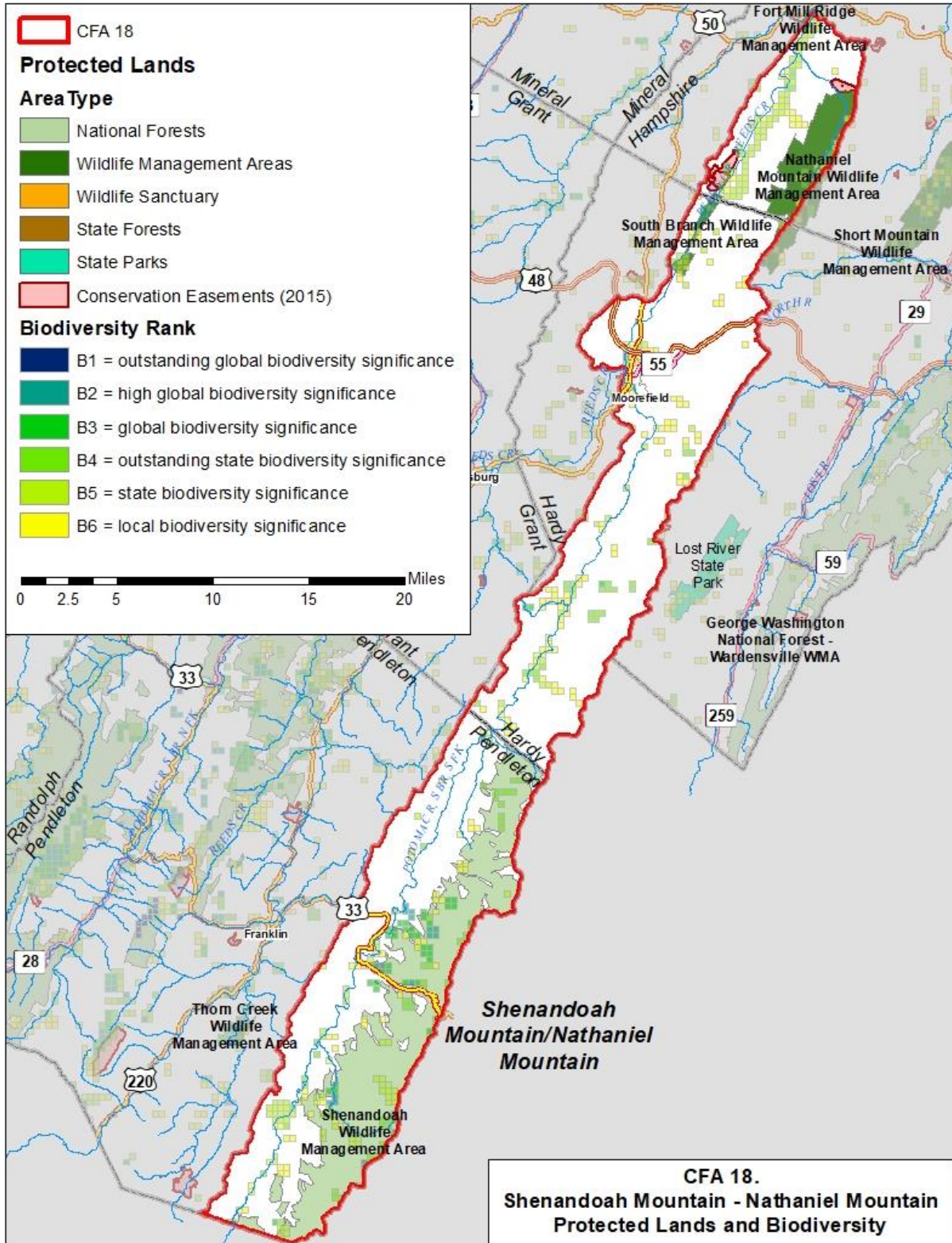
Public lands that may provide significant opportunities for wildlife conservation include:

- George Washington National Forest
- Nathaniel Mountain and South Branch WMAs
- Sugar Grove Naval Base

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. In addition, land trusts and conservation organizations including the West Virginia Land Trust, The Nature Conservancy and WV Division of Forestry's Forest Legacy Program hold conservation easements that may protect important wildlife habitat and provide additional wildlife conservation opportunities.

The next map shows the location of public lands and conservation easements in the CFA, based on data provided by The Conservation Fund (TCF), USGS Gap Analysis Program (GAP), The Nature Conservancy (TNC), and the National Conservation Easement Database (NCED) in 2015. It also shows known occurrences of SGCN and rare plant communities within 500- square meter areas, 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 communities occur on public lands and conservation easements in the CFA, and there may be opportunities for WVDNR, public agencies and landowners to protect them there. Many SGCN and rare plant 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 private landowners to restore and protect biodiversity on private lands. Appendix 4 lists partners and programs that provide assistance to private landowners in wildlife conservation.

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 develop relationships with conservation partners and key stakeholders to support and promote natural resource stewardship and guide efforts that protect, restore, enhance, and otherwise benefit natural communities and processes. Only through collaboration with agency partners, non-governmental organizations and the public can we 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 SGCN present in the CFA provided in the SWAP, WVDNR wildlife biologists selected priority species for conservation action that represent the best opportunity for successful conservation based on its population status and known trends in the CFA, the significance of each species at the global, state and local levels, the degree of dependence of each species on habitats within the CFA, conservation opportunities and likelihood of conservation success in the CFA, and other factors. The table below lists SGCN that were selected as priority species within the CFA based on the above criteria. Also listed are the priority species which are classified as rare, threatened or endangered species or as sensitive species by United States Forest Service's Region 8 and as at risk species by the United States Fish and Wildlife Service, indicating that the agencies may target these species for conservation action and may provide additional technical and financial support. 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 and will be included as an action in the implementation plan for each major habitat type that follows.

Priority Species in CFA

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFS R8	USFWS
Amphibians	<i>Plethodon punctatus</i>	Cow Knob (white Spotted) Salamander	S2	G3	S	
Amphibians	<i>Plethodon virginia</i>	Shenandoah Mountain Salamander	S2	G2G3Q	S	
Birds	<i>Falco sparverius</i>	American Kestrel	S3B	G5		
Birds	<i>Scolopax minor</i>	American Woodcock	S3B	G5		
Birds	<i>Tyto alba</i>	Barn Owl	S2B,S2N	G5		
Birds	<i>Lanius ludovicianus migrans</i>	Migrant Loggerhead Shrike	S1B,S1N	G4T3Q		
Birds	<i>Spizella pusilla</i>	Field Sparrow	S3B	G5		
Birds	<i>Ammodramus savannarum</i>	Grasshopper Sparrow	S3B	G5		
Birds	<i>Sturnella magna</i>	Eastern Meadowlark	S3B, S2N	G5		
Birds	<i>Chaetura pelagica</i>	Chimney Swift	S3B	G5		
Birds	<i>Buteo platypterus</i>	Broad-winged Hawk	S3B	G5		
Birds	<i>Bonasa umbellus</i>	Ruffed Grouse	S3B,S3N	G5		
Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	S2B	G5		
Birds	<i>Hylocichla mustelina</i>	Wood Thrush	S3B	G5		
Birds	<i>Setophaga discolor</i>	Prairie Warbler	S3B	G5		
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler	S3B	G5		
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler	S2B	G4		
Birds	<i>Geothlypis formosa</i>	Kentucky Warbler	S3B	G5		
Birds	<i>Parkesia motacilla</i>	Louisiana Waterthrush	S3B	G5		
Birds	<i>Riparia riparia</i>	Bank Swallow	S2B	G5		
Butterflies and Moths	<i>Zale calycanthata</i>	Double-banded Zale	SU	G4		
Butterflies and Moths	<i>Catocala herodias gerhardi</i>	Pine Barrens Underwing	SU	G3T3	S	
Dragonflies and Damselflies	<i>Calopteryx angustipennis</i>	Appalachian Jewelwing	S3	G4		
Fish	<i>Anguilla rostrata</i>	American Eel	S2	G4		

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFS R8	USFWS
Fish	<i>Luxilus cornutus</i>	Common Shiner	S1S2	G5		
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat	S2	G4T2	S	At Risk
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk	S1	G5		
Plants	<i>Arabis serotina</i>	Shalebarren Rockcress	S2	G2	E	
Plants	<i>Asplenium septentrionale</i>	Forked Spleenwort	S2	G4G5		
Plants	<i>Packera plattensis</i>	Prairie Ragwort	S1	G5		
Plants	<i>Trillium pusillum</i> var. <i>virginianum</i>	Dwarf Wakerobin	S1	G3T2		
Plants	<i>Talinum teretifolium</i>	Eastern Fameflower	S1	G4		
Plants	<i>Xerophyllum asphodeloides</i>	Eastern Turkeybeard	S1	G4		
Reptile	<i>Glyptemys insculpta</i>	Wood Turtle	S3	G4	S	At Risk
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake	S3	G4		

S = sensitive species, E= endangered species

Forest and Woodland Habitats

Dry Mesic Oak Forests cover almost half of the CFA and represent the largest portion of forest habitat types, followed by Dry Oak Pine Forests. Mixed Mesophytic and Pine-Oak Rocky Woodlands occupy much smaller portions of the CFA. Many of these dry forest types are threatened by invasive species, mesophication (gradual moistening), and lack of fire. Overbrowsing by deer reduces regeneration of oak and other palatable understory species. Smaller portions of forested areas are composed of Dry Calcareous Forests, Woodlands, and Glades, Montane Red Oak Forests on some high ridge tops, and Northern Hardwood Forests. The following pages include maps of 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.

Priority Species

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

Priority Species in Forest and Woodland Habitats.

Taxa	Scientific Name	Common Name
Amphibians	<i>Plethodon punctatus</i>	Cow Knob (white Spotted) Salamander
Amphibians	<i>Plethodon virginia</i>	Shenandoah Mountain Salamander
Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo
Birds	<i>Buteo platypterus</i>	Broad-winged Hawk
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler
Birds	<i>Geothlypis formosa</i>	Kentucky Warbler
Birds	<i>Setophaga discolor</i>	Prairie Warbler
Birds	<i>Bonasa umbellus</i>	Ruffed Grouse
Birds	<i>Hylocichla mustelina</i>	Wood Thrush
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler
Butterflies and Moths	<i>Zale calycanthata</i>	Double-banded Zale
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat
Plants	<i>Trillium pusillum</i> var. <i>virginianum</i>	Dwarf Wakerobin
Plants	<i>Talinum teretifolium</i>	Eastern Fameflower
Plants	<i>Xerophyllum asphodeloides</i>	Eastern Turkeybeard
Plants	<i>Asplenium septentrionale</i>	Forked Spleenwort
Plants	<i>Packera plattensis</i>	Prairie Ragwort

Taxa	Scientific Name	Common Name
Plants	Arabis serotina	Shalebarren Rockcress
Reptiles	Crotalus horridus	Timber Rattlesnake

Large, intact forest blocks core habitat for many forest interior breeding birds, including Broad-winged Hawk, Wood Thrush, Cerulean Warbler and Worm-eating Warbler. Early successional forest habitats support Prairie Warbler, and Black-billed Cuckoo. Intact forest patches provide habitat for the majority of known occurrences of rare species and plant communities in this CFA. Several rare plant species are associated with Pine-Oak Rocky Woodlands and Dry Oak-Pine Forests, but additional surveying will be required to ascertain their status and location.

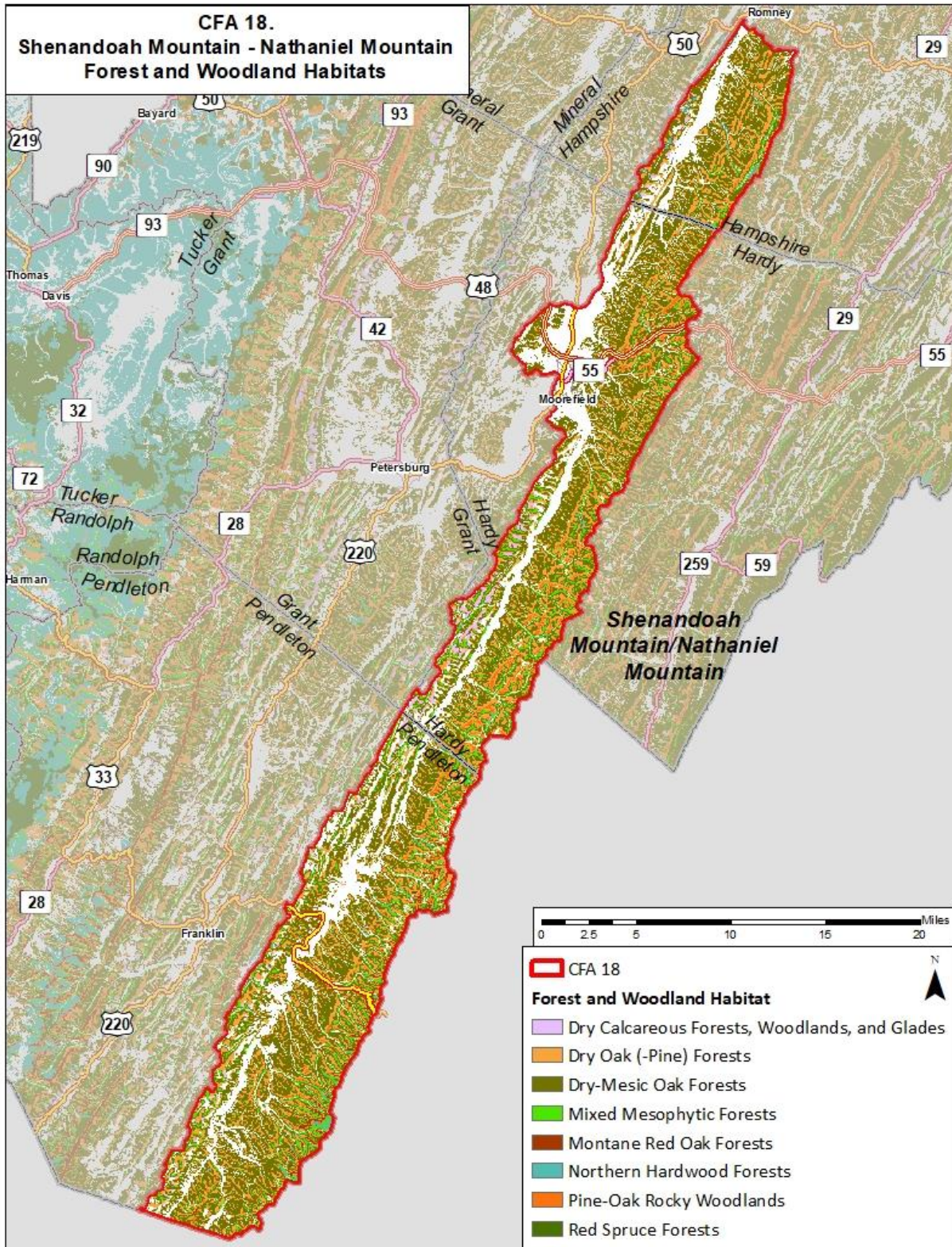
Rare Plant Communities

The following rare plant communities are found in Forest and Woodland habitats in this CFA. Note that majority of Ridge and Valley Northern Hardwood Forests are located here. These communities are vulnerable to disturbance by logging and grazing activities, and to the spread of non-native invasive plants. Disturbance should be avoided, and non-native invasive plant infestations should be treated.

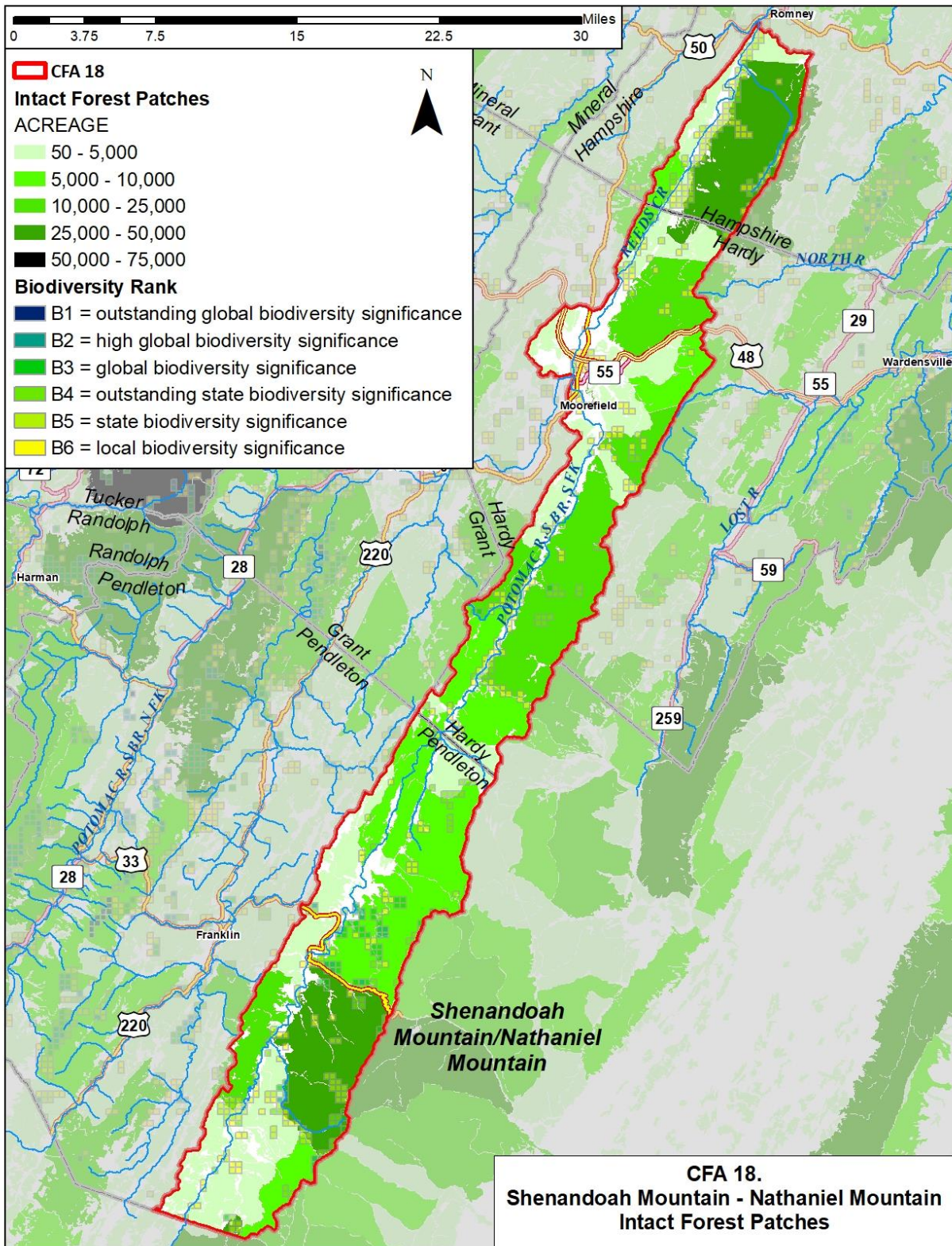
Rare Plant Communities in Forest and Woodland Habitats

HABITAT	COMMON NAME	G RANK	S RANK	RELATIVE ABUNDANCE
Dry Calcareous Forests, Woodlands, and Glades	Limestone Clifftop Woodland	G3G4	S2	7%
Montane Red Oak Forests	Eastern Ridges Montane Red Oak Forest	G3G4	S3	30%
Northern Hardwood Forests	Ridge and Valley Northern Hardwoods Forest	G3G4	S1	100%
Pine - Oak Rocky Woodlands	Natural Red Pine Forest	G1	S1	30%
Pine - Oak Rocky Woodlands	Pitch Pine - Virginia Pine Sandstone Pavement Woodland	G3	S1	22%

Forest and Woodland Habitats



Intact Forest Patches and Biodiversity



Habitat Stresses and Conservation Actions

The table below lists stresses impacting species in forest and woodland habitats, and conservation actions landowners and partners can take to address those stresses.

