

Action Plan for the North Fork Mountain & Thorn Creek Conservation Focus Area



West Virginia Division of Natural Resources

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Table of Contents

Executive Summary.....	1
Introduction to the State Wildlife Action Plan & Conservation Focus Areas.....	2
Species of Greatest Conservation Need, Habitats and Stresses.....	2
Conservation Actions.....	2
Conservation Focus Areas and Action Plans.....	3
Climate Change and Resilience.....	4
Monitoring and Adaptive Management.....	5
Organization of this Action Plan.....	6
How to use this plan.....	7
North Fork Mountain and Thorn Creek Conservation Focus Area.....	8
Overview.....	8
Habitats.....	10
Terrestrial Habitats.....	10
Aquatic Habitats.....	12
Species of Greatest Conservation Need.....	14
Distinctive Stresses.....	15
Conservation Actions.....	15
Potential Partners.....	15
Protected Lands.....	16
Action Plan for the Conservation Focus Area.....	18
Conservation Goals.....	18
Priority Species.....	18
Forest and Woodland Habitats.....	22
Priority Species.....	22
Rare Plant Communities.....	27
Habitat Stresses and Conservation Actions.....	28
Climate Change and Habitat Resilience.....	29
Implementation Plan.....	31
Human Benefits.....	33
Rock Outcrops, Cliffs and Talus, Heath Grass and Shale Barrens.....	34
Priority Species.....	34
Rare Plant Communities.....	34

Habitat Stresses and Conservation Actions	35
Climate Change and Habitat Resilience	37
Implementation Plan.....	37
Human Benefits.....	38
Aquatic, Floodplain and Riparian Habitats.....	39
Priority Species.....	39
Rare Plant Communities.....	40
Habitat Stresses and Conservation Actions	44
Climate Change and Habitat Resilience	44
Implementation Plan.....	46
Human Benefits.....	47
Subterranean Habitats.....	48
Karst and Cave Habitats	48
Priority Species.....	48
Habitat Stresses and Conservation Actions	49
Climate Change and Habitat Resilience	52
Implementation Plan.....	52
Human Benefits.....	54
Agricultural and Developed Habitats.....	55
Priority Species.....	55
Habitat Stresses and Conservation Actions	57
Climate Change and Habitat Resilience	57
Implementation Plan.....	59
Human Benefits.....	60
Landscape Resilience and Connectivity	61
Climate Stresses and Conservation Actions.....	61
Implementation Plan.....	67
Conclusion.....	68
Conservation Priorities.....	68
Integration of Conservation Actions	68
Connecting Conservation Actions for Climate Adaption	69
Next Steps in Implementation	69
References	71

Appendix 1. SGCN in this CFA.....	73
Appendix 2. Priority SGCN, Stresses, & Actions	83
Appendix 3: Terrestrial, Aquatic and Subterranean Habitats in Public Lands	99
Appendix 4. Partners and Assistance Provided.....	101
Appendix 5. Resources	107
Appendix 6. Initial Project Plan	109

LIST OF MAPS

Conservation Focus Areas in West Virginia.	4
Overview	9
Terrestrial Habitats	10
Aquatic Habitat	13
Protected Lands and Biodiversity	17
Forest and Woodland Habitat.....	25
Intact Forest Patches and Biodiversity.....	26
Rock Outcrops, Cliffs & Talus, Heath Grass and Shale Barren Habitat	36
Riparian and Floodplain Habitats.....	41
Streams, Mussel Streams, Brook Trout Habitat Patches, and Biodiversity	42
Impaired Streams and Biodiversity	43
Karst Areas and Intact Forest Patches	50
Karst and Cave Features.....	51
Developed & Agricultural Lands and Biodiversity.....	56
Landscape Integrity.....	62
Priority Resilient and Connected Network – Regional View	64
Priority Resilient and Connected Network- Detailed View	66

LIST OF TABLES

Terrestrial Habitat Summary.....	10
Aquatic Habitat Summary	12
SGCN Summary by Taxa	14
Priority Species in CFA.....	18
Priority Species in Forest and Woodland Habitats.	22
Rare Plant Communities in Forest and Woodland Habitats.	27
Stresses and actions affecting priority species in Forest and Woodland habitats:	28
Climate Stresses and Resilience Actions in Forest and Woodland Habitats.....	31
Implementation Plan for Forest and Woodland Habitats.....	31
Priority Species in Rock Outcrops, Cliffs and Talus, Heath Grass and Shale Barrens.....	34
Rare Plant Communities in Rock Outcrops, Cliffs and Talus, and Heath Grass Barrens	35
Habitat Stresses and Conservation Actions in Rock Outcrops, Cliffs and Talus, and Shale Barrens.....	35
Climate Stresses and Resilience Actions in Rock Outcrop, Cliff and Talus, and Shale Barren Habitats.....	37
Implementation Plan for Rock Outcrop, Cliffs and Talus, and Shale Barren habitats	37
Priority Aquatic Species	39
Priority Riparian and Floodplain Species.....	39
Rare Plant Communities in Aquatic, Floodplain and Riparian Habitats.....	40
Habitat Stresses and Conservation Actions for Aquatic, Floodplain and Riparian Habitat	44
Climate Stresses and Resilience Actions in Aquatic, Floodplain and Riparian Habitat.....	45
Implementation Plan for Aquatic, Floodplain and Riparian Habitats	46
Priority Species in Subterranean Habitats	48
Habitat stresses and conservation actions in Subterranean Habitats	49
Climate Stresses and Resilience Actions in Karst and Cave Habitats.....	52
Implementation Plan for Subterranean Habitats	53
Priority Species in Agricultural and Developed Habitats	55
Stresses and Actions in Agricultural and Developed Lands:	57
Climate Stresses and Resilience Actions for Agricultural and Developed Habitats.....	58
Implementation Plan for Agricultural and Developed Lands.....	59
Climate Stresses and Actions for Landscape Resilience and Connectivity	65
Implementation plan for Landscape Resilience and Connectivity.....	67

List of Acronyms Used

ACEP- Agricultural Conservation Easement Program
AMJV- Appalachian Mountain Joint Venture
BMPs- Best Management Practices
B-Rank- Biodiversity Rank
CFA- Conservation Focus Area
CCV- Cave Conservancy of the Virginias
CCVI- Climate Change Vulnerability Index
CERW- Cerulean Winged Warbler
CREP- Conservation Reserve Enhancement Program
CRP- Conservation Reserve Program
CSP- Conservation Stewardship Program
EQIP- Environmental Quality Improvement Program
FSA- Farm Service Agency
G Rank- Global Rank
GWWA- Golden-winged Warbler
HUC- Hydrologic Unit Code
NRCS- Natural Resources Conservation Service
NWTF- National Wild Turkey Foundation
R8- Region 8
RGS- Roughed Grouse Society
SGCN- Species of Greatest Conservation Need
S Rank- State Rank
SWAP- State Wildlife Action Plan
TNC- The Nature Conservancy
TU- Trout Unlimited
USDA- United States Department of Agriculture
USFWS- United States Fish and Wildlife Service
WVCA- West Virginia Conservation Agency
WVCC- West Virginia Cave Conservancy
WVDHHR- Department of Health and Human Resources
WVDNR- West Virginia Division of Natural Resources
WMA- Wildlife Management Area
WVACS- West Virginia Association for Cave Studies
WVDEP- West Virginia Department of Environmental Protection
WVDOF- West Virginia Division of Forestry
WVDOH- West Virginia Division of Highways
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. The characteristics, distribution, trends, and threats associated with each of the terrestrial and aquatic habitats are described in the 2015 SWAP.

For those SGCN listed in the SWAP 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 harvest, or indirectly, by affecting the quality or quantity of available habitat.

Conservation Actions

The purpose of stress assessment and prioritization in the 2015 SWAP was to identify statewide conservation actions that could reduce stress on SGCN populations and their habitats. Most stresses are

the result of the lawful activities of people, corporations, and public agencies. Rather than seeking a regulatory approach to restrict lawful activities, the intention of the SWAP was to promote voluntary collaboration with landowners, corporations, and other partner organizations and agencies to reduce stresses on wildlife species and their habitats.

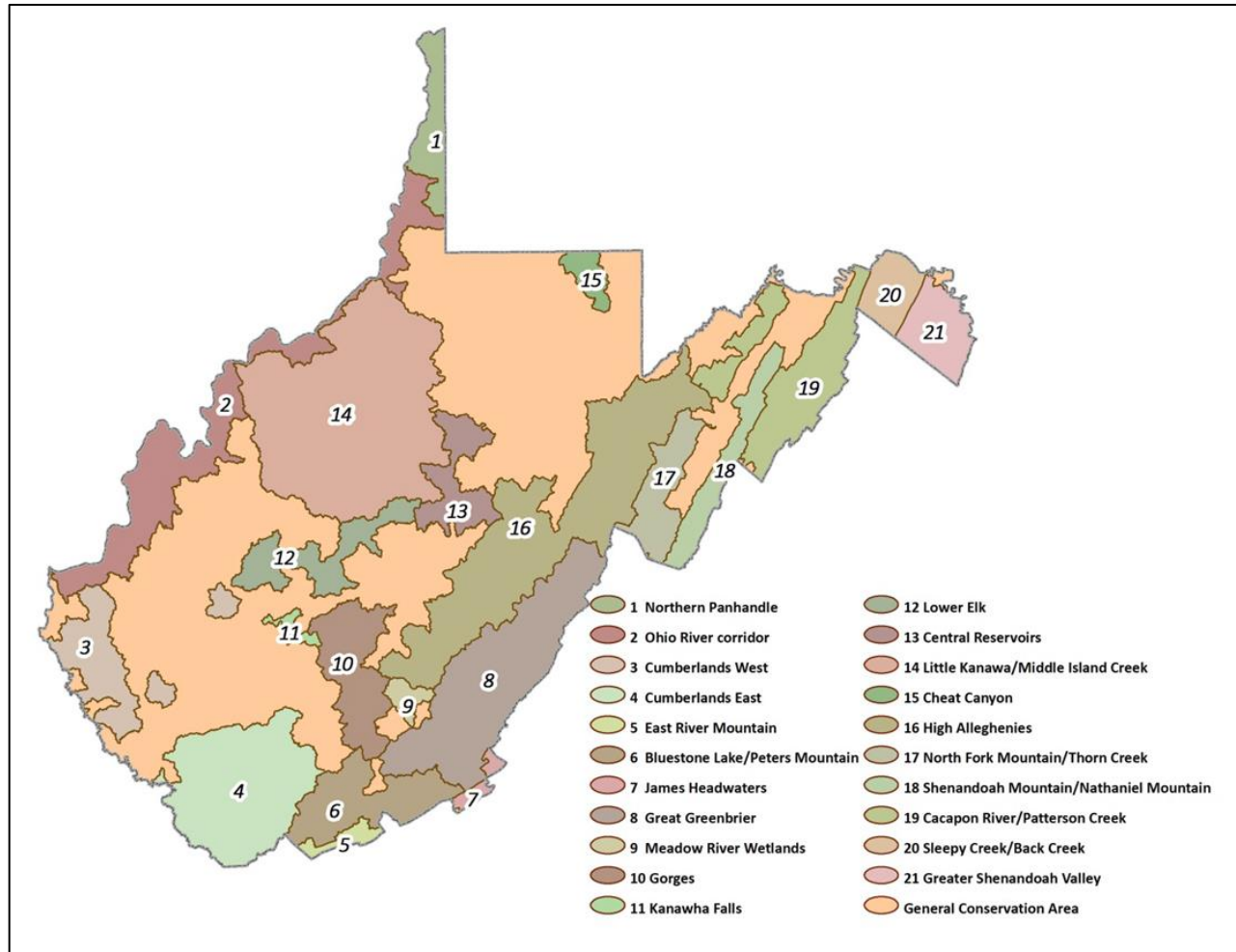
Conservation actions vary according to the species and the specific stresses being addressed and can take many forms. A lack of information on the status of a species or understanding of a threat may indicate a need for actions such as baseline inventory, research, or data acquisition. Direct action may involve directly protecting or restoring habitats or even restoring populations. Conservation easements are a form of habitat protection that preserves habitat in its current state or can include land management plans that benefit wildlife. It is likely that a suite of actions is required depending on the identified stress and the conservation 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

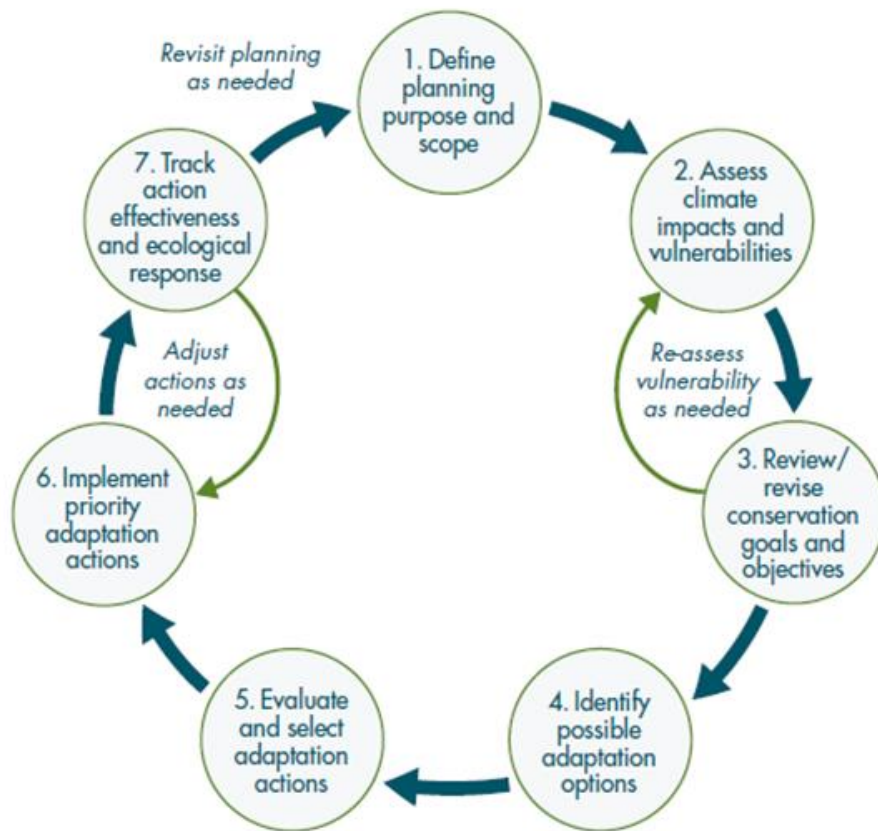
stated that efficient approaches to maintaining broad suites of species include maintaining functioning ecological systems, landscapes that are resilient to the effects of climate change, and ecological connectivity within and between landscapes. Rather than a species-specific approach, the SWAP therefore 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:

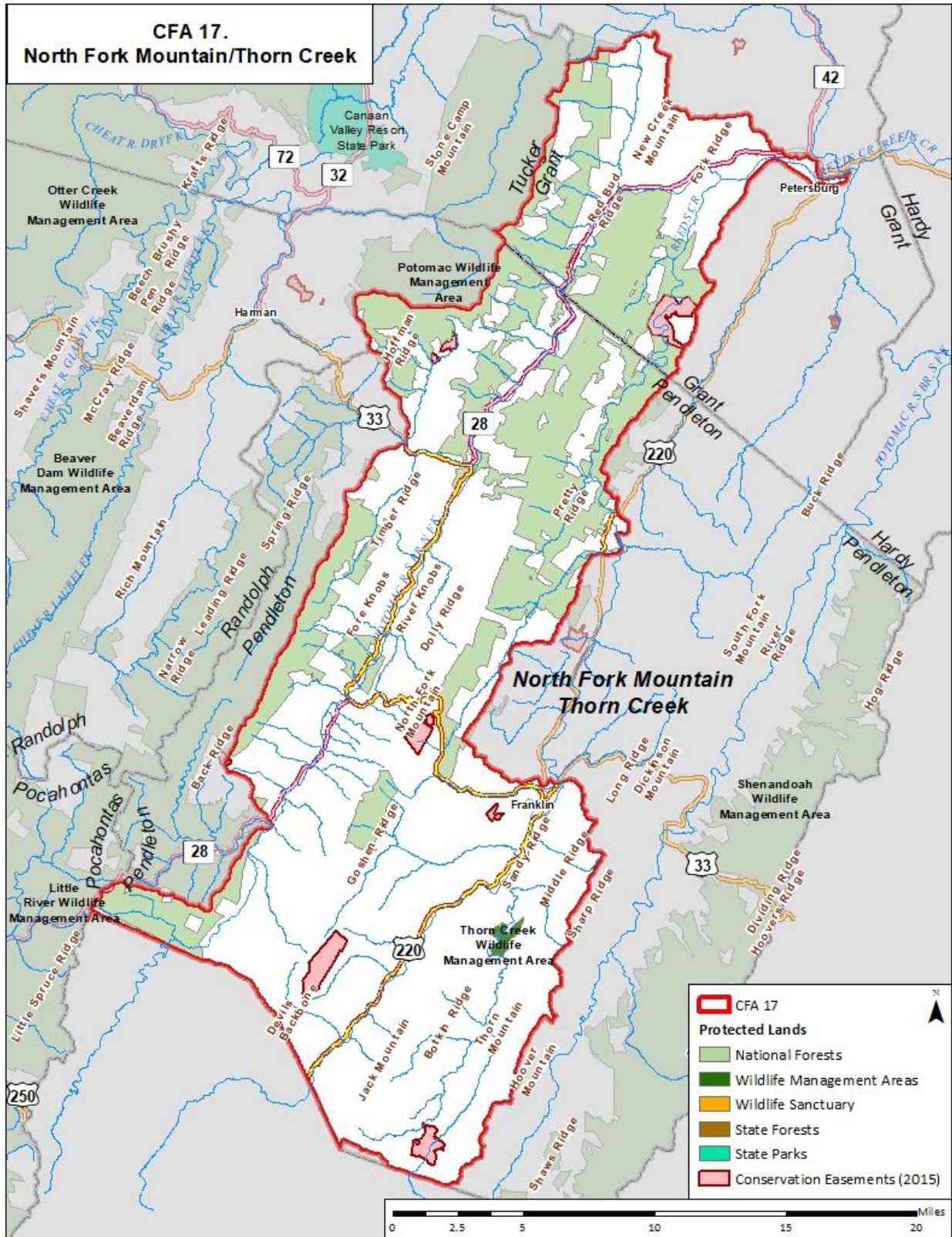
- Confirm whether specific priority wildlife species and habitats are present at specific sites
- Understand their vulnerability to climate change
- Further define or confirm stresses on wildlife species and habitats
- Tailor proposed wildlife conservation actions to alleviate stresses
- Consider adaptation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

North Fork Mountain and Thorn Creek Conservation Focus Area

Overview

This landscape extends along the north to south spine of North Fork Mountain, the highest mountain in the Ridge and Valley Ecoregion (4500+ feet), extends westward to the crests of Spruce Mountain and the Allegheny Front, and includes Germany Valley and the valley of the North Fork South Branch of the Potomac River. To the east it includes the rugged Smoke Hole Canyon along the mainstem South Branch of the Potomac River and nearby ridges, most notably Cave Mountain. It also includes the nearby but disjunct watershed of Thorn Creek, which flows into the South Branch of the Potomac River south of Franklin. Most of the area is in the rain shadow of the Allegheny Front and has some of the lowest precipitation in eastern North America. Consequently, most upland habitats are notably dry. Sandstone and conglomerates dominate North Fork Mountain and several other ridges, with shales in the lowlands and extensive areas of limestone in the Smoke Hole, Germany Valley, and Cave Mountain. This is a notably rugged, scenic mountainous area. The ridgetops, middle and upper slopes are primarily forested, with extensive federal ownership in the Monongahela National Forest. Large to medium-sized blocks of relatively intact forest remain. The lower slopes and valleys are mostly in agriculture, primarily pasture and hay. Vacation home developments occur scattered on Cave and North Fork mountains. This is an important area for outdoor recreation (hunting, hiking, camping, rock climbing, caving, fishing, canoeing, mountain biking). The towns of Petersburg and Franklin are also located in this CFA. A map on the following page illustrates the physical features, settlement patterns and land ownership in the CFA.

