

# Action Plan for the Greater Shenandoah Valley Conservation Focus Area

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**West Virginia Division of Natural Resources**

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## List of Acronyms Used

ACEP- Agricultural Conservation Easement Program  
BMP- Best Management Practice  
B-Rank- Biodiversity Rank  
CERW-Cerulean Winged Warbler  
CFA- Conservation Focus Area  
CCV- Cave Conservancy of the Virginias  
CCVI- Climate Change Vulnerability Index  
CREP- Conservation Reserve Enhancement Program  
CRP- Conservation Reserve Program  
CSP- Conservation Stewardship Program  
EQIP- Environmental Quality Improvement Program  
FSA- Farm Service Agency  
GWWA- Golden Winged Warbler  
G Rank- Global Rank  
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  
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  
WMA- Wildlife Management Area  
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 North Fork Mountain-Thorn Creek 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 281 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. This Conservation Focus Area Action Plan uses the habitat classifications provided in the 2015 SWAP.

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 collaboration with landowners, corporations, and other partner organizations and agencies to reduce stresses on wildlife species and their habitats.

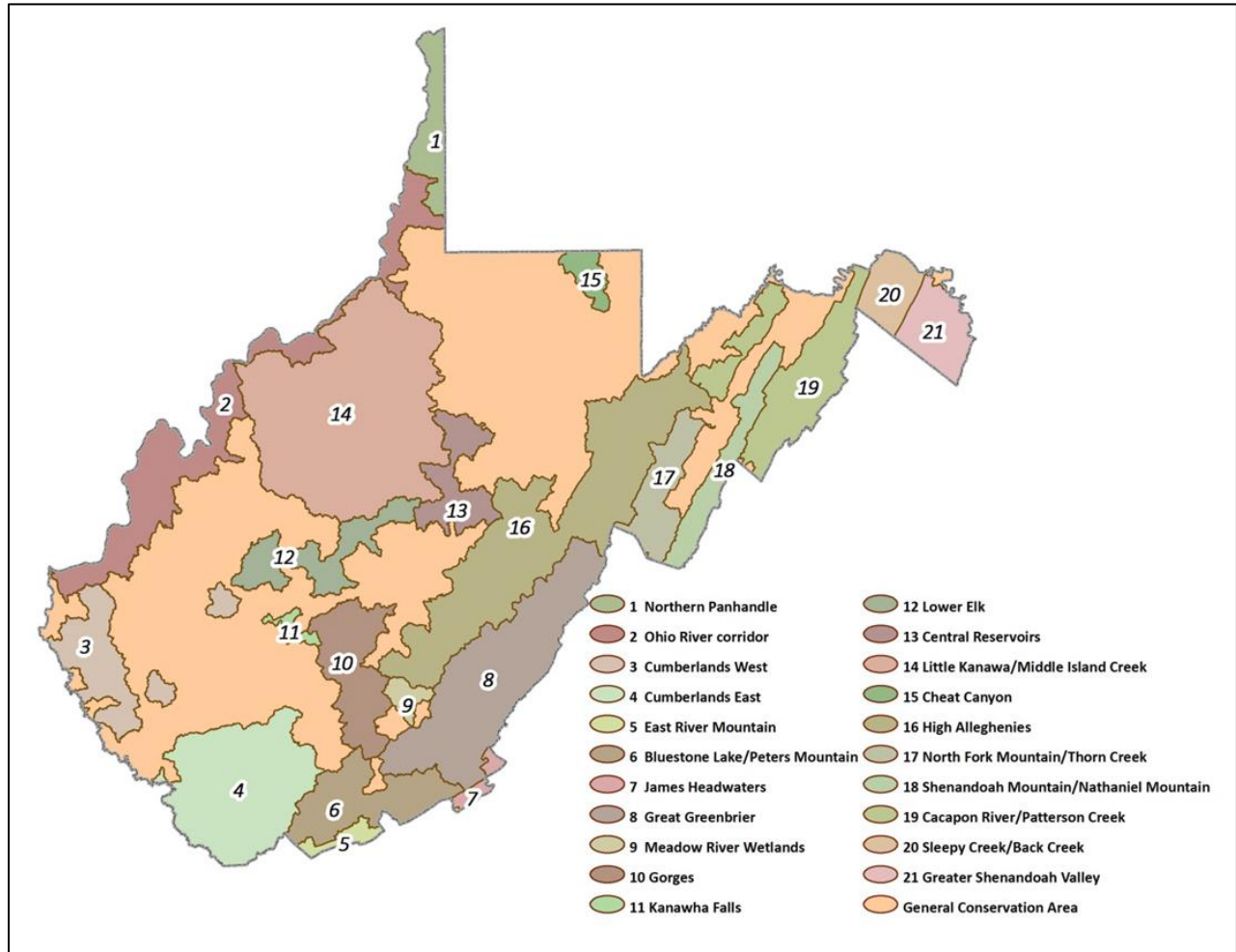
Conservation actions vary according to the species and the specific stresses. Actions can manifest themselves in many forms. A lack of information on the status of a species or understanding of a threat may indicate a need for actions such as baseline inventory, research, or data acquisition. Direct 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

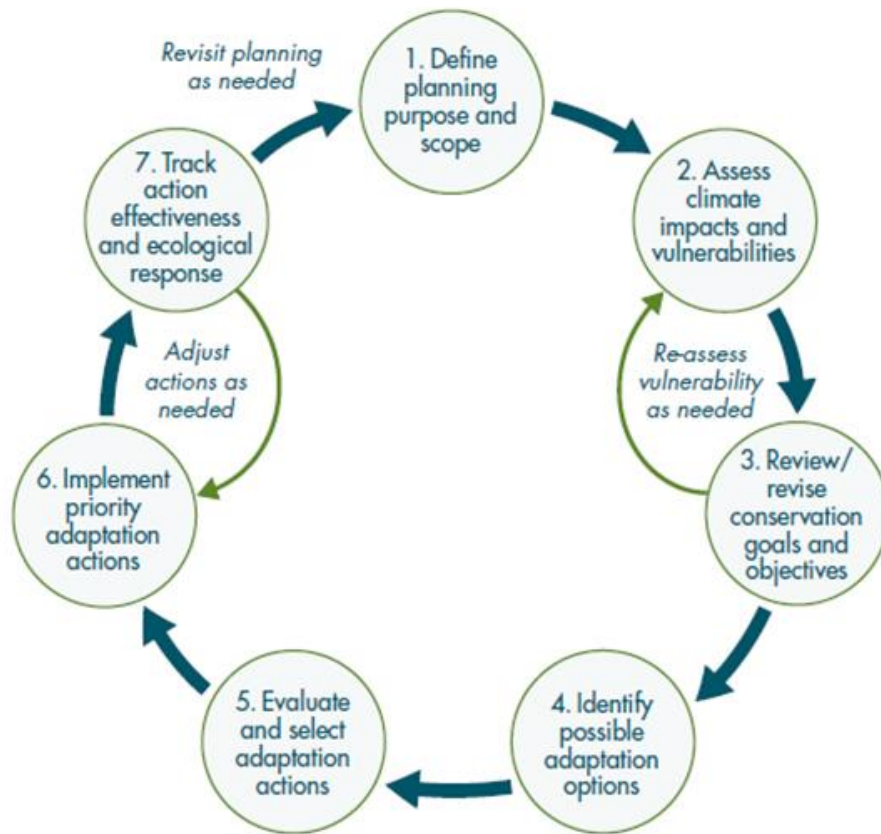
stated that efficient approaches to maintaining broad suites of species include maintaining functioning ecological systems, landscapes that are resilient to the effects of climate change, and ecological connectivity within and between landscapes. Rather than a species-specific approach, the SWAP therefore 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 Action Plan will rely upon voluntary actions by local stakeholders including landowners, public agencies and partner organizations, and collaboration between them to conserve wildlife species and their habitat. The role of WVDNR in implementing this 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



## The Greater Shenandoah Valley Conservation Focus Area

### Overview

This Ridge and Valley Conservation Focus Area (CFA) spans most of West Virginia from Little North Mountain east to the crest of the Blue Ridge. Terrain between these two ridges is flat to gently rolling. The low elevation uplands of the Shenandoah Valley include the lowest elevations in the State. Much of the valley is limestone, although there is a significant shale belt.

The Blue Ridge in West Virginia is a low elevation ridge, under 1700 feet. It is primarily sandstone and quartzite, but also including a metabasalt (a modified form of lava) that is the state's oldest surface rocks. The limestone terrain has numerous spring-fed streams, marl marshes, and caves. The entire West Virginia portion of the Shenandoah River passes through this CFA, which is bounded on the north with substantial frontage on the mainstem Potomac, which is part of Maryland.

The original deciduous forest of the Shenandoah Valley has been almost completely displaced by agriculture, residential, and industrial development. Due to its proximity to Washington, DC, this is West Virginia's most rapidly growing population center.

Many cities and towns are here including:

- Martinsburg
- Charles Town
- Ranson
- Shepherdstown

Agricultural land use includes:

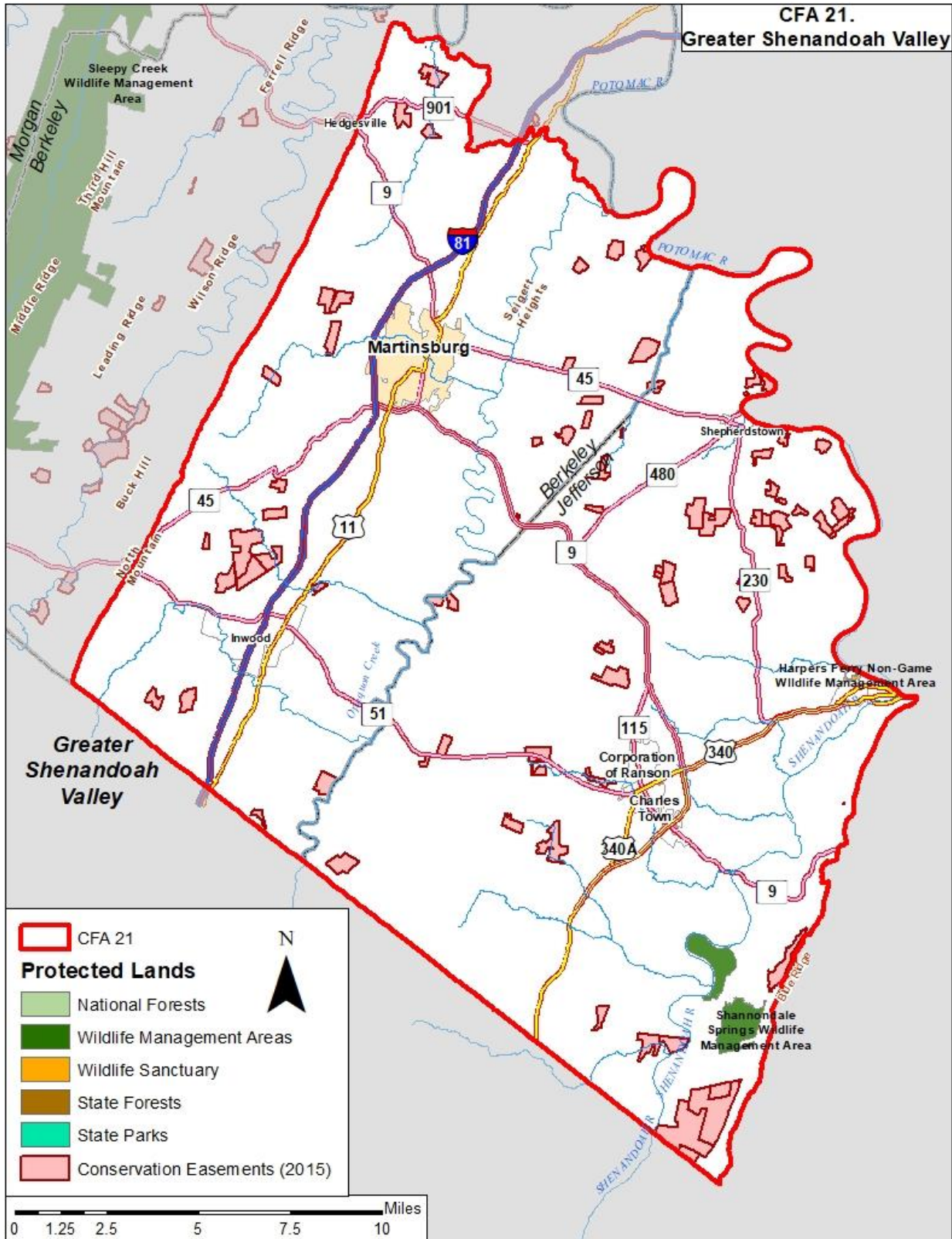
- Beef production
- Horse farms
- Apple and peach orchards
- Hay
- Corn

Industry includes:

- Active and legacy limestone quarries around Martinsburg and along the Shenandoah River

The Blue Ridge is largely forested, but much of it is covered with low to medium density residential and second home development.

Overview





## Habitats

The Shenandoah Valley CFA includes a variety of subterranean, terrestrial, and aquatic habitat types.

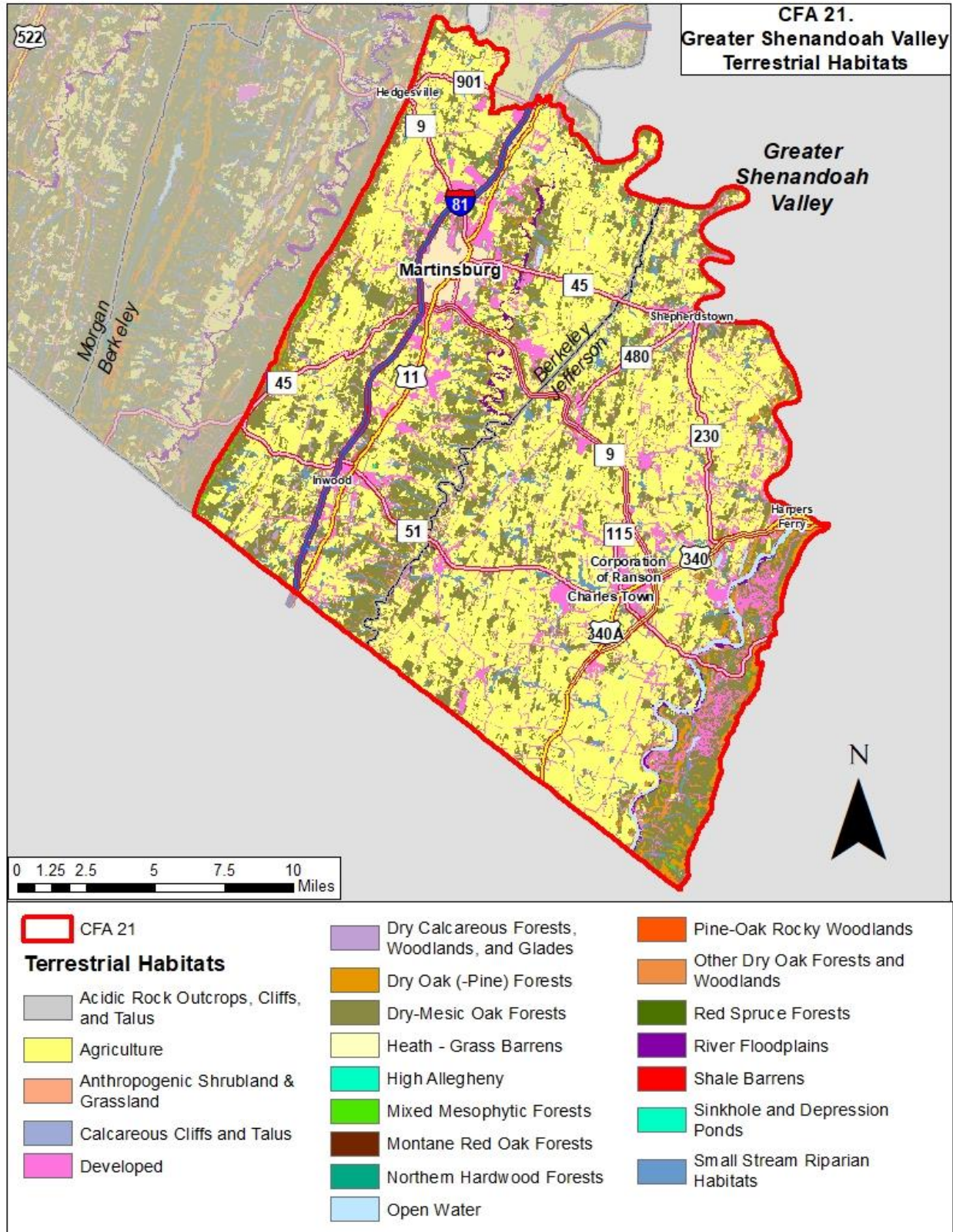
### Terrestrial Habitats

Thirteen of the habitat types described in the SWAP are present in this CFA, including agricultural lands. By far the most abundant habitat type present in the CFA, agricultural land covers over half of the area within the CFA and makes up roughly 10% of the states total agricultural land. While sinkhole and depression ponds represent a tiny portion of the terrestrial habitats in this CFA, they represent over 80% of the state's total sinkhole and depression pond habitat. Terrestrial habitats are described in Chapter 3 of the 2015 SWAP.

#### Terrestrial Habitat Summary

HABITAT TYPE	ACRES IN CFA	PERCENT OF CFA AREA	PERCENT OF WV TOTAL FOR TYPE
Acidic Rock Outcrops, Cliffs, and Talus	8	0.00%	0.01%
Agriculture	132,544	53.58%	9.23%
Calcareous Cliffs and Talus	4	0.00%	0.04%
Developed	36,450	14.73%	3.20%
Dry Calcareous Forests, Woodlands, and Glades	2,779	1.12%	3.88%
Dry Oak (-Pine) Forests	6,416	2.59%	0.26%
Dry-Mesic Oak Forests	55,233	22.33%	1.11%
Mixed Mesophytic Forests	353	0.14%	0.01%
Pine-Oak Rocky Woodlands	19	0.01%	0.02%
River Floodplains	2,254	0.91%	1.88%
Sinkhole and Depression Ponds	123	0.05%	82.44%
Small Stream Riparian Habitats	7,804	3.15%	1.58%
Unresolved	3,395	1.37%	2.91%
Totals	247,382	100.00%	

Terrestrial Habitats



## Aquatic Habitats

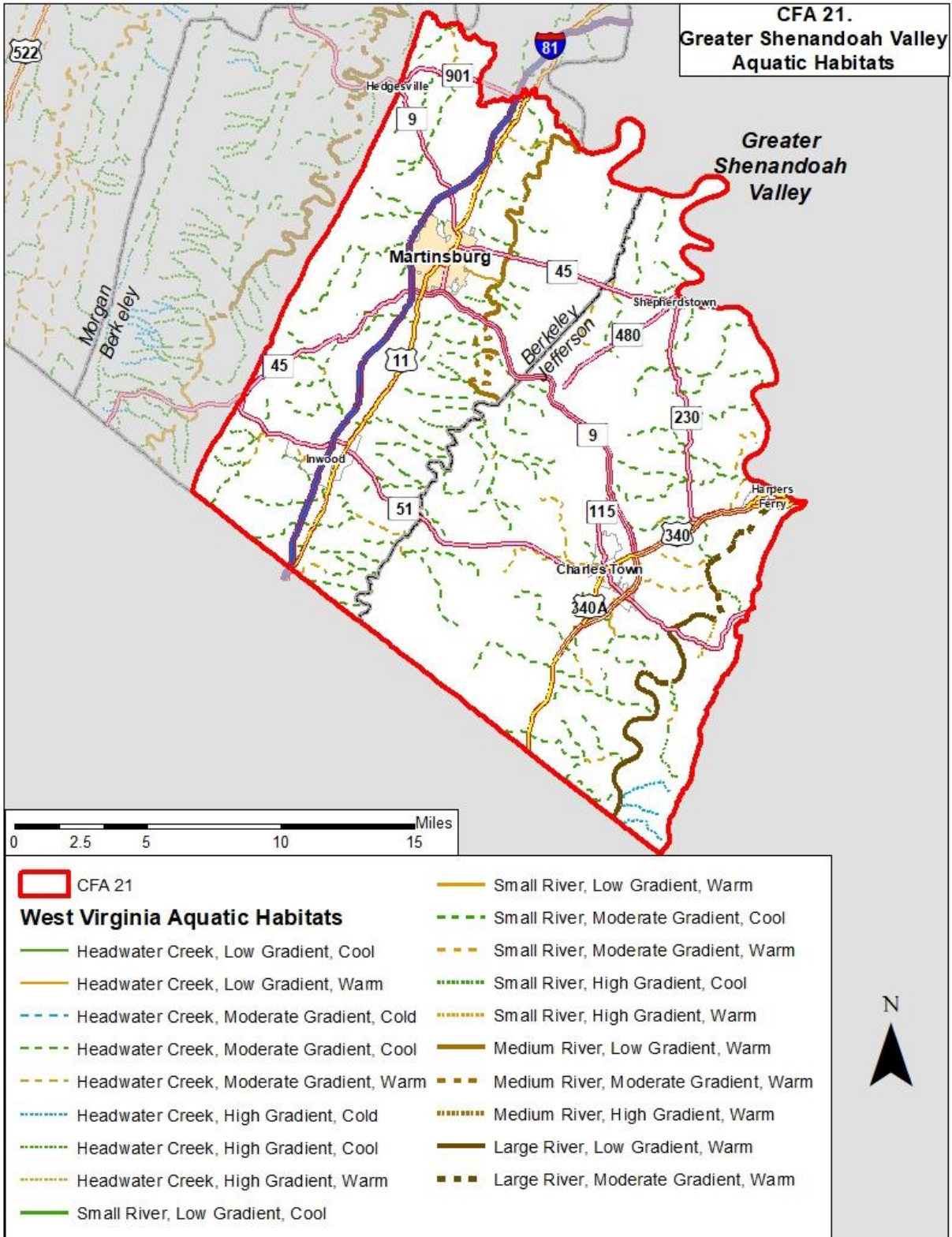
Twelve of the aquatic habitat types described in the SWAP are present within the Shenandoah Valley CFA, including over 10% of the state's cool, moderate gradient headwater. The Shenandoah River is classified as a large, warm river with both low and moderate gradients. Opequon Creek is classified as a medium, warm river. There are many cool headwater creeks but very few cold ones.