Habitat Stresses and Actions in Forest and Woodland Habitats

Habitat Stresses	Actions
Forest habitat fragmentation	Habitat protection to maintain large forest blocks, and forested corridors for wildlife passage between watersheds. <ul style="list-style-type: none"> • Land use planning by local governments • Land protection/conservation easements
Early successional forest: Insufficient habitat, forest maturation, and poor forest structure	Develop and implement forest management plans that create or maintain early successional habitat to benefit wildlife species through forest management activities on appropriate sites
Interior forests: Insufficient habitat, poor forest structure	Develop and implement forest management plans that improve or maintain interior forest habitat to benefit wildlife species through forest management activities on appropriate sites
Deer overbrowsing, poor forest structure	Reduce deer population, manage forests for structural and spatial complexity
Herbicide use/vegetation management in utility corridors	Reduce disturbance in utility corridors
Non-native invasive weeds	Prevent spread through forestry operations and other ground disturbance, conduct monitoring and treatment
Fire suppression and lack of disturbance in forest succession in habitat for Eastern Spotted Skunk	Forest management and prescribed burns by public agencies to provide early successional habitat, canopy gaps and vegetative cover
Exposure to aerial pesticides (for gypsy moths)	Reduce aerial application of pesticides
Land alteration (timber cutting, fire) in habitat for Cow Knob Salamander and Shenandoah Mountain Salamander	Limit timber harvests and pesticides, restore/protect forest and ground cover, especially over rocky habitat
Loss of basking, gestation, and denning habitat for Timber Rattlesnakes	Create canopy gaps over gestation and basking sites; develop den avoidance guidance

In addition to the habitat-linked stresses listed above, direct stresses to priority species include insecticides poisoning Black-billed Cuckoos and gypsy moth infestations for the Double-banded Zale.

While efforts to manage and restore both early successional and interior forest habitat are needed for priority SGCN, restoration efforts should not convert one to the other. Early successional forest habitat restoration should take place in small patches of forest and along forest edges. Existing young forests can be enhanced outside of large blocks of interior forest. And efforts to restore and expand interior forest blocks should not generate an overall loss of early successional forest.

Climate Change and Habitat Resilience

The Central Appalachian Forest Ecosystem Vulnerability Assessment (Butler et. al, 2015) described 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, although species such as red spruce may persist in cool, wet microclimates. 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 at greater risk from 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, and 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 a 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. Fire suppression and timber harvesting have allowed more mesic species to become dominant. But increased temperature and drought could increase the risk of wildfire. While low-intensity fires could restore fire-adapted species, severe fires, combined with drought and other stressors, could increase mortality of some species. Higher temperatures and drought may increase the susceptibility of these forests to invasive species, pests and pathogens, and drought as well as disturbances from stronger storms may enable the spread of non-native invasive plants.

Dry Oak Pine Forests and Pine-Oak Rocky Woodlands are adapted to heat, drought and fire. While moderate increases in these drivers could benefit this forest type, severe drought and fire could lead to increased mortality of tree species. Droughts may increase susceptibility to forest pests and pathogens and enable non-native 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.

Dry Calcareous Forests, Woodlands and Glades are adapted to heat, drought and wildfire, but may be impacted by increased fire intensity, correlated with increases in invasive plant species. Management of invasive plants will be critical for the long-term resilience of the ecosystem. Dependence on unique soils may impede the ecosystem's ability to shift across the landscape.

Mixed Mesophytic Forests may be vulnerable to increasing disturbance by wildfire, drought, and invasion by non-native 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.

The small areas of 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. Protection of large forest patches in areas with complex topography and diverse microclimates, and maintaining forested connections between them, may further enable their adaptation and shifting distribution across the landscape.

Below is 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 are similar to 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.

Climate Stresses and Resilience Actions in Forest and Woodland Habitats

Climate Stresses	Habitat Resilience Actions
<ul style="list-style-type: none"> • Increased spring and summer temperatures • Increased risk of drought and wildfire • Increased frequency and severity of storms, • Increased competition from non-native invasive species, pests, and pathogens 	<ul style="list-style-type: none"> • Restore or maintain fire in fire-adapted ecosystems • Manage deer herbivory to promote regeneration • Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species • Promote diversity of native species and age classes through planting and silviculture • Protect habitat refugia for rare plant communities and forest types dependent on unique soils, such as calcareous forests, woodlands, and glades • Protect forest reserves in areas of high biological diversity or priority species • Reduce forest fragmentation • Maintain or restore large patches and corridors of forest habitat • 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.

Implementation Plan for Forest and Woodland Habitats

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> • Conservation Easements 	<ul style="list-style-type: none"> • WVDOF Forest Legacy • County Farmland Protection Boards • WV Land Trust • The Nature Conservancy 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Abundance and diversity of priority species and habitats
Habitat Protection: <ul style="list-style-type: none"> • Land use planning 	<ul style="list-style-type: none"> • County Planning Commissions 	<ul style="list-style-type: none"> • Acres of habitat protected through land use planning in forested areas
Habitat Protection <ul style="list-style-type: none"> • Incentive Programs 	<ul style="list-style-type: none"> • USDA NRCS CSP • GHG Sequestration 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Abundance and diversity of priority species and habitats

Action	Partners /Programs	Effectiveness Measures
Develop and implement forest management plans that create or maintain early successional habitat to benefit wildlife species through forest management activities on appropriate sites	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • NWTF and RGS • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance & distribution of priority species
Develop and implement forest management plans that improve or maintain interior forest habitat to benefit wildlife species through forest management activities on appropriate sites	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance & distribution of priority species
Control invasive weeds	<ul style="list-style-type: none"> • WVDOF • WVCA and Conservation District • NRCS CSP & EQIP • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat protected or restored for priority species • Before and after comparison: abundance and diversity of priority species
Reduce aerial application of pesticides (for caterpillar control)	<ul style="list-style-type: none"> • Landowners/Orchards 	<ul style="list-style-type: none"> • Change in pesticide use • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Manage deer browse and reduce deer population	<ul style="list-style-type: none"> • Hunting • WVDNR (hunting licenses) • Private landowners • Public Land Managers 	<ul style="list-style-type: none"> • Change in deer population • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Manage utility corridors to reduce wildlife impacts (implement BMPs promoted by the Wildlife Habitat Council, NRCS and other organizations)	<ul style="list-style-type: none"> • Public Land Managers • Partners • Utility companies 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Create forest canopy gaps, managing timber harvests and other forest management activities	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

Action	Partners /Programs	Effectiveness Measures
Prescribed burning by public agencies in fire adapted forest types	<ul style="list-style-type: none"> • WVDNR • US Forest Service 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Promote diversity of native species and age classes in forested areas, and restore native forest vegetation on adjacent degraded lands through planting and silviculture	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Provide guidance on timber rattlesnake den avoidance	<ul style="list-style-type: none"> • WVDNR • WVU Extension 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

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 opportunities, and hunting, wildlife viewing, tourism, and recreational opportunities.

Rock Outcrops, Cliffs and Talus, and Shale Barrens

Acidic Rock Outcrops, Cliffs and Talus, Calcareous Cliffs and Talus, and Shale Barrens cover small areas within the CFA, but make up large percent coverage for the state. These habitats are threatened by non-native invasive plants, woody encroachment, quarrying and other development. A map illustrating the location of these rare habitat types is on the following page, and those in smaller forest patches may be more vulnerable to stresses. These habitat types, while covering only small areas, are priorities for the conservation of rare plant communities in this CFA.

Priority Species

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

Priority species associated with Rock Outcrops, Cliffs and Talus, and Barren habitats.

Taxa	Scientific Name	Common Name
Butterflies and Moths	Zale calycanthata	Double-banded Zale
Butterflies and Moths	Catocala herodias gerhardi	Pine Barrens Underwing
Mammals	Spilogale putorius	Eastern Spotted Skunk
Plants	Asplenium septentrionale	Forked Spleenwort
Plants	Arabis serotina	Shalebarren Rockcress
Reptiles	Crotalus horridus	Timber Rattlesnake

Several rare plant species are associated with Acidic Rock Outcrops Cliffs and Talus, and Shale Barrens, but additional surveying will be required to ascertain their status and location. Timber Rattlesnakes rely on rocky habitats and rely on connections between various habitats for passages.

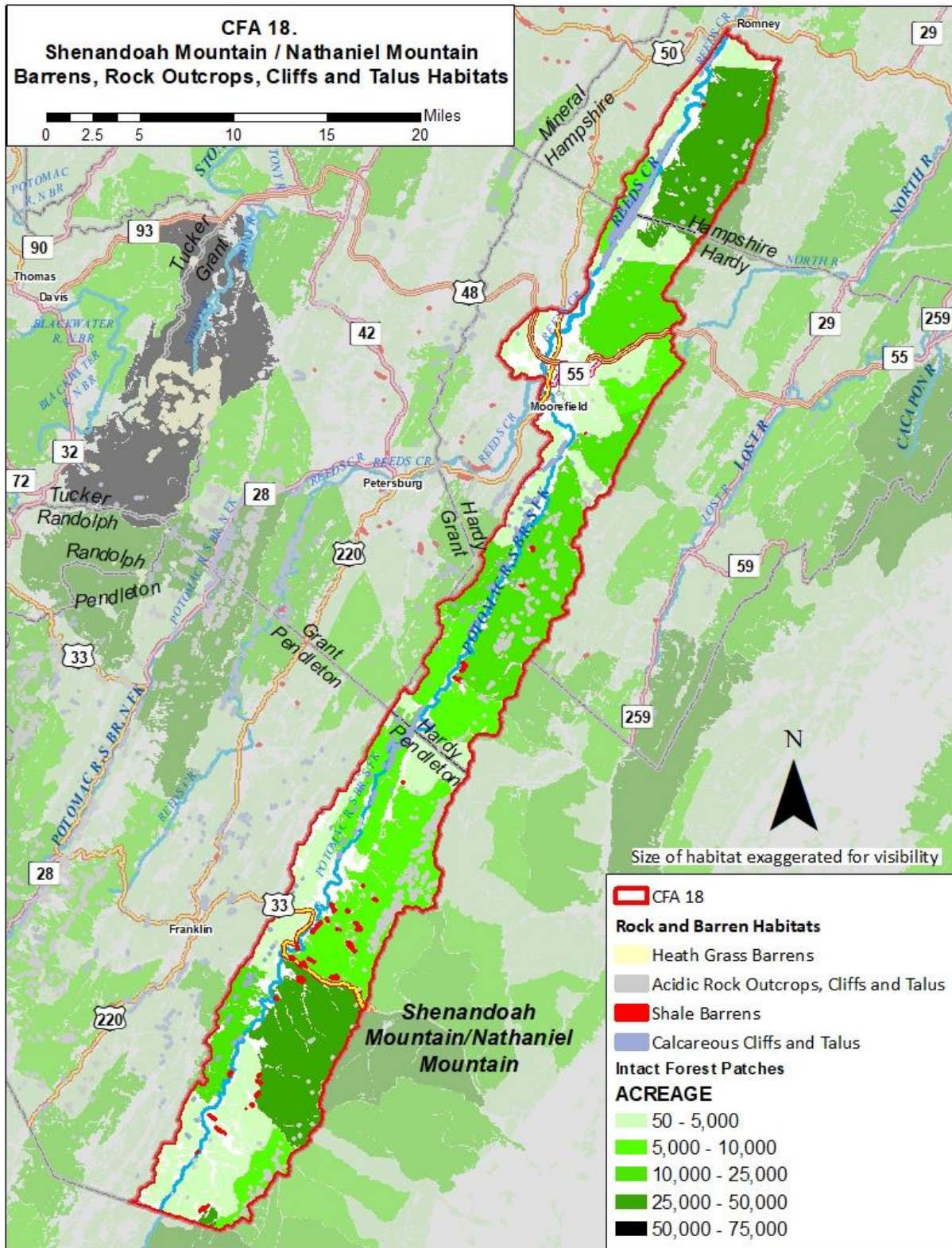
Rare Plant Communities

These habitats are home to several rare plant communities.

Rare Plant Communities in Acid Rock Outcrops and Shale Barrens

HABITAT	COMMON NAME	G RANK	S RANK	RELATIVE ABUNDANCE
Acidic Rock Outcrops, Cliffs, and Talus	High-Elevation Boulderfield Forest	G2	S2	27%
Shale Barrens	Xeric Sparse Herbs Shale Barren	G3	S3	43%
Shale Barrens	Classic Central Appalachian Shale Barren	G3G4	S3	30%

Acidic Rock Outcrop, Calcareous Cliff & Talus, and Shale Barren Habitat



Habitat Stresses and Conservation Actions

The following stresses to these sensitive habitats may be addressed through the actions below.

Habitat stresses and conservation actions in Rock Outcrops, Cliffs, Talus, and Barrens

Habitat Stress	Conservation Action
Fire Suppression/lack of disturbance in forest succession for Eastern Spotted Skunk in Acid Rock Outcrops, Cliffs and Talus	Implement forest management strategies- use of fire to increase vegetative cover and early successional habitat
Loss of basking/gestation/ denning habitat for timber rattlesnakes in Shale Barrens	Create canopy gaps over gestation and basking sites; develop den avoidance guidance.

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. Acidic rock outcrops, cliffs and talus and shale barren habitats 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 non-native invasive plants. Protecting and maintaining intact forest ecosystems around these rare habitats, and controlling invasive species, may help maintain resilience in a changing climate.

Climate Stresses and Resilience Actions in Rock Outcrop, Cliff and Talus, and Shale Barren Habitats

Climate Stresses	Habitat Resilience Actions
<ul style="list-style-type: none"> Increased risk of drought and wildfire Increased frequency and severity of storms Increased competition from non-native invasive species 	<ul style="list-style-type: none"> Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species Protect refugia for rare habitats and plant communities 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 heath-grass and shale barrens, acidic rock outcrops, and calcareous cliffs and talus.

Implementation Plan for Rock Outcrop, Cliff and Talus, and Shale Barren Habitats

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> • Conservation Easements 	<ul style="list-style-type: none"> • WVDOF Forest Legacy • County Farmland Protection Boards • WV Land Trust • The Nature Conservancy 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Abundance and diversity of priority species and habitats
Habitat Protection: <ul style="list-style-type: none"> • Land use planning 	<ul style="list-style-type: none"> • County Planning Commissions 	<ul style="list-style-type: none"> • Acres of habitat protected through land use planning for development around cliffs, steep slopes, and fragile soils
Habitat Protection <ul style="list-style-type: none"> • Incentive Programs 	<ul style="list-style-type: none"> • USDA NRCS CSP 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • 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	<ul style="list-style-type: none"> • WVDOF • WVCA and Conservation District • NRCS CSP • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Create and maintain openings in forest canopy and other forest management activities	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Prescribed burning by public agencies to restore fire adapted plant communities	<ul style="list-style-type: none"> • WVDNR • US Forest Service 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

Action	Partners /Programs	Effectiveness Measures
Provide guidance on timber rattlesnake den avoidance	<ul style="list-style-type: none"> • WVDNR • WVU Extension 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Minimize impact on fragile habitat	<ul style="list-style-type: none"> • Quarries and developers • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Manage recreation on sensitive sites	<ul style="list-style-type: none"> • U.S. Forest Service • WVDNR 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

Human Benefits

Actions to restore rock outcrop, cliffs and talus, and shale barren 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

Aquatic habitats in the CFA range include cold, high-gradient headwater streams to warm, medium gradient, large sized 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 wildlife species rely on aquatic habitats such as streams, rivers, and wetlands, as well as their adjacent terrestrial habitats, especially riparian areas and forests. Substantial portions of floodplain have been cleared for settlement and agriculture. The loss of natural floodplain habitats and riparian corridors often impacts water quality and adjacent aquatic habitat. And 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 are addressed together.

Priority Species

The tables below list priority species in streams, rivers, floodplains, and riparian areas in this CFA.