Overview



Habitats

North Fork Mountain and Thorn Creek CFA includes subterranean cave and karst habitats as well as a variety of terrestrial and aquatic habitat types.

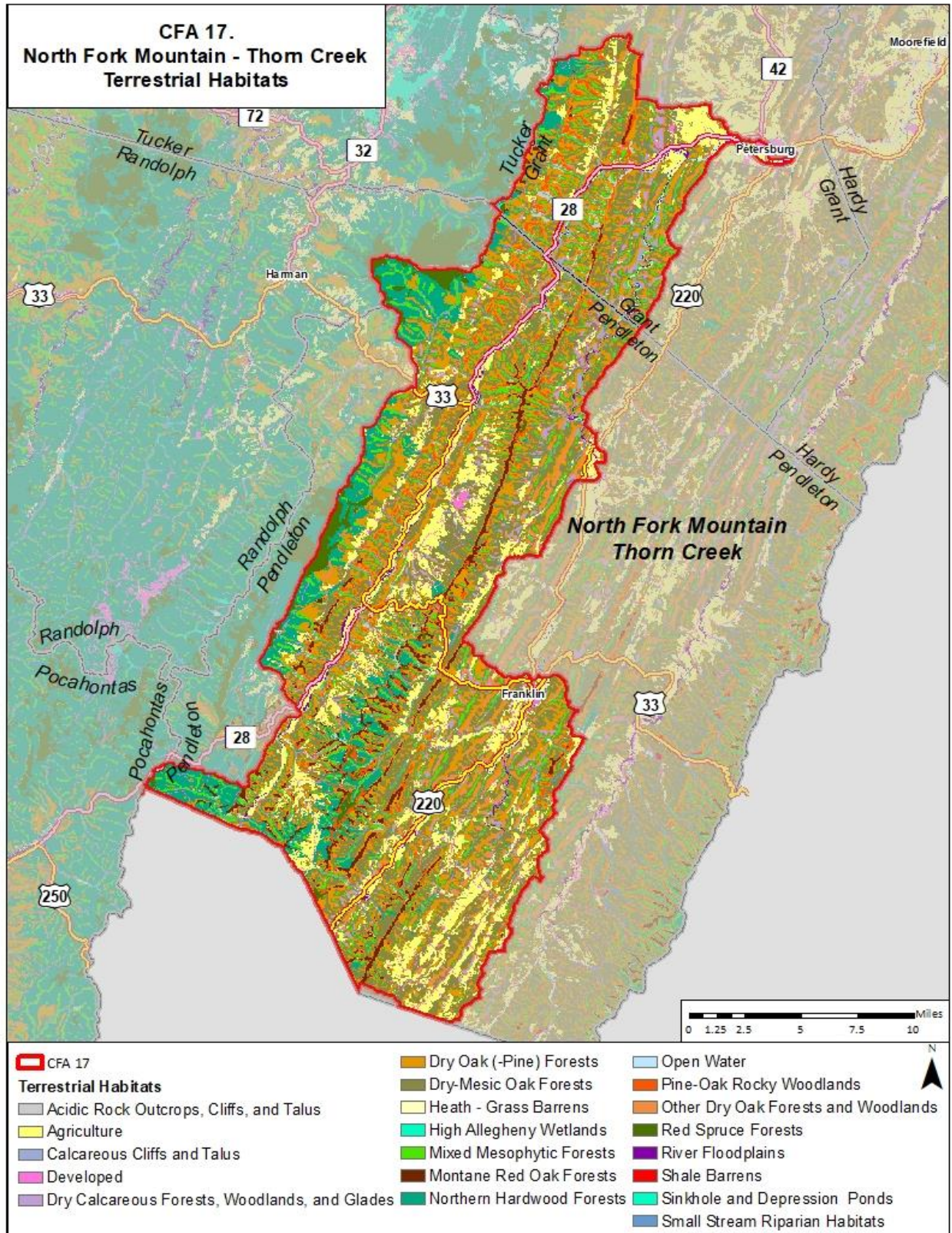
Terrestrial Habitats

Several the habitat types described in the SWAP are present in this CFA, and this Action Plan uses the same terrestrial habitat classifications. Montane red oak forests represent a tiny portion of the terrestrial habitats in this CFA yet represent over 30% of the state’s total montane red oak forest habitat. Similarly, calcareous cliffs and talus cover a minute portion of the CFA but comprise almost 20% of that habitat type in the state. Over half of the forests in the CFA are categorized as dry, and over 10% of the CFA is agricultural land.

Terrestrial Habitat Summary

HABITAT TYPE	ACRES IN CFA	PERCENT OF CFA AREA	PERCENT OF WV TOTAL FOR TYPE
Acidic Rock Outcrops, Cliffs, and Talus	2,752	1.03%	3.07%
Agriculture	35,467	13.22%	2.47%
Anthropogenic <u>Shrubland</u> & Grassland	0	0.00%	0.00%
Calcareous Cliffs and Talus	1,828	0.68%	19.85%
Developed	10,249	3.82%	0.90%
Dry Calcareous Forests, Woodlands, and Glades	5,735	2.14%	8.02%
Dry Oak (-Pine) Forests	57,087	21.28%	2.31%
Dry- <u>Mesic</u> Oak Forests	83,394	31.09%	1.67%
Heath-Grass Barrens	93	0.03%	3.32%
High Allegheny Wetlands	22	0.01%	0.11%
Mixed <u>Mesophytic</u> Forests	19,255	7.18%	0.65%
<u>Montane</u> Red Oak Forests	7,037	2.62%	33.29%
Northern Hardwood Forests	20,413	7.61%	2.05%
Pine-Oak Rocky Woodlands	6,727	2.51%	8.81%
Red Spruce Forests	4,888	1.82%	2.75%
River Floodplains	1,754	0.65%	1.46%
Shale Barrens	45	0.02%	2.49%
Sinkhole and Depression Ponds	3	0.00%	1.93%
Small Stream Riparian Habitats	5,033	1.88%	1.02%
Unresolved	6,459	2.41%	5.53%
Totals	268,242	100.00%	

Terrestrial Habitats



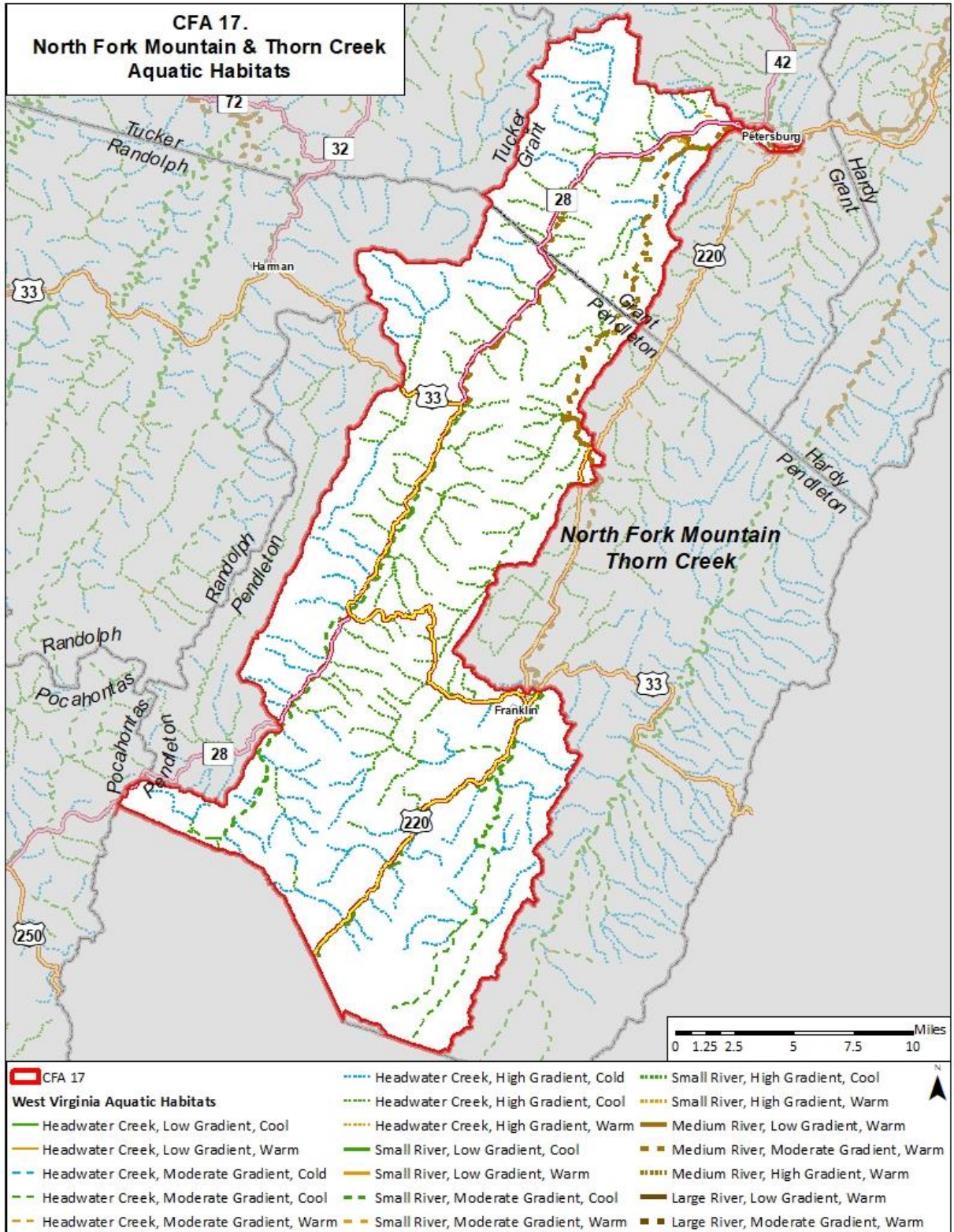
Aquatic Habitats

Several the aquatic habitat types described in the SWAP are present within the North Fork Mountain and Thorn Creek CFA, and this Action Plan uses the same aquatic habitat classifications. This CFA includes over 10% of the state’s cool, moderate gradient small river habitat and its warm, moderate gradient medium river habitat.

Aquatic Habitat Summary

HABITAT TYPE	MILES IN CFA	PERCENT OF CFA MILES	PERCENT OF WV TOTAL FOR TYPE
Headwater <u>Creek, Low Gradient, Cool</u>	0	0.03%	1.05%
Headwater <u>Creek, Low Gradient, Warm</u>	2	0.41%	0.36%
Headwater <u>Creek, Moderate Gradient, Cool</u>	46	9.63%	2.12%
Headwater <u>Creek, Moderate Gradient, Warm</u>	2	0.36%	0.04%
Headwater <u>Creek, High Gradient, Cold</u>	157	32.56%	5.36%
Headwater <u>Creek, High Gradient, Cool</u>	179	37.10%	2.86%
Small <u>River, Low Gradient, Cool</u>	0	0.08%	1.04%
Small <u>River, Moderate Gradient, Cool</u>	48	9.98%	10.33%
Medium <u>River, Low Gradient, Warm</u>	11	2.25%	2.29%
Medium <u>River, Moderate Gradient, Warm</u>	37	7.59%	10.57%
Totals	483	100.00%	

Aquatic Habitat



Species of Greatest Conservation Need

The table below provides the number of SGCN in each taxa group listed in the SWAP for the North Fork Mountain and Thorn Creek CFA (see full list in Appendix 1).

SGCN Summary by Taxa

TAXA	# SGCN
Amphibians	16
Birds	36
Butterflies and Moths	16
Cave Invertebrates	21
Dragonflies and Damselflies	10
Fish	6
Mammals	15
Mussels	4
Plants	124
Reptiles	12
Snails	18
Tiger Beetles	3
Totals	281

Caves within this landscape support highly endemic cave invertebrates (21 SGCN, including four cave species known from only one cave each). Caves here also support all West Virginia SGCN bats including 40% of the global population of Virginia Big-eared Bat, the largest concentrations of Indiana Bats and Little Brown Bats (*Myotis lucifugus*) in West Virginia. Prior to WNS infections, Hellhole Cave supported an estimated 200,000 bats, the largest concentration of wild mammals in the State and one of the largest bat hibernacula in the eastern United States. Thorn Creek Valley is literally a valley of caves, many supporting significant populations of bats.

The CFA has moderately large blocks of Dry Oak (-Pine) and Dry-Mixed Oak Forests, the state's most extensive Montane Red Oak Forests, and high proportions of Dry Calcareous Forests, Woodlands, and Glades. These forests and the embedded patch communities are of regional significance for:

- Forest interior nesting birds
- Allegheny Woodrat
- Timber Rattlesnake
- Eastern Small-footed Bats
- 15 SGCN snails
- 95 SGCN plants

The Smoke Hole and Cave Mountain support the most extensive limestone glade and barren complex in the Central Appalachians, providing habitat for the globally rare Smoke Hole Bergamot many other rare plants, and butterflies of concern. North Fork Mountain supports a very rich complex of acidic,

dry, high elevation habitats important for many rare plants and animals, including the largest pine barren/woodland complex in the Central Appalachians and the southernmost native forests of Red Pine. Pike and Panther Knobs on North Fork Mountain support outstanding examples of rare high elevation habitats; including high elevation Acidic Rock Outcrops, Cliffs, and Talus, red pine forests, and pine barrens. Thorn Creek supports some of the coldest and most productive spring-fed stream habitats in the state. The as-yet undescribed Checkered Sculpin can still be found in the coldest streams and the springs that feed them. Thorn Creek and Seneca Creek are renowned for the size and abundance of Brook Trout that are reported by anglers each year.

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

Distinctive Stresses

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

- Vacation home developments have occurred in ecologically significant areas and exceptional scenery here makes future development likely.
- A limestone quarry in Germany Valley could potentially impact cave resources, but the company has worked closely with the WVDNR and USFWS to ensure their operations do not impact the important caves near the quarry.
- Non-native invasive (NNIS) plant species are expanding from developed areas and agricultural fields into natural habitats containing sensitive plant communities (including several SGCN species).

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

Conservation Actions

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

1. Continue to coordinate with the quarry company to minimize potential for impacting cave resources.
2. There is exceptional opportunity for increased protection and management of important habitats on federal land, including addressing invasive plants, avoiding habitat loss and fragmentation by various activities, and avoiding impacts from recreational use.
3. Coordinate with the active land trust and farmland protection community to protect habitat through land conservation.
4. Coordinate with the Potomac Highlands Cooperative Weed Pest management Area to identify habitats impacted by NNIS and coordinate control or eradication efforts.