### Aquatic Habitat Summary

HABITAT TYPE	MILES IN CFA	PERCENT OF CFA MILES	PERCENT OF WV TOTAL FOR TYPE
Headwater Creek, Low Gradient, Warm	3	0.88%	0.59%
Headwater Creek, Moderate Gradient, Cool	250	67.06%	11.37%
Headwater Creek, Moderate Gradient, Warm	44	11.93%	1.14%
Headwater Creek, High Gradient, Cold	6	1.67%	0.21%
Headwater Creek, High Gradient, Cool	14	3.69%	0.22%
Headwater Creek, High Gradient, Warm	2	0.44%	0.21%
Small River, Low Gradient, Warm	5	1.23%	1.00%
Small River, Moderate Gradient, Warm	1	0.15%	0.10%
Medium River, Low Gradient, Warm	17	4.68%	3.66%
Medium River, Moderate Gradient, Warm	11	2.93%	3.14%
Large River, Low Gradient, Warm	15	3.91%	2.50%
Large River, Moderate Gradient, Warm	5	1.45%	4.90%
Totals	372	100.00%	



*Aquatic Habitat*



## Species of Greatest Conservation Need

The table below lists the number of Priority 1 and 2 SGCN in each taxa group listed in the SWAP for the Shenandoah Valley CFA (see full list in Appendix 1).

### Species Summary by Taxa and Priority

TAXA	# SGCN
Amphibians	13
Birds	37
Butterflies and Moths	10
Cave Invertebrates	9
Dragonflies and Damselflies	7
Fish	14
Mussels	9
Plants	80
Reptiles	13
Snails	10
Totals	202

In this CFA, stream, wetland, and riparian habitats are important for many SGCN, including Wood Turtles and Spotted Turtles, 14 fish species and 9 mussel species (all SGCN). Streams and wetlands in the CFA are also able to support 7 dragonfly and damselfly SGCN and 80 plant SGCN.

This is also an important CFA for birds, including 37 SGCN, more than half of which are priority 1 species. Pastures and hayfields are important for many grassland bird species. Dry forest types within this CFA also support a suite of bird species. The Forests and Shale Barrens present within this CFA play host to several associated rare plants and lepidopterans including 10 moth and butterfly SGCN.

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

## Distinctive Stresses

The 2015 SWAP lists population growth and development as distinctive stresses affecting SGCN and habitat in this CFA:

- The CFA is the fastest growing region in the state in terms of population and subsequent development. Residential and commercial development are displacing agriculture (which is compatible with many elements) and encroaching on important habitats (streams, marshes, farmland, groundwater).

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

## Conservation Actions

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

1. Watershed restoration and protection is a priority; a framework for watershed protection could help guide development so that impacts to water quality and thus habitat, are minimized.
2. Opequon Creek should be considered for a reintroduction of mussels if studies suggest water quality is acceptable. If so, a pilot project could be developed that introduces common species and monitors their survival.
3. Coordinate with the active land trust and farmland protection community to protect habitat through land conservation.

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

## Potential Partners

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

- WV Department of Environmental Protection
- USDA- Natural Resource Conservation Service
- National Park Service
- West Virginia Conservation Agency
- Opequon Creek Watershed Association
- Berkeley and Jefferson county farmland protection boards
- Berkeley and Jefferson County Planning Commissions
- Land Trust of the Eastern Panhandle
- Potomac Valley Audubon Society
- Leetown Science Center (USGS)
- Freshwater Institute

In addition, water quality issues on Opequon Creek and Shenandoah River may require engaging with the state of Virginia and planning commissions in Frederick and Clarke Counties, Virginia

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:

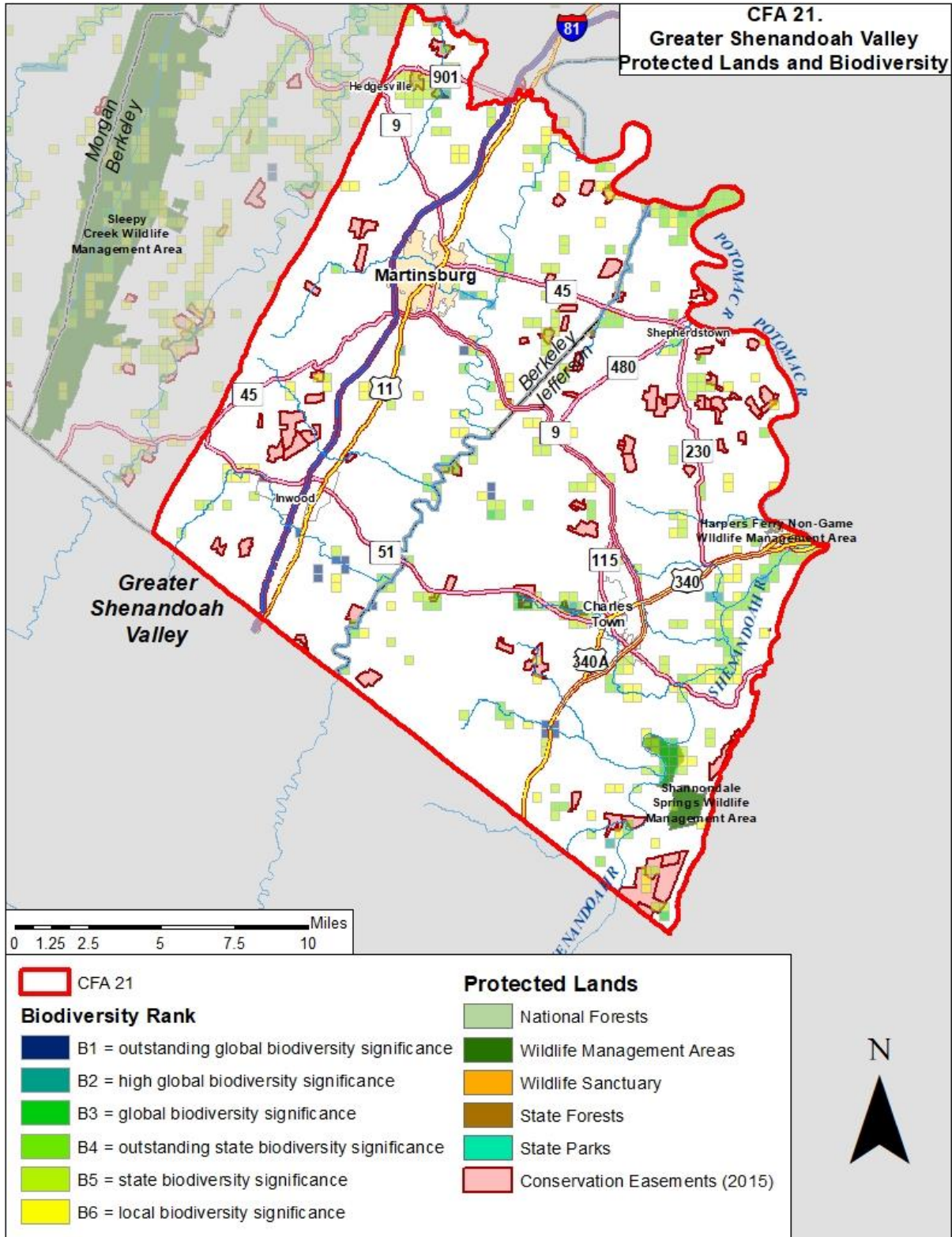
- Shannondale Springs WMA
- National Conservation Training Center
- Harpers Ferry National Historical Park
- Appalachian Trail National Scenic Trail
- Leetown Science Center (USGS)
- Numerous county parks

Many of these public lands provide important wildlife habitat and may be managed for conservation or other compatible goals. The table on the following page lists habitat types occurring in each of the public lands within this CFA. 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, including designation of special management areas. On state lands, this may 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 including the Land Trust of the Eastern Panhandle as well as The Nature Conservancy, the county farmland protection boards, the Wetlands Reserve Program, and the Appalachian Trail Conservancy all 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 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 communities also occur on private lands 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 at-risk species by the United States Fish and Wildlife Service, indicating that the agency 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	USFWS
Birds	<i>Falco sparverius</i>	American Kestrel	S3B	G5	
Birds	<i>Riparia riparia</i>	Bank Swallow	S2B	G5	
Birds	<i>Tyto alba</i>	Barn Owl	S2B,S2N	G5	
Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	S2B	G5	
Birds	<i>Dolichonyx oryzivorus</i>	Bobolink	S3B	G5	
Birds	<i>Buteo platypterus</i>	Broad-winged Hawk	S3B	G5	
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler	S2B	G4	
Birds	<i>Chaetura pelagica</i>	Chimney Swift	S3B	G5	
Birds	<i>Chordeiles minor</i>	Common Nighthawk	S2B	G5	
Birds	<i>Sturnella magna</i>	Eastern Meadowlark	S3B, S2N	G5	
Birds	<i>Spizella pusilla</i>	Field Sparrow	S3B	G5	
Birds	<i>Ammodramus savannarum</i>	Grasshopper Sparrow	S3B	G5	
Birds	<i>Geothlypis formosa</i>	Kentucky Warbler	S3B	G5	
Birds	<i>Lanius ludovicianus</i>	Loggerhead Shrike	S1B,S1N	G4	
Birds	<i>Lanius ludovicianus migrans</i>	Migrant Loggerhead Shrike	S1B,S1N	G4T3Q	
Birds	<i>Colinus virginianus</i>	Northern Bobwhite	S1B, S1N	G5	
Birds	<i>Falco peregrinus</i>	Peregrine Falcon	S2B,S2N	G4	
Birds	<i>Setophaga discolor</i>	Prairie Warbler	S3B	G5	
Birds	<i>Poocetes gramineus</i>	Vesper Sparrow	S2B, S2N	G5	
Birds	<i>Hylocichla mustelina</i>	Wood Thrush	S3B	G5	
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler	S3B	G5	
Birds	<i>Icteria virens</i>	Yellow-breasted Chat	S3B	G5	
Butterflies and Moths	<i>Celastrina serotina</i>	Cherry Gall Azure	SNR	G5	
Butterflies and Moths	<i>Erynnis lucilius</i>	Columbine Duskywing	S2	G4	
Butterflies and Moths	<i>Staphylus hayhurstii</i>	Hayhurst's Scallopwing	S1	G5	
Cave Invertebrates	<i>Erebomaster nr. acanthina</i>	A Cave Spider	S2	GNR	
Cave Invertebrates	<i>Stygobromus allegheniensis</i>	Allegheny Cave Amphipod	S1	G5	
Cave Invertebrates	<i>Stygobromus biggersi</i>	Biggers' Cave Amphipod	S1	G2G4	

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFWS
Cave Invertebrates	<i>Antrolana lira</i>	Madison Cave Isopod	S1	G2G4	At Risk
Cave Invertebrates	<i>Stygobromus tenuis potomacus</i>	Potomac Groundwater Amphipod	S1	G4T4	
Cave Invertebrates	<i>Caecidotea pricei</i>	Price's Cave Isopod	S1	G5	
Cave Invertebrates	<i>Stygobromus gracilipes</i>	Shenandoah Valley Cave Amphipod	S1	G3G4	
Plants	<i>Juncus balticus</i> var. <i>littoralis</i>	Baltic Rush	S1	G5T5	
Plants	<i>Eleocharis rostellata</i>	Beaked Spikerush	S1	G5	
Plants	<i>Carex conoidea</i>	Field Sedge	S1	G5	
Plants	<i>Schoenoplectus acutus</i> var. <i>acutus</i>	Hardstem Bulrush	S2	G5T5	
Plants	<i>Zannichellia palustris</i>	Horned Pondweed	S1	G5	
Plants	<i>Juncus nodosus</i> var. <i>nodosus</i>	Knotted Rush	S1S2	G5T5?	
*Plants	<i>Parnassia grandifolia</i>	<i>Largeleaf Grass-of-parnassus</i>	S1	G3	
Plants	<i>Carex comosa</i>	Longhair Sedge	S2	G5	
Plants	<i>Carex prairea</i>	Prairie Sedge	S1	G5?	
Plants	<i>Carex suberecta</i>	Prairie Straw Sedge	S1	G4	
Plants	<i>Carex tetanica</i>	Rigid Sedge	S1	G4G5	
Plants	<i>Bolboschoenus fluviatilis</i>	River Bulrush	S1	G5	
Plants	<i>Eupatorium maculatum</i> var. <i>maculatum</i>	Spotted Joe-pyeweed	S1	G5T5	
Plants	<i>Arabis patens</i>	Spreading Rockcress	S2	G3	
Plants	<i>Hydrocotyle ranunculoides</i>	Swamp Pennywort	S2	G5	
Plants	<i>Pycnanthemum torrei</i>	Torrey's Mountain-mint	S1	G2	
Plants	<i>Juncus torreyi</i>	Torrey's Rush	S2	G5	
Plants	<i>Carex pellita</i>	Woolly Sedge	S2	G5	
Plants	<i>Carex lasiocarpa</i> var. <i>americana</i>	Woolly-fruit Sedge	S1	G5T5	
Fish	<i>Anguilla rostrata</i>	American Eel	S2	G4	
Fish	<i>Luxilus cornutus</i>	Common Shiner	S1S2	G5	
Fish	<i>Margariscus margarita</i>	Pearl Dace	S2S3	G5	

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFWS
<i>*Fish</i>	<i>Cyprinella analostana</i>	<i>Satinfin Shiner</i>	S1	G5	
Fish	Notropis procne	Swallowtail Shiner	S1	G5	
Mussel	Lasmigona subviridis	Green Floater	S2	G3	At Risk
Mussel	Lampsilis cariosa	Yellow Lampmussel	S2	G3G4	
Odonata	Stylurus plagiatus	Russet-tipped Clubtail	SH	G5	
Reptile	Clemmys guttata	Spotted Turtle	S1	G5	At Risk
Reptile	Glyptemys insculpta	Wood Turtle	S3	G4	At Risk

*\*These species may be extirpated; their status and location are unknown and will require surveying*

## Forest and Woodland Habitats

Dry Mesic Oak Forests cover nearly one quarter of the CFA and represent the largest portion of forest habitat types. Dry Oak Pine Forests and Dry Calcareous Forests, Woodlands, and Glades 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 Mixed Mesophytic Forests and Pine-Oak Rocky Woodlands. 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. The remaining patches of intact forest provide small areas of core habitat for forest dependent species, as well as a matrix of forest habitat types within which forest species may shift and adapt to climate change. The diversity of forest types across elevational gradients requires careful management tied to specific site conditions and forest stand characteristics.

## Priority Species

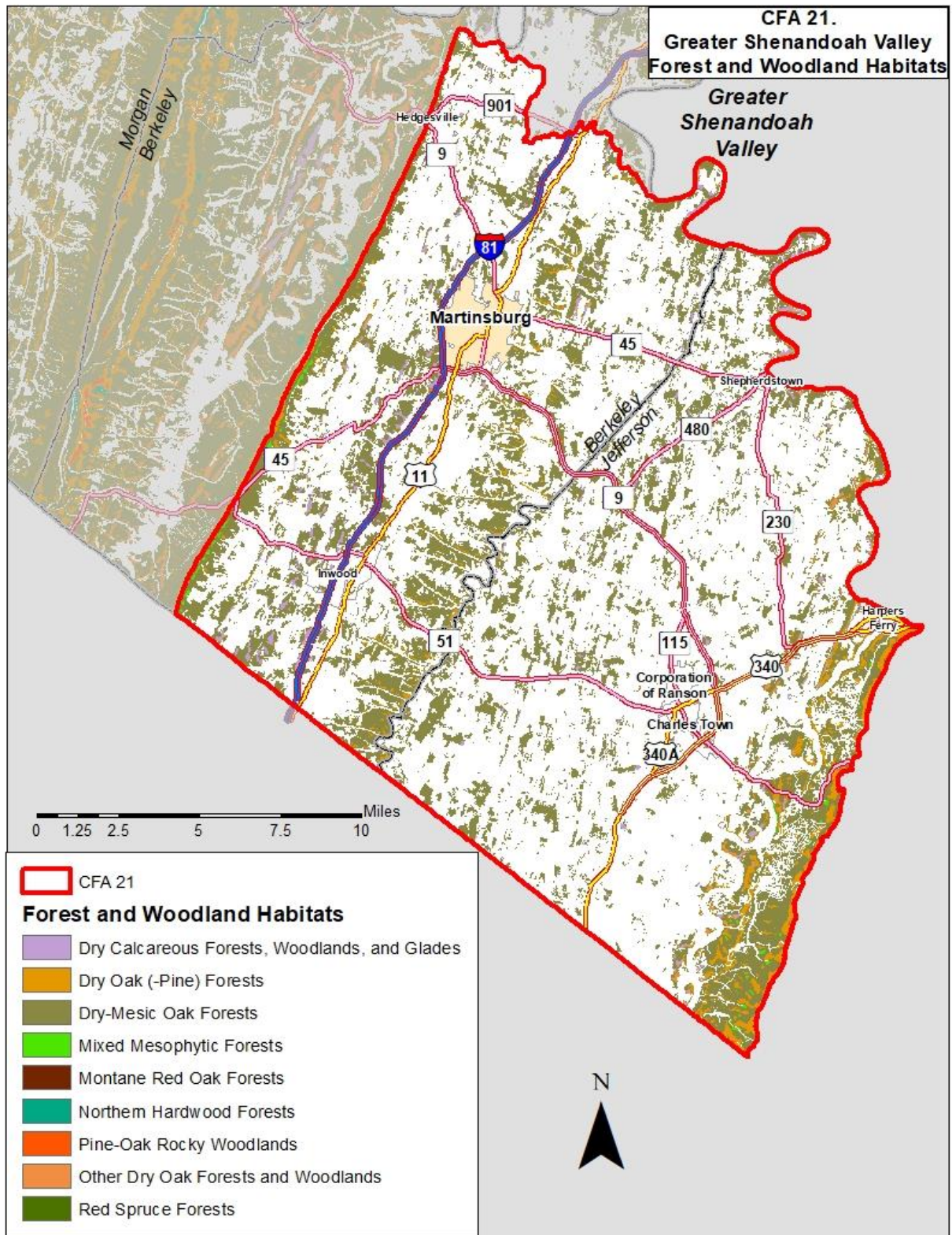
The table below lists priority species in the CFA associated with forest and woodland habitats.