Priority Aquatic Species

Taxa	Scientific Name	Common Name
Fish	<i>Anguilla rostrata</i>	American Eel
Fish	<i>Luxilus cornutus</i>	Common Shiner
Reptile	<i>Glyptemys insculpta</i>	Wood Turtle

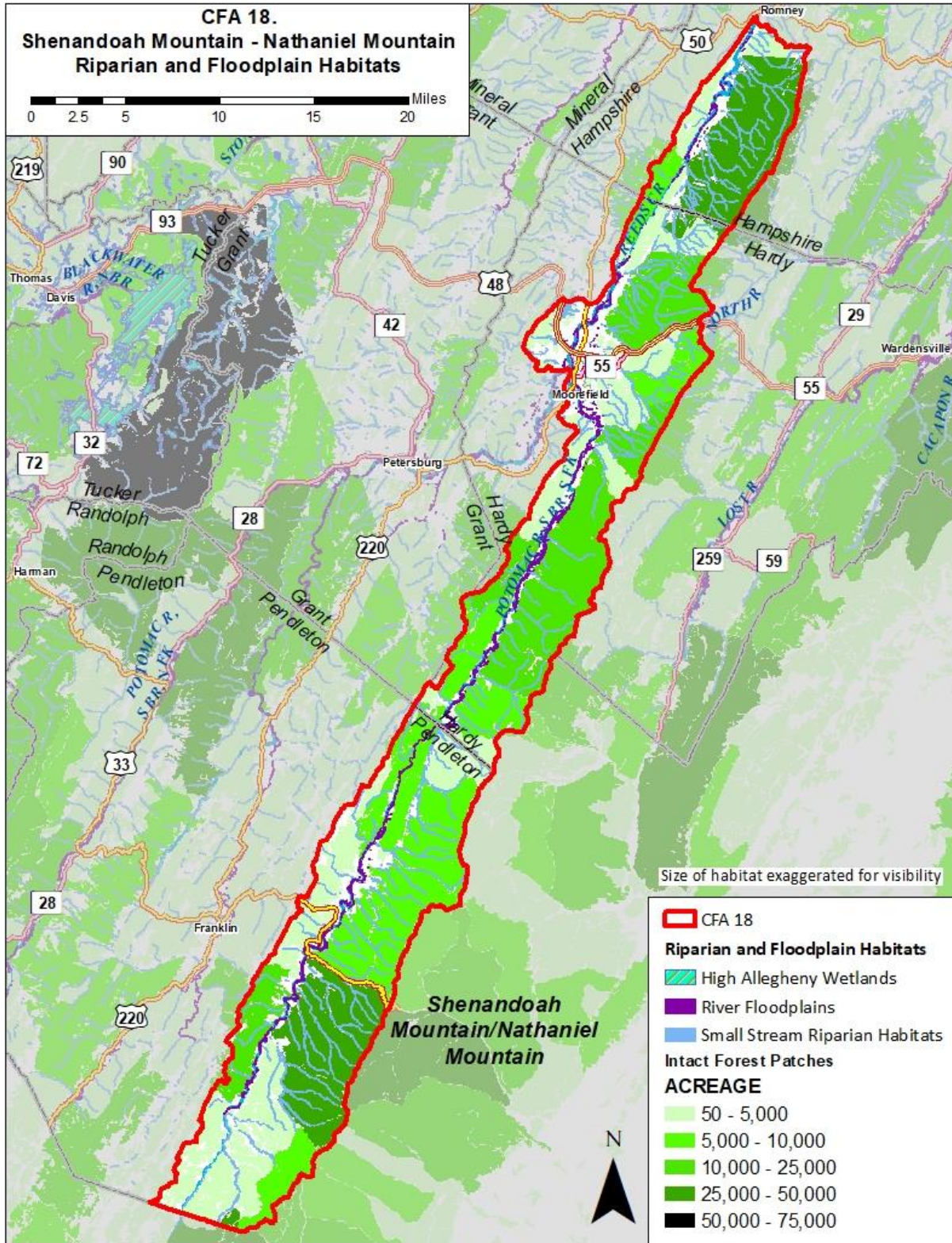
Because riparian and floodplain habitats are so closely connected to adjacent rivers and streams, they can host some of the same species, like Wood Turtles. Louisiana Waterthrush, Bank Swallows, and Appalachian Jewelwing rely on riparian and floodplain and habitats.

Priority Riparian and Floodplain Species

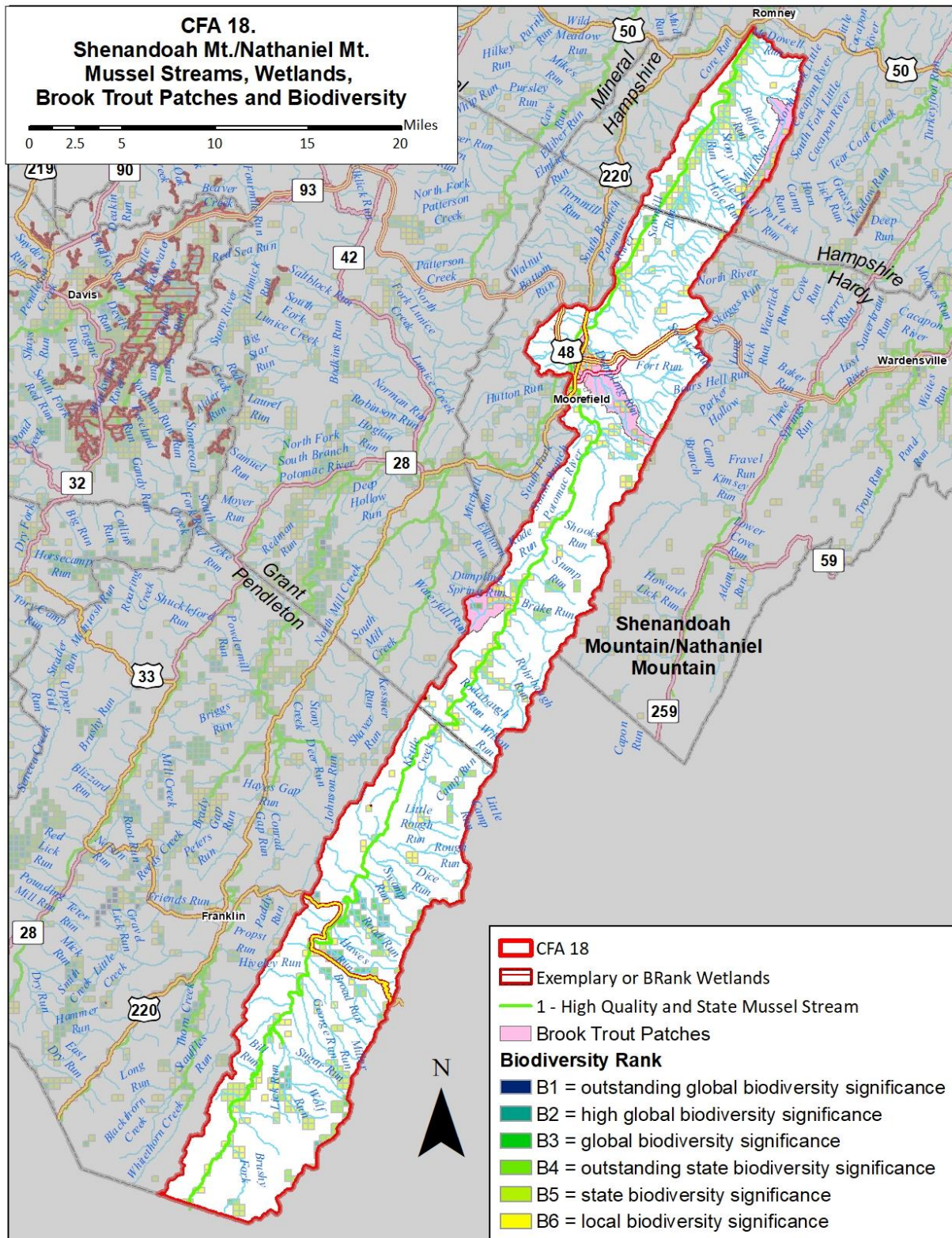
Taxa	Scientific Name	Common Name
Birds	<i>Riparia riparia</i>	Bank Swallow
Birds	<i>Parkesia motacilla</i>	Louisiana Waterthrush
Dragonflies and Damselflies	<i>Calopteryx angustipennis</i>	Appalachian Jewelwing

The following maps illustrates the riparian and floodplain habitats, as well as mussel streams (mapped by WVDNR in 2018), brook trout habitat patches (provided by the Eastern Brook Trout Joint Venture based on an assessment in 2015), and one small exemplary sinkhole wetland (based on data assembled by WVDNR in 2015) that provide core habitat and movement corridors for the priority species listed above. The South Fork is a designated state mussel stream. River floodplain habitat along the South Fork and numerous small stream riparian corridors maintain the form and function of streams and rivers and may be more vulnerable to stresses outside of the larger forest patches.

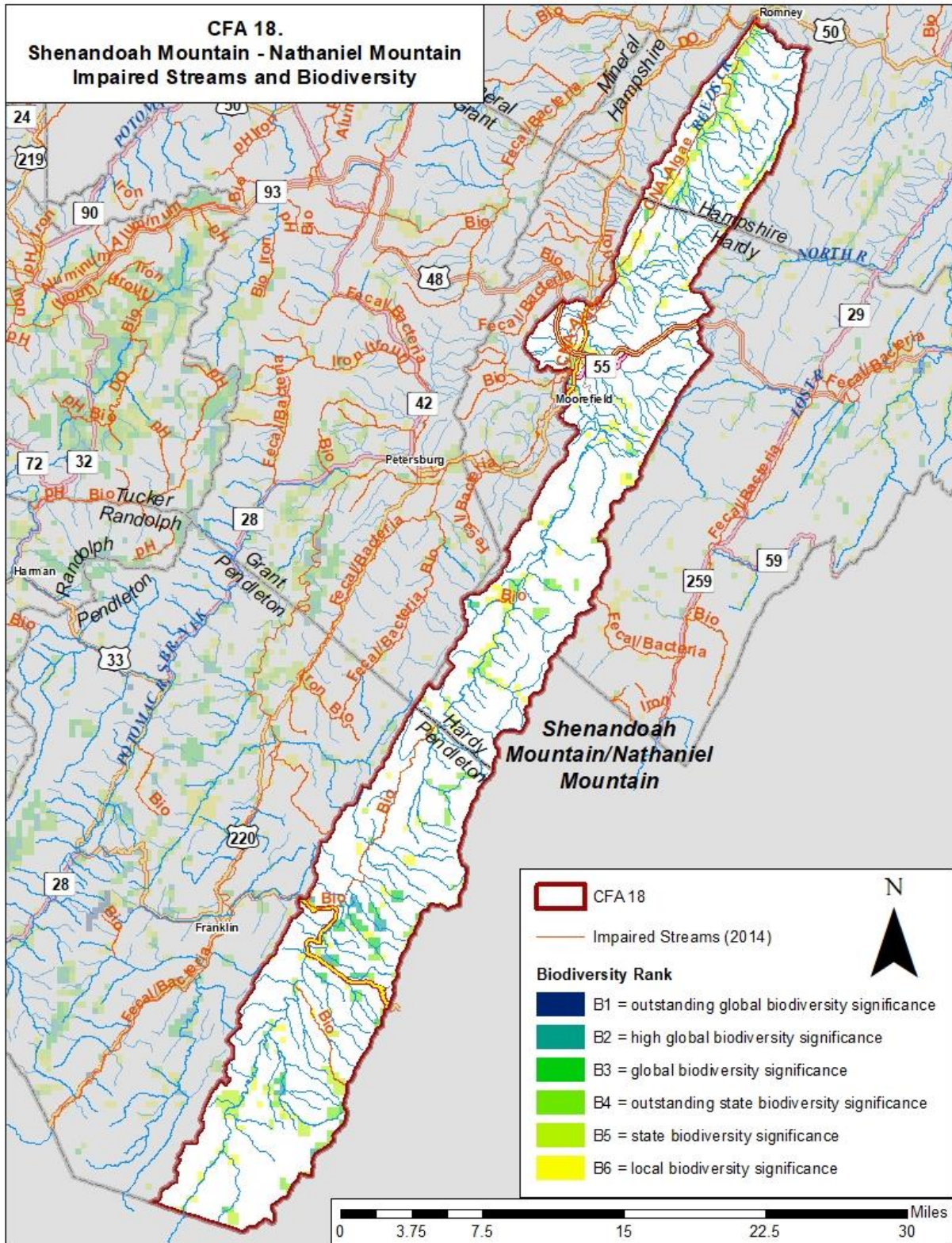
Riparian and Floodplain Habitats



Mussel Streams, Brook Trout Habitat Patches, Wetlands, and Biodiversity



Impaired Streams and Biodiversity



Rare Plant Communities

The following rare plant communities may be found in aquatic, floodplain and riparian habitats in this CFA. Note that Eelgrass Riverbed represents a third of this habitat type found in the state is located here. These plant communities are vulnerable to disturbance and the spread of non-native invasive plants. Disturbance should be avoided, and non-native invasive plant infestations should be treated. Customize

Rare Plant Communities in Aquatic, Floodplain and Riparian Habitats.

HABITAT	COMMON NAME	G RANK	S RANK	RELATIVE ABUNDANCE
River Floodplains	Eelgrass Riverbed	G3G4	S3	33%

Habitat Stresses and Conservation Actions

Direct stresses to priority species include cattle trampling mussels and the over-fishing of eels and elvers. Common shiners may suffer from translocation and hybridization. Wood turtles suffer from the direct impacts of illegal collection and poaching. The table below lists habitat stresses on priority species, and conservation actions to alleviate those stresses. For example, 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 bird, fish, mussel, dragonfly/damselfly, and plant species. A map showing several sections of impaired stream on the Reeds Creek, the South Branch, Miller Run and several other small tributaries (as mapped by WVDEP in 2014), along with clusters of SGCN, is on the previous page. Improving water quality in these impaired stream reaches is an important conservation action, especially where priority SGCN are present.

Habitat Stresses and Conservation Actions in Aquatic, Floodplain and Riparian Habitat

Habitat Stress	Conservation Action
Lack of protected floodplain and riparian habitat	Habitat protection and monitoring through land use planning, conservation easements and other programs and activities
Water quality- wastewater, nutrients, stormwater, and effluents	Treatment, regulation and management of wastewater, nutrients, stormwater, and effluents
Loss of instream habitat	Instream and riparian habitat restoration
Aquatic passage barriers	Remove or modify barriers
Loss of riparian vegetation and water quality	Planting and fencing stream buffer zones
Degradation of riparian corridors, decline in aerial insects for bank swallows	Monitor and survey nest colonies, outreach to landowners
Hemlock woolly adelgid	Treat remaining riparian hemlock stands
Acid deposition	Improve pH in streams

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 non-native 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, size, 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 a 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 may select the actions best suited to their specific site conditions, management goals and objectives, from the list below or other sources.

Climate Stresses and Resilience Actions in Aquatic, Floodplain and Riparian Habitat

Climate Stresses	Habitat Resilience Actions
<ul style="list-style-type: none"> • Increased flood frequency and severity, erosion, and sedimentation • Increased surface water temperatures, low-flow events, and water quality degradation • Increased risk of drought and wildfire • Increased competition from non-native invasive species, pests and pathogens 	<ul style="list-style-type: none"> • Restore and maintain the health, diversity, and connectivity of riparian forests • Stabilize eroding streambanks and reconnect stream hydrology to floodplains • Clean and enlarge culverts and stream crossings to accommodate peak flows and aquatic organism passage • Minimize disturbance to riparian forests, promptly revegetate after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species • 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.

Implementation Plan for Aquatic, Floodplain and Riparian Habitats

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> • Conservation Easements 	<ul style="list-style-type: none"> • County Farmland Protection Boards • WV Land Trust • The Nature Conservancy • USDA Natural Resource Conservation Service ACEP 	<ul style="list-style-type: none"> • Acres of aquatic and riparian habitat protected for priority species • Abundance and diversity of priority species and habitats
Habitat Protection: <ul style="list-style-type: none"> • Land Use Planning 	<ul style="list-style-type: none"> • County Planning Commissions 	<ul style="list-style-type: none"> • Acres of habitat protected through land use planning, floodplain, and stormwater regulations
Habitat Protection <ul style="list-style-type: none"> • Incentive Programs 	<ul style="list-style-type: none"> • USDA Farm Service Agency CRP and CREP 	<ul style="list-style-type: none"> • Acres of aquatic and riparian habitat protected for priority species • Abundance and diversity of priority species and habitats

Action	Partners /Programs	Effectiveness Measures
In-stream and riparian habitat restoration, streambank stabilization and floodplain re-connection	<ul style="list-style-type: none"> • USDA NRCS EQIP • USDA FSA CREP • Trout Unlimited • USFWS Partners for Fish and Wildlife • Public Land Managers 	<ul style="list-style-type: none"> • Acres or linear feet of in-stream and riparian habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Planting and fencing stream buffer zones	<ul style="list-style-type: none"> • USDA NRCS EQIP • USDA FSA CREP • Trout Unlimited • USFWS Partners for Fish and Wildlife • WVDOF • WVDEP and WVCA 	<ul style="list-style-type: none"> • Acres or linear feet of stream buffer zones planted and fenced to protect priority species • Before and after comparison: abundance and diversity of priority species
Improved wastewater and stormwater treatment	<ul style="list-style-type: none"> • WVDEP • WVDHHR • County governments 	<ul style="list-style-type: none"> • # wastewater and stormwater systems installed or improved • Change in fecal, sediment and other water quality measurements • Before and after comparison: abundance and diversity of priority species
Clean, enlarge or remove culverts and stream crossings for higher peak flow and aquatic organism passage	<ul style="list-style-type: none"> • Trout Unlimited • USFWS Partners for Fish and Wildlife • Public Land Managers 	<ul style="list-style-type: none"> • # barriers re-designed or removed • # miles stream opened • Before and after comparison: abundance and diversity of priority species
Treat and underplant remaining riparian hemlock stands along headwater streams	<ul style="list-style-type: none"> • Trout Unlimited • USFWS Partners for Fish and Wildlife • U.S. Forest Service • WVDNR 	<ul style="list-style-type: none"> • Acres or linear feet of riparian area treated • Treatment and planting success rate
Improve water quality in streams and wetlands	<ul style="list-style-type: none"> • WVDEP and WVCA • NRCS EQIP & CSP • FSA CRP & CREP 	<ul style="list-style-type: none"> • Change in water quality measurements • Before and after comparison: abundance and diversity of priority species
Improve pH in headwater streams	<ul style="list-style-type: none"> • WVDEP • WVDNR 	<ul style="list-style-type: none"> • Change in water quality measurements • Before and after comparison: abundance and diversity of priority species

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.