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

Potential Partners

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

- TNC
- WVDOF
- Greer Lime Company
- National Speleological Society
- Private cave owners
- Germany Valley Karst Survey
- Potomac Highlands Cooperative Weed and Pest Management Area

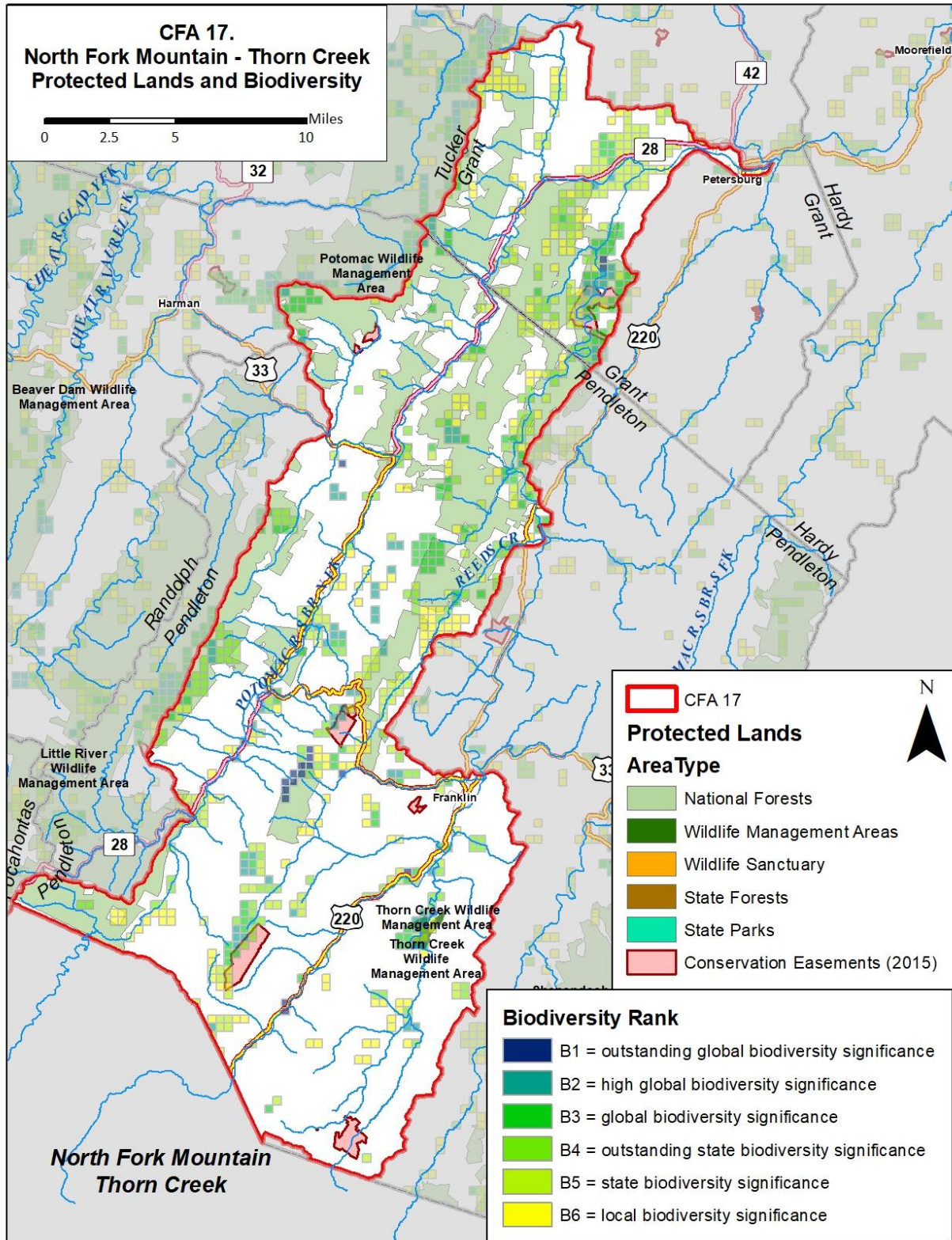
With an established “constituency”, many conservation partners can provide direct outreach to landowners and key stakeholders interested in wildlife conservation. The WVDNR will engage with these and other partners in regular face-to-face meetings and planning workshops during CFA planning, planning 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 including the Monongahela National Forest and Thorn Creek Wildlife Management Area, along with other protected lands including The Nature Conservancy’s 5,000 acres of fee owned lands and conservation easements in this CFA can provide significant opportunities for wildlife conservation. These public lands provide important wildlife habitat and are managed for conservation or other compatible goals. Appendix 3 lists habitat types occurring in each of the public lands within this CFA. WVDNR will work with public land managers to identify opportunities to plan and implement conservation actions that address stresses in these habitats and support priority SGCN. On state lands, this can include protection of important ecosystems, habitats, SGCN populations or plant communities through designation as State Natural Areas. City and county-owned public lands may also be managed to benefit wildlife and habitat. In addition, land trusts and conservation organizations including the WV Land Trust, The Nature Conservancy, the county farmland protection boards, the USDA Natural Resources Conservation Service and WV Division of Forestry’s Forest Legacy Program hold conservation easements that may protect important wildlife habitat and provide additional wildlife conservation opportunities.

The next map shows the location of public lands and conservation easements in the CFA, based on data provided by The Conservation Fund (TCF), USGS Gap Analysis Program (GAP), The Nature Conservancy (TNC), and the National Conservation Easement Database (NCED) in 2015. It also shows known occurrences of SGCN and rare plant communities within 500- square meter areas, and the biodiversity rank (including global, state or local significance) of those occurrences, as generated by WVDNR in 2017. This map illustrates that many SGCN and rare plant communities occur on public lands and conservation easements in the CFA, and there may be opportunities for WVDNR, public agencies and landowners to protect them there. Many SGCN and rare plant communities also occur on private land outside of public lands and conservation easements. This indicates how important it is for WVDNR and other partners to work with private landowners to restore and protect biodiversity on private lands. Appendix 4 lists partners and programs that provide assistance to private landowners in wildlife conservation.

Protected Lands and Biodiversity



Action Plan for the Conservation Focus Area

Conservation Goals

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

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

The WVDNR will develop relationships with conservation partners and key stakeholders to support and promote natural resource stewardship and guide efforts that protect, restore, enhance, and otherwise benefit natural communities and processes. Only through collaboration with agency partners, non-governmental organizations and the public [can we](#) address threats to Species of Greatest Conservation Need, key habitats, and unique communities.

Priority Species

Effectiveness and efficiency are paramount in targeting actions in CFAs and specifically addressing every SGCN present in the CFA is not feasible. From the list of SGCN present in the CFA provided in the SWAP, WVDNR wildlife biologists selected priority species for conservation action that represent the best opportunity for successful conservation based on its population status and known trends in the CFA, the significance of each species at the global, state and local levels, the degree of dependence of each species on habitats within the CFA, conservation opportunities and likelihood of conservation success in the CFA, and other factors. The table below lists SGCN that were selected as priority species within the CFA based on the above criteria. Also listed are the priority species which are classified as rare, threatened or endangered species or as sensitive species by United States Forest Service’s Region 9 and as at risk species by the United States Fish and Wildlife Service, indicating that the agencies may target these species for conservation action and may provide additional technical and financial support. Additional field surveying and information is needed to document and monitor the distribution, abundance, and population trends of these priority species in the habitats where they occur, and to assess their vulnerability to climate change. This work is ongoing and will be included as an action in the implementation plan for each major habitat type that follows.

Priority Species in CFA

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFS R9	USFWS
Birds	<i>Scolopax minor</i>	American Woodcock	S3B	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>Setophaga cerulea</i>	Cerulean Warbler	S2B	G4	S	

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFS R9	USFWS
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>Vermivora chrysoptera</i>	Golden-winged Warbler	S1B	G4		At Risk
Birds	<i>Ammodramus savannarum</i>	Grasshopper Sparrow	S3B	G5	S	
Birds	<i>Lanius ludovicianus</i>	Loggerhead Shrike	S1B,S1N	G4		
Birds	<i>Parkesia motacilla</i>	Louisiana Waterthrush	S3B	G5		
Birds	<i>Lanius ludovicianus migrans</i>	Migrant Loggerhead Shrike	S1B,S1N	G4T3Q		
Birds	<i>Falco peregrinus</i>	Peregrine Falcon	S2B,S2N	G4	S	
Birds	<i>Setophaga discolor</i>	Prairie Warbler	S3B	G5	S	
Birds	<i>Bonasa umbellus</i>	Ruffed Grouse	S3B,S3N	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	S	
Butterflies and Moths	<i>Brachionycha borealis</i>	Boreal Fan Moth	S1	G4	S	
Butterflies and Moths	<i>Erynnis lucilius</i>	Columbine Duskywing	S2	G4	S	
Butterflies and Moths	<i>Euchloe olympia</i>	Olympia Marble	S2S3	G4G5		
Butterflies and Moths	<i>Polytonia faunus smythi</i>	Smyth's Green Comma	S1	G5T3	S	
Cave Invertebrates	<i>Poecilophysis extraneostella</i>	A Cave Mite	S2	G2?		
Cave Invertebrates	<i>Caecidotea sinuncus</i>	An Isopod	S1	G1G2		
Cave Invertebrates	<i>Geocentrophora cavernicola</i>	Cave Flatworm	SH	G1G2		
Cave Invertebrates	<i>Islandiana speophila</i>	Cavern Sheet-web Spider	S1	G1		
Cave Invertebrates	<i>Stygobromus franzi</i>	Franz's Cave Amphipod	S1	G3G4		
Cave Invertebrates	<i>Pseudotremia lusciosa</i>	Germany Valley Cave Millipede	S1	G1G2	S	
Cave Invertebrates	<i>Zygonopus weyeri</i>	Grand Caverns Blind Cave Millipede	S2	G3G4	S	
Cave Invertebrates	<i>Stygobromus emarginatus</i>	Greenbrier Cave Amphipod	S3	G3G4		
Cave Invertebrates	<i>Macrocotyla hoffmasteri</i>	Hoffmaster's Cave Flatworm	S2	G3G4		
Cave Invertebrates	<i>Zygonopus whitei</i>	Luray Caverns Blind Cave Millipede	S1	G3G4	S	

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFS R9	USFWS
Cave Invertebrates	<i>Stygobromus morrisoni</i>	Morrison's Cave Amphipod	S1	G2G3		At Risk
Cave Invertebrates	<i>Pseudanopthalmus senecae</i>	Seneca Cave Beetle	S1	G1		
Cave Invertebrates	<i>Pseudanopthalmus potomaca</i>	South Branch Valley Cave Beetle	S1	G3G4		
Cave Invertebrates	<i>Pseudotremia princeps</i>	South Branch Valley Cave Millipede	S1	G1	S	At Risk
Cave Invertebrates	<i>Pseudanopthalmus hadenoecus</i>	Timber Ridge Cave Beetle	S1	G1		
Dragonflies and Damselflies	<i>Calopteryx angustipennis</i>	Appalachian Jewelwing	S3	G4		
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	S	
Mammals	<i>Neotoma magister</i>	Allegheny Woodrat	S3	G3G4	S	
Mammals	<i>Myotis leibii</i>	Eastern Small-footed Bat	S1	G3	S	
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk	S1	G5	S	
Mammals	<i>Myotis sodalis</i>	Indiana Bat	S1	G2		At Risk
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat	S2	G4T2		At Risk
Odonata	<i>Ophiogomphus mainensis fastigiatus</i>	Maine Snaketail	S3	G4TU		
Plants	<i>Allium allegheniense</i>	Allegheny Onion	S2	G3?	S	
Plants	<i>Trichophorum planifolium</i>	Bashful Bulrush	S1	G4G5		
Plants	<i>Piptatherum canadense</i>	Canada Mountain Ricegrass	S1	G5	S	
Plants	<i>Paxistima canbyi</i>	Canby's Mountain-lover	S2	G2	S	
Plants	<i>Astragalus neglectus</i>	Cooper's Milkvetch	S1	G4	S	
Plants	<i>Carex davisii</i>	Davis' Sedge	S1	G4		
Plants	<i>Hudsonia tomentosa</i> var. <i>tomentosa</i>	False Heather, Woolly Hudsonia	S1	G5T5		
Plants	<i>Linum sulcatum</i> var. <i>sulcatum</i>	Grooved Yellow Flax	S1	G5T5	S	
Plants	<i>Scutellaria ovata</i> ssp. <i>virginiana</i>	Heart-leaved Skullcap	S1?	G5TNR		
Plants	<i>Rhamnus lanceolata</i> ssp. <i>lanceolata</i>	Lance-leaved Buckthorn	S1	G5T4T5	S	
Plants	<i>Zigadenus elegans</i> ssp. <i>glaucus</i>	Mountain Deathcamas	S1	G5T4T5		
Plants	<i>Taenidia montana</i>	Mountain-pimpernel	S3	G3	S	
Plants	<i>Allium oxyphilum</i>	Nodding Wild Onion	S2	G2Q	S	
Plants	<i>Linum lewisii</i> var. <i>lewisii</i>	Prairie Flax	S2	G4G5T4T5		
Plants	<i>Pinus resinosa</i>	Red Pine	S1	G5		
Plants	<i>Oryzopsis asperifolia</i>	Roughleaf Ricegrass	S1	G5		

TAXA	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK	USFS R9	USFWS
Plants	<i>Cornus rugosa</i>	Roundleaf Dogwood	S1	G5	S	
Plants	<i>Trifolium stoloniferum</i>	Running Buffalo Clover	S3	G3	S	
Plants	<i>Monarda fistulosa</i> ssp. <i>brevis</i>	Smoke Hole Bergamot	S1	G5T1	S	
Plants	<i>Hexalectris spicata</i> var. <i>spicata</i>	Spiked Crested Coralroot	S1	G5T4T5	S	
Plants	<i>Arabis patens</i>	Spreading Rockcress	S2	G3	S	
Plants	<i>Delphinium exaltatum</i>	Tall Larkspur	S2	G3	S	
Plants	<i>Carex polymorpha</i>	Variable Sedge	S1	G3		
Plants	<i>Lupinus perennis</i> ssp. <i>perennis</i>	Wild Lupine, Sundial Lupine	S1	G5T4?		
Plants	<i>Paronychia virginica</i>	Yellow Nailwort	S2	G4	S	
Reptile	<i>Glyptemys insculpta</i>	Wood Turtle	S3	G4	S	At Risk
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake	S3	G4	S	
Tiger Beetles	<i>Cicindela ancocisconensis</i>	Appalachian Tiger Beetle	S3	G3	S	
Tiger Beetles	<i>Cicindela patruela</i>	Barrens Tiger Beetle	S2S3	G3	S	

Forest and Woodland Habitats

Dry-Mesic Oak Forests cover over one third of the CFA and represent the largest portion of forest habitat types, followed by Dry Oak Pine Forests. Montane Red Oak Forests occupy a much smaller portion within the CFA but represent a third of the forest habitat type in the state. 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 Pine-Oak Rocky Woodlands, Red Spruce Forests, and Dry Calcareous Forests, Woodlands, and Glades. 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 diversity of forest types across elevational gradients provides great opportunities for their conservation within larger forest patches and requires careful management tied to specific site conditions and forest stand characteristics. Intact forest patches provide core habitat for a significant portion of the SGCN and rare communities, as well as a matrix of forest habitat types and large corridors within which forest species may shift and adapt to climate change.

Priority Species

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

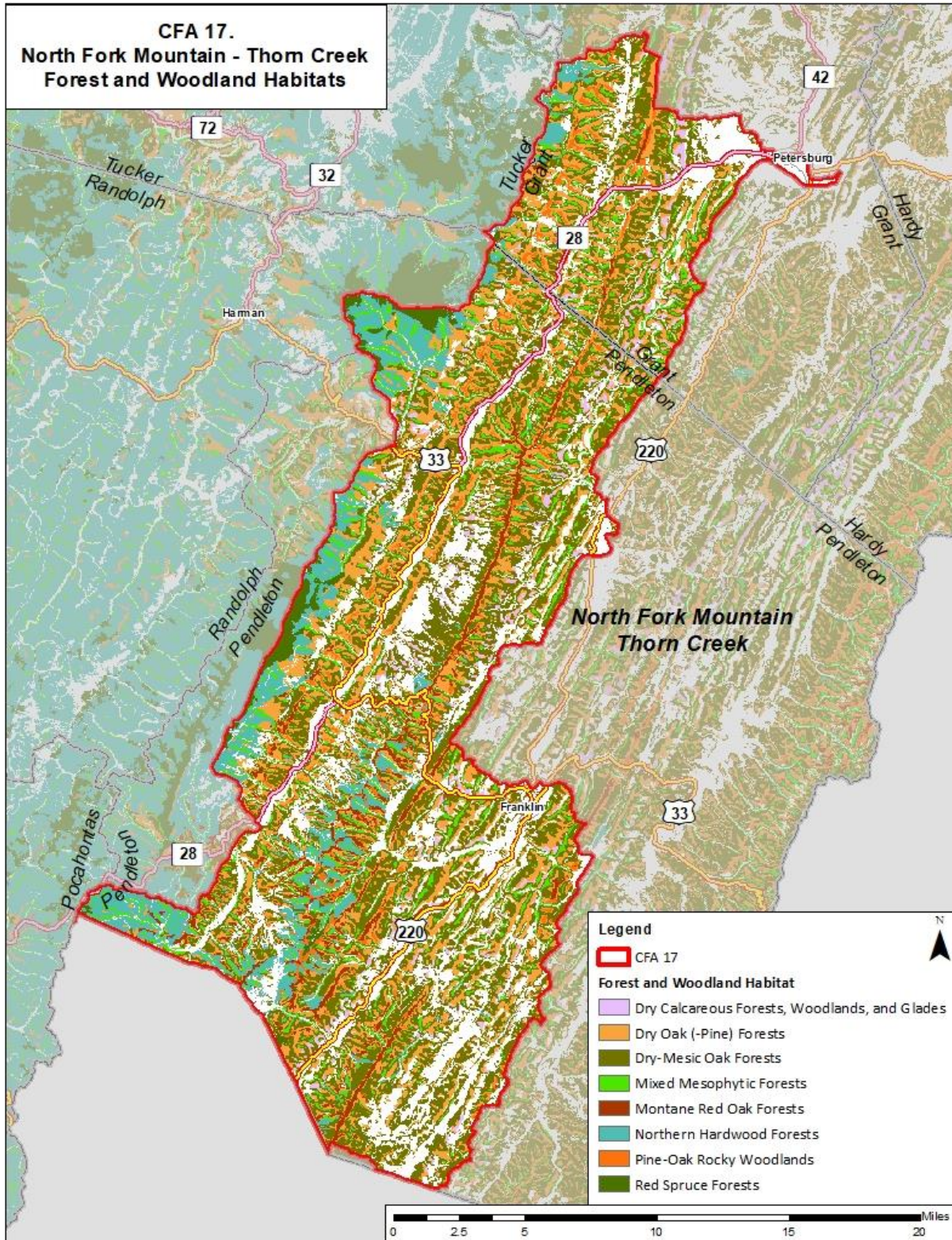
Priority Species in Forest and Woodland Habitats.