Priority Species in Forest and Woodland Habitats.

<b>TAXA</b>	<b>SCIENTIFIC NAME</b>	<b>COMMON NAME</b>
Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo
Birds	<i>Buteo platypterus</i>	Broad-winged Hawk
Birds	<i>Setophaga discolor</i>	Prairie Warbler
Birds	<i>Hylocichla mustelina</i>	Wood Thrush
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler
Birds	<i>Geothlypis formosa</i>	Kentucky Warbler
Butterflies and Moths	<i>Celastrina serotina</i>	Cherry Gall Azure
Plants	<i>Pycnanthemum torrei</i>	Torrey's Mountain-mint

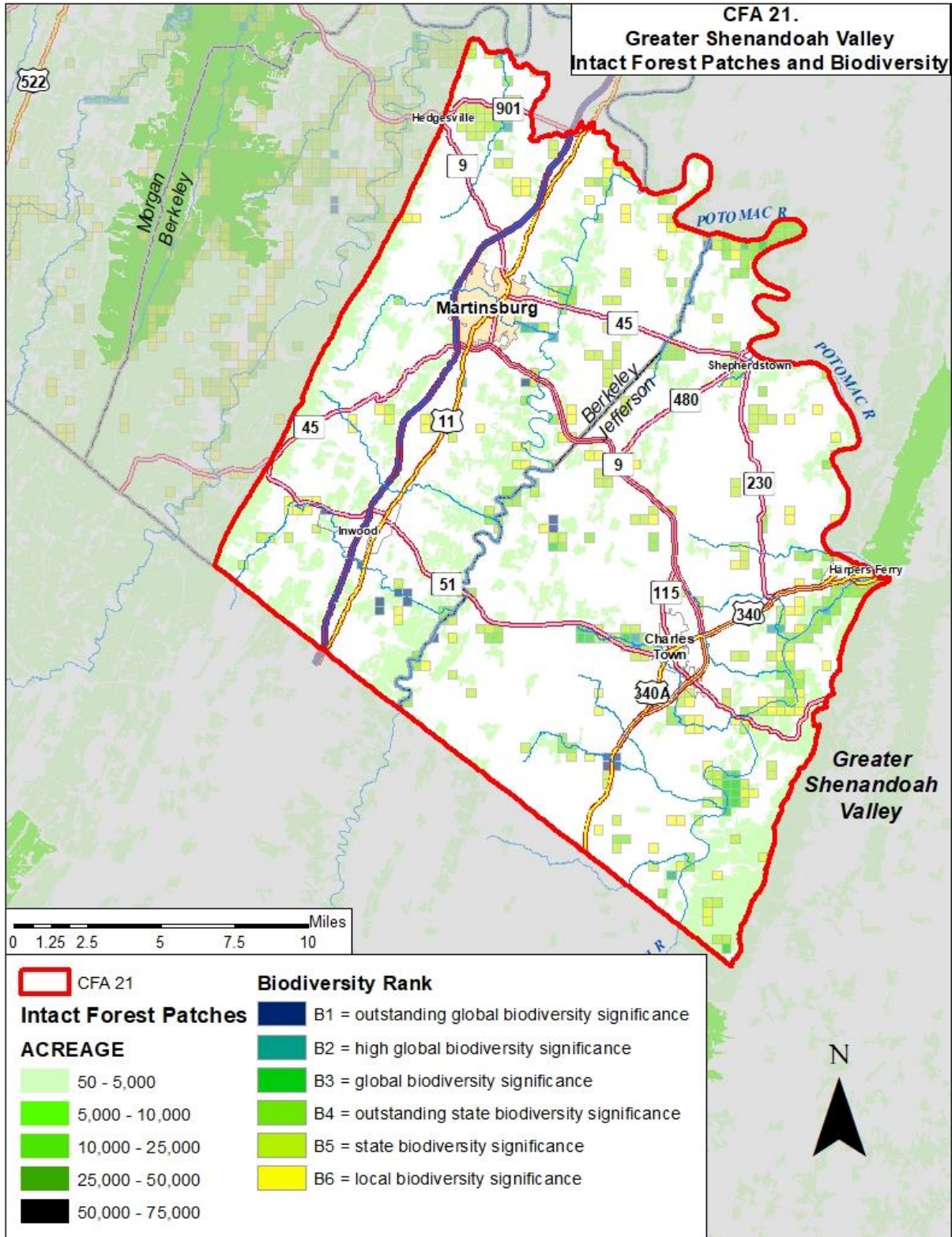
While there are no intact forest blocks over 5,000 acres in this CFA, smaller forest patches still support some forest interior breeding birds such as Broad-winged Hawk, Wood Thrush, Cerulean Warbler and Worm-eating Warbler. Small patches of early successional forest habitats may support Prairie Warbler, and Black-billed Cuckoo. Wood turtles rely on forested as well as aquatic habitats for different parts of their life history. They also rely on connections between those habitats for passage between them. Even small patches of forest cover can have great conservation value. Several forest corridors may allow forest species to shift across the landscape and adapt to climate change.

Forest and Woodland Habitats





Intact Forest Patches



### Rare Plant Communities

The following rare plant communities are found in Forest and Woodland habitats in this CFA. Note that all of the state’s Eastern Panhandle Basic Oak – Hickory Forest are located here, as well as over half of the state’s Low Elevation Calcareous Cove Forests. 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-Mesic Oak Forests	Eastern Panhandle Basic Oak - Hickory Forest	G3G4	S2	100%
Mixed Mesophytic Forests	Low Elevation Calcareous Cove Forest	G4G5	S2	56%
Dry Calcareous Forests, Woodlands, and Glades	Chinquapin Oak - Bitternut Hickory Limestone Forest	G3G4	S3	48%
Dry Calcareous Forests, Woodlands, and Glades	Calcareous Prairie	G1G2	S1	43%
Dry Calcareous Forests, Woodlands, and Glades	Calcareous Shale Prairie Woodland	G2	S1	38%

### 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 Conservation Actions in Forest and Woodland Habitats

Habitat Stress	Conservation Actions
Residential development	Land protection/conservation easements
Forest habitat fragmentation	Habitat protection to maintain interconnected forest patches, and forested corridors for wildlife passage between watersheds. <ul style="list-style-type: none"> <li>• Land use planning by local governments</li> <li>• Land protection/conservation easements</li> </ul>
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
Herbicide use/veg. management in utility corridors	Manage utility corridors to reduce wildlife impacts
Pesticide exposure (black-billed cuckoo and cherry gall azure)	Reduce aerial application of agricultural pesticides
Non-native invasive plants	Prevent spread through forestry operations and other ground disturbance, conduct monitoring and treatment

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 forest 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 of large number of tree species over a diversity of terrain, and many of the tree species are tolerant of drought and fire, providing some resilience to climate change. 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.

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 larger forest patches in areas with complex topography, and maintaining natural cover linkages between them, may further enable their adaptation and shifting distribution across the landscape.

On the next page 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 resemble previously listed conservation actions to reduce stress on priority species, meaning that they could have positive outcomes for priority species as well as habitat resilience. WVDNR, land managers, landowners and partners can select the actions best suited to their specific site conditions, management goals and objectives, from the list below or other sources.

## Climate Stresses and Resilience Actions for Forest and Woodland Habitats

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

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

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"> <li>• WVU Extension</li> <li>• USDA NRCS EQIP</li> <li>• WVDOF</li> <li>• Consulting Foresters</li> <li>• NWTF and RGS</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
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"> <li>• WVU Extension</li> <li>• USDA NRCS EQIP</li> <li>• WVDOF</li> <li>• Consulting Foresters</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Control invasive weeds	<ul style="list-style-type: none"> <li>• WVDOF</li> <li>• WVCA and Conservation District</li> <li>• NRCS CSP &amp; EQIP</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected or restored for priority species</li> <li>• Before and after comparison: abundance &amp; distribution of priority species</li> </ul>
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"> <li>• Public Land Managers</li> <li>• Partners</li> <li>• Utility companies</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Reduce aerial application of pesticides	<ul style="list-style-type: none"> <li>• Landowners/orchards</li> </ul>	<ul style="list-style-type: none"> <li>• Change in pesticide use</li> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Manage deer browse and reduce deer population	<ul style="list-style-type: none"> <li>• Hunting</li> <li>• WVDNR (hunting licenses)</li> <li>• Private landowners</li> <li>• WVDNR Wildlife Management Areas</li> </ul>	<ul style="list-style-type: none"> <li>• Change in deer population</li> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>

<p>Maintain forest corridors for wildlife passage between watersheds.</p>	<ul style="list-style-type: none"> <li>• USDA NRCS EQIP</li> <li>• USDA FSA CRP, CREP</li> <li>• Trout Unlimited</li> <li>• USFWS Partners for Fish and Wildlife</li> <li>• WVDOF</li> <li>• WVDEP and WVCA</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres or linear feet of habitat restored for priority species</li> <li>• Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>
<p>Promote diversity of native species and age classes in forested areas, and restore native forest vegetation on adjacent degraded lands through planting and silviculture</p>	<ul style="list-style-type: none"> <li>• WVU Extension</li> <li>• USDA NRCS EQIP</li> <li>• WVDOF</li> <li>• Consulting Foresters</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>

**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 and Calcareous Cliffs and Talus cover small areas within the CFA, and are threatened by non-native invasive plants, woody encroachment, quarrying and other development. A map illustrating the location of these rare habitat types on the east side of the CFA is on the following page, and those outside of forest patches may be more vulnerable to stresses. One priority SGCN listed for this CFA, as well as several rare plant communities associated with this CFA are listed below.

### Priority Species

The table below lists one priority species in the CFA associated with rock outcrops, cliffs and talus, and shale barrens.

Priority Species in Rock Outcrop, Cliff and Talus, and Shale Barren Habitats

TAXA	SCIENTIFIC NAME	COMMON NAME
Butterflies and Moths	Erynnis lucilius	Columbine Duskywing

### Rare Plant Communities

These habitats are home to several rare plant communities, with a significant proportion in this CFA.

Rare Plant Communities in Acid Rock Outcrops and Shale Barrens

Habitat	COMMON NAME	G RANK	S RANK	Relative Abundance
Shale Barrens	Calcareous Shale Prairie Woodland	G2	S1	38%
Acidic Rock Outcrops, Cliffs, and Talus	Sandstone Boulderfield Lichen Community	G5	S3	17%

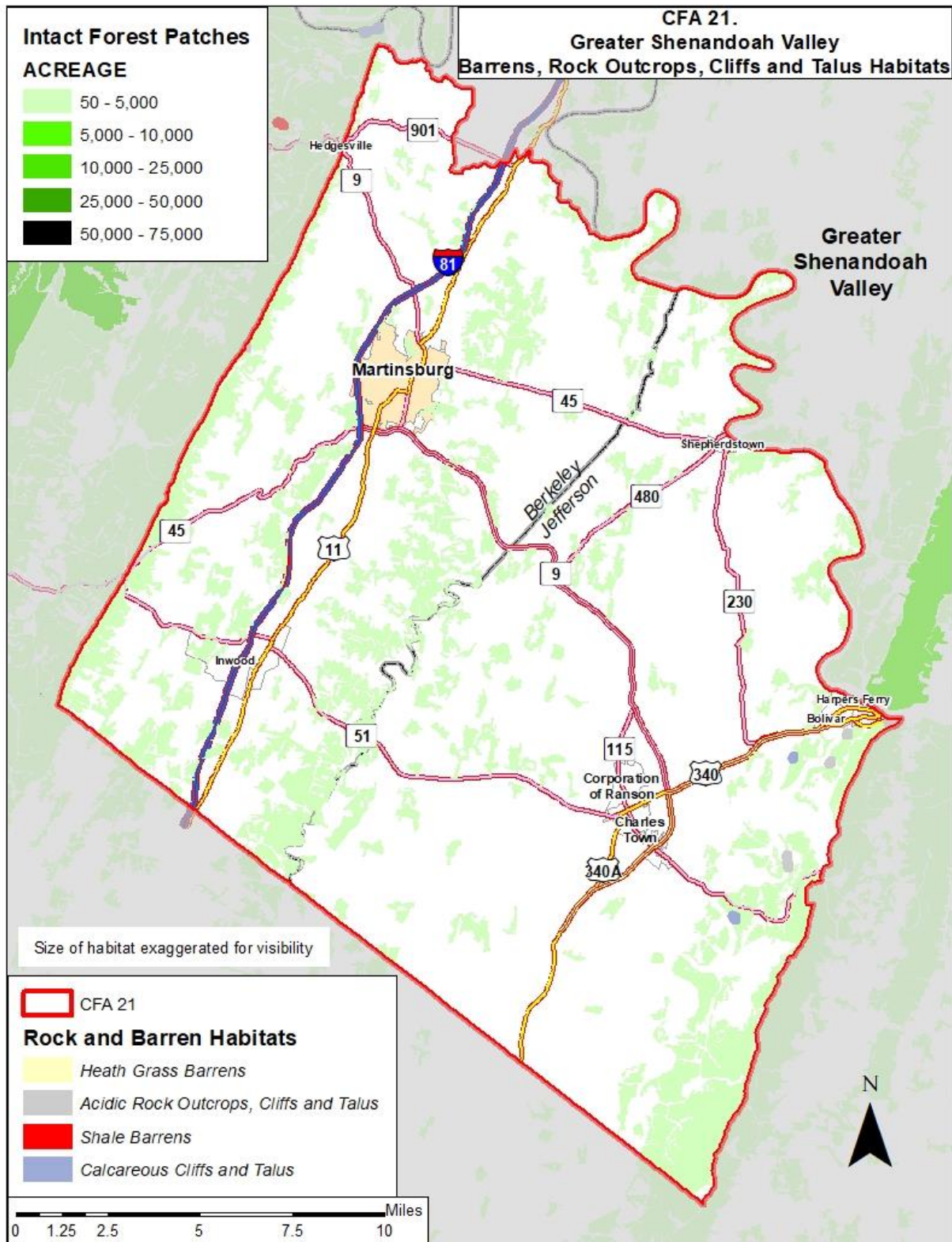
### Habitat Stresses and Conservation Actions

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

Habitat Stresses and Conservation Actions in Rock Outcrops, Cliffs and Talus, and Shale Barrens

Habitat Stress	Conservation Action
Non-native invasive plants	Targeted treatment of non-native invasive plants
Woody Encroachment; Lack of Fire	Create and maintain openings in forest canopy; Controlled burning by public agencies
Recreation and trampling	Manage recreation on sensitive sites
Quarries & development	Minimize impact on fragile habitat

*Rock Outcrop, Cliff and Talus, and Shale Barren Habitats*



## Climate Change and Habitat Resilience

As described in The Central Appalachians Forest Ecosystem Vulnerability Assessment (Butler et. al, 2015), ecosystems that are limited by geological features may be restricted from shifting across the landscape in response to climate change. These habitat types are dependent on underlying geology, so their ability to shift across the landscape in response to climate change is very limited. While they are usually adapted to extreme conditions, they may be vulnerable to increased disturbance from drought, fire and storms, and from invasion by non-native invasive plants. Maintaining intact forest ecosystems around these rare habitats, and controlling invasive species, may help maintain resilience to 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"> <li>• Increased risk of drought and wildfire</li> <li>• Increased frequency and severity of storms</li> <li>• Increased competition from non-native invasive species</li> </ul>	<ul style="list-style-type: none"> <li>• Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species</li> <li>• Protect refugia for rare habitats and plant communities</li> <li>• Maintain intact, resilient forest habitat in surrounding areas</li> </ul>

## Implementation Plan

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

### Implementation Plan for Rock Outcrop and Cliffs and Talus habitats

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> <li>• Conservation Easements</li> </ul>	<ul style="list-style-type: none"> <li>• WVDOF Forest Legacy</li> <li>• County Farmland Protection Boards</li> <li>• Land Trust of the Eastern Panhandle</li> <li>• WV Land Trust</li> <li>• The Nature Conservancy</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected for priority species</li> <li>• Abundance and diversity of priority species and habitats</li> </ul>



<b>Action</b>	<b>Partners /Programs</b>	<b>Effectiveness Measures</b>
Habitat Protection: <ul style="list-style-type: none"> <li>• Land use planning</li> </ul>	<ul style="list-style-type: none"> <li>• County Planning Commissions</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected through land use planning for development around cliffs, steep slopes, and fragile soils</li> </ul>
Habitat Protection <ul style="list-style-type: none"> <li>• Incentive Programs</li> </ul>	<ul style="list-style-type: none"> <li>• USDA NRCS CSP</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected for priority species</li> <li>• Abundance and diversity of priority species and habitats</li> </ul>
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"> <li>• WVDOP</li> <li>• WVCA and Conservation District</li> <li>• NRCS CSP</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>
Control invasive weeds	<ul style="list-style-type: none"> <li>• WVDOP</li> <li>• WVCA and Conservation District</li> <li>• NRCS CSP &amp; EQIP</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected or restored for priority species</li> <li>• Before and after comparison: abundance &amp; distribution of priority species</li> </ul>
Prescribed burning by public agencies to restore fire adapted plant communities	<ul style="list-style-type: none"> <li>• Wildlife Management Areas</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>
Minimize impact on fragile habitat	<ul style="list-style-type: none"> <li>• Quarries and developers</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected for priority species</li> <li>• Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>

<b>Action</b>	<b>Partners /Programs</b>	<b>Effectiveness Measures</b>
Manage recreation on sensitive sites	<ul style="list-style-type: none"> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat restored for priority species</li> <li>• Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>

**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

A diversity of aquatic habitats in the CFA range from warm, low-gradient headwater streams to warm, moderate gradient, large sized rivers such as sections of the Shenandoah River and Potomac River. 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 will be addressed together.

## Priority Species

The tables below list priority aquatic species in the CFA that occur in rivers and streams, riparian areas, floodplains and wetlands. This CFA contains the only occurrences of the state’s Russet-tipped Clubtail population, as well as nearly three quarters of the state’s Satinfin Shiner and Swallowtail Shiner populations. Additionally, almost half of the state’s Spotted Turtle populations can be found within this CFA. Spotted Turtles also rely on adjacent wetland habitats.

### Priority Aquatic Species

<b>TAXA</b>	<b>SCIENTIFIC NAME</b>	<b>COMMON NAME</b>
Fish	<i>Anguilla rostrata</i>	American Eel
Fish	<i>Luxilus cornutus</i>	Common Shiner
Fish	<i>Margariscus margarita</i>	Pearl Dace
*Fish	<i>Cyprinella analostana</i>	Satinfin Shiner
Fish	<i>Notropis procne</i>	Swallowtail Shiner
Mussel	<i>Lasmigona subviridis</i>	Green Floater
Mussel	<i>Lampsilis cariosa</i>	Yellow Lampmussel
Odonata	<i>Stylurus plagiatus</i>	Russet-tipped Clubtail
Reptile	<i>Clemmys guttata</i>	Spotted Turtle
Reptile	<i>Glyptemys insculpta</i>	Wood Turtle

\*These species may be extirpated; their status and location are unknown and require surveying

Because riparian, wetland and floodplain habitats are so closely connected to adjacent rivers and streams, they host some of the same species, such as Wood Turtles. Bank Swallows rely on riparian and floodplain habitats, as do rare plants including Spotted Joe-Pyeweed, River Bulrush, and Largeleaf Grass-of-parnassus, the current status of which is unknown.