Subterranean Habitats

Karst and Cave Habitats

Areas with karst geology and subterranean caves provide unique habitats that may be influenced by human activities, surface land use, and surface and underground hydrology in the surrounding landscape. Caves provide important habitat for bats that move in and out, as well as a diverse group of vertebrate and invertebrate animals that have evolved specialized adaptations to permanent underground living. Common traits exhibited by permanent cave dwellers (troglodites) include blindness (or complete loss of eyes) and reduced pigmentation. The map on the following page illustrates a band of karst geology running north to south along the western edge of the CFA. Karst areas in smaller and more fragmented forest patches may be more vulnerable to stresses. The map on the subsequent page illustrates karst feature density with 3-kilometer buffers offset randomly, and two biologically significant caves with 3-mile random offset buffers. Caves classified by WVDNR as biologically significant may host rare bat or endemic cave species, or exceptional biological diversity. Careful management is required to minimize disturbance on karst and cave habitats and protect priority species.

Priority Species

Caves in this CFA host Virginia Big-eared Bat listed as At Risk by USFWS and a Sensitive Species by USFS Region 8.

Priority Species in Subterranean Habitats

TAXA	SCIENTIFIC NAME	COMMON NAME
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat

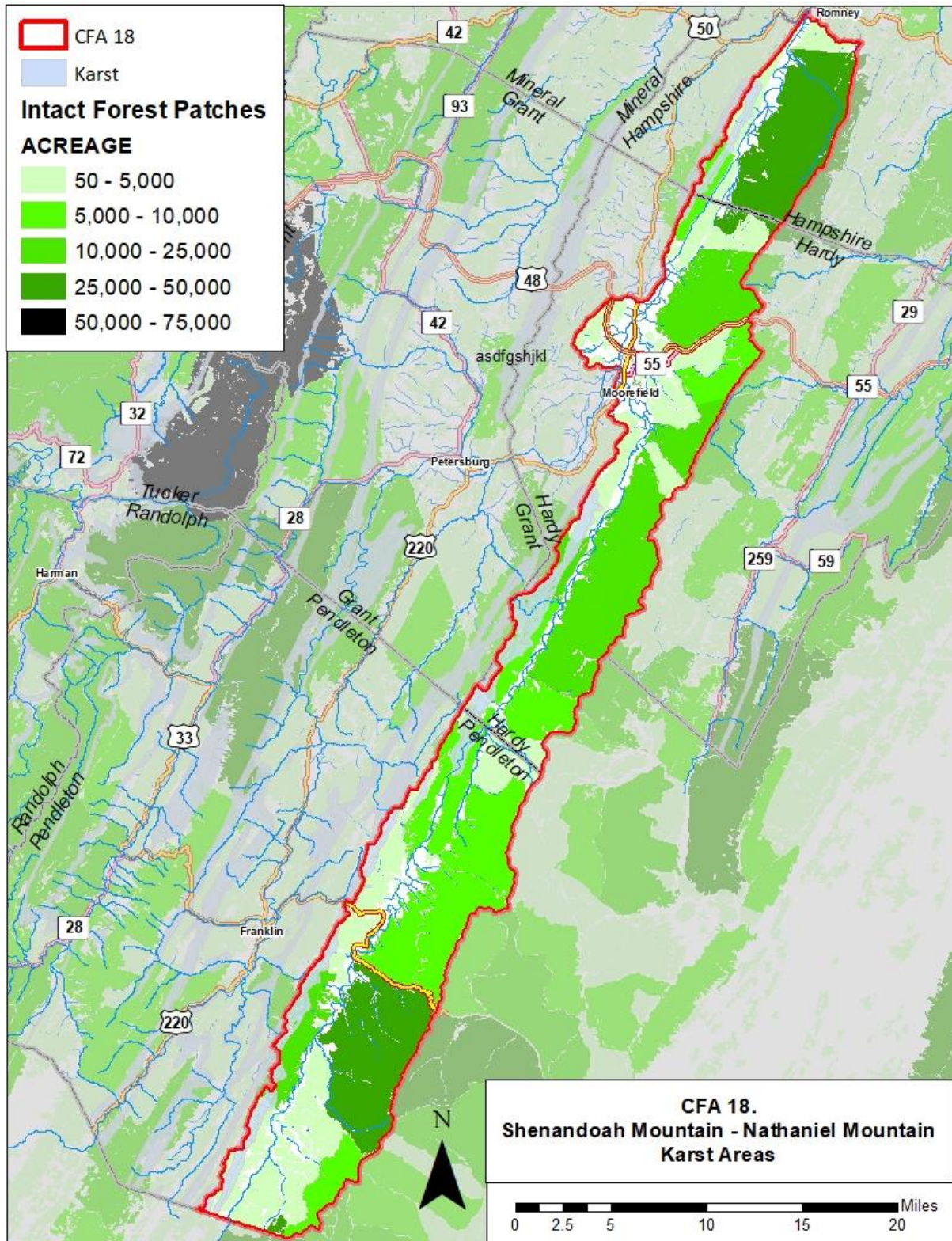
Habitat Stresses and Conservation Actions

Caves and subterranean habitats, particularly in porous karst geology, are closely tied to and impacted by changes to water quality and land use in adjacent areas. The following table lists stresses affecting wildlife in caves and subterranean habitats, and conservation actions landowners and partners can take to address them. In addition, WVDNR is developing cave management plans for all biologically significant caves. The management plans will describe cave ownership, access, bats and other SGCN present, threats, surrounding areas requiring careful management, recommended access restrictions and conservation actions.

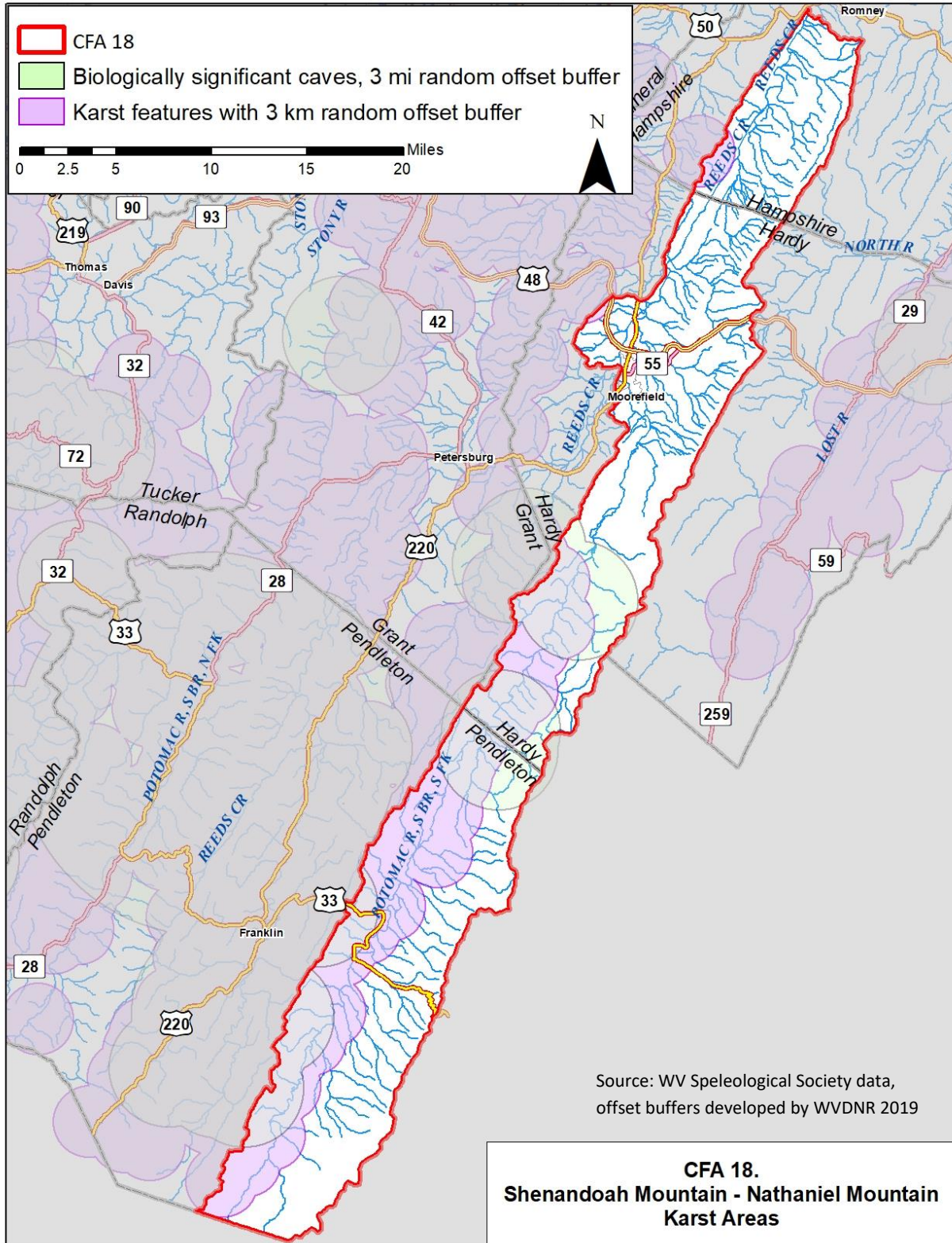
Habitat Stresses and Conservation Actions in Subterranean Habitats

Habitat Stress	Conservation Action
Agriculture, deforestation, disturbance on adjacent land	Protect cave locations and limit when access is allowed

Karst Areas and Intact Forest Patches



Karst and Cave Features



Climate Change and Habitat Resilience

The Central Appalachians Forest Ecosystem Vulnerability Assessment (Butler et. al, 2015), noted that ecosystems that are limited by geological or hydrological features, such as cave and karst habitats, may be restricted from shifting across the landscape in response to climate change. However, cave and karst habitats that are connected more closely with groundwater inputs than surface water may be buffered by the impacts of climate change, and subterranean habitats may be buffered from increasing surface temperatures. But caves and karst areas may be vulnerable to groundwater extraction during droughts as well as changes in surface water flow regimes, nutrient inputs, high flows, and contaminants carried by floods, which may be exacerbated by impervious cover within the watershed (Swanston et. al, 2016). Restoring and maintaining riparian corridors, water quality and natural flow regimes, and limiting impervious cover in areas upstream and above caves and karst may boost the resilience of cave ecosystems. Some cave dwelling species also rely on adjacent forest, riparian and aquatic habitats. Maintaining the resilience of adjacent ecosystems could further buffer cave species from the impacts of climate change.

Below is a summary of climate stresses on cave and karst habitats, and actions to boost their resilience. Although climate stresses are listed separately, subterranean habitats are often impacted by multiple climate stresses occurring simultaneously and actions to boost habitat resilience are intended to address multiple climate stresses. Some of these actions repeat previously listed conservation actions to reduce stress on priority species and could benefit priority species while also boosting habitat resilience.

Climate Stresses and Resilience Actions in Karst and Cave Habitats

Climate Stress:	Habitat Resilience Action:
<ul style="list-style-type: none">• Increased flood frequency and severity, nutrient inputs, and contaminants• Increased surface water temperatures, low-flow events, and ground water withdrawals• Impacts to adjacent forest, riparian and aquatic habitat	<ul style="list-style-type: none">• Restore and protect surface water quality and hydrology• Limit impervious cover• Maintain ground water quality and quantity• Maintain resilient forests, riparian and aquatic habitat around karst and cave ecosystems

Implementation Plan

WVDNR will work with landowners and the following partners and programs to implement and measure the impact of conservation actions around caves and karst habitat.

Implementation Plan for Subterranean Habitats

Action	Partners /Programs	Effectiveness Measures
Land protection around caves and karst habitat: <ul style="list-style-type: none"> • Conservation Easements 	<ul style="list-style-type: none"> • County Farmland Protection Boards • WV Land Trust • The Nature Conservancy • USDA Natural Resource Conservation Service ACEP 	<ul style="list-style-type: none"> • Acres of habitat protected around caves and karst habitat • Abundance and diversity of priority species and habitats
Land use planning around caves and karst habitat	<ul style="list-style-type: none"> • County Planning Commissions 	<ul style="list-style-type: none"> • Acres of cave, karst and buffer habitat protected for public health and safety through land use planning ordinances
Land protection around caves and karst habitat <ul style="list-style-type: none"> • Incentive Programs 	<ul style="list-style-type: none"> • USDA Farm Service Agency CRP and CREP 	<ul style="list-style-type: none"> • Acres of habitat protected • Abundance and diversity of priority species and habitats
Stream buffer fencing and riparian plantings around caves and karst	<ul style="list-style-type: none"> • USDA NRCS EQIP • USDA FSA CREP • Trout Unlimited • USFWS Partners for Fish and Wildlife • WVDOF • WVDEP and WVCA 	<ul style="list-style-type: none"> • Acres or linear feet of stream buffer zones planted and fenced • Before and after comparison: abundance and diversity of priority species
Land management around caves and karst	<ul style="list-style-type: none"> • USDA NRCS EQIP • USDA FSA CREP • Trout Unlimited • USFWS Partners for Fish and Wildlife • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat managed • Before and after comparison: abundance and diversity of priority species
Sinkhole Cleanups, cave research and mapping, protection and landowner outreach	<ul style="list-style-type: none"> • WVACS • WVCC • CCV 	<ul style="list-style-type: none"> • # of cave/karst resources protected or restored • # landowners participating in cave/karst protection and restoration activities
Improved wastewater treatment around caves and karst habitat	<ul style="list-style-type: none"> • WVDEP • WVDHHR 	<ul style="list-style-type: none"> • # systems installed or improved • Change in fecal and other water quality measurements • Before and after comparison: abundance and diversity of priority species

Human Benefits

Actions to restore and protect subterranean habitat may benefit human health and economies in surrounding communities, mainly through the protection of water quality and drinking water sources.

Agricultural and Developed Habitats

Many species of wildlife rely on agricultural lands, especially pastures and woody vegetation in fallow areas, abandoned fields, field borders, wetlands, and riparian corridors. Some species even rely on habitat in more developed lands in residential and urban areas. Most agricultural lands and developed areas are in valley bottoms and floodplains. The map that follows shows the location of agricultural and developed habitats and illustrates that there are many examples of biodiversity occurrences in and around agricultural areas in the CFA. Maintaining pastures, fallow fields, woody vegetation, wetlands, and riparian corridors is a priority for SGCN associated with these agricultural habitats.

Priority Species

Agricultural lands including cultivated crops, pastures and hayfields, along with adjacent areas of natural vegetation in and around adjacent forests and woodlots, hedgerows, fallow areas, ponds, wetlands and streams provide valuable habitat for several priority grassland bird species in the CFA, and Virginia Big-eared Bat. The following is a list of priority SGCN in the CFA associated with agricultural habitats. Developed areas also provide important habitat, most notably for the Chimney Swift and Barn Owl.

Priority Species in Agricultural and Developed Habitats

Taxa	Scientific Name	Common Name
Birds	<i>Chaetura pelagica</i>	Chimney Swift
Birds	<i>Tyto alba</i>	Barn Owl
Birds	<i>Falco sparverius</i>	American Kestrel
Birds	<i>Scolopax minor</i>	American Woodcock
Birds	<i>Sturnella magna</i>	Eastern Meadowlark
Birds	<i>Spizella pusilla</i>	Field Sparrow
Birds	<i>Ammodramus savannarum</i>	Grasshopper Sparrow
Birds	<i>Lanius ludovicianus migrans</i>	Migrant Loggerhead Shrike
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat

Habitat Stresses and Conservation Actions

The conversion of farmland for residential and commercial development reduces valuable habitat for wildlife, especially grassland birds. In addition, modern farming practices have resulted in the intensification of mechanized farming practices and the expansion of areas cleared for agriculture. Consequently, much natural vegetation providing wildlife habitat in grasslands, wetlands, fallow areas, riparian corridors, hedgerows, and forest edges has been cleared. Early haying impacts ground nesting birds. Many SGCN also rely on habitat created by utility corridors, where the cutting of vegetation or herbicide treatment can have direct impacts on native birds and their nests. Rodenticides used to kill pests may also harm Barn Owls and other birds of prey. Insufficient habitat negatively impacts for

nesting American Woodcocks and American Kestrels. The table below lists stresses to wildlife habitat in agricultural and developed areas, and conservation actions to address them.

Habitat Stresses and Conservation Actions in Agricultural and Developed Habitats:

Habitat Stress	Conservation Action
Clean farming practices: loss of woody veg.	Retain or plant shrubs, hedgerows, and hawthorns in pastures
Clean farming practices: grassland conversion	Prevent conversion of grasslands to croplands
Grassland bird nest loss from early haying	Delay hay harvests
Herbicide/veg. management in utility corridors	Reduce disturbance in utility corridors
Insufficient habitat, predation	Reduce clean farming practices, maintain early successional habitat
Insufficient nest microhabitat	Nest box installation and monitoring for barn owls and American kestrels
Barn owl poisoning from rodenticides	Outreach to landowners to reduce rodenticides
Residential development	Land protection, conservation easements
Chimney capping, turnover of older structures	Landowner outreach, uncap chimneys, install towers for chimney swifts

Climate Change and Habitat Resilience

According to Adaptation Resources for Agriculture (Janowiak et. al, 2016), agriculture will likely be impacted by many of the same climate changes that affect forest and freshwater habitats. Likely changes include increasing temperatures, longer growing seasons, increasing number of hot days and nights, and changing precipitation patterns. Impacts include increases in the risk of damage to soil, crops, and infrastructure from extreme storm and precipitation events, flood damage, soil moisture stress and drought, competition from weeds and invasive plants, crop damage from insects and pathogens, and livestock parasites and pathogens. Butler et. al (2015) also noted that impervious surfaces in developed areas can exacerbate many of these impacts.