Taxa	Scientific Name	Common Name
Birds	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler
Birds	<i>Vermivora chrysoptera</i>	Golden-winged Warbler
Birds	<i>Setophaga discolor</i>	Prairie Warbler
Birds	<i>Bonasa umbellus</i>	Ruffed Grouse
Birds	<i>Hylocichla mustelina</i>	Wood Thrush
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler
Butterflies and Moths	<i>Brachionycha borealis</i>	Boreal Fan Moth
Butterflies and Moths	<i>Euchloe olympia</i>	Olympia Marble
Butterflies and Moths	<i>Polygonia faunus smythi</i>	Smyth's Green Comma
Mammals	<i>Neotoma magister</i>	Allegheny Woodrat
Mammals	<i>Myotis leibii</i>	Eastern Small-footed Bat
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk
Mammals	<i>Myotis sodalis</i>	Indiana Bat

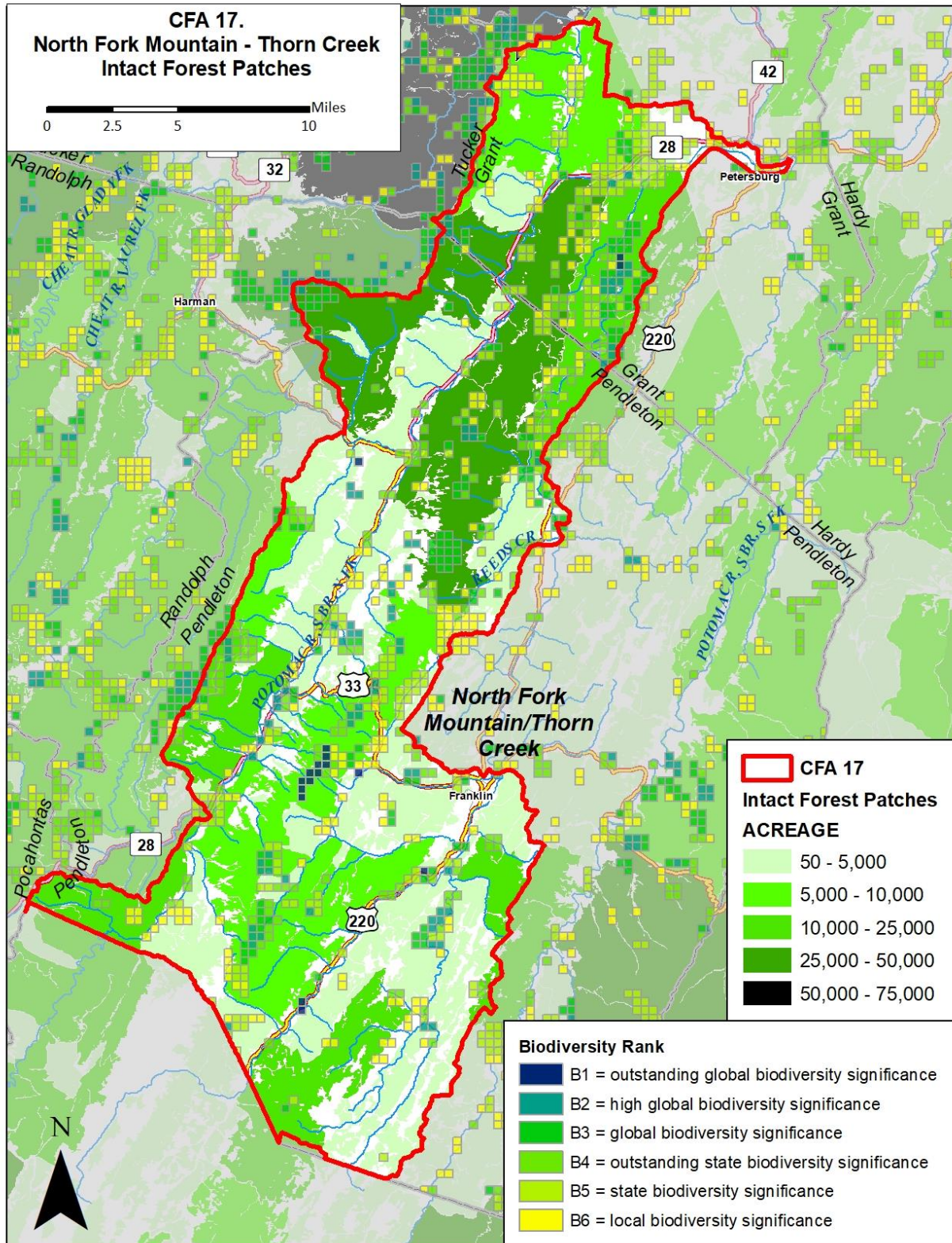
Taxa	Scientific Name	Common Name
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat
Plants	<i>Allium allegheniense</i>	Allegheny Onion
Plants	<i>Trichophorum planifolium</i>	Bashful Bulrush
Plants	<i>Piptatherum canadense</i>	Canada Mountain Ricegrass
Plants	<i>Paxistima canbyi</i>	Canby's Mountain-lover
Plants	<i>Astragalus neglectus</i>	Cooper's Milkvetch
Plants	<i>Hudsonia tomentosa</i> var. <i>tomentosa</i>	False Heather, Woolly Hudsonia
Plants	<i>Linum sulcatum</i> var. <i>sulcatum</i>	Grooved Yellow Flax
Plants	<i>Scutellaria ovata</i> ssp. <i>virginiana</i>	Heart-leaved Skullcap
Plants	<i>Rhamnus lanceolata</i> ssp. <i>lanceolata</i>	Lance-leaved Buckthorn
Plants	<i>Zigadenus elegans</i> ssp. <i>glaucus</i>	Mountain Deathcamas
Plants	<i>Taenidia montana</i>	Mountain-pimpernel
Plants	<i>Allium oxyphilum</i>	Nodding Wild Onion
Plants	<i>Linum lewisii</i> var. <i>lewisii</i>	Prairie Flax
Plants	<i>Pinus resinosa</i>	Red Pine
Plants	<i>Oryzopsis asperifolia</i>	Roughleaf Ricegrass
Plants	<i>Cornus rugosa</i>	Roundleaf Dogwood
Plants	<i>Trifolium stoloniferum</i>	Running Buffalo Clover
Plants	<i>Monarda fistulosa</i> ssp. <i>brevis</i>	Smoke Hole Bergamot
Plants	<i>Hexalectris spicata</i> var. <i>spicata</i>	Spiked Crested Coralroot
Plants	<i>Arabis patens</i>	Spreading Rockcress
Plants	<i>Delphinium exaltatum</i>	Tall Larkspur
Plants	<i>Carex polymorpha</i>	Variable Sedge
Plants	<i>Lupinus perennis</i> ssp. <i>perennis</i>	Wild Lupine, Sundial Lupine
Plants	<i>Paronychia virginica</i>	Yellow Nailwort
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake
Tiger Beetles	<i>Cicindela patruela</i>	Barrens Tiger Beetle

Large, intact forest blocks support many forest interior breeding birds, including Wood Thrush, Cerulean Warbler and Worm-eating Warbler. Early successional forest habitats support Prairie Warbler, and Black-billed Cuckoo. Several rare, endemic plant species are associated with pine-oak rocky woodlands and dry calcareous forests, woodlands, and glades, but additional surveying will be required to ascertain their status and location. 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.

Forest and Woodland Habitat



Intact Forest Patches and Biodiversity



Rare Plant Communities

The following rare plant communities are found in Forest and Woodland habitats in this CFA. Note that over three quarters of the state’s White Cedar Cliff Woodland, Limestone Clifftop Woodland, and Pitch Pine – Virginia Pine Sandstone Pavement Woodland are located here. Along with over half of the state’s Ridge and Valley Calcareous Red Oak – Sugar Maple Forest, Natural Red Pine Forest, and Ridge and Valley Pitch Pine - Table Mountain Pine Woodland. 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 ADUNDANCE
Dry Calcareous Forests, Woodlands, and Glades	White Cedar Cliff Woodland	G2G3	S2	93%
Dry Calcareous Forests, Woodlands, and Glades	Limestone Clifftop Woodland	G3G4	S2	85%
Dry Calcareous Forests, Woodlands, and Glades	Ridge and Valley Calcareous Red Oak - Sugar Maple Forest	G4	S3	56%
Dry Calcareous Forests, Woodlands, and Glades	Ridge and Valley Sugar Maple - Chinquapin Oak Dry Limestone Woodland	G4?	S2	33%
Dry Calcareous Forests, Woodlands, and Glades	Ridge and Valley Sugar Maple - Chinquapin Oak Dry Limestone Woodland	G4?	S2	33%
Dry Calcareous Forests, Woodlands, and Glades	Calcareous Prairie	G1G2	S1	28%
Dry Calcareous Forests, Woodlands, and Glades	Chinquapin Oak - Bitternut Hickory Limestone Forest	G3G4	S3	7%
Dry-Mesic Oak Forests	Eastern Ridges Oak - Hickory / Graminoid Forest	G3G4	S3	33%
Pine - Oak Rocky Woodlands	Pitch Pine - Virginia Pine Sandstone Pavement Woodland	G3	S1	78%
Pine - Oak Rocky Woodlands	Natural Red Pine Forest	G1	S1	70%
Pine - Oak Rocky Woodlands	Ridge and Valley Pitch Pine - Table Mountain Pine Woodland	G4	S3	61%
Red Spruce Forests	Red Spruce / Heath Rocky Woodland	G2	S1	41%
Red Spruce Forests	Red Spruce / Southern Mountain Cranberry Forest	G2	S1	3.7%
Red Spruce Forests	Red Spruce / Great Laurel Forest	G2G3	S2	3.5%

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.

Stresses and actions affecting priority species in Forest and Woodland habitats:

Habitat Stress	Conservation Action
Forest habitat fragmentation	Habitat protection to maintain large forest blocks, and forested corridors for wildlife passage between watersheds. <ul style="list-style-type: none"> • Land use planning by local governments • Land protection/conservation easements
Residential development	Land protection/conservation easements
Pesticide exposure	Reduce aerial application of pesticides (orchards)
Deer overbrowsing, poor forest structure	Reduce deer population, manage forests for structural and spatial complexity
Herbicide use/vegetation management in utility corridors	Reduce disturbance in utility corridors
Interior forest: Insufficient habitat, fragmentation, 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
Early successional forest: Insufficient habitat, forest maturation, 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
Non-native invasive weeds	Prevent spread through forestry operations and other ground disturbance, conduct monitoring and treatment
Lack of mast trees and forest cover on ridgetops for Allegheny Woodrat	Keep ridgetops forested and promote mast producing trees.
Forest fragmentation and disturbance from agriculture and development	Reduce and mitigate disturbance and fragmentation, especially for rare plants
Fire Suppression, woody encroachment, and poor structure in fire-adapted forests	Prescribed burns in fire-adapted forests
Closing canopy and resulting reduced light for Running Buffalo Clover	Careful canopy thinning to increase light penetration.
Loss of basking, gestation, and denning habitat for Timber Rattlesnakes	Create canopy gaps over gestation and basking sites; develop den avoidance guidance
Invasive adelgids on hemlock and fir	Environmentally sustainable adelgid control if available Woody encroachment

In addition to the habitat-linked stresses listed above, direct stresses to priority species include rodenticides poisoning Barn Owls, gypsy moth control for butterflies and moth species, or deer herbivory for Canby's Mountain-lover.

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

Climate Change and Habitat Resilience

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

The 2015 assessment also described likely impacts to specific forest types. Dry Mesic Oak Forests support a large number of tree species over a diversity of terrain, and many of the tree species are tolerant of drought and fire, providing some resilience to climate change. Fire suppression and timber harvesting have allowed more mesic species to become dominant, but increased temperature and drought could increase the risk of wildfire. While low-intensity fires could restore fire-adapted species, severe fires, combined with drought and other stressors, could increase mortality of some species. Higher temperatures and drought may increase the susceptibility of these forests to invasive species, pests and pathogens, and drought as well as disturbances from stronger storms may enable the spread of non-native invasive plants.

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

for fires and increasing fire intensity. Forest pests, pathogens and invasive plants need to be carefully managed to build resilience to climate change.

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

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

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

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

Below is a summary of climate stresses on forest habitats, and actions which could boost their resilience (Swanston et al, 2016). While climate stresses are listed separately, forest and woodland habitats are often impacted by multiple climate stresses occurring simultaneously and actions to boost habitat resilience are intended to address multiple climate stresses. Many of these actions 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 in Forest and Woodland Habitats

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

Implementation Plan

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

Implementation Plan for Forest and Woodland Habitats

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> Conservation Easements 	<ul style="list-style-type: none"> WVDOP Forest Legacy County Farmland Protection Boards Potomac Conservancy WV Land Trust The Nature Conservancy 	<ul style="list-style-type: none"> Acres of habitat protected for priority species Abundance and diversity of priority species and habitats
Habitat Protection: <ul style="list-style-type: none"> Land use planning 	<ul style="list-style-type: none"> County Planning Commissions 	<ul style="list-style-type: none"> Acres of habitat protected through land use planning in forested areas
Habitat Protection <ul style="list-style-type: none"> Incentive Programs 	<ul style="list-style-type: none"> USDA NRCS CSP GHG Sequestration 	<ul style="list-style-type: none"> Acres of habitat protected for priority species Abundance and diversity of priority species and habitats
Develop and implement forest management plans that create or maintain early successional	<ul style="list-style-type: none"> WVU Extension USDA NRCS EQIP WVDOP 	<ul style="list-style-type: none"> Acres of habitat restored for priority species

Action	Partners /Programs	Effectiveness Measures
habitat to benefit wildlife species through forest management activities on appropriate sites	<ul style="list-style-type: none"> • Consulting Foresters • NWTF and RGS • Public Land Managers 	<ul style="list-style-type: none"> • Before and after comparison: abundance & distribution of priority species
Develop and implement forest management plans that improve or maintain interior forest habitat to benefit wildlife species through forest management activities on appropriate sites	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance & distribution of priority species
Reduce aerial application of pesticides (to control caterpillars)	<ul style="list-style-type: none"> • Landowners/orchards 	<ul style="list-style-type: none"> • Change in pesticide use • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Manage deer browse and reduce deer population	<ul style="list-style-type: none"> • WVDNR (hunting licenses) • Private landowners • Public land managers • WVDNR Wildlife Management Areas • National Forests 	<ul style="list-style-type: none"> • Change in deer population • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Manage utility corridors to reduce wildlife impacts (implement BMPs promoted by the Wildlife Habitat Council, NRCS and other organizations)	<ul style="list-style-type: none"> • Public Land Managers • Partners • Utility companies 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance and diversity of priority species
Forest management to create forest canopy gaps and vegetative cover	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters • Public land managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Provide guidance on timber rattlesnake den avoidance	<ul style="list-style-type: none"> • WVU Extension • Public land managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

Action	Partners /Programs	Effectiveness Measures
Control invasive weeds	<ul style="list-style-type: none"> • WVDOP • WVCA and PVCD • NRCS CSP & EQIP • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat protected or restored for priority species • Before and after comparison: abundance and diversity of priority species
Promote diversity of native species and age classes in forested areas, and restore native forest vegetation on adjacent degraded lands through planting and silviculture	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOP • Consulting Foresters • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Prescribed burning by public agencies (in fire adapted forest habitats)	<ul style="list-style-type: none"> • WVDNR • US Forest Service 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

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, greenhouse gas sequestration and forest carbon opportunities, and hunting, wildlife viewing, tourism, and recreational opportunities.

Rock Outcrops, Cliffs and Talus, Heath Grass and Shale Barrens

Acidic Rock Outcrops, Cliffs and Talus, Calcareous Cliffs and Talus, Heath-Grass and Shale Barrens 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 is on the following page, and those in smaller forest patches may be more vulnerable to stresses. These habitat types, while covering only small areas, are priorities for the conservation of several SGCN and rare plant communities in this CFA.

Priority Species

The table below lists priority species in the CFA associated with Acidic Rock Outcrops, Cliffs and Talus, Calcareous Cliffs and Talus, Heath-Grass and Shale Barrens. This CFA contains more than half of the state's occurrences of rare plant species of Prairie Flax, Smoke Hole Bergamot, Yellow Nailwort, and Variable Sedge.

Priority Species in Rock Outcrops, Cliffs and Talus, Heath Grass and Shale Barrens

Taxa	Scientific Name	Common Name
Butterflies and Moths	<i>Erynnis lucilius</i>	Columbine Duskywing
Butterflies and Moths	<i>Euchloe olympia</i>	Olympia Marble
Mammals	<i>Neotoma magister</i>	Allegheny Woodrat
Mammals	<i>Myotis leibii</i>	Eastern Small-footed Bat
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk
Plants	<i>Zigadenus elegans</i> ssp. <i>glaucus</i>	Mountain Deathcamas
Plants	<i>Linum lewisii</i> var. <i>lewisii</i>	Prairie Flax
Plants	<i>Monarda fistulosa</i> ssp. <i>brevis</i>	Smoke Hole Bergamot
Plants	<i>Carex polymorpha</i>	Variable Sedge
Plants	<i>Paronychia virginica</i>	Yellow Nailwort
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake

Rare Plant Communities

These habitats are home to several rare plant communities, over 40% of which are found in this CFA. Additional field surveying is needed to better understand and monitor the distribution and abundance of these rare communities.