### Priority Riparian, Wetland and Floodplain Species

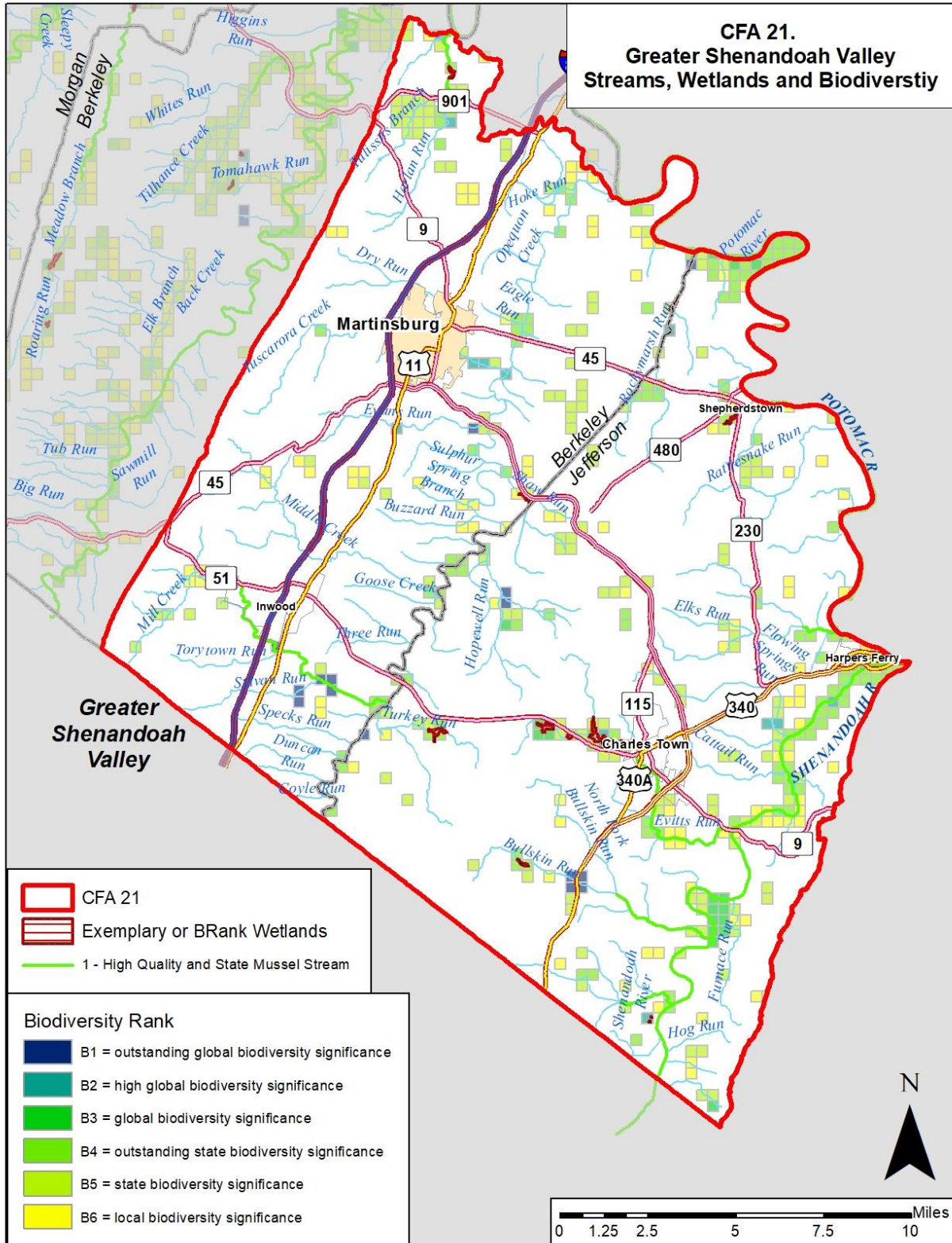
<b>TAXA</b>	<b>SCIENTIFIC NAME</b>	<b>COMMON NAME</b>
Birds	<i>Riparia riparia</i>	Bank Swallow
Plants	<i>Juncus balticus</i> var. <i>littoralis</i>	Baltic Rush

Plants	<i>Eleocharis rostellata</i>	Beaked Spikerush
Plants	<i>Carex conoidea</i>	Field Sedge
Plants	<i>Schoenoplectus acutus</i> var. <i>acutus</i>	Hardstem Bulrush
Plants	<i>Zannichellia palustris</i>	Horned Pondweed
Plants	<i>Juncus nodosus</i> var. <i>nodosus</i>	Knotted Rush
*Plants	<i>Parnassia grandifolia</i>	<i>Largeleaf Grass-of-parnassus</i>
Plants	<i>Carex comosa</i>	Longhair Sedge
Plants	<i>Carex prairea</i>	Prairie Sedge
Plants	<i>Carex suberecta</i>	Prairie Straw Sedge
Plants	<i>Carex tetanica</i>	Rigid Sedge
Plants	<i>Bolboschoenus fluviatilis</i>	River Bulrush
Plants	<i>Eupatorium maculatum</i> var. <i>maculatum</i>	Spotted Joe-pyeweed
Plants	<i>Hydrocotyle ranunculoides</i>	Swamp Pennywort
Plants	<i>Juncus torreyi</i>	Torrey's Rush
Plants	<i>Carex pellita</i>	Woolly Sedge
Plants	<i>Carex lasiocarpa</i> var. <i>americana</i>	Woolly-fruit Sedge

*\*These species may be extirpated; their status and location are unknown and will require surveying.*

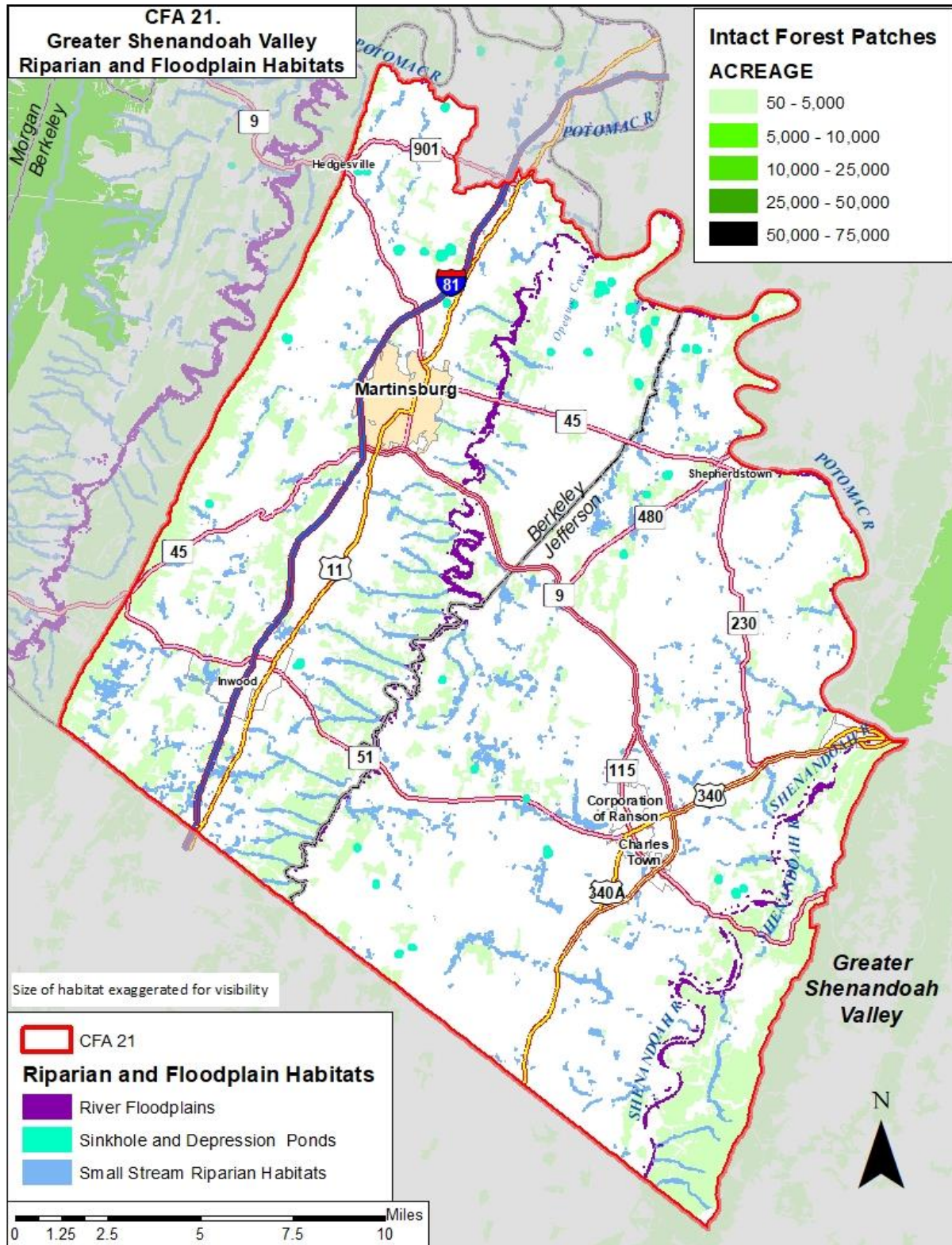
Maps illustrating riparian and floodplain habitats, mussel streams (mapped by WVDNR in 2018), exemplary wetlands (as assembled by WVDNR in 2015) and biodiversity are on the following pages. Mill Creek, the Shenandoah and Potomac Rivers are designated state mussel streams with large clusters of biodiversity occurrences. There are exemplary wetlands along Bullsken Run, Evitts Run, Harlan Run, Shaw Run, Turkey Run, and Town Marsh near Shepherdstown. Floodplain habitats along Opequon Creek and the Shenandoah River, and riparian habitats on many other streams provide important habitat and maintain the form and functions of streams and rivers. Those outside of forest patches may be more vulnerable to stresses. These aquatic, floodplain and riparian habitats require careful management to sustain priority species.

Streams, Wetlands and Biodiversity





Riparian and Floodplain Habitats





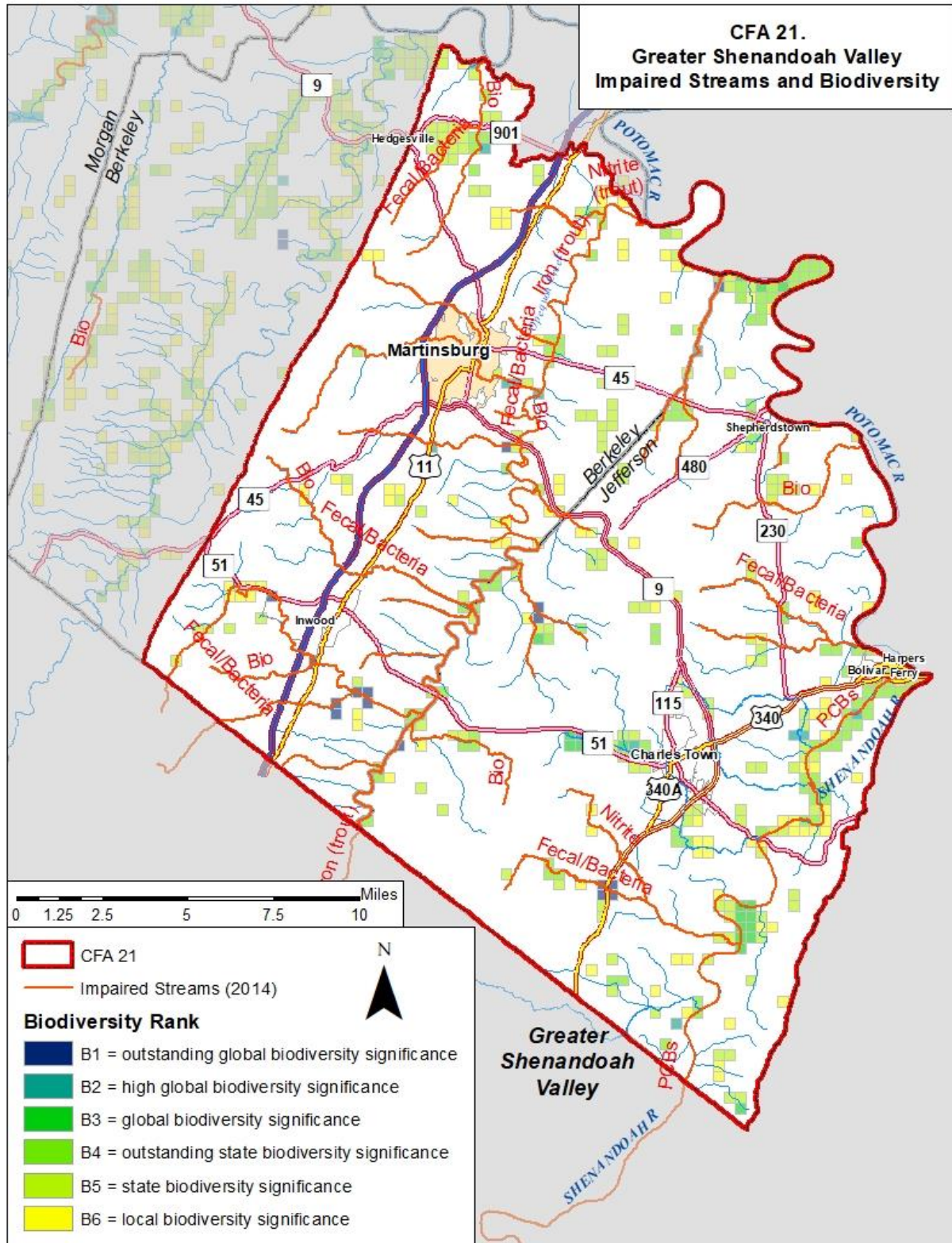
## Rare Plant Communities

The following rare plant communities may be found in aquatic, floodplain, and riparian habitats in this CFA. Note that all of the state's Shenandoah Bedrock Scour Bar Herbaceous Vegetation and Shenandoah Valley Marl Fern, and over 80% of its Marl Swamp Forest plant community are found in this CFA. 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.

### Rare Plant Communities in Aquatic, Floodplain and Riparian Habitats.

Habitat	COMMON NAME	G RANK	S RANK	Relative Abundance
River Floodplains	Shenandoah Bedrock Scour Bar Herbaceous Vegetation	GNR	S1	100%
Small Stream Riparian Habitats	Shenandoah Valley Marl Fen	G1Q	S1	100%
Small Stream Riparian Habitats	Marl Swamp Forest	G4	S1	86%
River Floodplains	Green Ash - Silver Maple Swamp	G4	S1	67%
River Floodplains	Potomac River Rich Floodplain Forest	G4	S2	67%
Small Stream Riparian Habitats	Green Ash - Silver Maple Swamp	G4	S1	67%
River Floodplains	Potomac River Silver Maple Floodplain Forest	G4	S2	60%
Small Stream Riparian Habitats	Potomac River Silver Maple Floodplain Forest	G4	S2	60%
River Floodplains	Giant Bur-Reed Marsh	G4G5	S2	27%
Small Stream Riparian Habitats	Giant Bur-Reed Marsh	G4G5	S2	27%
River Floodplains	Bitternut Hickory Floodplain Forest	G2G3	S1	15%
Sinkhole and Depression Ponds	Sinkhole Marsh	G1	S1	15%
River Floodplains	Big Bluestem - Blue Wild Indigo Riverscour Prairie	G3	S1	12%
High Allegheny Wetlands	Silky Willow Shrub Swamp	GNR	S2S3	8%
Small Stream Riparian Habitats	Pondweed - Mixed Aquatic Riverbed	G4?	S2	8%
Small Stream Riparian Habitats	Silky Willow Shrub Swamp	GNR	S2S3	8%
River Floodplains	Lizard's Tail Backwater Slough	G3	S2	6%
Small Stream Riparian Habitats	Lizard's Tail Backwater Slough	G3	S2	6%

Impaired Streams and Biodiversity



## 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 and Spotted 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 stream impairments to water quality (as listed by WVDEP in 2014), along with biodiversity, is on the previous page. Several impaired streams are home to clusters of SGCN and biological diversity. Improving water quality in these impaired streams is an important conservation action, especially where priority SGCN are present.

### Habitat Stresses and Conservation Actions for Aquatic, Floodplain and Riparian Habitat

<b>Habitat Stress</b>	<b>Conservation Actions</b>
Loss of instream habitat	Instream and riparian habitat restoration
Warming waters	Planting buffer zones
Water quality: loss of riparian vegetation, sedimentation	Planting and fencing stream buffer zones, landowner outreach
Water quality: wastewater and effluents	Treatment of wastewater and effluents
Invasive plants	Targeted treatment of cattail and other invasive plants
Aquatic passage barriers	Remove or modify barriers
Degradation of riparian habitat corridors, decline in aerial insects for bank swallows	Restore riparian corridors, monitor and survey nest colonies, outreach to landowners
Invasives, sedimentation, grazing, mowing in marl marshes	Fencing and protection of marl marshes

## 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.

The Assessment also describes how instream habitats and associated plant and animal species may be stressed by climate change-related increases in temperature, droughts, flood frequency and severity, and resulting erosion and sedimentation. Low flow events may also become more frequent and severe. Warming surface waters is likely to result in water quality degradation and eutrophication. Many aquatic species and life stages are adapted to specific timing and ranges of flow and temperature, as

well as water quality variables. Climate change may impact different species and life stages in different ways. Cold water habitats and aquatic communities may be at particular risk. Areas within a watershed may be more or less sensitive to increases in air temperature, depending on local factors such as watershed characteristics, position within the watershed, upstream land uses, groundwater contributions, forest cover and shading.