Many wildlife species associated with agricultural and developed lands rely on grassland and pasture, fallow fields, floodplain and riparian corridors, streams and wetlands, and areas of natural vegetation around field and forest edges. In agricultural settings, these areas may already be degraded and sensitive to disturbance. As we have seen in previous sections of this plan, these areas may also be susceptible to impacts from climate change. Riparian forests may be vulnerable to climate change stressors including increased flood frequency and severity and resulting erosion and sedimentation in streams. Drought may stress streams and aquatic life, as well as plants, and increase their susceptibility

to pests and pathogens. Warming temperatures and increased storm disturbances may enable non-native invasive plant species to outcompete native species.

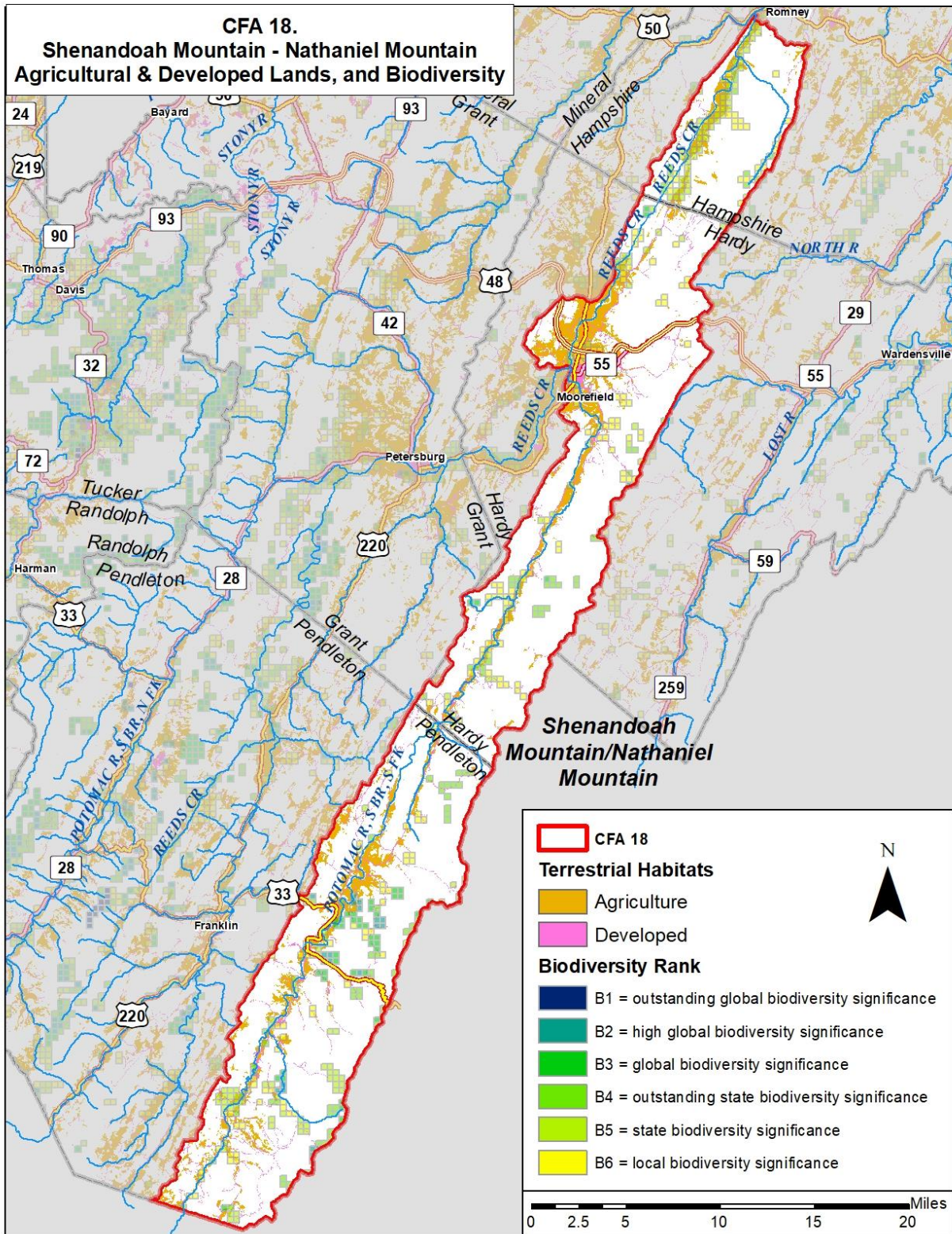
Janowiack et. al (2016) list numerous strategies to boost the resilience of agriculture to climate change, including maintaining soil health and water quality, reducing competition from weeds and invasive species, creating pollinator habitat, adapting farm infrastructure such as stream crossings to higher peak flows, adapting farm practices or shifting agricultural land use to match changing conditions. Managing farms as part of a larger landscape by maintaining, restoring and connecting natural habitats such as streams, wetlands, riparian areas and forest edges can boost the resilience of farms by buffering hydrological impacts while providing habitat and corridors wildlife to persist and adapt to climate change. In developed areas, limiting and buffering impervious surfaces, and using constructed wetlands and other green infrastructure can also reduce the hydrological impacts of climate change.

Below is a summary of climate stresses on wildlife habitat in agricultural and developed areas, 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 also reinforce previously listed 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.

Climate Stresses and Resilience Actions for Agricultural and Developed Habitats

Climate Stress:	Habitat Resilience Action:
<ul style="list-style-type: none"> • Increased flood frequency and severity, erosion, and sedimentation • Increased surface water temperatures, low-flow events, and water quality degradation • Increased risk of drought and wildfire • Increased competition from non-native invasive species, pests, and pathogens 	<ul style="list-style-type: none"> • Maintain soil health and water quality • Reduce competition from weeds and invasive species • Create pollinator habitat • Maintain, restore, and connect aquatic, riparian and forest habitats to buffer against hydrological impacts • Adapt farm practices, infrastructure and land uses to changing conditions • Reduce and buffer impervious surfaces, and use green infrastructure to absorb runoff and mitigate hydrological impacts

Developed & Agricultural Lands, and Biodiversity



Implementation Plan

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

Implementation Plan for agricultural and developed lands.

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> • Conservation Easements 	<ul style="list-style-type: none"> • County Farmland Protection Boards • WV Land Trust • The Nature Conservancy • NRCS ACEP 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Abundance and diversity of priority species and habitats
Habitat Protection: <ul style="list-style-type: none"> • Land use planning 	<ul style="list-style-type: none"> • County Planning Commissions 	<ul style="list-style-type: none"> • Acres of habitat protected through land use planning in agricultural areas
Habitat Protection <ul style="list-style-type: none"> • Incentive Programs 	<ul style="list-style-type: none"> • FSA CRP and CREP 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Abundance and diversity of priority species and habitats
Reduce clearing of native vegetation; Retain or plant hedgerows and areas with native plants	<ul style="list-style-type: none"> • FSA CRP and CREP • NRCS EQIP and CSP • Public Land Managers 	<ul style="list-style-type: none"> • Acres or linear feet of native vegetation planted and protected • 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 in natural areas in and around farmland, and enhance connections between them	<ul style="list-style-type: none"> • FSA CRP and CREP • NRCS EQIP and CSP • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Abundance & distribution of priority species and habitats
Maintain early successional habitat	<ul style="list-style-type: none"> • NRCS EQIP • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat created • Change in abundance, diversity and distribution of priority species and habitats
Prevent conversion of grasslands to croplands	<ul style="list-style-type: none"> • FSA CRP and CREP 	<ul style="list-style-type: none"> • Acres of grasslands planted and protected • Change in abundance, diversity and distribution of priority species and habitats

Action	Partners /Programs	Effectiveness Measures
Delay hay harvest	<ul style="list-style-type: none"> • FSA CRP 	<ul style="list-style-type: none"> • Acres of hay fields under delayed harvest management • Change in abundance, diversity and distribution of priority species and habitats
Manage utility corridors to reduce wildlife impacts (implement BMPs promoted by the Wildlife Habitat Council, NRCS and other organizations)	<ul style="list-style-type: none"> • Landowners, partners and utility companies • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Nest box installation and monitoring	<ul style="list-style-type: none"> • Landowners and volunteer groups 	<ul style="list-style-type: none"> • # nest boxes installed • Change in abundance, diversity and distribution of priority species
Outreach to landowners to reduce rodenticides	<ul style="list-style-type: none"> • Landowners and volunteer groups 	<ul style="list-style-type: none"> • # of landowners engaged • Reduction in use of rodenticides • Change in abundance, diversity and distribution of priority species
Adapt farm practices, infrastructure and land uses to changing conditions	<ul style="list-style-type: none"> • FSA CRP and CREP • NRCS EQIP and CSP • Public Land Managers 	<ul style="list-style-type: none"> • # practices or acres adapted • Change in abundance, diversity and distribution of priority species
Landowner outreach, uncapping chimneys, install swift towers	<ul style="list-style-type: none"> • Landowners and volunteer groups 	<ul style="list-style-type: none"> • # chimneys uncapped • # swift towers installed • Change in abundance, diversity and distribution of chimney swifts

Human Benefits

Actions to restore and protect wildlife habitat within agricultural areas and developed lands may provide benefits for human health and economies in surrounding communities. Benefits may include erosion control and improved water quality, improved hunting, fishing and recreational opportunities, and conservation of native pollinators for crop production.

Landscape Resilience and Connectivity

For this CFA, the SWAP included the following conservation action:

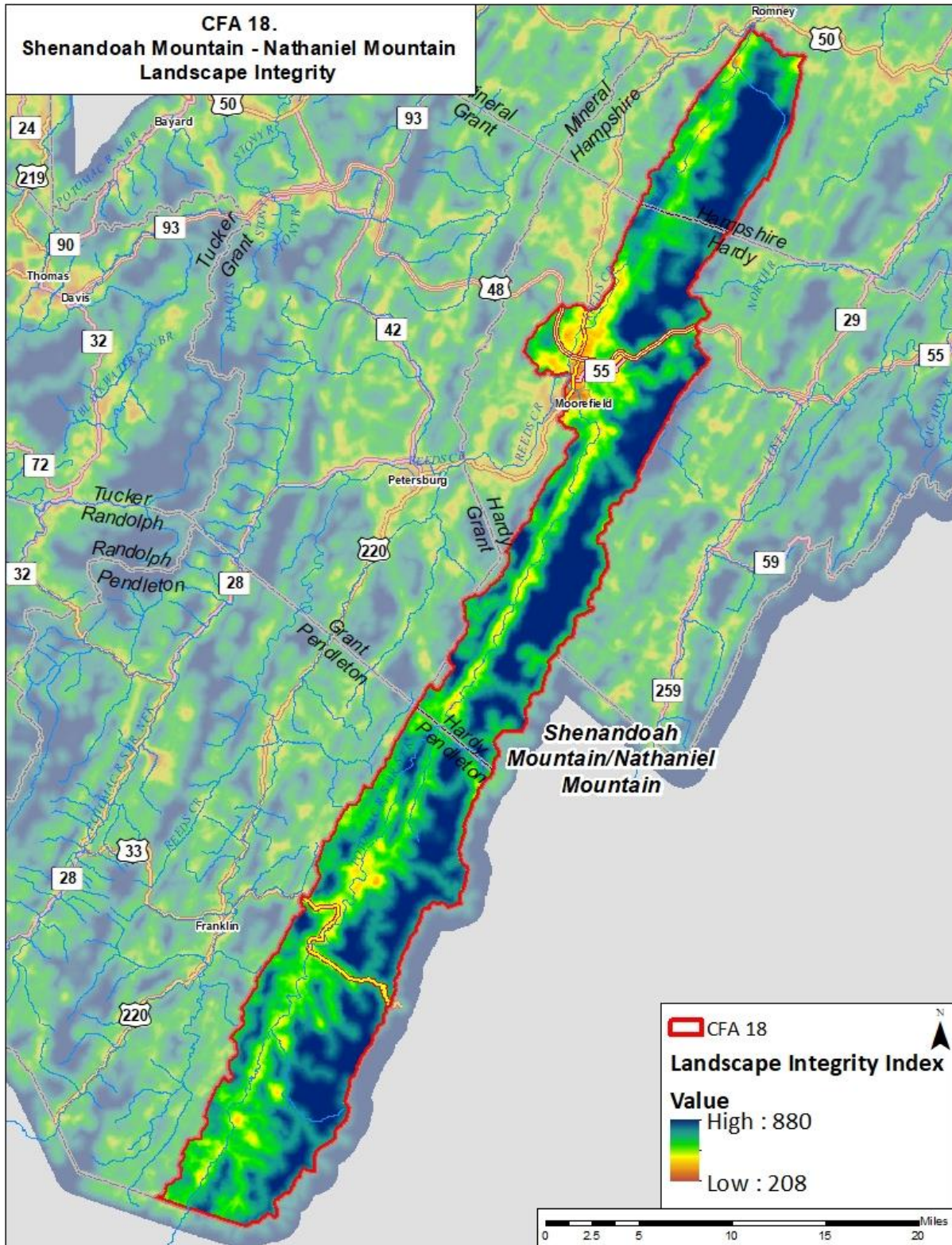
- “Implement a comprehensive plan to enhance climate change resiliency through reducing other stressors, identifying, maintaining and creating key habitat cores and corridors, and protecting areas of high landscape complexity and integrity”.

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 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 and brook trout habitat patches. 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).

But 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 WVDNR developed a model of landscape integrity to identify unfragmented landscapes. The map on the subsequent page illustrates areas of high landscape integrity in the CFA. Landscape integrity is estimated to increase with distance from roads, powerlines, development, and other features that fragment the landscape. These high integrity landscapes tend to correspond to larger forest patches along the eastern side of the CFA. The southern portion corresponds to the George Washington National Forest. The remaining landscapes of high integrity are in private ownership. These areas are important for species movement in response to climate change and are priorities for protection of wildlife habitat.

Landscape Integrity



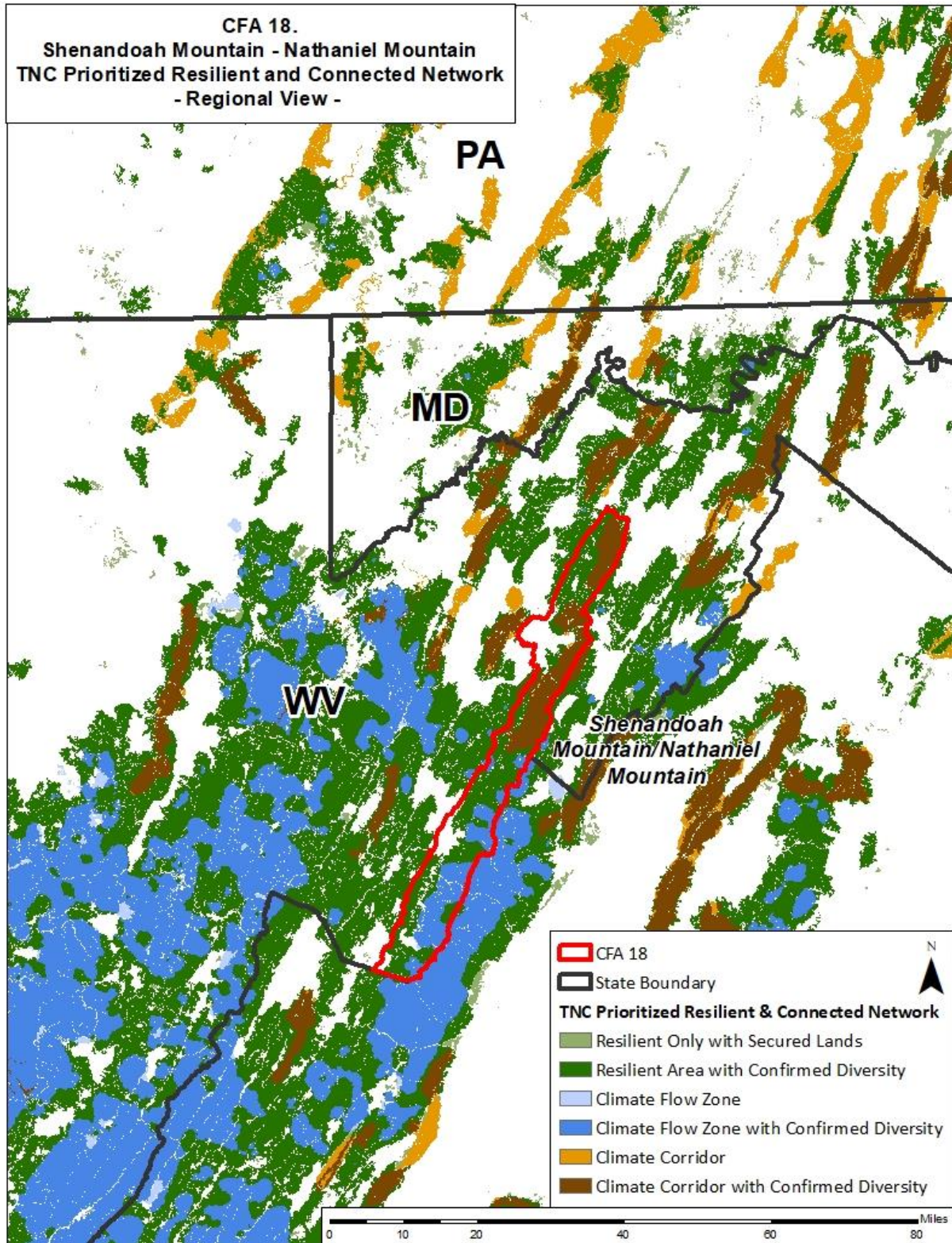
Building on the concept of landscape integrity, The Nature Conservancy (TNC) led a team of 60 scientists to identify areas representing all geophysical settings, with varied microclimates and natural cover, that were most likely to sustain native plants and animals and natural processes into the future 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, and 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 develop 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.