Rare Plant Communities in Rock Outcrops, Cliffs and Talus, and Heath Grass Barrens

HABITAT	COMMON NAME	G RANK	S RANK	RELATIVE ABUNDANCE
Acidic Rock Outcrops, Cliffs, and Talus	Sandstone Boulderfield Lichen Community	G5	S3	41%
Acidic Rock Outcrops, Cliffs, and Talus	Basswood Boulderfield Forest	G3	S1S2	37%
Acidic Rock Outcrops, Cliffs, and Talus	High Elevation Sandstone Boulderfield	G2?	S2	32%
Acidic Rock Outcrops, Cliffs, and Talus	High-Elevation Boulderfield Forest	G2	S2	18%
Calcareous Cliffs and Talus	White Cedar Cliff Woodland	G2G3	S2	92%
Heath - Grass Barrens	Mountain Laurel - Black Huckleberry Heath Barren	G2	S2	42%
Heath - Grass Barrens	Blueberry Heath Barren	G3G4	S2	4.5%

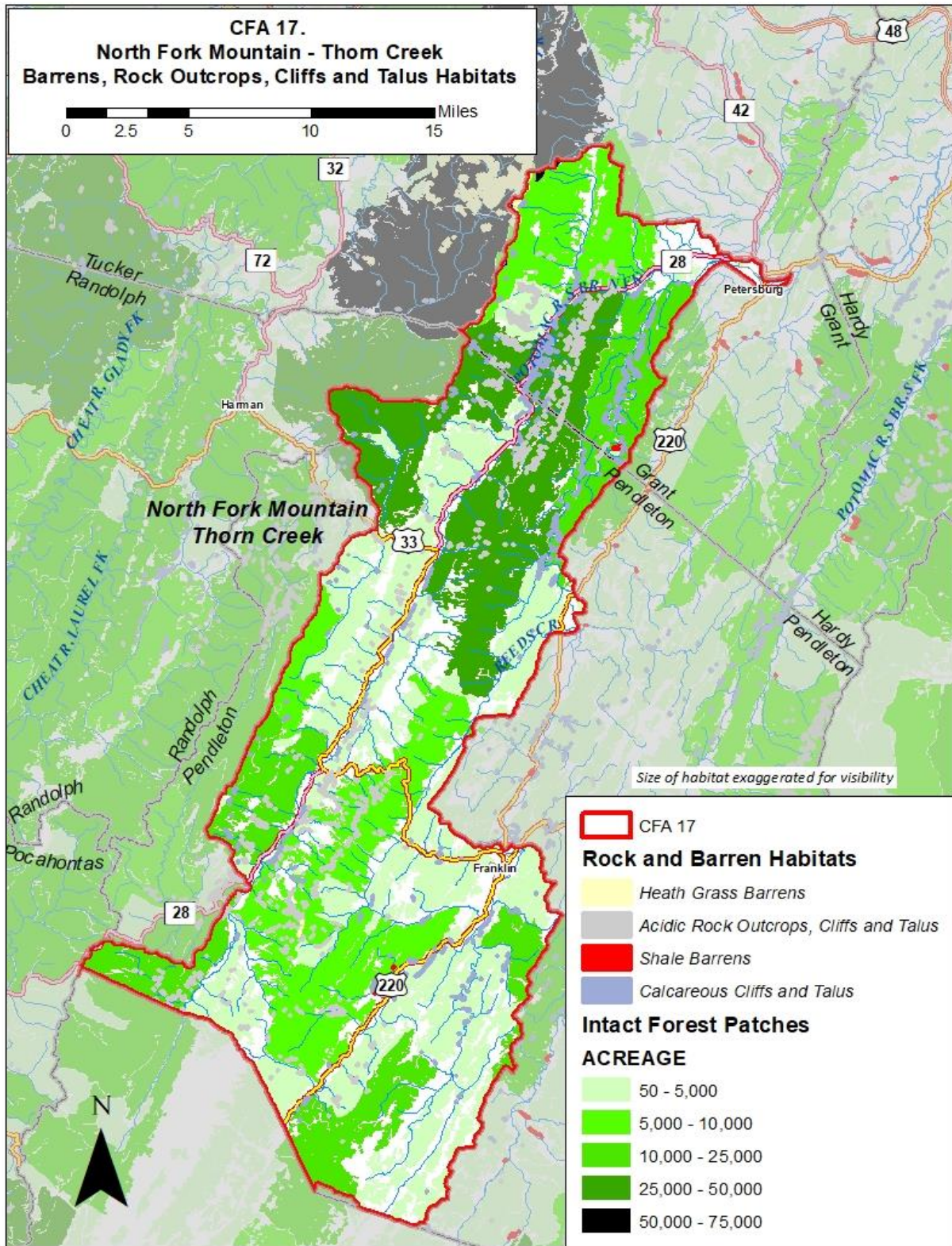
Habitat Stresses and Conservation Actions

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, Heath Grass and Shale Barrens

Habitat Stress	Conservation Action
Invasive plants and disturbance from agriculture, quarries, and development	Minimize disturbance, especially on rare plants
Fire Suppression, woody encroachment, and poor structure in fire-adapted forests	Controlled burns in fire-adapted habitats
Woody encroachment and forest maturation in timber rattlesnake habitat in shale barrens	Forest management and fire to maintain optimal denning, nesting, and basking habitat
Fire or lack of fire	Research impacts of fire

Rock Outcrops, Cliffs & Talus, Heath Grass and Shale Barren Habitat



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, Heath Grass and Shale Barren Habitats

Climate Stresses	Habitat Resilience Actions
<ul style="list-style-type: none"> Increased risk of drought and wildfire Increased frequency and severity of storms Increased competition from non-native invasive species 	<ul style="list-style-type: none"> Promptly revegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species Protect refugia for rare habitats and plant communities Maintain intact, resilient forest habitat in surrounding areas

Implementation Plan

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

Implementation Plan for Rock Outcrop, Cliffs and Talus, and Shale Barren habitats

Action	Partners /Programs	Effectiveness Measures
Habitat Protection: <ul style="list-style-type: none"> Conservation Easements 	<ul style="list-style-type: none"> WVDOF Forest Legacy County Farmland Protection Boards Potomac Conservancy WV Land Trust The Nature Conservancy 	<ul style="list-style-type: none"> Acres of habitat protected for priority species Abundance and diversity of priority species and habitats
Habitat Protection: <ul style="list-style-type: none"> Land use planning 	<ul style="list-style-type: none"> County Planning Commissions 	<ul style="list-style-type: none"> Acres of habitat protected through land use planning for development around cliffs, steep slopes, and fragile soils

Action	Partners /Programs	Effectiveness Measures
Habitat Protection <ul style="list-style-type: none"> • Incentive Programs 	<ul style="list-style-type: none"> • USDA NRCS CSP 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Abundance and diversity of priority species and habitats
Re-vegetate sites after disturbance, prevent the introduction and establishment of invasive plant species, and remove existing invasive species	<ul style="list-style-type: none"> • WVDOF • WVCA and Conservation District • NRCS CSP • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Forest management	<ul style="list-style-type: none"> • WVU Extension • USDA NRCS EQIP • WVDOF • Consulting Foresters 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Manage recreation on sensitive sites	<ul style="list-style-type: none"> • Public Land Managers • WVDNR 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Prescribed burning by public agencies to restore fire adapted plant communities	<ul style="list-style-type: none"> • WVDNR • US Forest Service 	<ul style="list-style-type: none"> • Acres of habitat restored for priority species • Before and after comparison: abundance, diversity, and distribution of priority species
Minimize impact on fragile habitat	<ul style="list-style-type: none"> • Quarries and developers • Public Land Managers 	<ul style="list-style-type: none"> • Acres of habitat protected for priority species • Before and after comparison: abundance, diversity, and distribution of priority species

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 cold, high-gradient headwater streams to warm, low gradient, medium sized 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, floodplain and riparian species in the CFA that occur in rivers and streams.

Priority Aquatic Species

Taxa	Scientific Name	Common Name
Fish	<i>Anguilla rostrata</i>	American Eel
Fish	<i>Luxilus cornutus</i>	Common Shiner
Fish	<i>Margariscus margarita</i>	Pearl Dace
Odonata	<i>Ophiogomphus mainensis fastigiatus</i>	Maine Snaketail
Reptile	<i>Glyptemys insculpta</i>	Wood Turtle

Because riparian and floodplain habitats are so closely connected to adjacent rivers and streams, they host some of the same species. Wood Turtles that rely on in-stream and floodplain/riparian habitats, as do rare plants including Davis' Sedge, the current status of which is unknown.

Priority Riparian and Floodplain Species

Taxa	Scientific Name	Common Name
Birds	<i>Parquesia motacilla</i>	Louisiana Waterthrush
Dragonflies and Damselflies	<i>Calopteryx angustipennis</i>	Appalachian Jewelwing
Mammals	<i>Myotis sodalis</i>	Indiana Bat
Plants	<i>Carex davisii</i>	Davis' Sedge
Tiger Beetles	<i>Cicindela ancocisconensis</i>	Appalachian Tiger Beetle

Rare Plant Communities

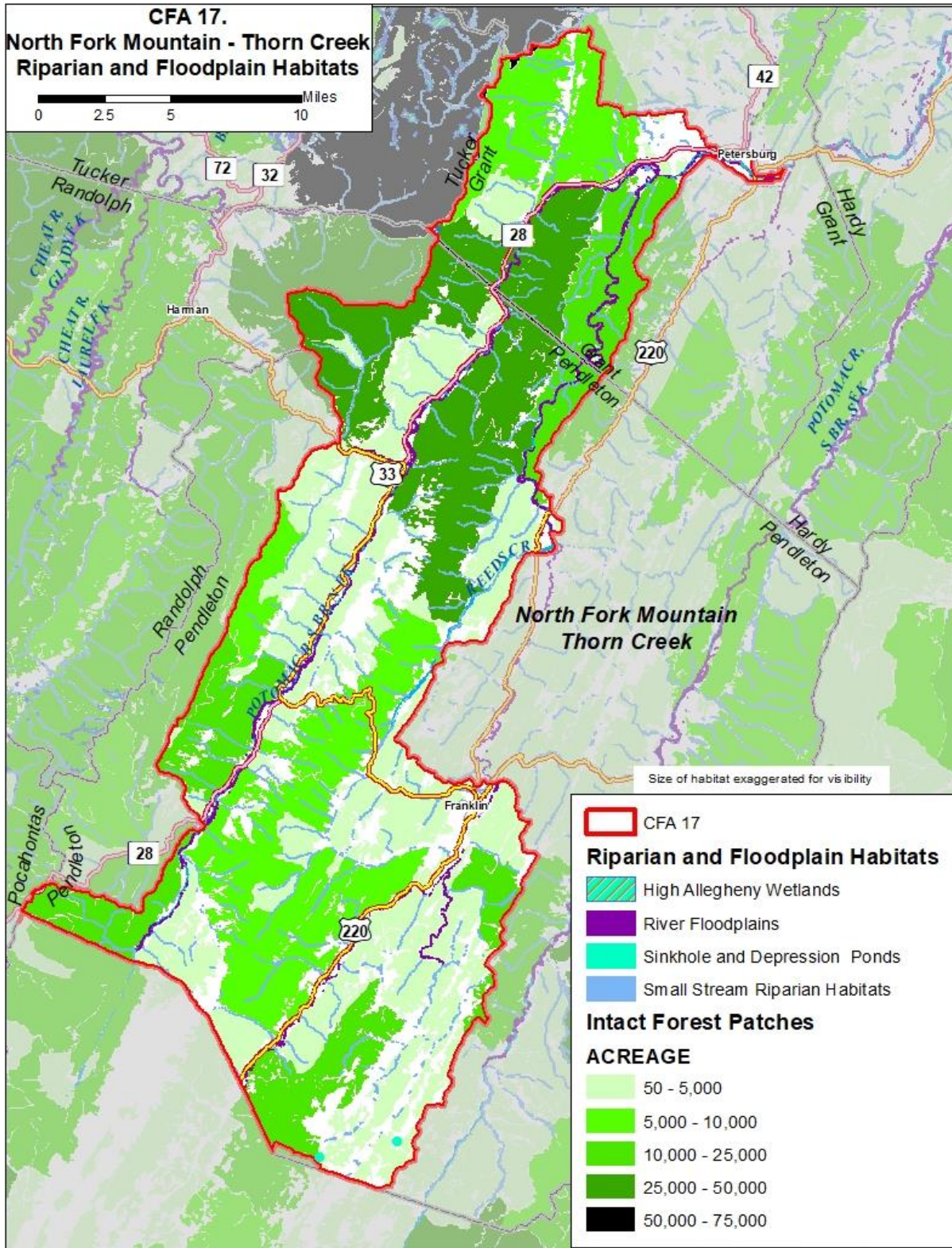
The following rare plant communities may be found in aquatic, floodplain, and riparian habitats in this CFA. Note that a third of the state's Pitch Pine/Heath Peat Woodland and Sinkhole Marsh are found in this CFA. These plant communities are vulnerable to disturbance and the spread of non-native invasive plants. Disturbance should be avoided, and non-native invasive plant infestations should be treated.

Rare Plant Communities in Aquatic, Floodplain and Riparian Habitats.

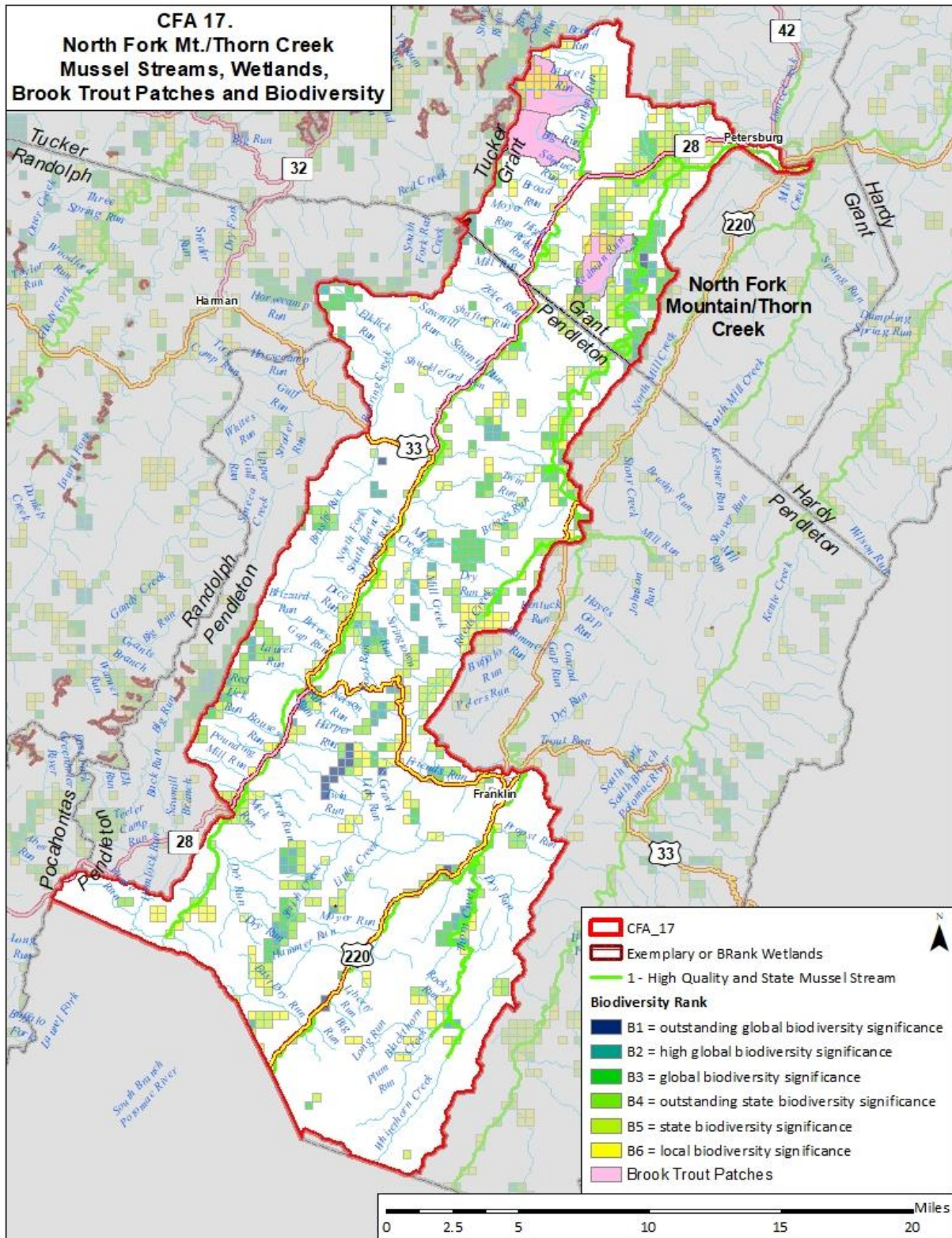
HABITAT	COMMON NAME	G RANK	S RANK	RELATIVE ABUNDANCE
High Allegheny Wetlands	Pitch Pine / Heath Peat Woodland	G1G2	S1	30%
High Allegheny Wetlands	Red Spruce / Three-seeded Sedge Peat Woodland	G2	S2	14%
High Allegheny Wetlands	Red Spruce - Yellow Birch - Mannagrass Swamp	G3	S1	5%
High Allegheny Wetlands	Red Spruce / Heath Peat Woodland	G2G3	S1	2%
River Floodplains	Red Spruce - Yellow Birch - Mannagrass Swamp	G3	S1	5%
Sinkhole and Depression Ponds	Sinkhole Marsh	G1	S1	30%
Small Stream Riparian Habitats	Red Spruce - Yellow Birch - Mannagrass Swamp	G3	S1	5%

Maps illustrating riparian and floodplain habitats, mussel streams (mapped by WVDNR in 2018), exemplary wetlands (as assembled by WVDNR in 2015), brook trout habitat patches (provided by the Eastern Brook Trout Joint Venture based on an assessment in 2015) and biodiversity are on the following pages. These areas provide core habitat and movement corridors for many of the priority species and rare plant communities listed above and are priority habitats. The B-Rank occurrences indicate that numerous SGCN and rare communities occupy stream, floodplain, and riparian habitats. A few sink hole and depression ponds are visible in the southern end of the CFA. The South Branch, North Fork, Reeds Creek, Thorn Creek, Jordan Run and several smaller tributaries are designated state mussel streams. These streams and brook trout patches require careful management to maintain those priority species. Small stream riparian corridors and floodplain habitats along the South Branch, North Fork, and Reeds Creek provide important habitat for wildlife and are important for maintaining the form and function of streams and rivers. Floodplain and riparian habitats and brook trout habitat patches outside of the larger forest patches may be more vulnerable to stresses. These are important habitats for conservation actions targeting priority SGCN.