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

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

#### Climate Stresses and Resilience Actions for Aquatic, Floodplain and Riparian Habitat

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

### 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

<b>Action</b>	<b>Partners /Programs</b>	<b>Effectiveness Measures</b>
Habitat Protection: <ul style="list-style-type: none"> <li>• Conservation Easements</li> </ul>	<ul style="list-style-type: none"> <li>• County Farmland Protection Boards</li> <li>• Land Trust of the Eastern Panhandle</li> <li>• WV Land Trust</li> <li>• Potomac Conservancy</li> <li>• The Nature Conservancy</li> <li>• USDA Natural Resource Conservation Service ACEP</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of aquatic and riparian habitat protected for priority species</li> <li>• Abundance and diversity of priority species and habitats</li> </ul>
Habitat Protection: <ul style="list-style-type: none"> <li>• Land Use Planning</li> </ul>	<ul style="list-style-type: none"> <li>• County Planning Commissions</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected through land use planning, floodplain, and stormwater regulations</li> </ul>
Habitat Protection <ul style="list-style-type: none"> <li>• Incentive Programs</li> </ul>	<ul style="list-style-type: none"> <li>• USDA Farm Service Agency CRP and CREP</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of aquatic and riparian habitat protected for priority species</li> <li>• Abundance and diversity of priority species and habitats</li> </ul>
In-stream and riparian habitat restoration, streambank stabilization and floodplain re-connection	<ul style="list-style-type: none"> <li>• USDA NRCS EQIP</li> <li>• USDA FSA CREP</li> <li>• Trout Unlimited</li> <li>• USFWS Partners for Fish and Wildlife</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres or linear feet of in-stream and riparian habitat restored for priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Planting and fencing stream buffer zones	<ul style="list-style-type: none"> <li>• USDA NRCS EQIP</li> <li>• USDA FSA CREP</li> <li>• Trout Unlimited</li> <li>• USFWS Partners for Fish and Wildlife</li> <li>• WVDOF</li> <li>• WVDEP and WVCA</li> </ul>	<ul style="list-style-type: none"> <li>• Acres or linear feet of stream buffer zones planted and fenced to protect priority species</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Improved wastewater and stormwater treatment	<ul style="list-style-type: none"> <li>• WVDEP</li> <li>• WVDHHR</li> <li>• County governments</li> </ul>	<ul style="list-style-type: none"> <li>• # wastewater and stormwater systems installed or improved</li> <li>• Change in fecal, sediment and other water quality measurements</li> <li>• Before and after comparison: abundance &amp; distribution of priority species</li> </ul>



Action	Partners /Programs	Effectiveness Measures
Clean, enlarge or remove culverts and stream crossings for higher peak flow and aquatic organism passage	<ul style="list-style-type: none"> <li>• Trout Unlimited</li> <li>• Public Land Managers</li> <li>• USFWS Partners for Fish and Wildlife</li> </ul>	<ul style="list-style-type: none"> <li>• # barriers re-designed or removed</li> <li>• # miles stream opened</li> <li>• Before and after comparison: abundance &amp; distribution of priority species</li> </ul>
Reduce flood impacts  see also: <ul style="list-style-type: none"> <li>• Remove or re-design barriers</li> <li>• Planting and fencing stream buffer zones</li> <li>• Restoration of in-stream and riparian habitat</li> </ul>	<ul style="list-style-type: none"> <li>• County Planning Departments</li> </ul>	
Treat and underplant remaining riparian hemlock stands along headwater streams	<ul style="list-style-type: none"> <li>• Trout Unlimited</li> <li>• USFWS Partners for Fish and Wildlife</li> <li>• U.S. Forest Service</li> <li>• WVDNR</li> </ul>	<ul style="list-style-type: none"> <li>• Acres or linear feet of riparian area treated</li> <li>• Treatment and planting success rate</li> </ul>
Improve water quality in streams and wetlands	<ul style="list-style-type: none"> <li>• WVDEP and WVCA</li> <li>• NRCS EQIP &amp; CSP</li> <li>• FSA CRP &amp; CREP</li> </ul>	<ul style="list-style-type: none"> <li>• Change in water quality measurements</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Improve pH in headwater streams	<ul style="list-style-type: none"> <li>• WVDEP</li> <li>• WVDNR</li> </ul>	<ul style="list-style-type: none"> <li>• Change in water quality measurements</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>
Treat cattail and other invasive plants in wetlands	<ul style="list-style-type: none"> <li>• NRCS EQIP</li> <li>• FSA CRP and CREP</li> <li>• USFWS Partners for Fish and Wildlife</li> <li>• Public Land Managers</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of wetland treated</li> <li>• Treatment success rate</li> <li>• Before and after comparison: abundance and diversity of priority species</li> </ul>

### 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 (troglobites) include blindness (or complete loss of eyes) and reduced pigmentation. The map on the following page illustrates vast areas with karst geology (based on maps from the WV Geologic and Economic Survey in 1998) on the west side of the CFA and east of Opequon Creek. The map on the subsequent page illustrates karst feature density with 3-kilometer buffers offset randomly, and one biologically significant cave on the east side, with a 3-mile random offset buffer. Caves classified by WVDNR as biologically significant may host rare bat or endemic cave species, or exceptional biodiversity. These areas require careful management to minimize disturbance on karst and cave habitats.

### Priority Species

Caves in this CFA host the following priority species, all of which are rare and dependent on specific cave habitats for their survival. Of special significance, this CFA hosts the entirety of the state's Biggers' Cave Amphipod, Madison Cave Isopod, and Potomac Groundwater Amphipod, as well as and 85% of the state's Price's Cave Isopod, and 75% of the State's Shenandoah Valley cave Amphipod.

#### Priority Species in Subterranean Habitats

TAXA	SCIENTIFIC NAME	COMMON NAME
Cave Invertebrates	Erebomaster nr. acanthina	A Cave Spider
Cave Invertebrates	Stygobromus allegheniensis	Allegheny Cave Amphipod
Cave Invertebrates	Stygobromus biggersi	Biggers' Cave Amphipod
Cave Invertebrates	Antrolana lira	Madison Cave Isopod
Cave Invertebrates	Stygobromus tenuis potomacus	Potomac Groundwater Amphipod
Cave Invertebrates	Caecidotea pricei	Price's Cave Isopod
Cave Invertebrates	Stygobromus gracilipes	Shenandoah Valley Cave Amphipod

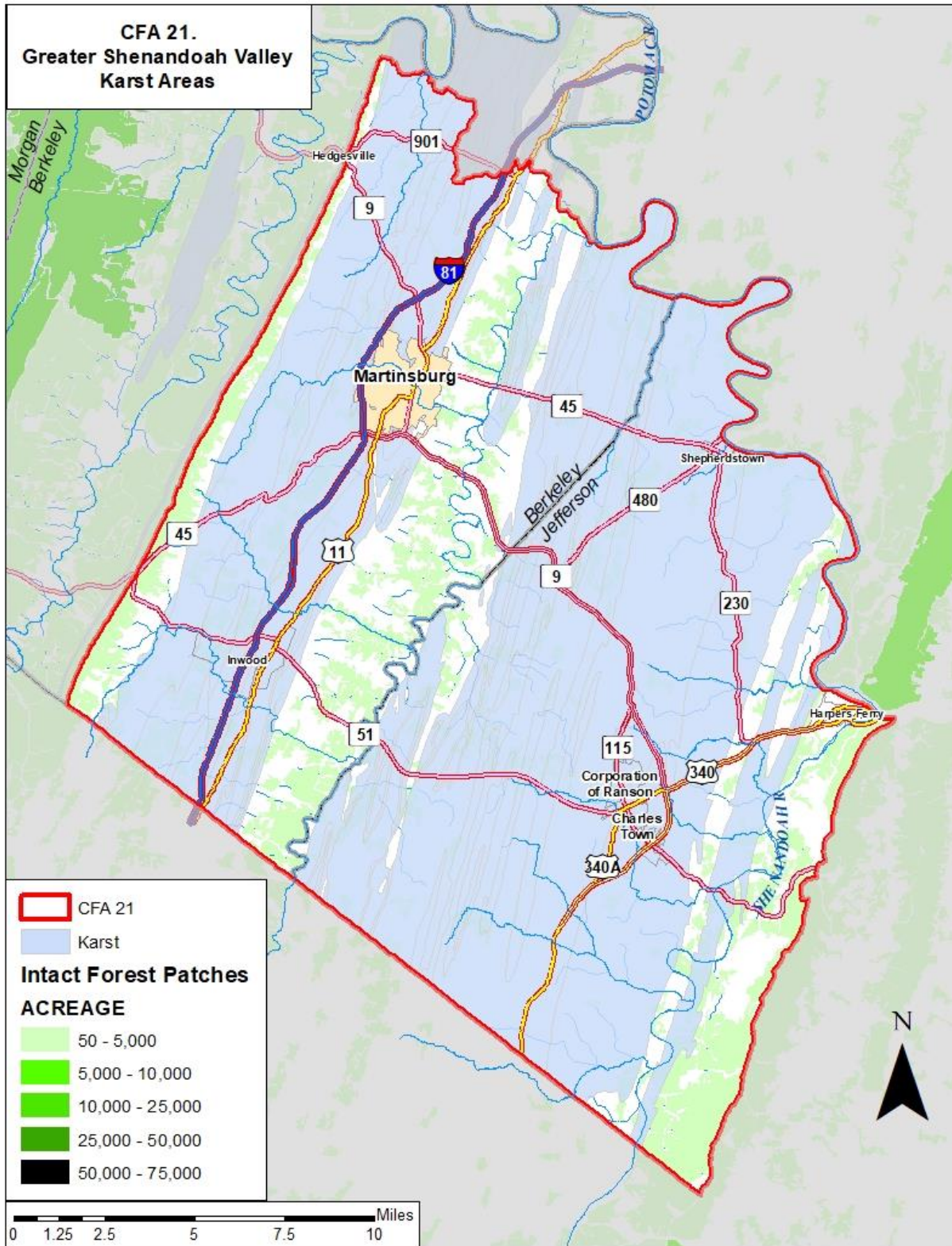
### Habitat Stresses and Conservation Actions

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 to address them.

#### Habitat Stresses and Conservation Actions in Subterranean Habitats

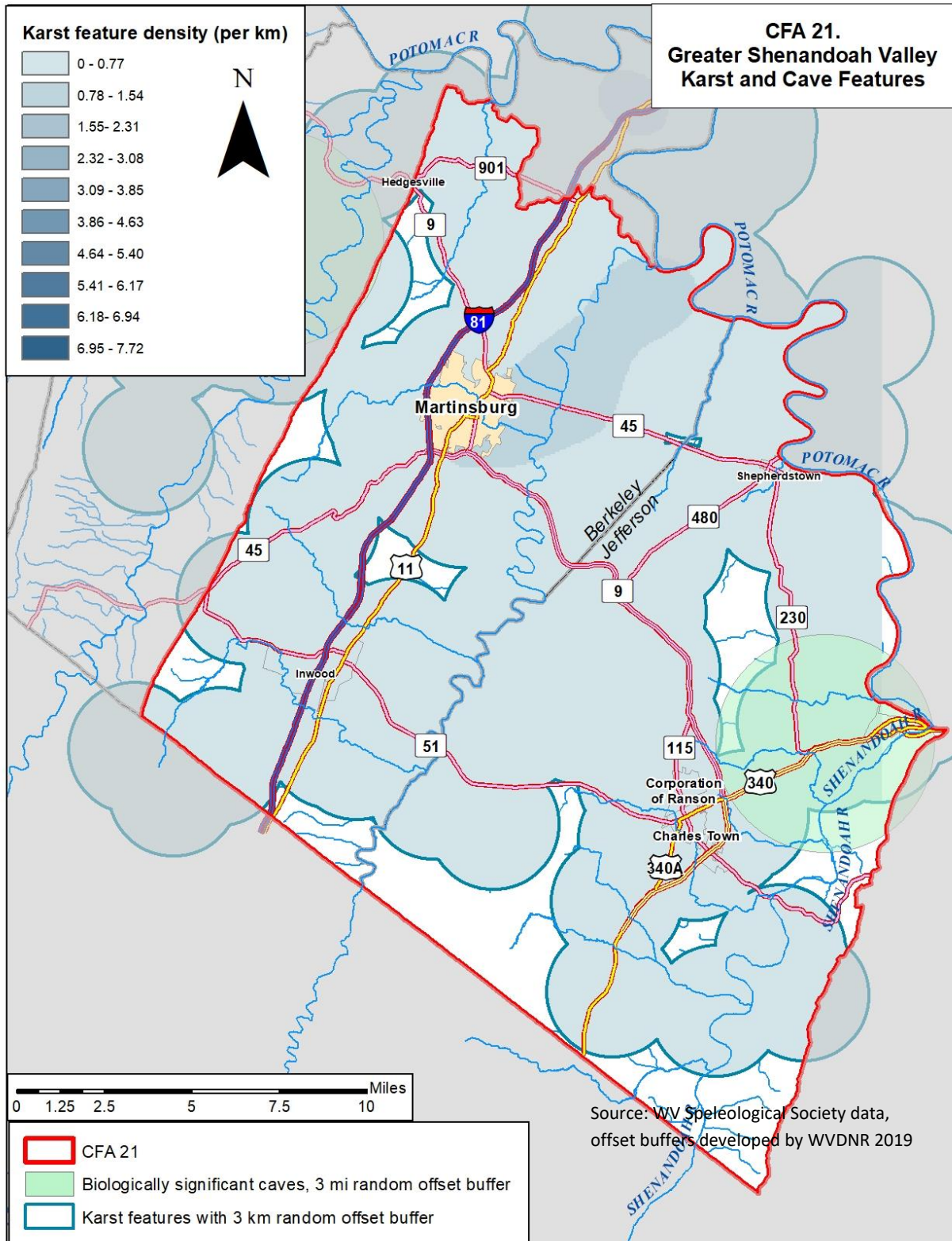
Habitat Stress	Conservation Action
Water quality	Education, wastewater treatment, fencing, riparian plantings
Land use changes	Land protection, land use planning and careful management around caves

Karst Areas





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 caves and karst areas 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 a 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. 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 Karst and Cave Habitats

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

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

### 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 more developed lands in residential and urban areas. Most agricultural areas and developed areas are in valley bottoms and floodplains. A map on the following page shows the extensive coverage of agricultural and developed lands and illustrates that there are many examples of biodiversity occurrences in and around these areas in the CFA. Maintaining natural vegetation within agricultural areas is a priority for SGCN associated with these habitats.

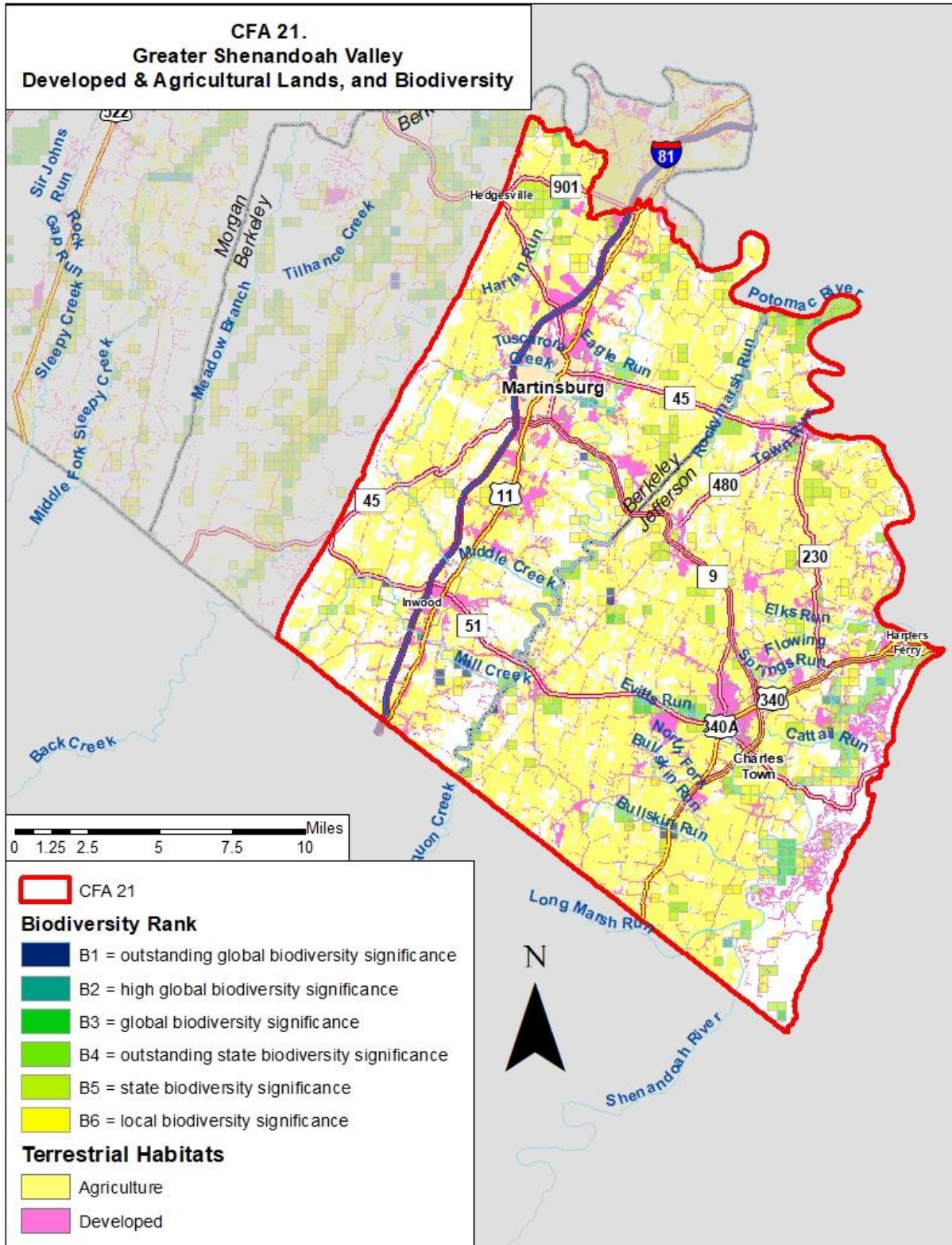
## Priority Species

Pastures and hayfields in agricultural lands, 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. 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.

### Priority Species in Agricultural and Developed Habitats

TAXA	SCIENTIFIC NAME	COMMON NAME
Birds	<i>Falco sparverius</i>	American Kestrel
Birds	<i>Tyto alba</i>	Barn Owl
Birds	<i>Dolichonyx oryzivorus</i>	Bobolink
Birds	<i>Chaetura pelagica</i>	Chimney Swift
Birds	<i>Chordeiles minor</i>	Common Nighthawk
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</i>	Loggerhead Shrike
Birds	<i>Lanius ludovicianus migrans</i>	Migrant Loggerhead Shrike
Birds	<i>Colinus virginianus</i>	Northern Bobwhite
Birds	<i>Falco peregrinus</i>	Peregrine Falcon
Birds	<i>Pooecetes gramineus</i>	Vesper Sparrow
Birds	<i>Icteria virens</i>	Yellow-breasted Chat
Butterflies and Moths	<i>Staphylus hayhurstii</i>	Hayhurst's Scallopwing

Agricultural and Developed Lands, and Biodiversity



## 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. The timing of agricultural practices also impacts some priority species. For example, 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. The table below lists stresses to wildlife habitat in agricultural areas, and conservation actions to address them.

Habitat Stresses and Conservation Actions in Agricultural and Developed Lands

Habitat Stress	Conservation Actions
Residential development	Land protection, conservation easements
Clean farming practices: loss of woody veg., insufficient habitat, predation	Retain or plant shrubs, hedgerows and hawthorns in pastures, and early successional habitat
Clean farming practices: grassland conversion	Prevent conversion of grasslands to croplands
Grassland bird nest loss from early haying	Delay hay harvest
Herbicide/veg. management in utility corridors	Manage utility corridors for wildlife habitat
Disturbance of peregrine falcon nest site(s)	Engage with property managers to minimize nest disturbance
Insufficient nest microhabitat	Install and monitor nest boxes
Barn owl poisoning from rodenticides	Outreach to landowners to reduce rodenticides
Rubberized roofs on new construction	Outreach to owners of gravel roofs, install gravel nest pads for common nighthawks
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.

Janowiak 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 reinforce conservation actions to reduce stress on priority species in agricultural and developed habitats. WVDNR, partners and landowners can collaborate to select the habitat resilience actions best suited to site conditions, conservation goals and land management objectives.