On the following page, the regional map of priority resilient and connected landscapes illustrates that the resilient, connected landscapes of the CFA form a critical bridge between the large forest blocks, resilient landscapes and flow zones to the south and the narrower climate corridors along the ridges and valleys stretching northeast into Pennsylvania. The resilient, connected landscapes in this CFA are critical to the species adapting to climate change within the larger network across the Eastern United States.

Priority Resilient and Connected Network- Regional View



On the next page is a more detailed view of the priority resilient, connected network of landscapes in and around the Shenandoah and Nathaniel Mountain CFA. This CFA is almost entirely within the resilient, connected network; almost the entire CFA is composed of resilient, connected landscapes. In the south end of the CFA there is also a large climate flow zone stretching across the Virginia border and the George Washington National Forest, and further north there are climate corridors around the large hunt clubs on Shenandoah Mountain and along Nathaniel Mountain. These priority resilient and connected landscapes contain the CFA’s large forest patches and high integrity areas, and most of the CFA’s rock outcrop, cliff and talus, and shale barren habitats, cave and karst features, and known biodiversity. Smaller patches of fragmented forest and agricultural areas are not included.

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 in order 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.

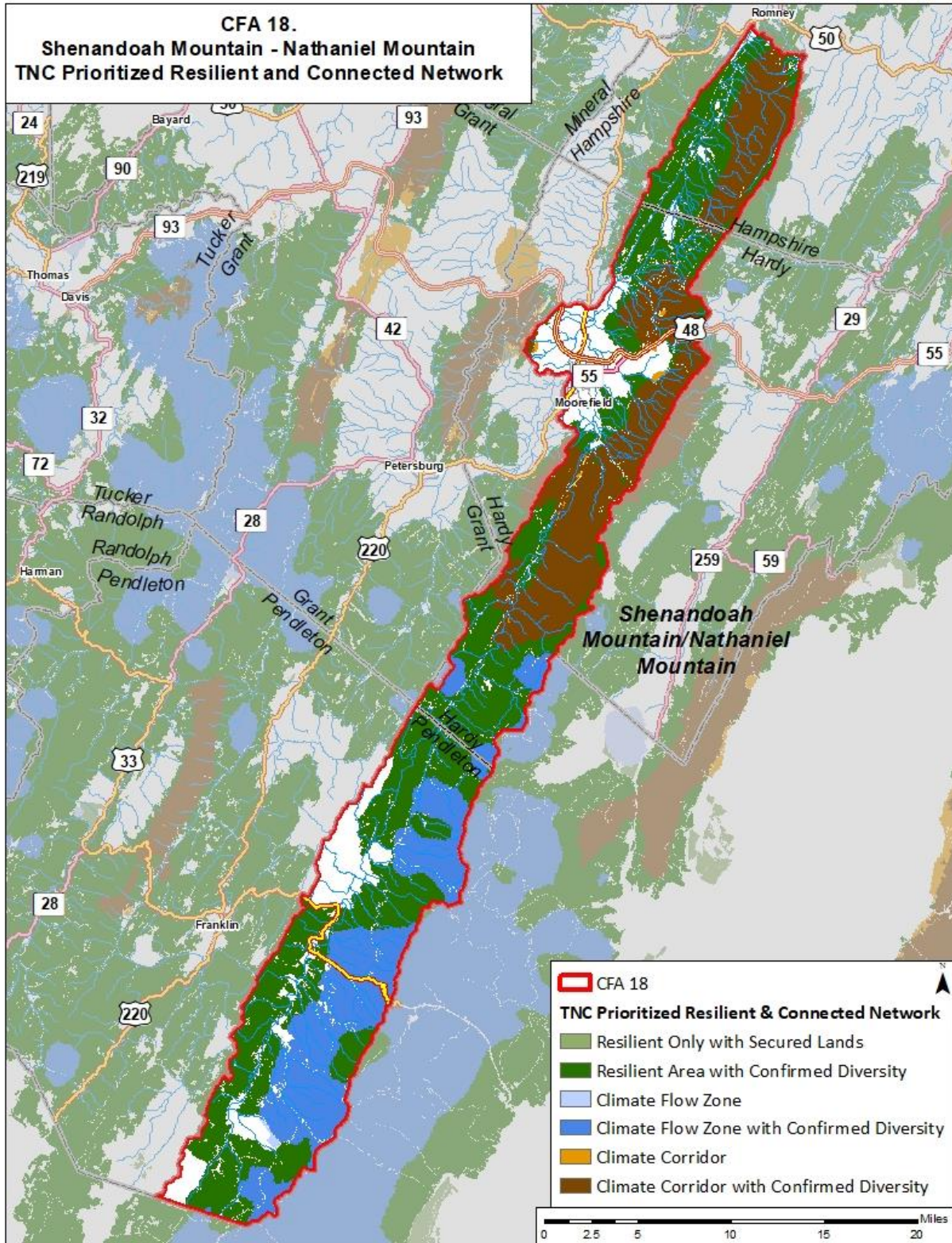
Protecting and maintaining these areas of high landscape integrity and the resilient areas, climate corridors and climate flow zones within the region’s priority resilient and connected network is critical in order to enable priority SGCN and their habitat to adapt to climate change and persist in this 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.

Climate Stresses and Actions for Landscape Resilience and Connectivity

Climate Stress	Conservation Action
<ul style="list-style-type: none"> • Changing conditions exacerbating existing stresses on species and habitat • Species responding to climate change by shifting locally as well as across the landscape • Landscape fragmentation that prevents or constrains species movement 	<ul style="list-style-type: none"> • 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

Priority Resilient and Connected Network- Detailed View



Implementation Plan

The resilient and connected landscapes in this CFA provide critical links to the larger network of resilient and connected landscapes in adjacent landscapes in West Virginia, Maryland, Virginia, and through Eastern North America. These resilient, connected landscapes 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. Customize text and replace info in table below according to partners active in CFA

Implementation plan for Climate Adaptation

Action	Partners /Programs	Effectiveness Measures
Protection of Resilient, Connected Landscapes: <ul style="list-style-type: none"> Conservation Easements 	<ul style="list-style-type: none"> County Farmland Protection Boards WV Land Trust The Nature Conservancy NRCS ACEP 	<ul style="list-style-type: none"> Acres of habitat protected for priority species in resilient landscapes and climate corridors Abundance and diversity of priority species and habitats
Protection of Resilient, Connected Landscapes: <ul style="list-style-type: none"> Land use planning 	<ul style="list-style-type: none"> County Planning Commissions 	<ul style="list-style-type: none"> Acres of habitat protected through land use planning in resilient, connected landscapes
Protection of Resilient, Connected Landscapes: <ul style="list-style-type: none"> Incentive Programs 	<ul style="list-style-type: none"> FSA CRP and CREP 	<ul style="list-style-type: none"> Acres of habitat protected for priority species in resilient landscapes and climate corridors Abundance and diversity of priority species and habitats
Protection of Resilient, Connected Landscapes: <ul style="list-style-type: none"> Conservation and Management 	<ul style="list-style-type: none"> US Forest Service WV Division of Natural Resources Private Landowners Partner Organizations 	<ul style="list-style-type: none"> Acres of habitat protected, restored and maintained in resilient landscapes and climate corridors Abundance & distribution of priority species and habitats

Conclusion

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 within major forests and woodlands; barrens, cliffs and talus; caves and karst; aquatic, riparian and floodplain habitats; and developed and agricultural 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 areas identified for conservation action within each major habitat type.

- Large, intact forest patches, including interior forest habitat
- Early successional forest habitat
- Small areas of unique, geologically derived habitat including:
 - Acidic rock outcrops, cliffs and talus,
 - Calcareous cliffs and talus
 - Shale barrens
- Areas with karst geology and caves, and their watersheds
- Buffer areas surrounding biologically significant caves for bats
- Special aquatic habitats including mussel streams, brook trout habitat patches and wetlands
- Small stream riparian and river floodplain habitats, which provide important habitat and play an important role in maintaining the form and function of streams and rivers
- Riparian corridors, wetlands, fallow fields, field borders and other areas of natural and woody vegetation within and around agricultural lands.

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 plant riparian stream buffers may benefit multiple plant communities and wildlife species. Coordinating actions across multiple habitats or priority areas, such as protecting large patches of diverse forest habitats that also include rare shale barrens, rock outcrops or cliff and talus habitats, or improving water

quality and planting riparian corridors in karst and cave watersheds, may benefit even more species. Private landowners, public land managers and conservation partners are encouraged to focus resources across habitats within areas targeted for action in ways 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. Maintaining and 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 move and adapt to changing conditions.

Furthermore, creating local networks of connected habitat cores and corridors within this CFA will enhance their resilience and connectivity, and the ability of wildlife species to adapt to changing conditions. 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 large patches of diverse forest habitat that also include rare shale barrens, rock outcrops, cliff and talus, karst or cave habitat buffers and enhances the resilience of these habitats and enables forest species to move to optimal sites as conditions change. These corridors of aquatic, riparian and floodplain habitat, along with areas of woody 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. Beyond undertaking conservation actions in the local priority areas listed above, and even beyond protecting the regional network of climate connectors and flow zones, stakeholders are encouraged to work to restore and protect the connections between these areas in order to maintain an interwoven fabric of natural systems for wildlife within to thrive within this CFA long into the future.

Next Steps in Implementation

WVDNR engaged partner organizations and public land managers in developing this Action Plan and will seek to remain engaged by convening semi-annual meetings with partners to promote continued collaboration. This work will include:

- 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; and
- 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 Shenandoah Mountain/Nathaniel Mountain CFA

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Amphibians	Ambystoma jeffersonianum	Jefferson Salamander	S2	G4
Amphibians	Ambystoma opacum	Marbled Salamander	S4	G5
Amphibians	Desmognathus fuscus	Northern Dusky Salamander	S5	G5
Amphibians	Desmognathus monticola	Seal Salamander	S5	G5
Amphibians	Desmognathus ochrophaeus	Allegheny Mountain Dusky Salamander	S4	G5
Amphibians	Eurycea bislineata	Northern Two-lined Salamander	S5	G5
Amphibians	Eurycea longicauda	Longtail Salamander	S5	G5
Amphibians	Gyrinophilus porphyriticus porphyriticus	Northern Spring Salamander	S5	G5T5
Amphibians	Plethodon glutinosus	Slimy Salamander	S5	G5
Amphibians	Plethodon hoffmani	Valley And Ridge Salamander	S4	G5
Amphibians	Plethodon punctatus	Cow Knob (White Spotted) Salamander	S2	G3
Amphibians	Plethodon wehrlei	Wehrle's Salamander	S4	G4
Amphibians	Plethodon virginia	Shenandoah Mountain Salamander	S2	G2G3Q
Amphibians	Plethodon cylindraceus	White-spotted Slimy Salamander	S5	G5
Amphibians	Pseudotriton ruber ruber	(northern) Red Salamander	S3	G5
Amphibians	Anaxyrus fowleri	Fowler's Toad	S5	G5
Amphibians	Pseudacris feriarum	Upland Chorus Frog	S3	G5
Amphibians	Lithobates pipiens (R. pipiens)	Northern Leopard Frog	S1	G5
Birds	Butorides virescens	Green Heron	S3B	G5
Birds	Lophodytes cucullatus	Hooded Merganser	S1B,S4N	G5
Birds	Mergus merganser	Common Merganser	S3B,S3N	G5
Birds	Pandion haliaetus	Osprey	S2B	G5
Birds	Haliaeetus leucocephalus	Bald Eagle	S3B,S3N	G5
Birds	Buteo platypterus	Broad-winged Hawk	S3B	G5
Birds	Falco sparverius	American Kestrel	S3B	G5
Birds	Bonasa umbellus	Ruffed Grouse	S3B,S3N	G5
Birds	Scolopax minor	American Woodcock	S3B	G5

Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	S2B	G5
Birds	<i>Tyto alba</i>	Barn Owl	S2B,S2N	G5
Birds	<i>Anrostomus vociferus</i>	Eastern Whip-poor-will	S3B	G5
Birds	<i>Chaetura pelagica</i>	Chimney Swift	S3B	G5
Birds	<i>Melanerpes erythrocephalus</i>	Red-headed Woodpecker	S3B,S3N	G5
Birds	<i>Riparia riparia</i>	Bank Swallow	S2B	G5
Birds	<i>Hylocichla mustelina</i>	Wood Thrush	S3B	G5
Birds	<i>Lanius ludovicianus migrans</i>	Migrant Loggerhead Shrike	S1B,S1N	G4T3Q
Birds	<i>Vermivora cyanoptera</i>	Blue-winged Warbler	S3B	G5
Birds	<i>Setophaga caerulea</i>	Black-throated Blue Warbler	S3B	G5
Birds	<i>Setophaga fusca</i>	Blackburnian Warbler	S3B	G5
Birds	<i>Setophaga discolor</i>	Prairie Warbler	S3B	G5
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler	S2B	G4
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler	S3B	G5
Birds	<i>Parkesia motacilla</i>	Louisiana Waterthrush	S3B	G5
Birds	<i>Geothlypis formosa</i>	Kentucky Warbler	S3B	G5
Birds	<i>Spizella pusilla</i>	Field Sparrow	S3B	G5
Birds	<i>Ammodramus savannarum</i>	Grasshopper Sparrow	S3B	G5
Birds	<i>Sturnella magna</i>	Eastern Meadowlark	S3B, S2N	G5
Birds	<i>Loxia curvirostra</i>	Red Crossbill	S2B,S2N	G5
Fish	<i>Anguilla rostrata</i>	American Eel	S2	G4
Fish	<i>Notropis amoenus</i>	Comely Shiner	S3	G5
Fish	<i>Luxilus cornutus</i>	Common Shiner	S1S2	G5
Fish	<i>Erimyzon oblongus</i>	Creek Chubsucker	S3	G5
Fish	<i>Ameiurus nebulosus</i>	Brown Bullhead	S2	G5
Fish	<i>Fundulus diaphanus</i>	Banded Killifish	S2	G5
Fish	<i>Etheostoma olmstedi</i>	Tessellated Darter	S1S2	G5
Mammals	<i>Sorex hoyi winnemana</i>	Southern Pygmy Shrew	S2S3	G5T4
Mammals	<i>Myotis sodalis</i>	Indiana Bat	S1	G2
Mammals	<i>Myotis leibii</i>	Eastern Small-footed Bat	S1	G3
Mammals	<i>Myotis septentrionalis</i>	Northern Myotis	S2*	G2G3

Mammals	<i>Lasionycteris noctivagans</i>	Silver-haired Bat	S2	G5
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat	S2	G4T2
Mammals	<i>Neotoma magister</i>	Allegheny Woodrat	S3	G3G4
Mammals	<i>Synaptomys cooperi</i>	Southern Bog Lemming	S3	G5
Mammals	<i>Zapus hudsonius</i>	Meadow Jumping Mouse	S3	G5
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk	S1	G5
Reptiles	<i>Glyptemys insculpta</i>	Wood Turtle	S3	G4
Reptiles	<i>Pseudemys rubriventris</i>	Northern Red-bellied Cooter	S2	G5
Reptiles	<i>Terrapene carolina carolina</i>	Eastern Box Turtle	S5	G5T5
Reptiles	<i>Scincella lateralis</i>	Little Brown Skink	S2	G5
Reptiles	<i>Carphophis amoenus</i>	Wormsnake	S3	G5
Reptiles	<i>Coluber constrictor constrictor</i>	Northern Black Racer	SNR	G5T5
Reptiles	<i>Diadophis punctatus edwardsii</i>	Northern Ring-necked Snake	S5	G5T5
Reptiles	<i>Heterodon platirhinos</i>	Eastern Hog-nosed Snake	S2	G5
Reptiles	<i>Virginia valeriae valeriae</i>	Eastern Earthsnake	S2	G5T5
Reptiles	<i>Liochlorophis vernalis</i>	Smooth Greensnake	S5	G5
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake	S3	G4
Tiger Beetles	<i>Cicindela unipunctata</i>	A Tiger Beetle	S3	G4G5
Butterflies and Moths	<i>Pyrgus (centaureae) wyandot</i>	Grizzled Skipper	S1	G1G2Q
Butterflies and Moths	<i>Hesperia metea</i>	Cobweb Skipper	S2S3	G4G5
Butterflies and Moths	<i>Euphyes bimacula</i>	Two-spotted Skipper	S1	G4
Butterflies and Moths	<i>Euchloe olympia</i>	Olympia Marble	S2S3	G4G5
Butterflies and Moths	<i>Satyrium edwardsii</i>	Edwards' Hairstreak	S2	G4
Butterflies and Moths	<i>Satyrium caryaevorus</i>	Hickory Hairstreak	S2	G4
Butterflies and Moths	<i>Satyrium favonius ontario</i>	Northern Hairstreak	S1S2	G4T4
Butterflies and Moths	<i>Celastrina neglectamajor</i>	Appalachian Azure	SNR	G4
Butterflies and Moths	<i>Celastrina lucia</i>	Northern Spring Azure	SNR	G5
Butterflies and Moths	<i>Glaucoopsyche l. lygdamus</i>	Silvery Blue	S4	G5T3T4
Butterflies and Moths	<i>Speyeria atlantis</i>	Atlantis Fritillary	S3	G5
Butterflies and Moths	<i>Phyciodes cocyta diminutor</i>	Summer Crescent	SNR	GNR
Butterflies and Moths	<i>Phyciodes cocyta selene</i>	Northern Crescent	S2	G5