Riparian and Floodplain Habitats



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



Habitat Stresses and Conservation Actions

Direct stresses to priority species include passage barriers for American Eels, and illegal collection and poaching of Wood Turtles. 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 (compiled by WVDEP in 2014), along with biodiversity, is on the previous page. The South Branch River Jordan Run and several tributaries, Mill Creek and Gravel Lick Run are impaired streams that are also 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

Habitat Stress	Conservation Action
Lack of protected floodplain, wetland, and riparian habitat	Habitat protection and monitoring through land use planning, conservation easements and other programs and activities
Water quality- wastewater, stormwater, and effluents	Treatment, regulation and management of wastewater, stormwater, and effluents
Invasive plants	Treating of cattail and other invasive plants
Passage barriers	Remove barriers
Degradation of riparian habitat and water quality, warming waters, decline in aerial insects	Planting and fencing stream buffer zones, outreach to landowners
Loss of instream habitat	Create or establish instream habitat features
Hemlock woolly adelgid	Treat remaining riparian hemlock stands

Climate Change and Habitat Resilience

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

The Assessment also describes how instream habitats and associated plant and animal species may be stressed by climate change-related increases in temperature, droughts, flood frequency and severity, and resulting erosion and sedimentation. Low flow events may also become more frequent and severe.

Warming surface waters is likely to result in water quality degradation and eutrophication. Many aquatic species and life stages are adapted to specific timing and ranges of flow and temperature, as well as water quality variables. Climate change may impact different species and life stages in different ways. Cold water habitats and aquatic communities may be at particular risk. Areas within a watershed may be more or less sensitive to increases in air temperature, depending on local factors such as watershed characteristics, position within the watershed, upstream land uses, groundwater contributions, forest cover and shading.

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

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

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

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

Implementation Plan

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

Implementation Plan for Aquatic, Floodplain and Riparian Habitats

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

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

Human Benefits

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

Subterranean Habitats

Karst and Cave Habitats

Areas with karst geology and subterranean caves provide unique habitats that may be influenced by human activities, surface land use, and surface and underground hydrology in the surrounding landscape. Caves provide important habitat for bats that move in and out, as well as a diverse group of vertebrate and invertebrate animals that have evolved specialized adaptations to permanent underground living. Common traits exhibited by permanent cave dwellers (troglobites) include blindness (or complete loss of eyes) and reduced pigmentation. The map on the following page illustrates several bands of karst geology (based on maps from the WV Geologic and Economic Survey in 1998) along the length of the CFA. Karst areas in smaller and more fragmented forest patches may be more vulnerable to stresses. The map on the subsequent page illustrates multiple biologically significant caves that host rare bat or endemic cave species, or exceptional biological diversity, with 3-mile buffers offset randomly. It also illustrates numerous karst features with 3-kilometer random offset buffers, and karst feature density. This data was provided by the West Virginia Speleological Society, with offset buffers developed by WVDNR. Buffers around karst features and biologically significant caves occupy the majority of the CFA. These areas require careful management to minimize disturbance on priority species.

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 eight endemic cave invertebrate species including the Timber Ridge Cave Beetle, Cave Flatworm, and Germany Valley Cave Millipede.

Priority Species in Subterranean Habitats

TAXA	SCIENTIFIC NAME	COMMON NAME
Cave Invertebrates	Caecidotea sinuncus	An Isopod
Cave Invertebrates	Stygobromus franzi	Franz's Cave Amphipod
Cave Invertebrates	Stygobromus emarginatus	Greenbrier Cave Amphipod
Cave Invertebrates	Stygobromus morrisoni	Morrison's Cave Amphipod
Cave Invertebrates	Pseudanophthalmus hadenoecus	Timber Ridge Cave Beetle
Cave Invertebrates	Pseudanophthalmus potomaca	South Branch Valley Cave Beetle
Cave Invertebrates	Pseudanophthalmus senecae	Seneca Cave Beetle
Cave Invertebrates	Poecilophysis extraneostella	A Cave Mite
Cave Invertebrates	Islandiana speophila	Cavern Sheet-web Spider
Cave Invertebrates	Macrocotyla hoffmasteri	Hoffmaster's Cave Flatworm
Cave Invertebrates	Geocentrophora cavernicola	Cave Flatworm

TAXA	SCIENTIFIC NAME	COMMON NAME
Cave Invertebrates	<i>Pseudotremia lusciosa</i>	Germany Valley Cave Millipede
Cave Invertebrates	<i>Pseudotremia princeps</i>	South Branch Valley Cave Millipede
Cave Invertebrates	<i>Zygonopus weyeri</i>	Grand Caverns Blind Cave Millipede
Cave Invertebrates	<i>Zygonopus whitei</i>	Luray Caverns Blind Cave Millipede
Mammals	<i>Myotis sodalis</i>	Indiana Bat
Mammals	<i>Myotis leibii</i>	Eastern Small-footed Bat
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat
Mammals	<i>Neotoma magister</i>	Allegheny Woodrat

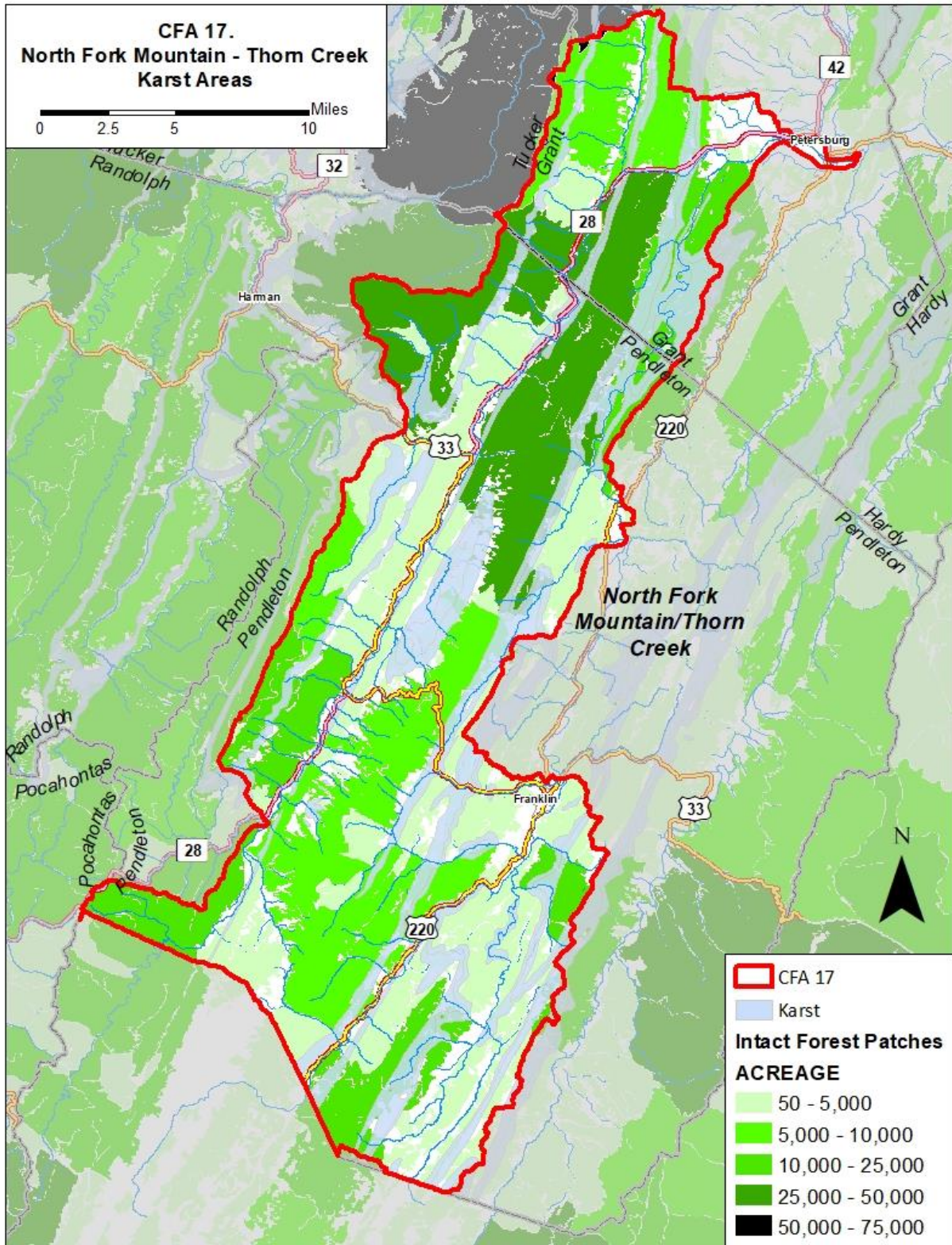
Habitat Stresses and Conservation Actions

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

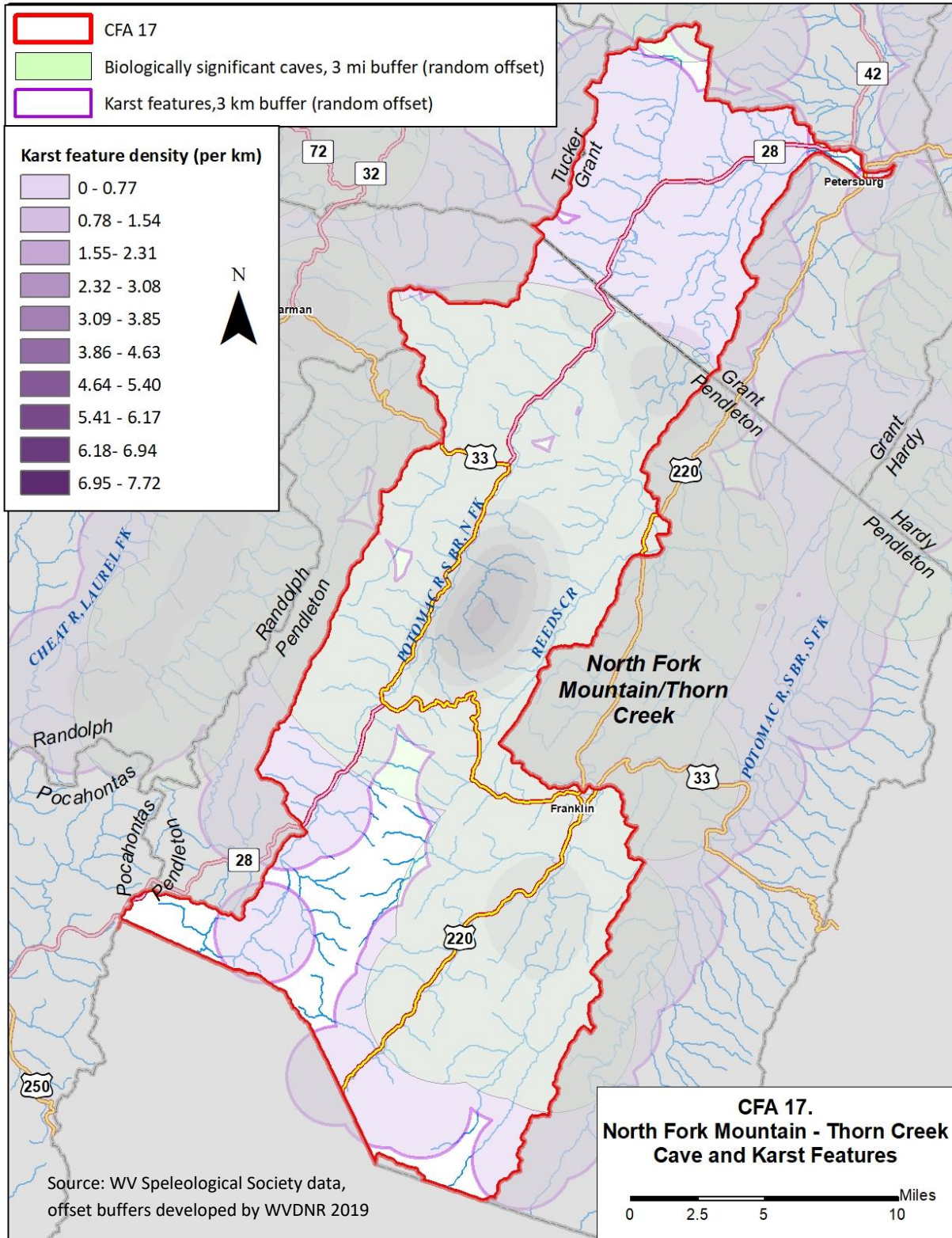
Habitat stresses and conservation actions in Subterranean Habitats

Habitat Stress	Conservation Action
Water quality	Education, wastewater treatment, fencing, riparian plantings
Land use changes	Land protection, land use planning and careful management around caves
Disturbance	Cave closure during important life stages.

Karst Areas and Intact Forest Patches



Karst and Cave Features



Climate Change and Habitat Resilience

The Central Appalachians Forest Ecosystem Vulnerability Assessment (Butler et. al, 2015), noted that ecosystems that are limited by geological or hydrological features, such as cave and karst habitats, may be restricted from shifting across the landscape in response to climate change. However, caves 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 and contaminants carried by floods. Restoring and maintaining water quality and natural flow regimes in areas upstream and above caves and karst may boost the resilience of cave ecosystems. Some cave dwelling species also rely on adjacent forest, riparian and aquatic habitats. Maintaining the resilience of adjacent ecosystems could further buffer cave species from the impacts of climate change.

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

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

Implementation Plan

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

Implementation Plan for Subterranean Habitats

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

Human Benefits

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

Agricultural and Developed Habitats

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

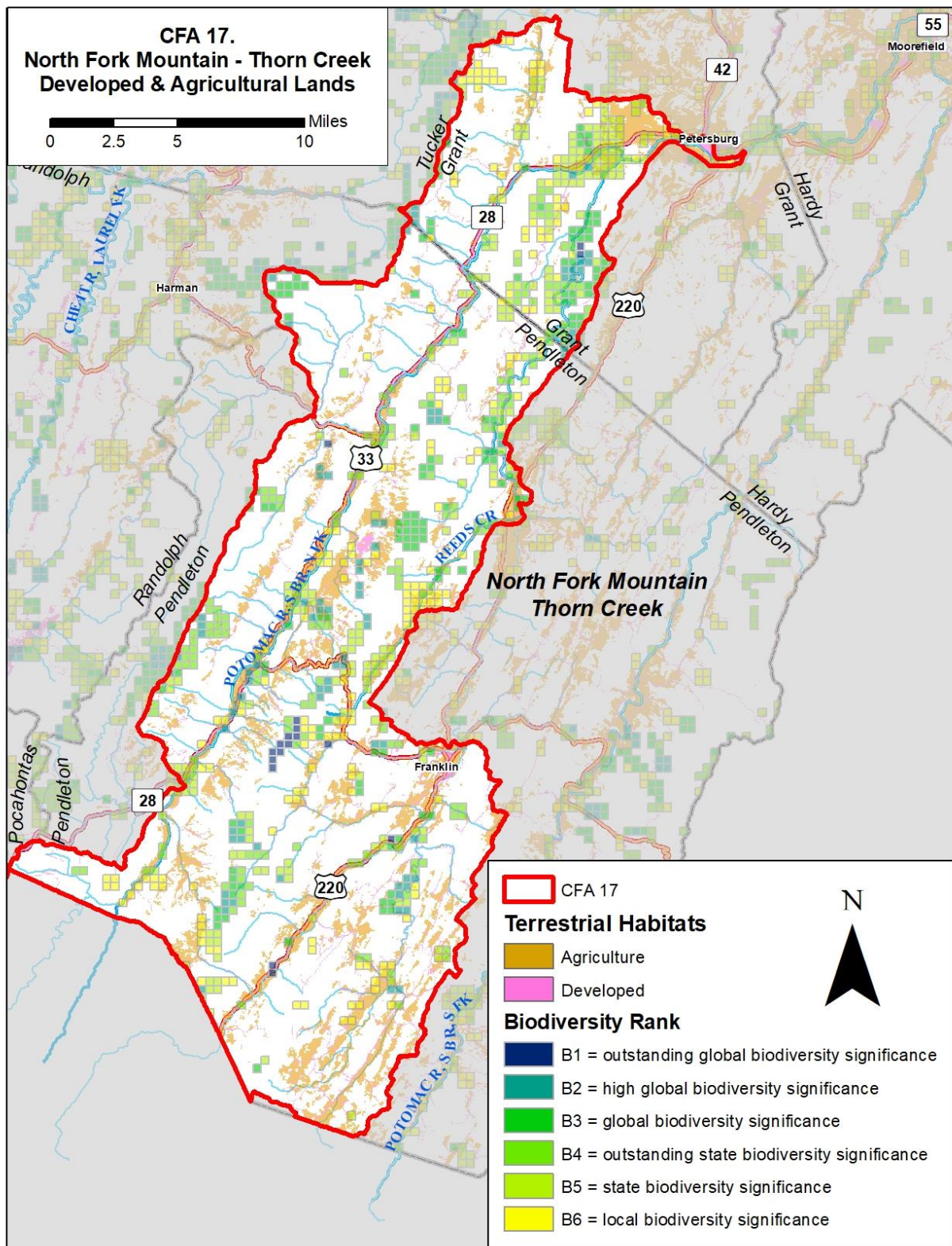
Priority Species

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

Priority Species in Agricultural and Developed Habitats

Taxa	Scientific Name	Common Name
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat
Birds	<i>Scolopax minor</i>	American Woodcock
Birds	<i>Tyto alba</i>	Barn Owl
Birds	<i>Dolichonyx oryzivorus</i>	Bobolink
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>Poocetes gramineus</i>	Vesper Sparrow
Birds	<i>Icteria virens</i>	Yellow-breasted Chat
Birds	<i>Chaetura pelagica</i>	Chimney Swift
Birds	<i>Chordeiles minor</i>	Common Nighthawk
Birds	<i>Falco peregrinus</i>	Peregrine Falcon

Developed & Agricultural 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 following table lists stresses to wildlife habitat in agricultural areas, and conservation actions to address them.