#### Climate Stresses and Resilience Actions for Agricultural and Developed Lands

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

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

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

### 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.



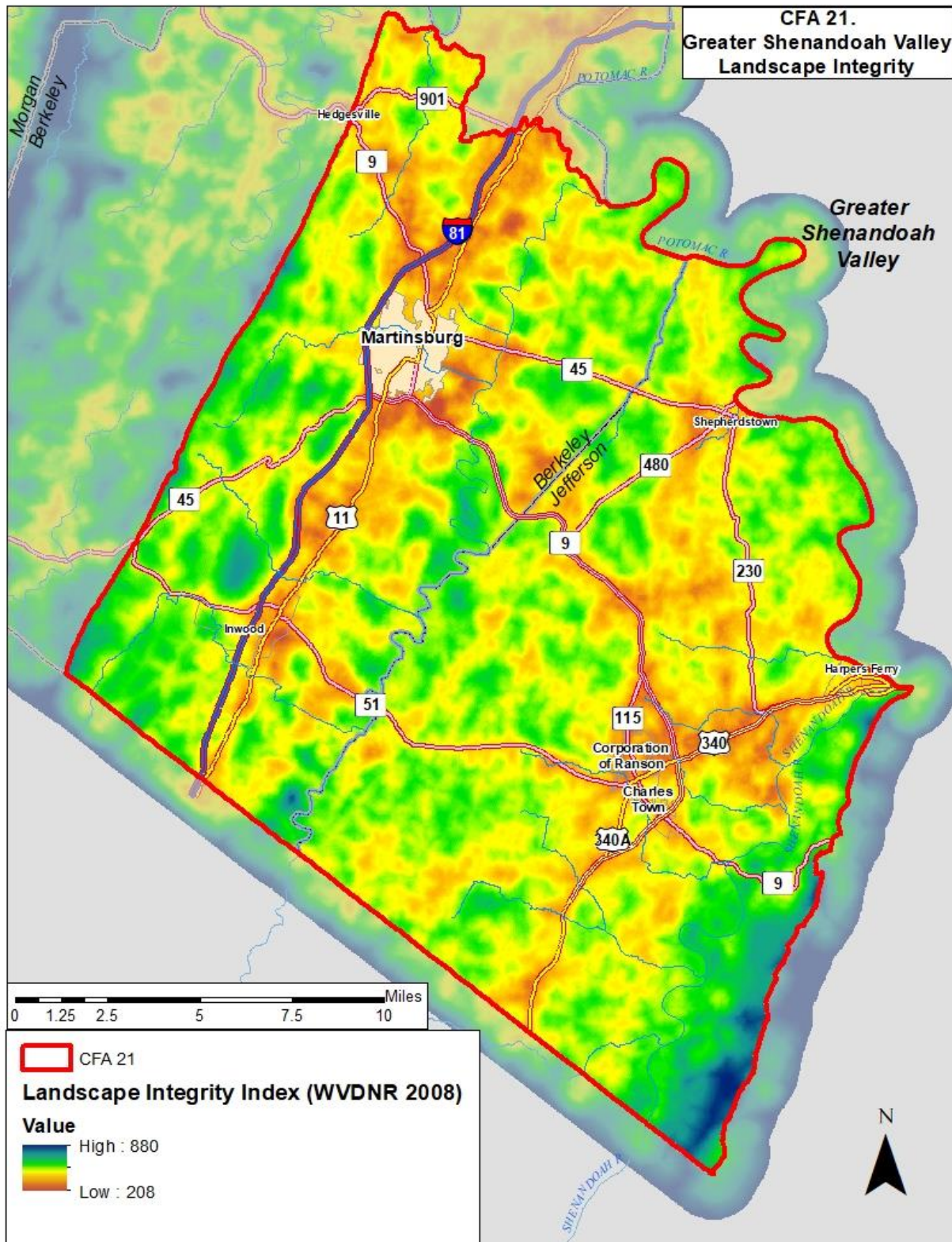
## Landscape Resilience and Connectivity

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. There are some moderately high integrity landscapes corresponding with forest patches along Opequon Creek, the Shenandoah and Potomac Rivers, and the edges of the CFA. Aside from Shannondale Springs WMA, most of these areas are in private ownership. These areas are important for species movement in response to climate change and are priorities for protection of wildlife habitat in this CFA.

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.

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:

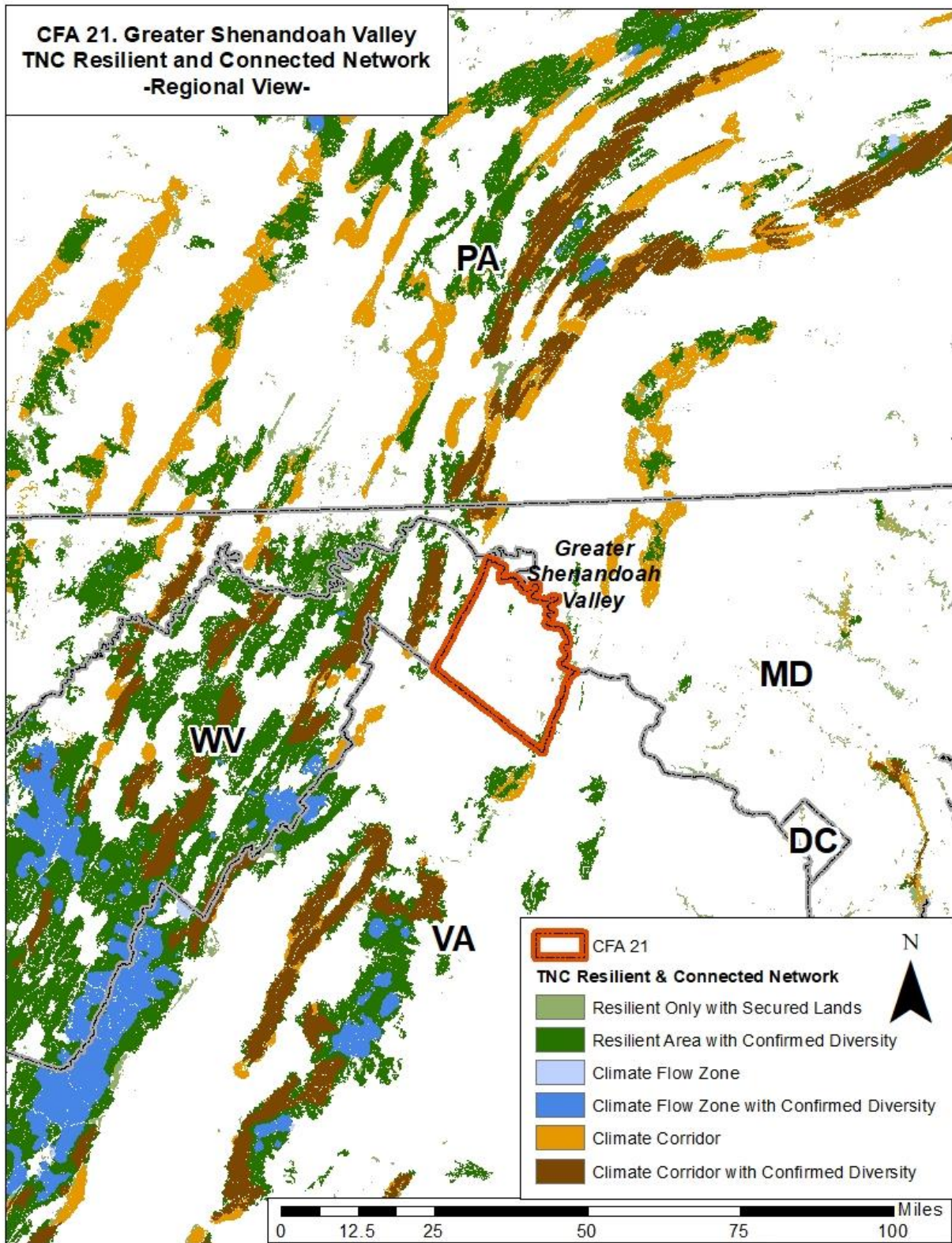
- Resilient area: a place buffered from climate change because it contains diverse, complex, connected landscapes with many micro-climates that create options for species adapting to climate change.
- Climate corridor: a narrow conduit of natural cover in which the movement of plants and animals becomes 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.

Following the regional map is a more detailed view of the Shenandoah Valley CFA. While the Greater Shenandoah Valley CFA does not contain large forested areas and corridors connected to TNC's priority resilient, connected network, it does contain smaller patches and corridors of resilient lands along the Shenandoah and Potomac rivers, Opequon Creek and Little North Mountain. These smaller networks may enable some climate adaptation at a local level and provide linkages to the larger network.

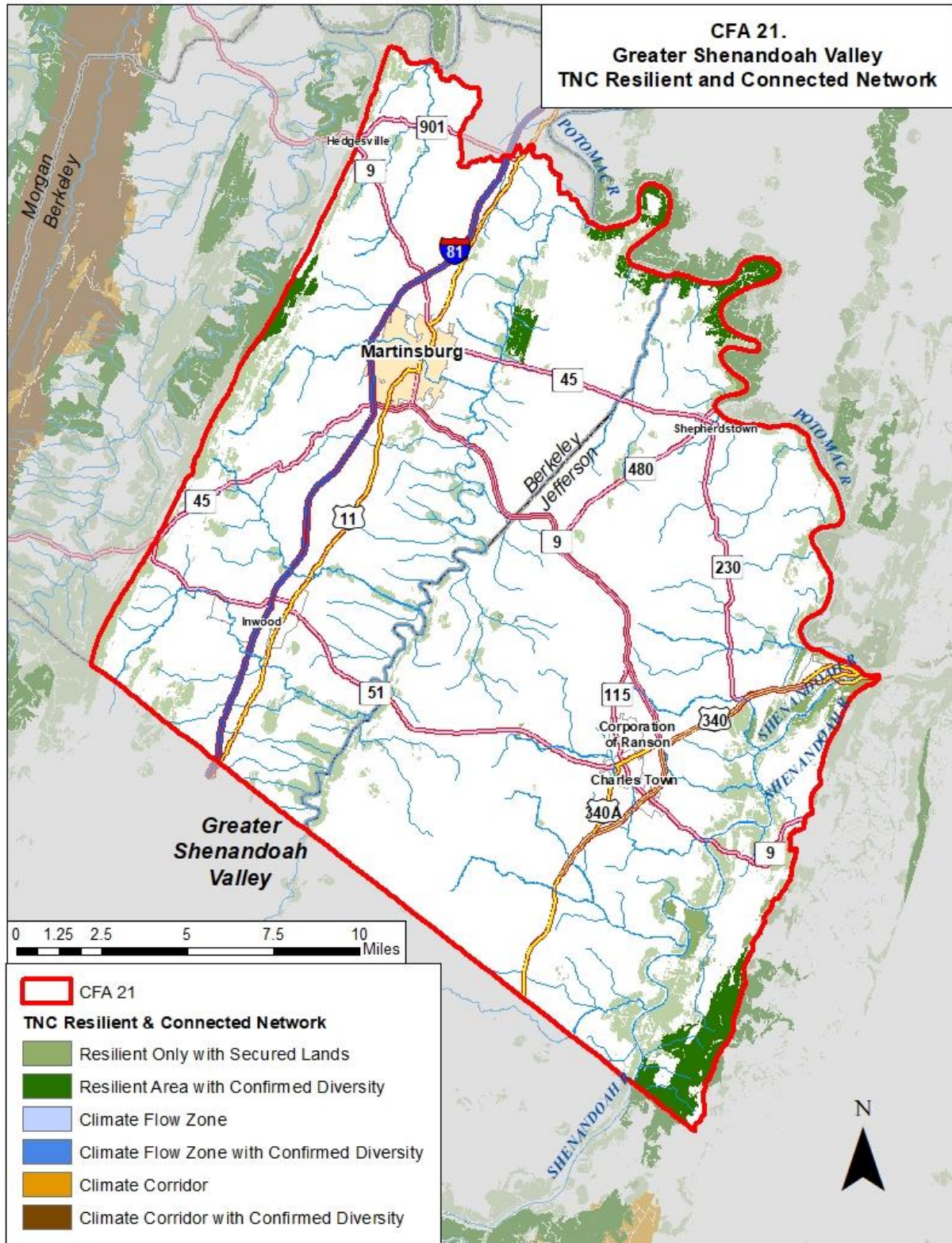


TNC Resilient and Connected Network – Regional View





TNC Resilient and Connected Network – Greater Shenandoah Valley 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"> <li>• Changing conditions exacerbating existing stresses on species and habitat</li> <li>• Species responding to climate change by shifting locally as well as across the landscape</li> <li>• Landscape fragmentation that prevents or constrains species movement</li> </ul>	<ul style="list-style-type: none"> <li>• Restore, protect, and maintain a connected network of resilient landscapes for species to adapt and shift locally and regionally in response to climate change</li> </ul>

**Implementation Plan**

The small networks of resilient and connected lands in this CFA provide critical links to the larger network of resilient and connected landscapes in West Virginia, Maryland, Virginia, and through Eastern North America. These small networks 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

Implementation Plan for Climate Adaptation

Action	Partners /Programs	Effectiveness Measures
Protection of Resilient, Connected Landscapes <ul style="list-style-type: none"> <li>• Conservation Easements</li> </ul>	<ul style="list-style-type: none"> <li>• County Farmland Protection Boards</li> <li>• Potomac Conservancy</li> <li>• WV Land Trust</li> <li>• The Nature Conservancy</li> <li>• NRCS ACEP</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected for priority species in resilient landscapes and climate corridors</li> <li>• Abundance and diversity of priority species and habitats</li> </ul>
Protection of Resilient, Connected Landscapes <ul style="list-style-type: none"> <li>• Land use planning</li> </ul>	<ul style="list-style-type: none"> <li>• County Planning Commissions</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected through land use planning in resilient, connected landscapes</li> </ul>
Protection of Resilient, Connected Landscapes <ul style="list-style-type: none"> <li>• Incentive Programs</li> </ul>	<ul style="list-style-type: none"> <li>• FSA CRP and CREP</li> </ul>	<ul style="list-style-type: none"> <li>• Acres of habitat protected for priority species in resilient landscapes and climate corridors</li> <li>• Abundance and diversity of priority species and habitats</li> </ul>

<p>Protection of Resilient, Connected Landscapes</p> <ul style="list-style-type: none"><li>• Conservation and Management</li></ul>	<ul style="list-style-type: none"><li>• Public Land Managers</li><li>• WV Division of Natural Resources</li><li>• Partner Organizations</li></ul>	<ul style="list-style-type: none"><li>• Acres of habitat protected, restored, and maintained in resilient landscapes and climate corridors</li><li>• Abundance &amp; distribution of priority species and habitats</li></ul>
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## Conclusion

### Habitat Conservation Priorities

This action plan lists priority species and rare plant communities targeted for conservation action on public and private land and within each major habitat type. The major habitat types include forests and woodlands; 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 habitats identified by this Action Plan for conservation action within each major habitat type.

- Intact forest patches, including interior forest habitat and 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
- Special aquatic habitats, such as mussel streams, brook trout habitat patches and wetlands
- Small stream riparian and river floodplain habitats
- 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, 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 landscapes or cave watersheds, may benefit additional species.

Private landowners, public land managers and conservation partners are encouraged to focus resources across habitats to maximize benefits to multiple species in areas targeted for action in ways.

### 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 resilient and connected lands is also critical for enabling wildlife species to adapt to changing conditions and shift across the landscape.

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

### Next Steps in Implementation

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

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

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

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## Appendix 1. SGCN in Greater Shenandoah Conservation Focus Area

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Amphibians	<i>Ambystoma jeffersonianum</i>	Jefferson Salamander	S2	G4
Amphibians	<i>Desmognathus fuscus</i>	Northern Dusky Salamander	S5	G5
Amphibians	<i>Desmognathus monticola</i>	Seal Salamander	S5	G5
Amphibians	<i>Eurycea bislineata</i>	Northern Two-lined Salamander	S5	G5
Amphibians	<i>Eurycea longicauda</i>	Longtail Salamander	S5	G5
Amphibians	<i>Gyrinophilus porphyriticus porphyriticus</i>	Northern Spring Salamander	S5	G5T5
Amphibians	<i>Plethodon hoffmani</i>	Valley And Ridge Salamander	S4	G5
Amphibians	<i>Pseudotriton ruber ruber</i>	(northern) Red Salamander	S3	G5
Amphibians	<i>Anaxyrus fowleri</i>	Fowler's Toad	S5	G5
Amphibians	<i>Acris crepitans</i>	Northern Cricket Frog	S2	G5
Amphibians	<i>Pseudacris feriarum</i>	Upland Chorus Frog	S3	G5
Birds	<i>Butorides virescens</i>	Green Heron	S3B	G5
Birds	<i>Lophodytes cucullatus</i>	Hooded Merganser	S1B,S4N	G5
Birds	<i>Mergus merganser</i>	Common Merganser	S3B,S3N	G5
Birds	<i>Pandion haliaetus</i>	Osprey	S2B	G5
Birds	<i>Haliaeetus leucocephalus</i>	Bald Eagle	S3B,S3N	G5
Birds	<i>Buteo platypterus</i>	Broad-winged Hawk	S3B	G5
Birds	<i>Falco sparverius</i>	American Kestrel	S3B	G5
Birds	<i>Falco peregrinus</i>	Peregrine Falcon	S2B,S2N	G4
Birds	<i>Colinus virginianus</i>	Northern Bobwhite	S1B, S1N	G5
Birds	<i>Rallus limicola</i>	Virginia Rail	S1B,S1N	G5
Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	S2B	G5
Birds	<i>Tyto alba</i>	Barn Owl	S2B,S2N	G5
Birds	<i>Chordeiles minor</i>	Common Nighthawk	S2B	G5
Birds	<i>Antrostomus 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

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Birds	<i>Eremophila alpestris</i>	Horned Lark	S2B,S3N	G5
Birds	<i>Riparia riparia</i>	Bank Swallow	S2B	G5
Birds	<i>Petrochelidon pyrrhonota</i>	Cliff Swallow	S3B	G5
Birds	<i>Hylocichla mustelina</i>	Wood Thrush	S3B	G5
Birds	<i>Lanius ludovicianus</i>	Loggerhead Shrike	S1B,S1N	G4
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 caerulescens</i>	Black-throated Blue Warbler	S3B	G5
Birds	<i>Setophaga discolor</i>	Prairie Warbler	S3B	G5
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler	S2B	G4
Birds	<i>Protonotaria citrea</i>	Prothonotary Warbler	S2B	G5
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler	S3B	G5
Birds	<i>Geothlypis formosa</i>	Kentucky Warbler	S3B	G5
Birds	<i>Icteria virens</i>	Yellow-breasted Chat	S3B	G5
Birds	<i>Spiza americana</i>	Dickcissel	S1B	G5
Birds	<i>Spizella pusilla</i>	Field Sparrow	S3B	G5
Birds	<i>Pooecetes gramineus</i>	Vesper Sparrow	S2B, S2N	G5
Birds	<i>Ammodramus savannarum</i>	Grasshopper Sparrow	S3B	G5
Birds	<i>Ammodramus henslowii</i>	Henslow's Sparrow	S1B	G4
Birds	<i>Dolichonyx oryzivorus</i>	Bobolink	S3B	G5
Birds	<i>Sturnella magna</i>	Eastern Meadowlark	S3B, S2N	G5
Fish	<i>Anguilla rostrata</i>	American Eel	S2	G4
Fish	<i>Hybognathus regius</i>	Eastern Silvery Minnow	S1	G5
Fish	<i>Notropis amoenus</i>	Comely Shiner	S3	G5
Fish	<i>Notropis procne</i>	Swallowtail Shiner	S1	G5
Fish	<i>Cyprinella analostana</i>	Satinfin Shiner	S1	G5
Fish	<i>Luxilus cornutus</i>	Common Shiner	S1S2	G5
Fish	<i>Margariscus margarita</i>	Pearl Dace	S2S3	G5
Fish	<i>Erimyzon oblongus</i>	Creek Chubsucker	S3	G5
Fish	<i>Moxostoma macrolepidotum</i>	Shorthead Redhorse	S1	G5

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
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
Fish	<i>Percina peltata</i>	Shield Darter	S1	G5
Mammals	<i>Myotis septentrionalis</i>	Northern Myotis	S2*	G2G3
Mammals	<i>Nycticeius humeralis</i>	Evening Bat	S1	G5
Mammals	<i>Zapus hudsonius</i>	Meadow Jumping Mouse	S3	G5
Mammals	<i>Erethizon dorsatum</i>	Porcupine	S3	G5
Reptiles	<i>Clemmys guttata</i>	Spotted Turtle	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>Plestiodon laticeps</i>	Broad-headed Skink	S2	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>Opheodrys aestivus</i>	Rough Greensnake	S2	G5
Reptiles	<i>Regina septemvittata</i>	Queen Snake	S4	G5
Reptiles	<i>Liochlorophis vernalis</i>	Smooth Greensnake	S5	G5
Reptiles	<i>Agkistrodon contortrix mokasen</i>	Northern Copperhead	S5	G5T5
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake	S3	G4
Cave Invertebrates	<i>Caecidotea pricei</i>	Price's Cave Isopod	S1	G5
Cave Invertebrates	<i>Antrolana lira</i>	Madison Cave Isopod	S1	G2G4
Cave Invertebrates	<i>Stygobromus biggersi</i>	Biggers' Cave Amphipod	S1	G2G4
Cave Invertebrates	<i>Stygobromus gracilipes</i>	Shenandoah Valley Cave Amphipod	S1	G3G4
Cave Invertebrates	<i>Stygobromus tenuis potomacus</i>	Potomac Groundwater Amphipod	S1	G4T4
Cave Invertebrates	<i>Stygobromus allegheniensis</i>	Allegheny Cave Amphipod	S1	G5
Cave Invertebrates	<i>Sinella hoffmani</i>	Hoffman's Springtail	S3	G5
Butterflies & Moths	<i>Staphylus hayhurstii</i>	Hayhurst's Scallopwing	S1	G5
Butterflies & Moths	<i>Erynnis lucilius</i>	Columbine Duskywing	S2	G4