Butterflies and Moths	<i>Euphydryas phaeton</i>	Baltimore Checkerspot	S3S4	G4
Butterflies and Moths	<i>Polygonia progne</i>	Gray Comma	S3	G4G5
Butterflies and Moths	<i>Euchlaena milnei</i>	Milne's Euchlaena Moth	S2	G2G4
Butterflies and Moths	<i>Zale calycanthata</i>	Double-banded Zale	SU	G4
Butterflies and Moths	<i>Catocala herodias gerhardi</i>	Pine Barrens Underwing	SU	G3T3
Butterflies and Moths	<i>Acronicta dolli</i>	Doll's Merolonche	SH	G3G4
Butterflies and Moths	<i>Brachionycha borealis</i>	Boreal Fan Moth	S1	G4
Dragonflies and Damselflies	<i>Cordulegaster erronea</i>	Tiger Spiketail	S2	G4
Dragonflies and Damselflies	<i>Gomphus viridifrons</i>	Green-faced Clubtail	S3	G3G4
Dragonflies and Damselflies	<i>Macromia illinoiensis</i>	Illinois River Cruiser	S3	G5
Dragonflies and Damselflies	<i>Calopteryx angustipennis</i>	Appalachian Jewelwing	S3	G4
Mussels	<i>Alasmidonta undulata</i>	Triangle Floater	S1	G4
Mussels	<i>Alasmidonta varicosa</i>	Brook Floater	S2	G3
Mussels	<i>Elliptio complanata</i>	Eastern Elliptio	S2	G5
Mussels	<i>Lampsilis cariosa</i>	Yellow Lampmussel	S2	G3G4
Mussels	<i>Lasmigona subviridis</i>	Green Floater	S2	G3
Mussels	<i>Strophitus undulatus</i>	Squawfoot	S3	G5
Snails	<i>Hendersonia occulta</i>	Cherrystone Drop	S3	G4
Snails	<i>Vallonia excentrica</i>	Iroquois Vallonia	S3	G5
Snails	<i>Vallonia perspectiva</i>	Thin-lip Vallonia	S3	G4G5
Snails	<i>Punctum vitreum</i>	Glass Spot	S2	G5
Snails	<i>Glyphyalinia cumberlandiana</i>	Hill Glyph	S3	G4
Snails	<i>Ventridens arcellus</i>	Golden Dome	S3	G4
Snails	<i>Ventridens collisella</i>	Sculptured Dome	S3	G4G5
Snails	<i>Ventridens suppressus</i>	Flat Dome	S3	G5
Snails	<i>Ventridens virginicus</i>	Split-tooth Dome	S3	G4
Snails	<i>Euchemotrema leai</i>	Lowland Pillsnail	S3	G5
Snails	<i>Mesodon clausus</i>	Yellow Globelet	S2	G5
Snails	<i>Triodopsis tennesseensis</i>	Budded Threetooth	S3	G4
Snails	<i>Anguispira clarki</i>	Elfin Tigersnail	S1	GNR
Snails	<i>Triodopsis tennesseensis</i>	Budded Threetooth	S3	G4

Snails	<i>Triodopsis vulgata</i>	Dished Threetooth	S2	G5
Snails	<i>Vallonia excentrica</i>	Iroquois Vallonia	S3	G5
Snails	<i>Vallonia perspectiva</i>	Thin-lip Vallonia	S3	G4G5
Snails	<i>Ventridens coelaxis</i>	Bidentate Dome	S1	G3
Snails	<i>Ventridens suppressus</i>	Flat Dome	S3	G5
Snails	<i>Ventridens virginicus</i>	Split-tooth Dome	S3	G4
Plants	<i>Taenidia montana</i>	Mountain-pimpernel	S3	G3
Plants	<i>Helianthus laevigatus</i>	Smooth Sunflower	S2	G4
Plants	<i>Packera antennariifolia</i>	Shalebarren Ragwort	S3	G4
Plants	<i>Packera plattensis</i>	Prairie Ragwort	S1	G5
Plants	<i>Solidago arguta</i> var. <i>harrisii</i>	Shalebarren Goldenrod	S3	G5T4
Plants	<i>Symphotrichum laeve</i> var. <i>concinnum</i>	Smooth Blue American-aster	S2	G5T4
Plants	<i>Betula papyrifera</i>	Paper Birch	S2	G5
Plants	<i>Arabis serotina</i>	Shalebarren Rockcress	S2	G2
Plants	<i>Campanula rotundifolia</i>	Bluebell Bellflower	S3	G5
Plants	<i>Paronychia argyrocoma</i>	Silvery Nailwort	S3	G4
Plants	<i>Paronychia virginica</i>	Yellow Nailwort	S2	G4
Plants	<i>Lechea tenuifolia</i>	Narrowleaf Pinweed	S1	G5
Plants	<i>Calystegia spithamea</i> ssp. <i>purshiana</i>	Shale Bindweed	S3	G4G5T4
Plants	<i>Symphoricarpos albus</i> var. <i>albus</i>	Snowberry	S2	G5T5
Plants	<i>Viburnum rafinesquianum</i>	Downy Arrow-wood	S2	G5
Plants	<i>Drosera rotundifolia</i> var. <i>rotundifolia</i>	Roundleaf Sundew	S3	G5T5
Plants	<i>Pieris floribunda</i>	Mountain Fetterbush	S3	G4
Plants	<i>Lupinus perennis</i> ssp. <i>perennis</i>	Wild Lupine, Sundial Lupine	S1	G5T4?
Plants	<i>Trifolium virginicum</i>	Kate's Mountain Clover	S3	G3
Plants	<i>Trichostema setaceum</i>	Narrowleaf Bluecurls	S2	G5
Plants	<i>Linum lewisii</i> var. <i>lewisii</i>	Prairie Flax	S2	G4G5T4T5
Plants	<i>Utricularia gibba</i>	Humped Bladderwort	S2	G5
Plants	<i>Oenothera argillicola</i>	Shalebarren Evening-primrose	S3	G3G4
Plants	<i>Eriogonum allenii</i>	Shalebarren Wild Buckwheat	S2	G4
Plants	<i>Talinum teretifolium</i>	Eastern Fameflower	S1	G4

Plants	<i>Clematis albicoma</i>	White-hair Leatherflower	S3	G4
Plants	<i>Clematis occidentalis</i> var. <i>occidentalis</i>	Purple Virgin's Bower	S2	G5T5
Plants	<i>Delphinium exaltatum</i>	Tall Larkspur	S2	G3
Plants	<i>Ranunculus macounii</i>	Macoun's Buttercup	S1	G5
Plants	<i>Ranunculus pusillus</i> var. <i>pusillus</i>	Low Spearwort	S1	G5T4?
Plants	<i>Ranunculus sceleratus</i> var. <i>sceleratus</i>	Cursed Crowfoot	S2	G5T5
Plants	<i>Thalictrum clavatum</i>	Mountain Meadowrue	S2	G4
Plants	<i>Rhamnus lanceolata</i> ssp. <i>lanceolata</i>	Lance-leaved Buckthorn	S1	G5T4T5
Plants	<i>Prunus alleghaniensis</i> var. <i>alleghaniensis</i>	Allegheny Plum	S3	G4T4
Plants	<i>Sibbaldiopsis tridentata</i>	Mountain-cinquefoil	S2	G5
Plants	<i>Heuchera americana</i> var. <i>hispida</i>	Rough Alumroot, Rough Heuchera	S2	G5T3?
Plants	<i>Heuchera alba</i>	White Alumroot	S2	G2Q
Plants	<i>Veronica scutellata</i>	Grassleaf Speedwell	S2	G5
Plants	<i>Viola tripartita</i>	Three-parted Yellow Violet	S1	G5
Plants	<i>Thuja occidentalis</i>	Northern White-cedar	S2	G5
Plants	<i>Pinus resinosa</i>	Red Pine	S1	G5
Plants	<i>Commelina erecta</i>	Slender Dayflower	S2	G5T5
Plants	<i>Carex aestivalis</i>	Summer Sedge	S3	G4
Plants	<i>Carex comosa</i>	Longhair Sedge	S2	G5
Plants	<i>Carex emoryi</i>	Emory's Sedge	S2	G5
Plants	<i>Carex pellita</i>	Woolly Sedge	S2	G5
Plants	<i>Carex nigromarginata</i>	Black-edge Sedge	S3	G5
Plants	<i>Carex appalachica</i>	Appalachian Sedge	S3	G4
Plants	<i>Carex molestiformis</i>	Frightful Sedge	S2	G4
Plants	<i>Trichophorum planifolium</i>	Bashful Bulrush	S1	G4G5
Plants	<i>Juncus dichotomus</i>	Forked Rush	S1	G5
Plants	<i>Stenanthium gramineum</i> var. <i>gramineum</i>	Featherbells	S2S3	G4G5T3T5
Plants	<i>Trillium nivale</i>	Snowy Trillium	S2	G4
Plants	<i>Trillium pusillum</i> var. <i>virginianum</i>	Dwarf Wakerobin	S1	G3T2
Plants	<i>Xerophyllum asphodeloides</i>	Eastern Turkeybeard	S1	G4
Plants	<i>Coeloglossum viride</i> var. <i>virescens</i>	Long-bracted Green Orchid, Satyr Orchid	S1	G5T5

Plants	<i>Hexalectris spicata</i> var. <i>spicata</i>	Spiked Crested Coralroot	S1	G5T4T5
Plants	<i>Bouteloua curtipendula</i> var. <i>curtipendula</i>	Sideoats Grama	S3	G5T5
Plants	<i>Calamagrostis porteri</i> ssp. <i>porteri</i>	Reedgrass	S3	G4T4
Plants	<i>Dichanthelium acuminatum</i> ssp. <i>acuminatum</i>	Hairy Panicgrass	S1	G5T5
Plants	<i>Glyceria acutiflora</i>	Creeping Mannagrass	S2	G5
Plants	<i>Piptatherum racemosum</i>	Black-seed Mountain Ricegrass	S2	G5
Plants	<i>Panicum flexile</i>	Wiry Panicgrass	S1	G5
Plants	<i>Potamogeton illinoensis</i>	Illinois Pondweed	S2	G5
Plants	<i>Cheilanthes eatonii</i>	Chestnut Lipfern	S2	G5?
Plants	<i>Asplenium septentrionale</i>	Forked Spleenwort	S2	G4G5
Plants	<i>Gymnocarpium appalachianum</i>	Appalachian Oak Fern	S2	G3
Plants	<i>Woodsia appalachiana</i>	Allegheny Cliff Fern	S2	G4
Plants	<i>Woodsia ilvensis</i>	Rusty Cliff Fern	S2	G5
Plants	<i>Ophioglossum engelmannii</i>	Limestone Adder's-tongue	S1	G5

Appendix 2. Priority SGCN, Known Stresses and Actions

Agricultural Habitat		
COMMON_NAME	Local Stress	Action
American Kestrel	<ul style="list-style-type: none"> • Insufficient nest microhabitat • Residential development 	<ul style="list-style-type: none"> • Nest box installation and monitoring
American Woodcock	<ul style="list-style-type: none"> • Insufficient habitat 	<ul style="list-style-type: none"> • Reduce clean farming practices • Create early successional habitat
Barn Owl	<ul style="list-style-type: none"> • Insufficient nest microhabitat • Clean farming practices • Poisoning 	<ul style="list-style-type: none"> • Install and monitor nest boxes • Outreach to landowners to reduce rodenticide use
Migrant Loggerhead Shrike	<ul style="list-style-type: none"> • Clean farming practices 	<ul style="list-style-type: none"> • Retain or plant hawthorns in pastures • Retain or plant hedgerows
Field Sparrow	<ul style="list-style-type: none"> • Clean farming practices • Residential development 	<ul style="list-style-type: none"> • Retain or plant shrubs in fields • Retain or plant hedgerows
Grasshopper Sparrow	<ul style="list-style-type: none"> • Clean farming practices • Nest loss from early haying 	<ul style="list-style-type: none"> • Delay hay harvest until July 15 • Prevent conversion of grasslands to croplands
Eastern Meadowlark	<ul style="list-style-type: none"> • Clean farming practices • Nest loss from early haying 	<ul style="list-style-type: none"> • Delay hay harvest until July 15 • Prevent conversion of grasslands to croplands
Virginia Big-eared Bat	<ul style="list-style-type: none"> • Agricultural activities • Deforestation around caves • Disturbance on adjacent land 	<ul style="list-style-type: none"> • Protect cave locations • Limit public access to caves
Developed Lands		
COMMON_NAME	Local Stress	Action
Barn Owl	<ul style="list-style-type: none"> • Insufficient nest microhabitat • Clean farming practices, • Poisoning 	<ul style="list-style-type: none"> • Install and monitor nest boxes • Outreach to landowners to reduce rodenticide use
Chimney Swift	<ul style="list-style-type: none"> • Chimney capping, • Turnover of older structures 	<ul style="list-style-type: none"> • Landowner outreach and education • Uncap chimneys, • Install swift towers

Caves and Karst		
COMMON_NAME	Local Stress	Action
Virginia Big-eared Bat	<ul style="list-style-type: none"> • Agricultural activities • Deforestation around caves • Disturbance on adjacent land 	<ul style="list-style-type: none"> • Protect cave locations • Limit public access to caves
Acidic Rock Outcrops, Cliffs, and Talus		
COMMON_NAME	Local Stress	Action
Eastern Spotted Skunk	<ul style="list-style-type: none"> • Fire Suppression • Lack of disturbance in forest succession • Predation 	<ul style="list-style-type: none"> • Forest and fire management to increase vegetative cover and generate early successional habitat
Heath Grass and Shale Barrens		
COMMON_NAME	Local Stress	Action
Double-banded Zale	<ul style="list-style-type: none"> • Legacy of gypsy moth control 	<ul style="list-style-type: none"> • Avoid spraying preferred habitat • Survey for extant populations
Pine Barrens Underwing	<ul style="list-style-type: none"> • Legacy of gypsy moth control 	<ul style="list-style-type: none"> • Avoid spraying preferred habitat • Survey for extant populations
Shale barren Rockcress	<ul style="list-style-type: none"> • Encroaching forest 	<ul style="list-style-type: none"> • Examine the potential use of controlled fire to maintain the barren habitat
Timber Rattlesnake	<ul style="list-style-type: none"> • Loss of basking, gestation, or denning habitat 	<ul style="list-style-type: none"> • Create canopy gaps over gestation and basking sites • Develop den avoidance guidance.
Forests and Woodlands		
COMMON_NAME	Local Stress	Action
Black-billed Cuckoo	<ul style="list-style-type: none"> • Insufficient habitat • Pesticide exposure 	<ul style="list-style-type: none"> • Create early successional habitat, • Reduce aerial application of pesticides
Broad-winged Hawk	<ul style="list-style-type: none"> • Unsuitable forest structure 	<ul style="list-style-type: none"> • Forest management for gaps
Cerulean Warbler	<ul style="list-style-type: none"> • Unsuitable forest structure 	<ul style="list-style-type: none"> • Manage forests to create suitable habitat as per CERW guidelines
Cow Knob (White spotted) Salamander	<ul style="list-style-type: none"> • Climate change • Land alteration (timber cutting, fire) 	<ul style="list-style-type: none"> • Limit timber harvest and pesticide use • Restore forest cover, especially over rocky habitat
Double-banded Zale	<ul style="list-style-type: none"> • Legacy of gypsy moth spraying 	<ul style="list-style-type: none"> • Work with partners to avoid spraying habitat • Survey for extant populations
Dwarf Wakerobin	<ul style="list-style-type: none"> • Non-native invasive plants 	<ul style="list-style-type: none"> • Treat and control
Eastern Fameflower	<ul style="list-style-type: none"> • Non-native invasive plants 	<ul style="list-style-type: none"> • Treat and control
Eastern Spotted Skunk	<ul style="list-style-type: none"> • Fire Suppression • Lack of disturbance in forest succession • Predation 	<ul style="list-style-type: none"> • Forest and fire management to increase vegetative cover and generate early successional habitat.