Stresses and Actions in Agricultural and Developed Lands:

Habitat Stress	Conservation Action
Clean farming practices: loss of woody veg.	Retain or plant shrubs, hedgerows and hawthorns in pastures
Clean farming practices: grassland conversion	Prevent conversion of grasslands to croplands
Insufficient habitat, predation	Reduce clean farming practices, maintain early successional habitat
Herbicide/veg. management in utility corridors	Reduce disturbance in utility corridors
Residential development	Land protection, conservation easements
Barn owl poisoning from rodenticides	Outreach to landowners to reduce rodenticides
Insufficient barn owl nest microhabitat	Install and monitor nest boxes
Chimney capping and loss of old homes	Uncap chimneys, install towers for chimney swifts
Disturbance of peregrine falcon nests	Survey and monitor nesting sites
Loss of bird habitat and nesting sites	Landowner outreach and education

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 Habitats

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

	<ul style="list-style-type: none"> • Reduce and buffer impervious surfaces, and use green infrastructure to absorb runoff and mitigate hydrological impacts
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Implementation Plan

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

Implementation Plan for Agricultural and Developed Lands.

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

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

Human Benefits

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

Landscape Resilience and Connectivity

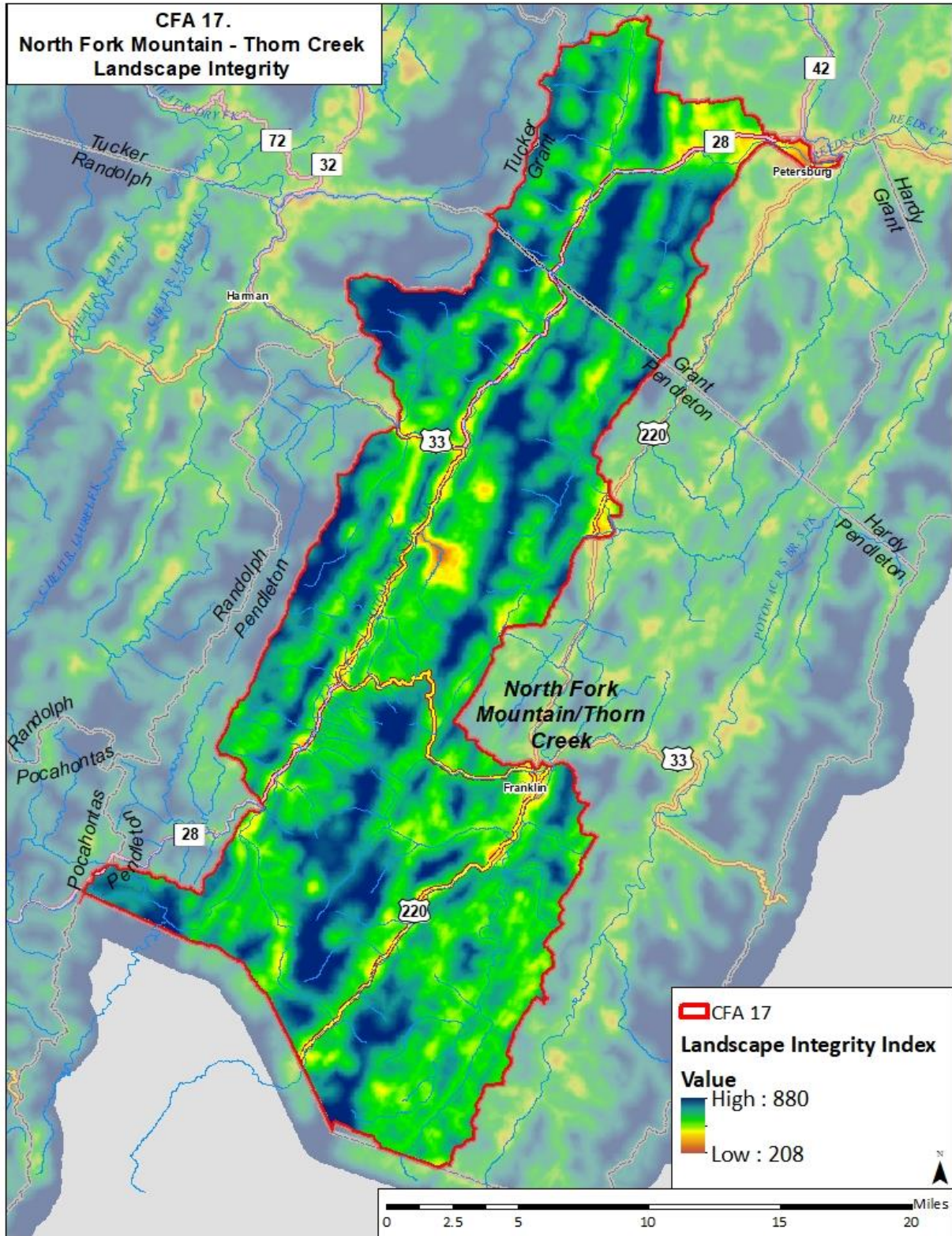
Climate Stresses and Conservation Actions

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 the WVDNR developed a model of landscape integrity to identify unfragmented landscapes. Landscape integrity is estimated to increase with distance from roads, powerlines, development, and other features that fragment the landscape. The map on the following page illustrates areas of high landscape integrity in the CFA. Many of these high integrity landscapes are in larger forest patches and correspond to Monongahela National Forest lands and areas in and around The Nature Conservancy's preserves and easements. Some high integrity areas are also in private ownership. These are priority areas for protection of wildlife habitat. These areas are important for species movement in response to climate change and are priorities for protection of wildlife habitat.

Landscape Integrity



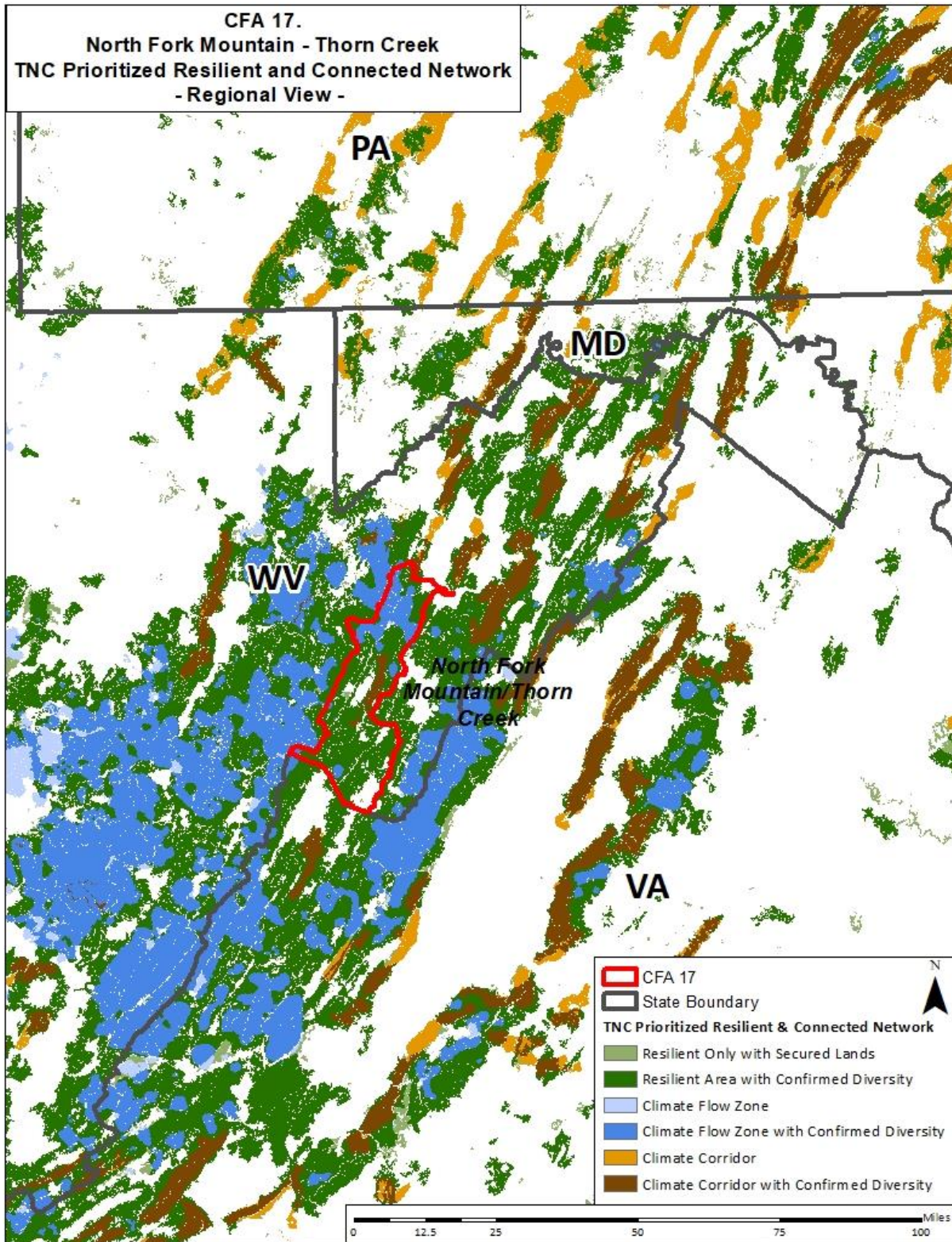
Building on the concept of landscape integrity, The Nature Conservancy (TNC) led a team of 60 scientists to identify areas representing all geophysical settings, with varied microclimates and natural cover, that were most likely to sustain native plants and animals and natural processes into the future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

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

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

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

Priority Resilient and Connected Network – Regional View



Following the regional map is a more detailed view of the of the priority resilient and connected network in the North Fork Mountain & Thorn Creek CFA, which includes many resilient lands with confirmed biodiversity, a large climate flow zone in the northern section of the CFA and several smaller ones providing dispersed movement of wildlife species, and one climate corridor for more concentrated movement along the ridge of North Fork Mountain. These priority resilient and connected landscapes contain the CFA’s large forest patches and high integrity areas, and most of the CFA’s rock outcrop, cliff and talus, and shale barren habitats, cave and karst features, and known biodiversity. Smaller patches of fragmented forest and agricultural areas are not included.

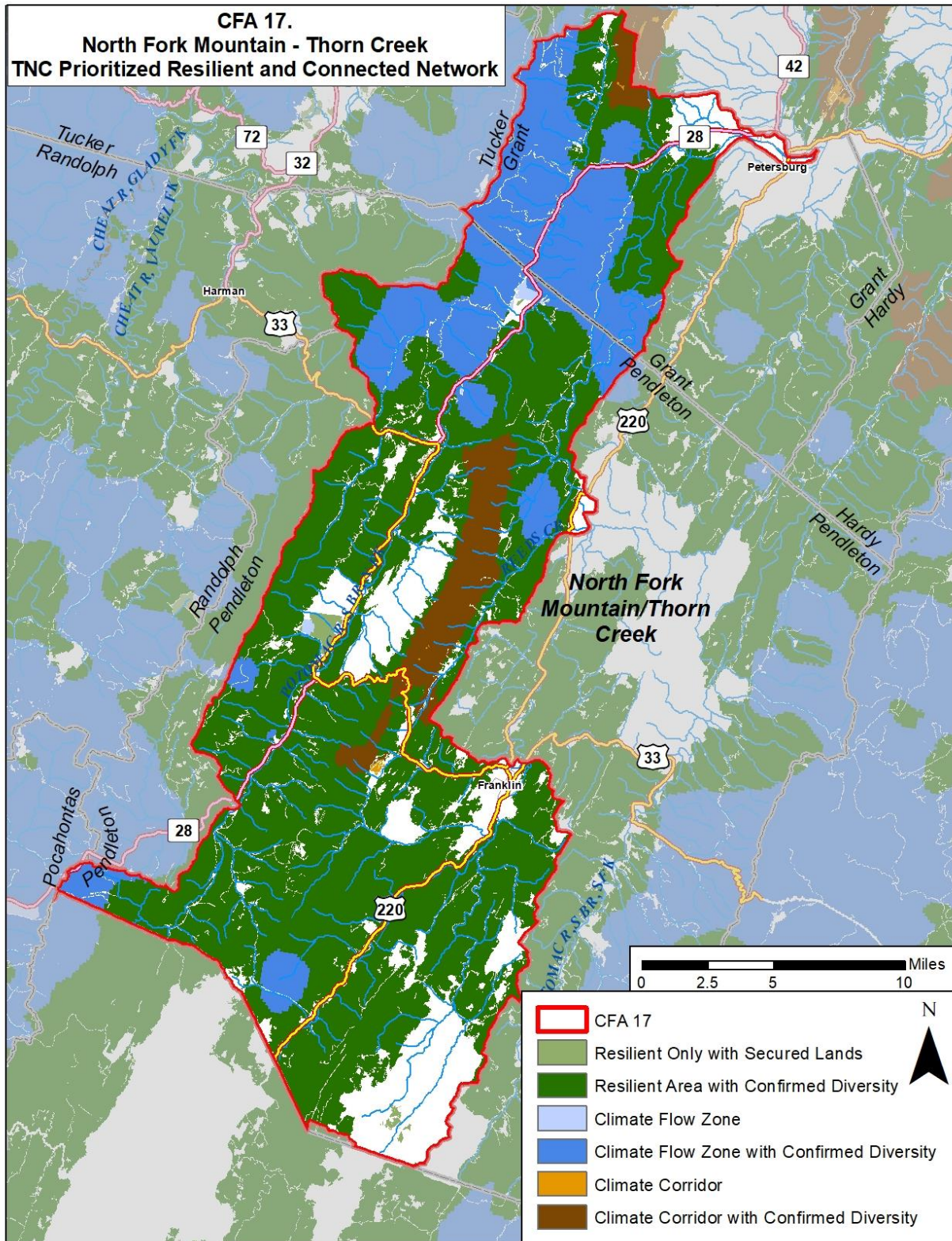
Protecting and maintaining these areas of high landscape integrity and the resilient areas, climate corridors and climate flow zones within the region’s priority resilient and connected network is critical in order to enable priority SGCN and their habitat to adapt to climate change and persist in this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

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

Climate Stresses and Actions for Landscape Resilience and Connectivity

Climate Stress	Conservation Action
<ul style="list-style-type: none"> • Changing conditions exacerbating existing stresses on species and habitat • Species responding to climate change by shifting locally as well as across the landscape • Landscape fragmentation that prevents or constrains species movement 	<ul style="list-style-type: none"> • Protect and maintain a connected network of resilient landscapes, flow zones and climate corridors across the landscape for species to adapt and shift locally and regionally in response to climate change

Priority Resilient and Connected Network- Detailed View



Implementation Plan

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

Implementation Plan for Landscape Resilience and Connectivity

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

Conclusion

Conservation Priorities

This action plan lists priority species and rare plant communities targeted for conservation action on public and private land and within each major habitat type. The major habitat types include 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 for conservation action within each major habitat type.

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

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

Integration of Conservation Actions

Integration of conservation actions within the above priority habitats, such as projects to improve water quality in a mussel stream and plant riparian vegetation on streambanks, may benefit multiple plant and wildlife species. Coordinating actions across multiple habitats or priority areas, such as protecting large patches of diverse forest habitats that also include rare shale barrens, rock outcrops or cliff and talus habitats, or improving water quality and planting riparian corridors in karst and cave watersheds, may

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

Connecting Conservation Actions for Climate Adaption

As we have seen, conservation actions to relieve stresses on priority species and efforts to boost the resilience of wildlife habitat are essential for enabling climate adaptation. Maintaining and protecting areas of high landscape integrity as well as the regional network of resilient lands, climate corridors, and flow zones is also critical for enabling wildlife species to 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 in the CFA to thrive 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; and
- Engaging and supporting private landowners in this work.

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

promote avoidance, minimization, and mitigation for development impacts to priority habitats and other priority areas for conservation action.