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Butterflies & Moths	<i>Pieris virginiensis</i>	West Virginia White	S3	G3?
Butterflies & Moths	<i>Calycopis cecrops</i>	Red-banded Hairstreak	S3	G5
Butterflies & Moths	<i>Parrhasius m-album</i>	White-m Hairstreak	S2	G5
Butterflies & Moths	<i>Celastrina neglectamajor</i>	Appalachian Azure	SNR	G4
Butterflies & Moths	<i>Celastrina serotina</i>	Cherry Gall Azure	SNR	G5
Butterflies & Moths	<i>Celastrina lucia</i>	Northern Spring Azure	SNR	G5
Butterflies & Moths	<i>Boloria selene myrina</i>	Silver-bordered Fritillary	S3	G5T5
Butterflies & Moths	<i>Euphydryas phaeton</i>	Baltimore Checkerspot	S3S4	G4
Dragonflies/Damselflies	<i>Gomphus vastus</i>	Cobra Clubtail	S2	G5
Dragonflies/Damselflies	<i>Macromia illinoensis</i>	Illinois River Cruiser	S3	G5
Dragonflies/Damselflies	<i>Celithemis fasciata</i>	Banded Pennant	S3	G5
Dragonflies/Damselflies	<i>Ladona deplanata</i>	Blue Corporal	S3	G5
Dragonflies/Damselflies	<i>Sympetrum internum</i>	Cherry-faced Meadowhawk	S2	G5
Dragonflies/Damselflies	<i>Lestes inaequalis</i>	Elegant Spreadwing	S3	G5
Dragonflies/Damselflies	<i>Stylurus plagiatus</i>	Russet-tipped Clubtail	SH	G5
Cave Invertebrates	<i>Porrhomma cavernicola</i>	Appalachian Cave Spider	S2	G5
Cave Invertebrates	<i>Phanetta subterranea</i>	A Spider	S3	G5
Cave Invertebrates	<i>Erebomaster nr. acanthina</i>	A Cave Spider	S2	GNR
Mussels	<i>Alasmidonta marginata</i>	Elktoe	S1	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>Elliptio fisheriana</i>	Northern Lance	S2	G4
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
Mussels	<i>Pyganodon cataracta</i>	Eastern Floater	S2	G5
Snails	<i>Hendersonia occulta</i>	Cherrystone Drop	S3	G4
Snails	<i>Gastrocopta holzingeri</i>	Lambda Snaggletooth	S2	G5
Snails	<i>Vertigo tridentata</i>	Honey Vertigo	S3	G5



TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Snails	Vallonia excentrica	Iroquois Vallonia	S3	G5
Snails	Punctum vitreum	Glass Spot	S2	G5
Snails	Catinella vermeta	Suboval Ambersnail	S3	G5
Snails	Euconulus polygyratus	Fat Hive	S1	G5
Snails	Hawaiiia alachuana	Southeastern Gem	S3	G4G5Q
Snails	Ventridens suppressus	Flat Dome	S3	G5
Snails	Triodopsis anteridon	Carter Threetooth	S3	G3
Snails	Triodopsis vulgata	Dished Threetooth	S2	G5
Snails	Vallonia excentrica	Iroquois Vallonia	S3	G5
Snails	Ventridens suppressus	Flat Dome	S3	G5
Plants	Ruellia humilis	Low Wild Petunia	S1	G5
Plants	Hydrocotyle ranunculoides	Swamp Pennywort	S2	G5
Plants	Eupatorium maculatum var. maculatum	Spotted Joe-pyeweed	S1	G5T5
Plants	Eupatorium pilosum	Rough Boneset	S2	G5
Plants	Vernonia glauca	Broad-leaved Ironweed	S1	G5
Plants	Ageratina aromatica var. aromatica	Small White Snakeroot	S1	G5T5
Plants	Arabis hirsuta ssp. pycnocarpa	Hairy Rockcress	S2	G5T5
Plants	Arabis patens	Spreading Rockcress	S2	G3
Plants	Arabis shortii	Short's Rockcress	S1	G5
Plants	Arabis serotina	Shalebarren Rockcress	S2	G2
Plants	Lobelia kalmii	Ontario Lobelia	S1	G5
Plants	Paronychia argyrocoma	Silvery Nailwort	S3	G4
Plants	Paronychia virginica	Yellow Nailwort	S2	G4
Plants	Silene nivea	Snowy Catchfly	S1	G4?
Plants	Baptisia australis var. australis	False Blue Indigo	S3	G5T3T4
Plants	Galactia volubilis	Downy Milkpea	S2	G5
Plants	Quercus shumardii	Shumard Oak	S2	G5
Plants	Juglans cinerea	Butternut	S3	G4
Plants	Pycnanthemum torrei	Torrey's Mountain-mint	S1	G2
Plants	Scutellaria galericulata	Hooded Skullcap	S1	G5

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Plants	<i>Scutellaria saxatilis</i>	Rock Skullcap	S2	G3
Plants	<i>Stachys tenuifolia</i>	Smooth Hedge-nettle	S3	G5
Plants	<i>Trichostema setaceum</i>	Narrowleaf Bluecurls	S2	G5
Plants	<i>Linum sulcatum</i> var. <i>sulcatum</i>	Grooved Yellow Flax	S1	G5T5
Plants	<i>Utricularia macrorhiza</i>	Greater Bladderwort	S1	G5
Plants	<i>Decodon verticillatus</i>	Swamp-loosestrife	S1	G5
Plants	<i>Lythrum alatum</i> var. <i>alatum</i>	Winged Loosestrife	S2	G5T5
Plants	<i>Hibiscus laevis</i>	Halberd-leaf Rosemallow	S2	G5
Plants	<i>Polygonum amphibium</i>	Water Knotweed	S3	G5
Plants	<i>Lysimachia hybrida</i>	Lowland Loosestrife	S1	G5
Plants	<i>Lysimachia quadriflora</i>	Four-flower Loosestrife	S1	G5?
Plants	<i>Lysimachia thyrsoiflora</i>	Water Loosestrife	S1	G5
Plants	<i>Samolus valerandi</i> ssp. <i>parviflorus</i>	Seaside Brookweed	S2	G5T5
Plants	<i>Ranunculus hispidus</i> var. <i>caricetorum</i>	Bristly Buttercup	S1	G5T5
Plants	<i>Ranunculus sceleratus</i> var. <i>sceleratus</i>	Cursed Crowfoot	S2	G5T5
Plants	<i>Rhamnus lanceolata</i> ssp. <i>lanceolata</i>	Lance-leaved Buckthorn	S1	G5T4T5
Plants	<i>Salix discolor</i>	Pussy Willow	S2	G5
Plants	<i>Parnassia grandifolia</i>	Largeleaf Grass-of-parnassus	S1	G3
Plants	<i>Lindernia dubia</i> var. <i>anagallidea</i>	Yellowseed False Pimpernel	S2	G5T4
Plants	<i>Pedicularis lanceolata</i>	Swamp Lousewort	S2	G5
Plants	<i>Vitis rotundifolia</i> var. <i>rotundifolia</i>	Muscadine	SH	G5T5
Plants	<i>Thuja occidentalis</i>	Northern White-cedar	S2	G5
Plants	<i>Peltandra virginica</i>	Green Arrow-arum	S2	G5
Plants	<i>Carex aggregata</i>	Glomerate Sedge	S2	G5
Plants	<i>Carex bushii</i>	Bush's Sedge	S2S3	G4
Plants	<i>Carex buxbaumii</i>	Brown Bog Sedge	S2	G5
Plants	<i>Carex comosa</i>	Longhair Sedge	S2	G5
Plants	<i>Carex conoidea</i>	Field Sedge	S1	G5
Plants	<i>Carex lacustris</i>	Lake Sedge	S2	G5
Plants	<i>Carex pellita</i>	Woolly Sedge	S2	G5

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Plants	<i>Carex lasiocarpa</i> var. <i>americana</i>	Woolly-fruit Sedge	S1	G5T5
Plants	<i>Carex molesta</i>	Troublesome Sedge	S3	G4
Plants	<i>Carex nigromarginata</i>	Black-edge Sedge	S3	G5
Plants	<i>Carex prairea</i>	Prairie Sedge	S1	G5?
Plants	<i>Carex styloflexa</i>	Bent Sedge	S1	G4G5
Plants	<i>Carex suberecta</i>	Prairie Straw Sedge	S1	G4
Plants	<i>Carex tetanica</i>	Rigid Sedge	S1	G4G5
Plants	<i>Carex trichocarpa</i>	Hairy-fruit Sedge	S1	G4
Plants	<i>Carex appalachica</i>	Appalachian Sedge	S3	G4
Plants	<i>Carex utriculata</i>	Beaked Sedge	S3	G5
Plants	<i>Cyperus squarrosus</i>	Awned Flatsedge	S3	G5
Plants	<i>Eleocharis intermedia</i>	Spikerush	S1	G5
Plants	<i>Eleocharis palustris</i>	Marsh Spikerush	S3	G5
Plants	<i>Eleocharis rostellata</i>	Beaked Spikerush	S1	G5
Plants	<i>Eleocharis compressa</i>	Flat-stem Spikerush	S2	G4
Plants	<i>Schoenoplectus acutus</i> var. <i>acutus</i>	Hardstem Bulrush	S2	G5T5
Plants	<i>Bolboschoenus fluviatilis</i>	River Bulrush	S1	G5
Plants	<i>Trichophorum planifolium</i>	Bashful Bulrush	S1	G4G5
Plants	<i>Juncus balticus</i> var. <i>littoralis</i>	Baltic Rush	S1	G5T5
Plants	<i>Juncus dichotomus</i>	Forked Rush	S1	G5
Plants	<i>Juncus nodosus</i> var. <i>nodosus</i>	Knotted Rush	S1S2	G5T5?
Plants	<i>Juncus scirpoides</i>	Needle-pod Rush	S2	G5
Plants	<i>Juncus torreyi</i>	Torrey's Rush	S2	G5
Plants	<i>Maianthemum stellatum</i>	Starflower False Solomon's-seal	S2	G5
Plants	<i>Trillium cernuum</i>	Nodding Trillium	S1	G5
Plants	<i>Corallorhiza wisteriana</i>	Wister's Coralroot, Spring Coralroot	S2	G5
Plants	<i>Liparis loeselii</i>	Yellow Wide-lip Orchid	S3	G5
Plants	<i>Arundinaria gigantea</i> ssp. <i>gigantea</i>	Giant Cane	S2	G5T5?
Plants	<i>Bouteloua curtipendula</i> var. <i>curtipendula</i>	Sideoats Grama	S3	G5T5
Plants	<i>Diarrhena obovata</i>	Twin Grass	S1	G4G5

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Plants	<i>Glyceria acutiflora</i>	Creeping Mannagrass	S2	G5
Plants	<i>Hierochloe hirta</i> ssp. <i>arctica</i>	Holy Grass, Sweetgrass	S1	G5T5
Plants	<i>Melica nitens</i>	Three-flower Melicgrass	S1	G5
Plants	<i>Panicum flexile</i>	Wiry Panicgrass	S1	G5
Plants	<i>Sparganium androcladum</i>	Branched Bur-reed	S2S3	G4G5
Plants	<i>Zannichellia palustris</i>	Horned Pondweed	S1	G5
Plants	<i>Cheilanthes eatonii</i>	Chestnut Lipfern	S2	G5?
Plants	<i>Cheilanthes tomentosa</i>	Woolly Lipfern	S1	G5
Plants	<i>Pellaea glabella</i> ssp. <i>glabella</i>	Smooth Cliffbrake	S2	G5T5
Plants	<i>Equisetum fluviatile</i>	Water Horsetail	S2	G5
Plants	<i>Ophioglossum engelmannii</i>	Limestone Adder's-tongue	S1	G5

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

Anthropogenic Shrubland & Grassland		
COMMON_NAME	Local Stress	Action
American Kestrel	<ul style="list-style-type: none"> <li>Residential development</li> <li>Insufficient nest microhabitat</li> </ul>	<ul style="list-style-type: none"> <li>Land protection/conservation easements</li> </ul>
Barn Owl	<ul style="list-style-type: none"> <li>Insufficient nest microhabitat</li> <li>Clean farming practices</li> <li>Poisoning</li> </ul>	<ul style="list-style-type: none"> <li>Install and monitor nest boxes,</li> <li>Outreach to landowners to reduce rodenticide use</li> </ul>
Bobolink	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Nest loss from early haying</li> <li>Residential development</li> </ul>	<ul style="list-style-type: none"> <li>Delay hay harvest until July 15</li> <li>Prevent conversion of grasslands to croplands</li> <li>Purchase conservation easements</li> </ul>
Eastern Meadowlark	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Nest loss from early haying</li> </ul>	<ul style="list-style-type: none"> <li>Delay hay harvest</li> <li>Prevent conversion of grasslands to croplands</li> <li>Purchase conservation easements</li> </ul>
Field Sparrow	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Residential development</li> </ul>	<ul style="list-style-type: none"> <li>Retain or plant shrubs in fields</li> <li>Retain or plant hedgerows</li> <li>Conservation easements</li> </ul>
Grasshopper Sparrow	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Nest loss from early haying</li> </ul>	<ul style="list-style-type: none"> <li>Delay hay harvest until July 15</li> <li>Prevent conversion of grasslands to croplands</li> <li>Purchase conservation easements</li> </ul>
Hayhurst's Scallopwing	<ul style="list-style-type: none"> <li>Status is unknown.</li> <li>No longer found at known sites</li> </ul>	<ul style="list-style-type: none"> <li>Survey to determine if species still extant in WV</li> </ul>
Loggerhead Shrike	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Residential development</li> </ul>	<ul style="list-style-type: none"> <li>Retain or plant hawthorns in pastures</li> <li>Retain or plant hedgerows</li> <li>Purchase conservation easements</li> </ul>
Migrant Loggerhead Shrike	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Residential development</li> </ul>	<ul style="list-style-type: none"> <li>Retain or plant hawthorns in pastures</li> <li>Retain or plant hedgerows</li> </ul>
Northern Bobwhite	<ul style="list-style-type: none"> <li>Insufficient habitat</li> <li>Predation</li> </ul>	<ul style="list-style-type: none"> <li>Reduce clean farming practices</li> <li>Create early successional habitat</li> </ul>
Vesper Sparrow	<ul style="list-style-type: none"> <li>Clean farming practices</li> <li>Nest loss from early haying</li> </ul>	<ul style="list-style-type: none"> <li>Delay hay harvest until July 15</li> <li>Prevent conversion of grasslands to croplands</li> <li>Purchase conservation easements</li> </ul>
Yellow-breasted Chat	<ul style="list-style-type: none"> <li>Forest maturation</li> <li>Residential development</li> <li>Vegetation management in utility corridors</li> </ul>	<ul style="list-style-type: none"> <li>Manage forests to create early successional habitat</li> <li>Develop BMPs for rights of way management</li> </ul>



Developed Lands		
COMMON_NAME	Local Stress	Action
Barn Owl	<ul style="list-style-type: none"> <li>• Insufficient nest microhabitat</li> <li>• Clean farming practices</li> <li>• Poisoning</li> </ul>	<ul style="list-style-type: none"> <li>• Install and monitor nest boxes</li> <li>• Outreach to landowners to reduce rodenticides</li> </ul>
Chimney Swift	<ul style="list-style-type: none"> <li>• Chimney capping</li> <li>• Turnover of older structures</li> </ul>	<ul style="list-style-type: none"> <li>• Landowner outreach and education</li> <li>• Uncap chimneys</li> <li>• Install swift towers</li> </ul>
Common Nighthawk	<ul style="list-style-type: none"> <li>• Rubberized roofs on new home construction</li> </ul>	<ul style="list-style-type: none"> <li>• Educate owners of gravel roofs</li> <li>• Encourage installing gravel nest pads on rubberized roofs</li> </ul>
Peregrine Falcon	<ul style="list-style-type: none"> <li>• Disturbance at nest site(s),</li> <li>• Collision risk</li> </ul>	<ul style="list-style-type: none"> <li>• Engage with property managers to minimize nest disturbance</li> </ul>
Caves and Karst		
COMMON_NAME	Local Stress	Action
A Cave Spider ( <i>Erebomaster nr. acanthina</i> )	<ul style="list-style-type: none"> <li>• Land use changes around cave entrances</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's</li> </ul>
Allegheny Cave Amphipod	<ul style="list-style-type: none"> <li>• Water quality of underground drainage from surface runoff</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's Stream buffer protection</li> </ul>
Biggers' Cave Amphipod	<ul style="list-style-type: none"> <li>• Water quality of underground drainage from surface runoff</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's Stream buffer protection</li> </ul>
Madison Cave Isopod	<ul style="list-style-type: none"> <li>• Water quality of deep underground aquifer from surface runoff</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's Stream buffer protection</li> </ul>
Potomac Groundwater Amphipod	<ul style="list-style-type: none"> <li>• Water quality of underground drainage from surface runoff</li> <li>• Educate landowners about land use BMP's</li> <li>• Stream buffer protection</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's Stream buffer protection</li> </ul>
Price's Cave Isopod	<ul style="list-style-type: none"> <li>• Water quality of underground drainage from surface runoff</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's Stream buffer protection</li> </ul>
Shenandoah Valley Cave Amphipod	<ul style="list-style-type: none"> <li>• Water quality of underground drainage from surface runoff</li> </ul>	<ul style="list-style-type: none"> <li>• Educate landowners about BMP's Stream buffer protection</li> </ul>

Forests		
COMMON_NAME	Local Stress	Action
Black-billed Cuckoo	<ul style="list-style-type: none"> <li>• Insufficient habitat</li> <li>• Pesticide exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Create early successional habitat</li> <li>• Reduce aerial application of pesticides</li> </ul>
Broad-winged Hawk	<ul style="list-style-type: none"> <li>• Unsuitable forest structure</li> <li>• Residential development</li> </ul>	<ul style="list-style-type: none"> <li>• Conservation easements</li> </ul>
Cerulean Warbler	<ul style="list-style-type: none"> <li>• Unsuitable forest structure</li> </ul>	<ul style="list-style-type: none"> <li>• Manage forests to create suitable habitat as per CERW guidelines</li> </ul>
Cherry Gall Azure	<ul style="list-style-type: none"> <li>• Newly described species</li> <li>• Poor understanding of life history</li> </ul>	<ul style="list-style-type: none"> <li>• Surveys to document population size and extent</li> </ul>
Columbine Duskywing	<ul style="list-style-type: none"> <li>• Legacy of gypsy moth control</li> </ul>	<ul style="list-style-type: none"> <li>• Avoid spraying on habitat</li> <li>• Control invasive species and dense forest development to keep habitat suitable for larval host and nectar resources</li> </ul>
Kentucky Warbler	<ul style="list-style-type: none"> <li>• Deer overbrowsing</li> <li>• Residential development</li> <li>• Unsuitable forest structure</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce deer population</li> <li>• Manage forests for structural and spatial complexity</li> </ul>
Prairie Warbler	<ul style="list-style-type: none"> <li>• Forest maturation, veg management in utility corridors</li> </ul>	<ul style="list-style-type: none"> <li>• Manage forests to create early successional habitat</li> <li>• Develop BMP's for managing rights of way corridors</li> </ul>
Spreading Rockcress	<ul style="list-style-type: none"> <li>• Threats to limestone forest and woodland habitats including:</li> <li>• Nonnative invasive plants</li> <li>• Grazing</li> <li>• Residential development</li> </ul>	<ul style="list-style-type: none"> <li>• Protect areas from invasions of non-native plants by limiting ground disturbance and by creating weed free buffers</li> <li>• Treat non-native invasive plants without disturbing rare native species</li> <li>• Conservation management, easements, and ownership</li> </ul>
Torrey's Mountain-mint	<ul style="list-style-type: none"> <li>• Nonnative invasive plants</li> <li>• Railroad maintenance</li> <li>• Unknown population viability</li> </ul>	<ul style="list-style-type: none"> <li>• Treat nonnative invasive plants without harming rare native plants</li> <li>• Work with railroad to protect population</li> <li>• Survey</li> </ul>
Wood Thrush	<ul style="list-style-type: none"> <li>• Deer overbrowsing</li> <li>• Residential development,</li> <li>• Unsuitable forest structure</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce deer population</li> <li>• Manage forests for structural and spatial complexity</li> </ul>
Worm-eating Warbler	<ul style="list-style-type: none"> <li>• Poor forest structure</li> <li>• Deer overbrowsing</li> <li>• Residential development</li> </ul>	<ul style="list-style-type: none"> <li>• Manage forests for structural and spatial complexity</li> <li>• Reduce deer populations</li> </ul>