COMMON_NAME	Local Stress	Action
Eastern Turkeybeard	<ul style="list-style-type: none"> • Lack of fire 	<ul style="list-style-type: none"> • Use prescribed fire in adjacent habitat
Kentucky Warbler	<ul style="list-style-type: none"> • Deer overbrowsing • Poor forest structure 	<ul style="list-style-type: none"> • Reduce deer population • Manage forests for structural and spatial complexity
Prairie Ragwort	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of non-native plants by limiting ground disturbance and by creating weed free buffers • Treat non-native invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Prairie Warbler	<ul style="list-style-type: none"> • Forest maturation • Herbicide use and vegetation management in utility corridors 	<ul style="list-style-type: none"> • Manage forests to create early successional habitat • Develop BMP's for right of way corridor management
Ruffed Grouse	<ul style="list-style-type: none"> • Insufficient habitat • West Nile Virus 	<ul style="list-style-type: none"> • Create early successional habitat through forest management
Shale barren Rockcress	<ul style="list-style-type: none"> • Forest encroachment 	<ul style="list-style-type: none"> • Use controlled fire to maintain barren habitat
Shenandoah Mountain Salamander	<ul style="list-style-type: none"> • Climate change 	<ul style="list-style-type: none"> • Limit timber harvest and pesticide use • Restore forest and ground cover, especially over rocky habitat
Timber Rattlesnake	<ul style="list-style-type: none"> • Loss of basking/ gestation/ denning habitat; 	<ul style="list-style-type: none"> • Create canopy gaps over gestation and basking sites • Develop den avoidance guidance.
Virginia Big-eared Bat	<ul style="list-style-type: none"> • Agricultural activities • Deforestation around caves • Disturbance on adjacent land 	<ul style="list-style-type: none"> • Protect cave locations • Limit when cave access is allowed
Wood Thrush	<ul style="list-style-type: none"> • Deer overbrowsing • Unsuitable forest structure 	<ul style="list-style-type: none"> • Reduce deer population • Manage forests for structural and spatial complexity
Worm-eating Warbler	<ul style="list-style-type: none"> • Deer overbrowsing • Unsuitable forest structure 	<ul style="list-style-type: none"> • Reduce deer population • Manage forests for structural and spatial complexity

Streams and Floodplains		
COMMON_NAME	Local Stress	Action
American Eel	<ul style="list-style-type: none"> Fish passage barriers 	<ul style="list-style-type: none"> Remove barriers Install Eel ladders
Appalachian Jewelwing	<ul style="list-style-type: none"> Loss of riparian vegetation and water quality 	<ul style="list-style-type: none"> Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks
Bank Swallow	<ul style="list-style-type: none"> Degradation of riparian corridors Decline in aerial insects 	<ul style="list-style-type: none"> Monitor and survey nest colonies, outreach to landowners
Common Shiner	<ul style="list-style-type: none"> Warming instream water temperatures Sedimentation Hybridization and interspecific competition with Striped Shiners 	<ul style="list-style-type: none"> Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks Perform tree plantings to create overhead canopy cover and reduce sedimentation Limit livestock to streambanks and stream channel by fencing out livestock of riparian area. Prohibit use of baitfish ban to prevent bait bucket transfers and introductions Stop stocking fishes outside of their native ranges
Louisiana Waterthrush	<ul style="list-style-type: none"> Stream corridor degradation Acid deposition Hemlock wooly adelgid 	<ul style="list-style-type: none"> Introduce lime into streams to improve pH Treat remaining riparian hemlock stands for adelgid
Wood Turtle	<ul style="list-style-type: none"> Degradation or lack of nesting habitat Loss of instream habitat 	<ul style="list-style-type: none"> Create or establish instream woody habitat features

Appendix 3. Terrestrial and Aquatic Habitats in Public Lands

Public Land	Terrestrial Habitat	Aquatic Habitat
Fort Mill Ridge Wildlife Management Area	<ul style="list-style-type: none"> • Forest and Woodland <ul style="list-style-type: none"> • Dry-Mesic Oak Forests • Dry Oak (-Pine) Forests • Aquatic, Floodplain, and Riparian <ul style="list-style-type: none"> • River Floodplains • Agricultural and Developed <ul style="list-style-type: none"> • Agriculture 	<ul style="list-style-type: none"> • N/A
Nathaniel Mountain Wildlife Management Area	<ul style="list-style-type: none"> • Forest and Woodland <ul style="list-style-type: none"> • Dry-Mesic Oak Forests • Dry Oak (-Pine) Forests • Mixed Mesophytic Forests • Montane Red Oak Forests • Northern Hardwood Forests • Pine-Oak Rocky Woodlands • Rock Outcrops, Cliffs and Talus, and Shale Barrens <ul style="list-style-type: none"> • Acidic Rock Outcrops, Cliffs, and Talus • Aquatic, Floodplain, and Riparian <ul style="list-style-type: none"> • Small Stream Riparian Habitats • Agricultural and Developed <ul style="list-style-type: none"> • Developed 	<ul style="list-style-type: none"> • Headwater Creek, High Gradient, Cold • Headwater Creek, High Gradient, Cool
South Branch Wildlife Management Area	<ul style="list-style-type: none"> • Forest and Woodland <ul style="list-style-type: none"> • Dry-Mesic Oak Forests • Dry Oak (-Pine) Forests • Northern Hardwood Forests • Other Dry Oak Forests and Woodlands • Rock Outcrops, Cliffs and Talus, and Shale Barrens <ul style="list-style-type: none"> • Calcareous Cliffs and Talus • Aquatic, Floodplain, and Riparian <ul style="list-style-type: none"> • Open Water • River Floodplains • Small Stream Riparian Habitats • Agricultural and Developed <ul style="list-style-type: none"> • Agriculture • Developed 	<ul style="list-style-type: none"> • Headwater Creek, Moderate Gradient, Cool • Headwater Creek, High Gradient, Cool • Large River, Moderate Gradient, Warm

Public Land	Terrestrial Habitat	Aquatic Habitat
Shenandoah Wildlife Management Area	<ul style="list-style-type: none"> • Forest and Woodland <ul style="list-style-type: none"> • Dry-Mesic Oak Forests • Dry Oak (-Pine) Forests • Mixed Mesophytic Forests • Montane Red Oak Forests • Northern Hardwood Forests • Pine-Oak Rocky Woodlands • Red Spruce Forests • Rock Outcrops, Cliffs and Talus, and Shale Barrens <ul style="list-style-type: none"> • Acidic Rock Outcrops, Cliffs, and Talus • Shale Barrens • Aquatic, Floodplain, and Riparian <ul style="list-style-type: none"> • Open Water • Small Stream Riparian Habitats • Agricultural and Developed <ul style="list-style-type: none"> • Agriculture • Developed 	<ul style="list-style-type: none"> • Headwater Creek, Low Gradient, Warm • Headwater Creek, Moderate gradient, Cool • Headwater Creek, High Gradient, Cold • Small River, Moderate Gradient, Cool

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
<p>West Virginia University Extension Service (WVU Extension):</p> <ul style="list-style-type: none"> • Forestry https://extension.wvu.edu/natural-resources/forestry • Wildlife https://extension.wvu.edu/natural-resources/wildlife 	<ul style="list-style-type: none"> • Landowner technical assistance and information on financial assistance for forest and wildlife management • Training workshops and conferences on forestry Best Management Practices and safety practices
<p>US Fish and Wildlife Service (USFWS) Partners for Fish and Wildlife Program https://www.fws.gov/northeast/ecologicalservices/partners.html</p>	<ul style="list-style-type: none"> • 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) • CFA is part of the program’s Upper Potomac Priority Area • Efforts focus on controlling non-native 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 • Works in coordination with the USDA Natural Resources Conservation Service farm bill programs, Trout Unlimited and other partners
<p>US Fish and Wildlife Service (USFWS)</p> <ul style="list-style-type: none"> • Appalachian Fish and Wildlife Conservation Office https://www.fws.gov/northeast/apco/ 	<ul style="list-style-type: none"> • Works with partners to restore rivers, wetlands and aquatic species in collaboration with Partners for Fish and Wildlife Program, National Fish Habitat Partnership and National Fish Passage Program • Provides technical assistance to private landowners to restore and enhance fish and wildlife habitat • Conducts outreach and education on aquatic resources with youth and their families
<p>USDA Natural Resources Conservation Service: https://www.nrcs.usda.gov/wps/portal/nrcs/site/wv/home/</p>	<ul style="list-style-type: none"> • EQIP provides cost-share to forest and agricultural landowners targeting needs such as reduction of nutrient, sediment and pesticide pollution and wildlife habitat enhancement, including stream buffers • EQIP funds in the Potomac Valley Conservation District have been prioritized for improved grazing and pasture

Partner	Role/Assistance Provided
<ul style="list-style-type: none"> • Environmental Quality Incentive Program (EQIP) • Conservation Stewardship Program (CSP) • Agricultural Conservation Easement Program (ACEP) 	<p>management (including alternative water and fencing), nutrient management to protect streams, enhancing riparian corridors and natural stream restoration promoting brook trout in headwater streams.</p> <ul style="list-style-type: none"> • 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. CSP targets include forest management, riparian areas and wildlife habitat. • Ruffed Grouse Habitat Initiative in the Potomac Valley Conservation District to create early successional forest habitat for species including ruffed grouse, wild turkey, cerulean warbler and other neotropical migrants • ACEP can be used for both agricultural land easements and wetland reserve easements to protect farmland and associated habitat • Potomac Valley Conservation District, in partnership with NRCS, hosts a Local Work Group to identify and prioritize resource concerns, develop long range plans and evaluate EQIP applications for funding through the NRCS Focal Conservation Approach (FCA). • West Virginia funding pools include Conservation Activity Planning, Forest Management Implementation and Wildlife Habitat Conservation • Other funding initiatives target Golden Winged Warblers, Cerulean Warblers and Aquatic Organism Passage
<p>USDA Farm Service Agency https://www.fsa.usda.gov/state-offices/West-Virginia/programs/index</p> <ul style="list-style-type: none"> • Conservation Reserve Program (CRP) • Conservation Reserve Enhancement Program (CREP) 	<ul style="list-style-type: none"> • CRP provides rental payments to participating agricultural producers to safeguard environmentally sensitive land, conserve water quality, control soil erosion and enhance wildlife habitat, including floodplain wetlands. • CREP provides extra incentives and payments to eligible producers in the Potomac watershed (including this CFA) 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

Partner	Role/Assistance Provided
<p>WV Division of Natural Resources (WVDNR) http://www.wvdnr.gov/wildlife/wdpintro.shtm</p>	<ul style="list-style-type: none"> • Identify, survey and monitor SGCN and rare communities • Technical assistance on habitat management for SGCN • Facilitating partnerships to manage habitat for SGCN • Provide letters of support for partner proposals and grant applications seeking to benefit SGCN • Education, outreach and teaching resources on SGCN and their habitat • Field guides, Landscaping and Management guidelines • Fish, game and wildlife research and management • Fishing and river access • Wildlife Management Areas
<p>WV Division of Forestry http://www.wvforestry.com/</p>	<ul style="list-style-type: none"> • Oversees the Managed Timberland Program to provide tax incentives for landowners who manage their forest land sustainably according to a management plan • Oversee timber sales and Best Management Practices • Provides training workshops for loggers on safety and Best Management Practices • Maintains list of consulting foresters who can help landowners with Forest Stewardship Plans to enhance wildlife habitat • Assists watershed groups and other partners on riparian planting in the Chesapeake Bay watershed (including this CFA). • Protection of large private forest tracts through Forest Legacy Program
<p>WV Conservation Agency (WVCA) http://www.wvca.us/</p>	<ul style="list-style-type: none"> • Promotes the protection and conservation of West Virginia's soil, land, water and related resources • Works with WVDEP on to improve water quality through the Non-Point Source and Chesapeake Bay programs • Works with Conservation Districts to implement Agricultural Best Management Practices, such as invasive species management and exclusion fencing to protect streams, wetlands and other environmentally sensitive areas • Potomac Valley Conservation District, in partnership with NRCS, hosts Local Work Group to identify and prioritize resource concerns and evaluate EQIP applications for funding through the NRCS Focal Conservation Approach (FCA).

Partner	Role/Assistance Provided
<p>WV Department of Environmental Protection (WVDEP)</p> <ul style="list-style-type: none"> • Nonpoint Source Program https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx • Chesapeake Bay Program https://dep.wv.gov/WWE/watershed/wqmonitoring/Pages/Chesapeake Bay.aspx • Save Our Streams Program https://dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx • Rehabilitation Environmental Action Plan (REAP) https://dep.wv.gov/environmental-advocate/reap/Pages/default.aspx • WVDEP Youth Environmental Program (YEP) https://dep.wv.gov/environmental-advocate/yep/Pages/default.aspx 	<ul style="list-style-type: none"> • Supports partners and citizen-based watershed organizations in restoring impaired watersheds • Provides assistance in proper installation and maintenance of Best Management Practices • Provides funding for projects by watershed groups and partners to improve water quality in watersheds listed as impaired • WV Chesapeake Bay funding for water quality improvements (including this CFA) • Practices include wastewater treatment, agricultural BMPs, rain gardens for stormwater runoff, streambank restoration, and community outreach • Save our Streams provides training for volunteers to monitor local wadable streams and rivers • REAP provides communities with technical, financial and resource assistance in cleanup efforts. • YEP organizes youth and volunteer groups for hands-on conservation projects
<p>WV Department of Health and Human Resources (WVDHHR) On-Site Sewage Program https://www.wvdhhr.org/phs/sewage/index.asp</p>	<ul style="list-style-type: none"> • 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.
<p>County Commissions and Organizations</p> <ul style="list-style-type: none"> • Hardy County Planning Commission http://hardycounty.com/hardy-county-planning-commission • Hampshire County Planning Commission http://planning.hampshirewv.com/ • Pendleton County https://pencowv.com/ 	<ul style="list-style-type: none"> • County Planning, Economic and Community Development, Tourism, Parks and Recreation, Floodplain Management • Land use planning to manage floodplains, subdivisions, development and stormwater
<p>Land Conservation Organizations</p> <ul style="list-style-type: none"> • Potomac Conservancy https://potomac.org/ • Land Trust of the Eastern Panhandle https://www.landtrustepwv.org/ 	<ul style="list-style-type: none"> • Conservation easements to protect farms, forests and riparian areas

Partner	Role/Assistance Provided
<ul style="list-style-type: none"> • County Farmland Protection Boards http://wvfp.org/ • West Virginia Land Trust https://www.wvlandtrust.org/ 	
<p>The Nature Conservancy https://www.nature.org/en-us/about-us/where-we-work/united-states/west-virginia/</p>	<ul style="list-style-type: none"> • Assist land conservation organizations with forest and land protection and restoration • Assist landowners with protection and improved management of large forest tracts through conservation easements and forest carbon projects
<p>Trout Unlimited</p> <ul style="list-style-type: none"> • http://www.wvtu.org/ • http://www.tu.org/ 	<ul style="list-style-type: none"> • Restoring brook trout populations in small watersheds such as the Upper South Branch Potomac. • 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 • 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
<p>American Forest Foundation: My Land Plan https://mylandplan.org/</p>	<ul style="list-style-type: none"> • Woodland owners planning tool for forest management
<p>National Wild Turkey Federation (NWTf) https://www.nwtf.org/</p>	<ul style="list-style-type: none"> • Provides information to landowners on hunting and habitat management for wild turkey and other wildlife • Partners with state and federal agencies on hunting access and habitat management for wild turkey and other wildlife species
<p>Ruffed Grouse Society/American Woodcock Society (RGS) https://ruffedgrousesociety.org/#</p>	<ul style="list-style-type: none"> • Creates healthy forest habitat for the benefit of ruffed grouse, American woodcock and other forest wildlife • Works with landowners and government agencies to develop critical habitat using scientific management practices
<p>West Virginia Association for Cave Studies (WVACS) https://www.wvacs.org/</p>	<ul style="list-style-type: none"> • Contributes to cave surveys and research • Hosts cave scientists and graduate students pursuing cave research at field stations in Greenbrier County
<p>West Virginia Cave Conservancy https://wvcc.net/</p>	<ul style="list-style-type: none"> • Manages caves to protect sensitive cave resources and environments • Educates and provides expertise to landowners, developers, local governments and the public on the value of cave and karst resources • Organizes cave and karst conservation projects including sinkhole cleanups and livestock barrier fences. • Preserves access to significant caves through ownership and management agreements • Sponsor research and survey projects on WVCC caves

Partner	Role/Assistance Provided
Cave Conservancy of the Virginias (CCV) https://caveconservancyofvirginia.org/	<ul style="list-style-type: none"> • Promoting conservation, management, knowledge and acquisition of caves and karst resources in Virginia and West Virginia • Contributes to educational, research and environmental protection projects • Funds a variety of cave and karst education, outreach, research, cleanup and acquisition projects. • Provides research scholarships and stipends for graduate and undergraduate students • Supports <i>Project Underground</i> environmental education program to promote a better understand of caves and karst lands.
Master Naturalists Program http://mnofwv.org/	<ul style="list-style-type: none"> • Training interested people in the fundamentals of natural history, nature interpretation and teaching. • Instilling an appreciation of the importance of responsible environmental stewardship. • 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

Appendix 5. Resources

West Virginia's Phase 3 Watershed Implementation Plan for the Chesapeake Bay Total Maximum Daily Load (TMDL)

http://www.wvca.us/bay/files/bay_documents/1298_WV_WIP3_final_082319.pdf

West Virginia's Chesapeake Bay Program

Web resources to restore streams, reduce runoff and improve water quality, focusing on agriculture, urban stormwater, homeowners and forestry.

<http://www.wvchesapeakebay.us/>

Long Range Plan for Natural Resource Management in the Potomac Valley Conservation District
Summarizes natural resources conditions and ranks resource concerns that could be addressed through NRCS technical and financial assistance. Available at:

<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

http://www.livingonkarst.org/living_on_karst.htm

Guidelines for Cave and Karst Protection- IUCN

<https://www.iucn.org/content/guidelines-cave-and-karst-protection-0>

A Guide to Responsible Caving, by the National Speleological Society

https://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf

National Wild Turkey Foundation- Landowner's Toolbox

<https://www.nwtf.org/conservation/category/landowners-tool-box>

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>

Cerulean Warbler Management Guidelines for Enhancing Breeding Habitat in Appalachian Hardwood Forests

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.

http://gwwa.org/resources/GWWA-APPLRegionalGuide_130808_lo-res.pdf

Brochures about Aquatic Invasive Species, Forest Pests and Pathogens, and Invasive Plant Species
<https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/technical/ecoscience/invasive/>

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>

American Forest Foundation: Woodland owners planning tool for forest management
<https://mylandplan.org/>

The Nature Conservancy Resilient Land Mapping Tool and Documents:
<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
<https://www.fs.fed.us/nrs/atlas/>

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: <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 across the U.S. federal government in one easy-to-use location.
<https://toolkit.climate.gov/tool/climate-smart-conservation-putting-adaptation-principles-practice>

Forest Adaptation Resources: climate change tools and approaches for land managers, published by the USDA Forest Service, Northern Research Station: <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.
<https://www.climatehubs.usda.gov/sites/default/files/AdaptationResourcesForAgriculture.pdf>

Appendix 6. Initial Project Plan

Partners met in January 2020 to review the draft Action Plan for this CFA and develop Initial Project Plans for implementation. The following is an outline of the Initial Project Plan for aquatic, riparian and floodplain habitats.

- **Threat to be addressed:**
 - Sedimentation, stream bank erosion, riparian deforestation
- **Species and Habitats that will benefit:**
 - Target: wood turtles, along with mussels, brook trout, aquatic invertebrates
- **Overall Project goals:**
 - Restore instream and riparian buffer habitat, install cattle fencing
- **Actions to be taken:**
 - Initial partner meeting in 2020 to develop timeline and budget
- **Partners involved:**
 - George Washington National Forest
 - USDA NRCS, FSA
 - WVCA, WVDEP
 - USFWS Partners for Fish and Wildlife program
 - Trout Unlimited
 - WVDNR (technical assistance)