<b>Streams and Floodplains</b>		
<b>COMMON NAME</b>	<b>Local Stress</b>	<b>Action</b>
American Eel	<ul style="list-style-type: none"> <li>• Passage barriers</li> </ul>	<ul style="list-style-type: none"> <li>• Remove barriers</li> <li>• Install eel ladders</li> </ul>
Common Shiner	<ul style="list-style-type: none"> <li>• Warming instream water temperatures</li> <li>• Sedimentation</li> <li>• Hybridization and interspecific competition with Striped Shiners</li> </ul>	<ul style="list-style-type: none"> <li>• Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks</li> <li>• Perform tree plantings to create overhead canopy cover and reduce sedimentation</li> <li>• Install fencing to keep cattle out of streams</li> <li>• Do not introduce (bait) fish from outside the watershed</li> </ul>
Pearl Dace	<ul style="list-style-type: none"> <li>• Warming instream temperatures</li> <li>• Spring diversions</li> <li>• Habitat alterations</li> <li>• Sedimentation</li> </ul>	<ul style="list-style-type: none"> <li>• Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks</li> <li>• Perform tree plantings to create overhead canopy cover and reduce sedimentation</li> <li>• Install fencing to keep cattle out of streams</li> </ul>

### Appendix 3. Terrestrial and Aquatic Habitats in Public Lands

Public Land	Terrestrial Habitat	Aquatic Habitat
Shannondale Springs Wildlife Management Area	<ul style="list-style-type: none"> <li>• <b>Forest and Woodland</b> <ul style="list-style-type: none"> <li>• Dry-Mesic Oak Forests</li> <li>• Dry Calcareous Forests, Woodlands, and Glades</li> <li>• Dry Oak (-Pine) Forests</li> <li>• Mixed Mesophytic Forests</li> <li>• Other Dry Oak Forests and Woodlands</li> </ul> </li> <li>• <b>Aquatic, Floodplain, and Riparian</b> <ul style="list-style-type: none"> <li>• Open Water</li> <li>• River Floodplains</li> <li>• Small Stream Riparian Habitats</li> </ul> </li> <li>• <b>Agricultural and Developed</b> <ul style="list-style-type: none"> <li>• Agriculture</li> <li>• Developed</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Headwaters Creek, Moderate Gradient, Cool</li> <li>• Headwater Creek, High Gradient, Cool</li> </ul>

## 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"> <li>• Forestry <a href="https://extension.wvu.edu/natural-resources/forestry">https://extension.wvu.edu/natural-resources/forestry</a></li> <li>• Wildlife  <a href="https://extension.wvu.edu/natural-resources/wildlife">https://extension.wvu.edu/natural-resources/wildlife</a></li> </ul>	<ul style="list-style-type: none"> <li>• Landowner technical assistance and information on financial assistance for forest and wildlife management</li> <li>• Training workshops and conferences on forestry Best Management Practices and safety practices</li> </ul>
<p>US Fish and Wildlife Service (USFWS) Partners for Fish and Wildlife Program <a href="https://www.fws.gov/northeast/ecologicalservices/partners.html">https://www.fws.gov/northeast/ecologicalservices/partners.html</a></p>	<ul style="list-style-type: none"> <li>• 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)</li> <li>• CFA is part of the program’s Upper Potomac Priority Area</li> <li>• 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</li> <li>• Works in coordination with the USDA Natural Resources Conservation Service farm bill programs, Trout Unlimited and other partners</li> </ul>
<p>US Fish and Wildlife Service (USFWS)</p> <ul style="list-style-type: none"> <li>• Appalachian Fish and Wildlife Conservation Office  <a href="https://www.fws.gov/northeast/apco/">https://www.fws.gov/northeast/apco/</a></li> </ul>	<ul style="list-style-type: none"> <li>• 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</li> <li>• Provides technical assistance to private landowners to restore and enhance fish and wildlife habitat</li> <li>• Conducts outreach and education on aquatic resources with youth and their families</li> </ul>



Partner	Role/Assistance Provided
<p>USDA Natural Resources Conservation Service:  <a href="https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/programs/financial/">https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/programs/financial/</a></p> <ul style="list-style-type: none"> <li>• Environmental Quality Incentive Program (EQIP)</li> <li>• Conservation Stewardship Program (CSP)</li> <li>• Agricultural Conservation Easement Program (ACEP)</li> </ul>	<ul style="list-style-type: none"> <li>• 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</li> <li>• EQIP funds in the Potomac Valley Conservation District have been prioritized for improved grazing and pasture management (including alternative water and fencing), nutrient management to protect streams, enhancing riparian corridors and natural stream restoration promoting brook trout in Patterson Creek and New Creek, and water quality improvement on Edwards Run and Dillon’s Run</li> <li>• 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</li> <li>• 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</li> <li>• ACEP can be used for both agricultural land easements and wetland reserve easements to protect farmland and associated habitat</li> </ul>
<p>USDA Farm Service Agency  <a href="https://www.fsa.usda.gov/state-offices/West-Virginia/programs/index">https://www.fsa.usda.gov/state-offices/West-Virginia/programs/index</a></p> <ul style="list-style-type: none"> <li>• Conservation Reserve Program (CRP)</li> <li>• Conservation Reserve Enhancement Program (CREP)</li> </ul>	<ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> </ul>

Partner	Role/Assistance Provided
<p>WV Division of Forestry  <a href="http://www.wvforestry.com/">http://www.wvforestry.com/</a></p>	<ul style="list-style-type: none"> <li>• Oversees the Managed Timberland Program to provide tax incentives for landowners who manage their forest land sustainably according to a management plan</li> <li>• Oversee timber sales and Best Management Practices</li> <li>• Provides training workshops for loggers on safety and Best Management Practices</li> <li>• Maintains list of consulting foresters who can help landowners with Forest Stewardship Plans to enhance wildlife habitat</li> <li>• Assists watershed groups and other partners on riparian planting in the Chesapeake Bay watershed</li> <li>• Protection of large private forest tracts through Forest Legacy Program</li> </ul>
<p>WV Department of Environmental Protection (WVDEP)</p> <ul style="list-style-type: none"> <li>• Nonpoint Source Program  <a href="https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx">https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx</a></li> <li>• Chesapeake Bay Program  <a href="https://dep.wv.gov/WWE/watershed/wqmonitoring/Pages/ChesapeakeBay.aspx">https://dep.wv.gov/WWE/watershed/wqmonitoring/Pages/ChesapeakeBay.aspx</a></li> <li>• Save Our Streams Program  <a href="https://dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx">https://dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx</a></li> <li>• Watershed Based Plans  <a href="https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Pages/WBP.aspx">https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Pages/WBP.aspx</a></li> </ul>	<ul style="list-style-type: none"> <li>• Supports partners and citizen-based watershed organizations in restoring impaired watersheds</li> <li>• Provides assistance in proper installation and maintenance of Best Management Practices</li> <li>• Provides funding for projects by watershed groups and partners to improve water quality in watersheds listed as impaired, including Mill Creek/Opequon, Tuscarora Creek and Elks Run in this CFA</li> <li>• WV Chesapeake Bay funding for water quality improvements through the CFA</li> <li>• Practices include wastewater treatment, agricultural BMPs, rain gardens for stormwater runoff, streambank restoration, and community outreach</li> <li>• Save our Streams provides training for volunteers to monitor local wadable streams and rivers</li> </ul>
<p>WV Conservation Agency (WVCA)  <a href="http://www.wvca.us/">http://www.wvca.us/</a></p>	<ul style="list-style-type: none"> <li>• Promotes the protection and conservation of West Virginia’s soil, land, water, and related resources</li> <li>• Works with WV DEP on to improve water quality through the Non-Point Source and Chesapeake Bay programs</li> <li>• 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</li> </ul>

Partner	Role/Assistance Provided
<p>Trout Unlimited</p> <ul style="list-style-type: none"> <li>• <a href="http://www.wvtu.org/">http://www.wvtu.org/</a></li> <li>• <a href="http://www.tu.org/">http://www.tu.org/</a></li> </ul>	<ul style="list-style-type: none"> <li>• Restoring brook trout populations in small watersheds</li> <li>• 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</li> <li>• 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</li> </ul>
<p>Land Conservation Organizations</p> <ul style="list-style-type: none"> <li>• Land Trust of the Eastern Panhandle <a href="https://www.landtrustepwv.org/">https://www.landtrustepwv.org/</a></li> <li>• County Farmland Protection Boards <a href="http://wvfp.org/">http://wvfp.org/</a></li> <li>• Potomac Conservancy <a href="https://potomac.org/">https://potomac.org/</a></li> <li>• West Virginia Land Trust <a href="https://www.wvlandtrust.org/">https://www.wvlandtrust.org/</a></li> <li>• The Nature Conservancy <a href="https://www.nature.org/en-us/about-us/where-we-work/united-states/west-virginia/">https://www.nature.org/en-us/about-us/where-we-work/united-states/west-virginia/</a></li> </ul>	<ul style="list-style-type: none"> <li>• Conservation easements to protect farms, forests, and riparian areas</li> </ul>
<p>American Forest Foundation: My Land Plan <a href="https://mylandplan.org/">https://mylandplan.org/</a></p>	<ul style="list-style-type: none"> <li>• Woodland owners planning tool for forest management</li> </ul>
<p>County Planning Departments</p> <ul style="list-style-type: none"> <li>• Berkeley County <a href="http://www.berkeleycountycomm.org/services/planning-faq.cfm">http://www.berkeleycountycomm.org/services/planning-faq.cfm</a></li> <li>• Jefferson County <a href="http://www.jeffersoncountywv.org/county-government/engineering-planning-and-zoning">http://www.jeffersoncountywv.org/county-government/engineering-planning-and-zoning</a></li> </ul>	<ul style="list-style-type: none"> <li>• Planning to manage floodplains and guide new development</li> </ul>
<p>DEP Youth Environmental Program (YEP) <a href="https://dep.wv.gov/environmental-advocate/yep/Pages/default.aspx">https://dep.wv.gov/environmental-advocate/yep/Pages/default.aspx</a></p>	<ul style="list-style-type: none"> <li>• Organizes youth and volunteer groups for hands-on conservation projects</li> </ul>
<p>WV Division of Natural Resources (WVDNR) <a href="http://www.wvdnr.gov/wildlife/wdpintro.shtm">http://www.wvdnr.gov/wildlife/wdpintro.shtm</a></p>	<ul style="list-style-type: none"> <li>• Identification of SGCN and rare communities</li> <li>• Education, outreach, and teaching resources</li> <li>• Field guides, Landscaping and Management guidelines</li> <li>• Fish and game management</li> <li>• Habitat restoration assistance</li> </ul>

## Appendix 5. Resources

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

West Virginia's Phase 3 Watershed Implementation Plan for the Chesapeake Bay Total Maximum Daily Load (TMDL) <a href="http://www.wvca.us/bay/files/bay_documents/1298_WV_WIP3_final_082319.pdf">http://www.wvca.us/bay/files/bay_documents/1298_WV_WIP3_final_082319.pdf</a>
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. <a href="http://www.wvchesapeakebay.us/">http://www.wvchesapeakebay.us/</a>
Ecological Assessment of the Shenandoah River Watershed in WV <a href="https://dep.wv.gov/WWE/watershed/wqmonitoring/Documents/EcologicalAssessments/EcoAssess_Shenand_1996.pdf">https://dep.wv.gov/WWE/watershed/wqmonitoring/Documents/EcologicalAssessments/EcoAssess_Shenand_1996.pdf</a>
Elks Run Watershed Based Plan <a href="https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Documents/ElkRun_WBP.pdf">https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Documents/ElkRun_WBP.pdf</a>
Watershed Based Plan for Mill Creek (Opequon) <a href="https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Documents/WP/MillCreekOpequon_WBP.pdf">https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Documents/WP/MillCreekOpequon_WBP.pdf</a>
Long Range Strategic Plan for the Eastern Panhandle Conservation District <a href="https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd1177607&amp;ext=pdf">https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd1177607&amp;ext=pdf</a>
Living on Karst- A Reference Guide for Landowners in Limestone Regions <a href="http://www.livingonkarst.org/living_on_karst.htm">http://www.livingonkarst.org/living_on_karst.htm</a>
Guidelines for Cave and Karst Protection- IUCN <a href="https://www.iucn.org/content/guidelines-cave-and-karst-protection-0">https://www.iucn.org/content/guidelines-cave-and-karst-protection-0</a>
A Guide to Responsible Caving, by the National Speleological Society <a href="https://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf">https://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf</a>
National Wild Turkey Foundation- Landowner's Toolbox <a href="https://www.nwtf.org/conservation/category/landownershttps://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf-tool-box">https://www.nwtf.org/conservation/category/landownershttps://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf-tool-box</a>

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

Wildlife Habitat Council Integrated Vegetation Management Project Guidance for Infrastructure Corridors: <https://www.wildlifehc.org/wp-content/uploads/2015/11/WHC-Integrated-Vegetation-Management-Project-Guidance.pdf>

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/>

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 all 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, 2<sup>nd</sup> edition, 2016, 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 Plans

Partners met in January 2020 to review the draft Action Plan for the Greater Shenandoah Valley and Sleepy Creek/Back Creek CFAs and develop Initial Project Plans for Implementation. Outlines of the Initial Project Plans for Forests and Woodlands, Aquatic and Riparian, Agricultural and Subterranean Habitats are included below.

### Forest and Woodland Habitats

- Threat to be addressed:
  - NNIS
    - Sleepy Creek Wildlife Management Area: Japanese stiltgrass, garlic mustard, tree of heaven in disturbed areas
    - Cacapon Resort State Park: barberry and oriental bittersweet in protected forests
- Location(s) or area of interest:
  - Sleepy Creek WMA: active forest management setting
  - Cacapon Resort SP: protected forest setting
- Species and habitats that will benefit:
  - Sleepy Creek WMA: roughed grouse, prairie warbler and other species benefiting from early successional and diverse forest habitats
  - Cacapon Resort SP: interior forest species such as broad-winged hawk, wood thrush, cerulean warbler, and worm-eating warbler.
- Overall project goals:
  - Control invasive weeds
  - Use these areas as demonstration sites for invasive weed control in both protected and managed forest settings.
- Actions to be taken:
  - Sleepy Creek WMA:
    - Apply non-commercial timber management (“hack and squirt” selected trees with herbicide) to stimulate regeneration of forest understory with minimal disturbance on 50-acre unit
    - Monitor and evaluate results
    - Report and present results to other private and public lands
  - Cacapon Resort SP:
    - Complete NNIS inventory, mapping, and control plan
    - Work with Master Naturalists to remove oriental bittersweet and barberry in priority areas
    - Monitor and evaluate results
    - Report and present results to other private and public lands
- Partners involved, and roles:
  - Cacapon Resort SP: Master Naturalists

- Implementation timeline or milestones:
  - Sleepy Creek WMA: 2 yrs, then monitoring and evaluation
  - Cacapon Resort SP: 2 yrs, then monitoring and evaluation
- Information gaps that need to be filled:
  - NNIS prevention and control methods in both protected and managed forest settings
- Potential funding sources:
  - Sleepy Creek WMA: Wildlife Management Institute funding for non-commercial timber management

### Agricultural Habitats

- Threat to be addressed:
  - Residential Development.
- Location of Interest:
  - Riparian and agricultural properties that are high priority for farmland protection
- Species and Habitats that will benefit:
  - Any SGCN present (aquatic, riparian and agricultural habitats especially)
- Overall Project goals:
  - Protect intact habitat, implement BMPs to maintain SGCN
- Measurable objectives:
  - Acreage under easement, value of acreage under protection
  - Improved water quality
  - Response of aquatic, riparian and grassland species
  - Habitat connectivity (acres of connected habitat)
- Actions to be taken (practices):
  - Outreach to landowners about easement opportunities
  - Outreach to landowners with easements about BMPs for wildlife
- Partners involved:
  - Morgan, Berkeley and Jefferson County Farmland Protection Boards
  - Region 9 (Eastern Panhandle) Planning and Development Council: liaison for federal funds
  - WV Department of Environmental Protection: co-funding
  - NRCS: co-funding (EQIP contracts)
  - WVDNR (technical assistance)
- Implementation Timeline
  - Food for Thought dinner: March 2020
  - Demonstration tour of project: TBD
- Information Gaps
  - Connecting with prospective clients
    - Watershed groups can do outreach
- Potential funding sources:
  - NRCS Farm Bill apportionments

### Aquatic/Riparian Habitats

- Threat to be addressed:
  - Sedimentation, stream bank erosion, riparian deforestation
- Location of Interest:
  - Cacapon watershed down to North River
- Species and Habitats that will benefit:
  - Target: wood turtles
  - Also benefit mussels, brook trout, aquatic invertebrates
- Overall Project goals:
  - Protect and restore habitat for wood turtle, along with mussels and brook trout
    - Restore instream and riparian buffer habitat
    - Plant riparian buffers, install cattle fencing,
- Measurable objectives:
- Actions to be taken:
  - Meet 2/19/2020, develop budget and timeline
- Partners involved:
  - GWNF
  - USDA Partners: NRCS, FSA
  - WVCA, WV DEP
  - USFWS Partners for Fish and Wildlife program
  - Trout Unlimited
  - WVDNR (technical assistance)
- Implementation Timeline
- Information Gaps
  - How to reach absentee landowners (who own larger forest tracts)
- Potential funding sources:
  - USDA Farm Bill funding
  - USFWS Partners for Fish and Wildlife
  - WVDEP, WVCA, Chesapeake Bay program
  - 50% match:
    - Master Naturalists and other volunteers
    - labor, equipment (TU)

### Subterranean Habitats

- Threat to be addressed:
  - Illegal dumping, trash, and pollution in sinkholes
  - Sinkhole filling / drainage alteration in developing areas
- Location of Interest:
  - Berkeley county
  - Karst areas in Sleepy Creek/Back Creek CFA

- Species and Habitats that will benefit:
  - Cave invertebrates, Karst habitats, groundwater
- Overall Project goals:
  - Protect cave invertebrate species and groundwater
  - Establish guidelines to ensure sound home construction and protection of subterranean habitats.
- Measurable objectives:
  - Elimination of sinkhole dumping
  - Implementation of development guidelines
- Actions to be taken:
  - Educate homeowners about the importance of clean water and aquifers in karst
  - Sinkhole cleanups
  - Incorporating sinkholes/sinkhole protections (in development guidelines and regulations?)
  - Sinkhole buffers in farmland
- Partners involved:
  - Cave Conservancy of the Virginias
  - USGS (LiDAR mapping of sinkholes)
  - Tri-State Grotto
  - National Speleological Society
  - Solid Waste Authority
  - DEP REAP program
  - NRCS
  - USFWS partners program
- Measures:
  - Number of sinkhole dumps cleaned up and pounds removed
  - Number of sinkhole buffers (vegetation or fencing) established
  - Implementation success/ dissemination of development guidelines (#)
- Information Gaps
  - Are there local government guidelines for development around karst?
  - What legal actions may be taken by homeowners when homes built on sinkholes are damaged?
  - Authority of county to implement development guidelines
  - Organization / abilities of county litter control officer to assist with funding and enforcement
- Potential funding sources:
  - WVDEP Reap program
  - Cave Conservancy of the Virginias grants.
  - NSS grants
  - NRCS