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Appendix 1. SGCN in this CFA

TAXA	SCIENTIFIC_NAME	COMMON_NAME	S_RANK	G_RANK
Amphibians	Ambystoma jeffersonianum	Jefferson Salamander	S2	G4
Amphibians	Aneides aeneus	Green Salamander	S3	G3G4
Amphibians	Desmognathus fuscus	Northern Dusky Salamander	S5	G5
Amphibians	Desmognathus monticola	Seal Salamander	S5	G5
Amphibians	Desmognathus ochrophaeus	Allegheny Mountain Dusky Salamander	S4	G5
Amphibians	Eurycea bislineata	Northern Two-lined Salamander	S5	G5
Amphibians	Eurycea longicauda	Longtail Salamander	S5	G5
Amphibians	Gyrinophilus porphyriticus porphyriticus	Northern Spring Salamander	S5	G5T5
Amphibians	Plethodon cylindraceus	White-spotted Slimy Salamander	S5	G5
Amphibians	Plethodon glutinosus	Slimy Salamander	S5	G5
Amphibians	Plethodon hoffmani	Valley And Ridge Salamander	S4	G5
Amphibians	Plethodon nettingi	Cheat Mountain Salamander	S2	G2G3
Amphibians	Plethodon punctatus	Cow Knob (white Spotted) Salamander	S2	G3
Amphibians	Plethodon wehrlei	Wehrle's Salamander	S4	G4
Amphibians	Pseudacris feriarum	Upland Chorus Frog	S3	G5
Amphibians	Pseudotriton ruber ruber	(northern) Red Salamander	S3	G5
Birds	Accipiter gentilis	Northern Goshawk	S1B,S1N	G5
Birds	Ammodramus savannarum	Grasshopper Sparrow	S3B	G5
Birds	Antrostomus vociferus	Eastern Whip-poor-will	S3B	G5
Birds	Bonasa umbellus	Ruffed Grouse	S3B,S3N	G5
Birds	Buteo platypterus	Broad-winged Hawk	S3B	G5
Birds	Butorides virescens	Green Heron	S3B	G5
Birds	Certhia familiaris	Brown Creeper	S3B	G5
Birds	Chaetura pelagica	Chimney Swift	S3B	G5
Birds	Chordeiles minor	Common Nighthawk	S2B	G5
Birds	Coccyzus erythrophthalmus	Black-billed Cuckoo	S2B	G5
Birds	Dolichonyx oryzivorus	Bobolink	S3B	G5

Birds	<i>Empidonax alnorum</i>	Alder Flycatcher	S3B	G5
Birds	<i>Eremophila alpestris</i>	Horned Lark	S2B,S3N	G5
Birds	<i>Falco peregrinus</i>	Peregrine Falcon	S2B,S2N	G4
Birds	<i>Haliaeetus leucocephalus</i>	Bald Eagle	S3B,S3N	G5
Birds	<i>Helmitheros vermivorum</i>	Worm-eating Warbler	S3B	G5
Birds	<i>Hylocichla mustelina</i>	Wood Thrush	S3B	G5
Birds	<i>Icteria virens</i>	Yellow-breasted Chat	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>Melanerpes erythrocephalus</i>	Red-headed Woodpecker	S3B,S3N	G5
Birds	<i>Mergus merganser</i>	Common Merganser	S3B,S3N	G5
Birds	<i>Parkesia motacilla</i>	Louisiana Waterthrush	S3B	G5
Birds	<i>Pooecetes gramineus</i>	Vesper Sparrow	S2B, S2N	G5
Birds	<i>Scolopax minor</i>	American Woodcock	S3B	G5
Birds	<i>Seiurus noveboracensis</i>	Northern Waterthrush	S2B	G5
Birds	<i>Setophaga caerulea</i>	Black-throated Blue Warbler	S3B	G5
Birds	<i>Setophaga cerulea</i>	Cerulean Warbler	S2B	G4
Birds	<i>Setophaga discolor</i>	Prairie Warbler	S3B	G5
Birds	<i>Setophaga fusca</i>	Blackburnian Warbler	S3B	G5
Birds	<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker	S2B,S3N	G5
Birds	<i>Spiza americana</i>	Dickcissel	S1B	G5
Birds	<i>Spizella pusilla</i>	Field Sparrow	S3B	G5
Birds	<i>Sturnella magna</i>	Eastern Meadowlark	S3B, S2N	G5
Birds	<i>Tyto alba</i>	Barn Owl	S2B,S2N	G5
Birds	<i>Vermivora chrysoptera</i>	Golden-winged Warbler	S1B	G4
Butterflies and Moths	<i>Brachionycha borealis</i>	Boreal Fan Moth	S1	G4
Butterflies and Moths	<i>Calycopsis cecrops</i>	Red-banded Hairstreak	S3	G5
Butterflies and Moths	<i>Celastrina lucia</i>	Northern Spring Azure	SNR	G5
Butterflies and Moths	<i>Celastrina neglectamajor</i>	Appalachian Azure	SNR	G4
Butterflies and Moths	<i>Colias interior</i> (high elev)	Pink-edged Sulphur	S1	G5T2Q
Butterflies and Moths	<i>Erora laeta</i>	Early Hairstreak	S2	GU

Butterflies and Moths	<i>Erynnis lucilius</i>	Columbine Duskywing	S2	G4
Butterflies and Moths	<i>Euchloe olympia</i>	Olympia Marble	S2S3	G4G5
Butterflies and Moths	<i>Hesperia metea</i>	Cobweb Skipper	S2S3	G4G5
Butterflies and Moths	<i>Papilio appalachiensis</i>	Appalachian Tiger Swallowtail	SNR	G4
Butterflies and Moths	<i>Pieris virginensis</i>	West Virginia White	S3	G3?
Butterflies and Moths	<i>Polygonia faunus smythi</i>	Smyth's Green Comma	S1	G5T3
Butterflies and Moths	<i>Polygonia progne</i>	Gray Comma	S3	G4G5
Butterflies and Moths	<i>Satyrium edwardsii</i>	Edwards' Hairstreak	S2	G4
Butterflies and Moths	<i>Satyrium favonius ontario</i>	Northern Hairstreak	S1S2	G4T4
Butterflies and Moths	<i>Syngrapha rectangula</i>	Salt & Pepper Looper Moth	S1	G5
Cave Invertebrates	<i>Bathyphantes weyeri</i>	A Cave Spider	S3	G4
Cave Invertebrates	<i>Caecidotea sinuncus</i>	An Isopod	S1	G1G2
Cave Invertebrates	<i>Geocentrophora cavernicola</i>	Cave Flatworm	SH	G1G2
Cave Invertebrates	<i>Islandiana speophila</i>	Cavern Sheet-web Spider	S1	G1
Cave Invertebrates	<i>Macrocotyla hoffmasteri</i>	Hoffmaster's Cave Flatworm	S2	G3G4
Cave Invertebrates	<i>Phanetta subterranea</i>	A Spider	S3	G5
Cave Invertebrates	<i>Poecilophysis extraneostella</i>	A Cave Mite	S2	G2?
Cave Invertebrates	<i>Porrhomma cavernicola</i>	Appalachian Cave Spider	S2	G5
Cave Invertebrates	<i>Pseudanopthalmus hadenoecus</i>	Timber Ridge Cave Beetle	S1	G1
Cave Invertebrates	<i>Pseudanopthalmus potomaca</i>	South Branch Valley Cave Beetle	S1	G3G4
Cave Invertebrates	<i>Pseudanopthalmus senecae</i>	Seneca Cave Beetle	S1	G1
Cave Invertebrates	<i>Pseudotremia lusciosa</i>	Germany Valley Cave Millipede	S1	G1G2
Cave Invertebrates	<i>Pseudotremia princeps</i>	South Branch Valley Cave Millipede	S1	G1
Cave Invertebrates	<i>Rhagidia varia</i>	A Cave Mite	S3	G5
Cave Invertebrates	<i>Sinella hoffmani</i>	Hoffman's Springtail	S3	G5
Cave Invertebrates	<i>Sphalloplana percoeca</i>	A Cave Planarian	S1	G5
Cave Invertebrates	<i>Stygobromus emarginatus</i>	Greenbrier Cave Amphipod	S3	G3G4
Cave Invertebrates	<i>Stygobromus franzi</i>	Franz's Cave Amphipod	S1	G3G4
Cave Invertebrates	<i>Stygobromus morrisoni</i>	Morrison's Cave Amphipod	S1	G2G3
Cave Invertebrates	<i>Zygonopus weyeriensis</i>	Grand Caverns Blind Cave Millipede	S2	G3G4
Cave Invertebrates	<i>Zygonopus whitei</i>	Luray Caverns Blind Cave Millipede	S1	G3G4

Dragonflies and Damselflies	<i>Aeshna tuberculifera</i>	Black-tipped Darner	S3	G4
Dragonflies and Damselflies	<i>Calopteryx angustipennis</i>	Appalachian Jewelwing	S3	G4
Dragonflies and Damselflies	<i>Cordulia shurtleffi</i>	American Emerald	S4	G5
Dragonflies and Damselflies	<i>Gomphus descriptus</i>	Harpoon Clubtail	S2S3	G4
Dragonflies and Damselflies	<i>Gomphus quadricolor</i>	Rapids Clubtail	S3	G3G4
Dragonflies and Damselflies	<i>Gomphus viridifrons</i>	Green-faced Clubtail	S3	G3G4
Dragonflies and Damselflies	<i>Lestes forcipatus</i>	Sweetflag Spreadwing	S3	G5
Dragonflies and Damselflies	<i>Macromia illinoensis</i>	Illinois River Cruiser	S3	G5
Dragonflies and Damselflies	<i>Neurocordulia yamaskanensis</i>	Stygian Shadowdragon	S3	G5
Dragonflies and Damselflies	<i>Ophiogomphus mainensis fastigiatus</i>	Maine Snaketail	S3	G4TU
Fish	<i>Anguilla rostrata</i>	American Eel	S2	G4
Fish	<i>Erimyzon oblongus</i>	Creek Chubsucker	S3	G5
Fish	<i>Etheostoma olmstedi</i>	Tessellated Darter	S1S2	G5
Fish	<i>Luxilus cornutus</i>	Common Shiner	S1S2	G5
Fish	<i>Margariscus margarita</i>	Pearl Dace	S2S3	G5
Fish	<i>Thoburnia rathoeca</i>	Torrent Sucker	S3	G4
Mammals	<i>Corynorhinus townsendii virginianus</i>	Virginia Big-eared Bat	S2	G4T2
Mammals	<i>Erethizon dorsatum</i>	Porcupine	S3	G5
Mammals	<i>Glaucomys sabrinus fuscus</i>	WV Northern Flying Squirrel	S2	G5T2
Mammals	<i>Lasionycteris noctivagans</i>	Silver-haired Bat	S2	G5
Mammals	<i>Lasiurus borealis</i>	Eastern Red Bat	S4	G5
Mammals	<i>Microtus chrotorrhinus carolinensis</i>	Southern Rock Vole	S2	G4T3
Mammals	<i>Myotis leibii</i>	Eastern Small-footed Bat	S1	G3
Mammals	<i>Myotis lucifugus</i>	Little Brown Myotis	S2*	G3
Mammals	<i>Myotis septentrionalis</i>	Northern Myotis	S2*	G2G3
Mammals	<i>Myotis sodalis</i>	Indiana Bat	S1	G2
Mammals	<i>Neotoma magister</i>	Allegheny Woodrat	S3	G3G4
Mammals	<i>Sorex palustris punctulatus</i>	Southern Water Shrew	S1	G5T3
Mammals	<i>Spilogale putorius</i>	Eastern Spotted Skunk	S1	G5
Mammals	<i>Sylvilagus obscurus</i>	Appalachian Cottontail	S2	G4
Mammals	<i>Synaptomys cooperi</i>	Southern Bog Lemming	S3	G5

Mussels	<i>Elliptio complanata</i>	Eastern Elliptio	S2	G5
Mussels	<i>Lasmigona subviridis</i>	Green Floater	S2	G3
Mussels	<i>Pyganodon cataracta</i>	Eastern Floater	S2	G5
Mussels	<i>Strophitus undulatus</i>	Squawfoot	S3	G5
Plants	<i>Abies balsamea</i>	Balsam Fir	S1	G5
Plants	<i>Aconitum reclinatum</i>	White Monkshood	S3	G3
Plants	<i>Adlumia fungosa</i>	Allegheny-vine	S2?	G4
Plants	<i>Allium allegheniense</i>	Allegheny Onion	S2	G3?
Plants	<i>Allium oxyphilum</i>	Nodding Wild Onion	S2	G2Q
Plants	<i>Amelanchier bartramiana</i>	Oblong-fruit Serviceberry	S2	G5
Plants	<i>Arabis hirsuta</i> ssp. <i>pyncocarpa</i>	Hairy Rockcress	S2	G5T5
Plants	<i>Arabis patens</i>	Spreading Rockcress	S2	G3
Plants	<i>Arabis serotina</i>	Shalebarren Rockcress	S2	G2
Plants	<i>Astragalus distortus</i> var. <i>distortus</i>	Bent Milkvetch	S2	G5T5?
Plants	<i>Astragalus neglectus</i>	Cooper's Milkvetch	S1	G4
Plants	<i>Betula papyrifera</i>	Paper Birch	S2	G5
Plants	<i>Botrychium matricariifolium</i>	Daisy-leaved Grape-fern	S2	G5
Plants	<i>Bouteloua curtipendula</i> var. <i>curtipendula</i>	Sideoats Grama	S3	G5T5
Plants	<i>Calamagrostis porteri</i> ssp. <i>porteri</i>	Reedgrass	S3	G4T4
Plants	<i>Calystegia spithamea</i> ssp. <i>purshiana</i>	Shale Bindweed	S3	G4G5T4
Plants	<i>Campanula rotundifolia</i>	Bluebell Bellflower	S3	G5
Plants	<i>Carex aestivalis</i>	Summer Sedge	S3	G4
Plants	<i>Carex appalachica</i>	Appalachian Sedge	S3	G4
Plants	<i>Carex davisii</i>	Davis' Sedge	S1	G4
Plants	<i>Carex eburnea</i>	Bristleleaf Sedge	S3	G5
Plants	<i>Carex emoryi</i>	Emory's Sedge	S2	G5
Plants	<i>Carex laxiculmis</i> var. <i>copulata</i>	Spreading Sedge	S2	G5T3T5
Plants	<i>Carex molesta</i>	Troublesome Sedge	S3	G4
Plants	<i>Carex nigromarginata</i>	Black-edge Sedge	S3	G5
Plants	<i>Carex normalis</i>	Greater Straw Sedge	S3	G5
Plants	<i>Carex pauciflora</i>	Few-flower Sedge	S1	G5

Plants	<i>Carex pedunculata</i>	Longstalk Sedge	S2	G5
Plants	<i>Carex polymorpha</i>	Variable Sedge	S1	G3
Plants	<i>Carex roanensis</i>	Roan Mountain Sedge	S2	G3
Plants	<i>Carex tonsa</i> var. <i>rugosperma</i>	Parachute Sedge	S2S3	G5T5
Plants	<i>Carex tonsa</i> var. <i>tonsa</i>	Shaved Sedge	S1	G5T5
Plants	<i>Carex woodii</i>	Pretty Sedge	S3	G4
Plants	<i>Cheilanthes eatonii</i>	Chestnut Lipfern	S2	G5?
Plants	<i>Chenopodium standleyanum</i>	Standley's Goosefoot	S2	G5
Plants	<i>Clematis albicoma</i>	White-hair Leatherflower	S3	G4
Plants	<i>Clematis occidentalis</i> var. <i>occidentalis</i>	Purple Virgin's Bower	S2	G5T5
Plants	<i>Coeloglossum viride</i> var. <i>virescens</i>	Long-bracted Green Orchid, Satyr Orchid	S1	G5T5
Plants	<i>Commelina erecta</i>	Slender Dayflower	S2	G5T5
Plants	<i>Coptis trifolia</i>	Threelobed Goldthread	S2	G5
Plants	<i>Cornus canadensis</i>	Canadian Bunchberry	S2	G5
Plants	<i>Cornus rugosa</i>	Roundleaf Dogwood	S1	G5
Plants	<i>Cryptogramma stelleri</i>	Fragile Rockbrake	S1	G5
Plants	<i>Cuscuta rostrata</i>	Beaked Dodder	S2	G4
Plants	<i>Cyperus squarrosus</i>	Awed Flatsedge	S3	G5
Plants	<i>Dalibarda repens</i>	Robin-run-away	S3	G5
Plants	<i>Dasistoma macrophylla</i>	Mullein Foxglove	S2	G4
Plants	<i>Delphinium exaltatum</i>	Tall Larkspur	S2	G3
Plants	<i>Drosera rotundifolia</i> var. <i>rotundifolia</i>	Roundleaf Sundew	S3	G5T5
Plants	<i>Elodea nuttallii</i>	Western Waterweed	S3	G5
Plants	<i>Eragrostis hirsuta</i>	Big-top Lovegrass	SH	G5
Plants	<i>Eriogonum allenii</i>	Shalebarren Wild Buckwheat	S2	G4
Plants	<i>Erysimum capitatum</i> var. <i>capitatum</i>	Western Wallflower	S1	G5T5
Plants	<i>Galactia volubilis</i>	Downy Milkpea	S2	G5
Plants	<i>Gaultheria hispidula</i>	Creeping Snowberry	S3	G5
Plants	<i>Glyceria acutiflora</i>	Creeping Mannagrass	S2	G5
Plants	<i>Gymnocarpium appalachianum</i>	Appalachian Oak Fern	S2	G3
Plants	<i>Gymnocarpium dryopteris</i>	Northern Oak Fern	S1	G5

Plants	<i>Helianthemum canadense</i>	Long-branch Frostweed	S2	G5
Plants	<i>Heuchera alba</i>	White Alumroot	S2	G2Q
Plants	<i>Hexalectris spicata</i> var. <i>spicata</i>	Spiked Crested Coralroot	S1	G5T4T5
Plants	<i>Hudsonia tomentosa</i> var. <i>tomentosa</i>	False Heather, Woolly Hudsonia	S1	G5T5
Plants	<i>Hypericum mitchellianum</i>	Blue Ridge St. John's-wort	S1	G3
Plants	<i>Juglans cinerea</i>	Butternut	S3	G4
Plants	<i>Juncus biflorus</i>	Bog Rush	S2	G5
Plants	<i>Juncus dichotomus</i>	Forked Rush	S1	G5
Plants	<i>Juncus torreyi</i>	Torrey's Rush	S2	G5
Plants	<i>Juncus trifidus</i>	Highland Rush	S1	G5
Plants	<i>Lechea tenuifolia</i>	Narrowleaf Pinweed	S1	G5
Plants	<i>Lilium philadelphicum</i> var. <i>philadelphicum</i>	Wood Lily	S2S3	G5T4T5
Plants	<i>Linum lewisii</i> var. <i>lewisii</i>	Prairie Flax	S2	G4G5T4T5
Plants	<i>Linum sulcatum</i> var. <i>sulcatum</i>	Grooved Yellow Flax	S1	G5T5
Plants	<i>Listera cordata</i> var. <i>cordata</i>	Heartleaf Twayblade	S2	G5T5
Plants	<i>Listera smallii</i>	Kidneyleaf Twayblade	S2	G4
Plants	<i>Lonicera canadensis</i>	Fly Honeysuckle	S2	G5
Plants	<i>Lupinus perennis</i> ssp. <i>perennis</i>	Wild Lupine, Sundial Lupine	S1	G5T4?
Plants	<i>Luzula bulbosa</i>	Bulbous Woodrush	S1	G5
Plants	<i>Maianthemum stellatum</i>	Starflower False Solomon's-seal	S2	G5
Plants	<i>Melanelia stygia</i>	Stygian Black-parmelia	S2	G4G5
Plants	<i>Monarda fistulosa</i> ssp. <i>brevis</i>	Smoke Hole Bergamot	S1	G5T1
Plants	<i>Oenothera argillicola</i>	Shalebarren Evening-primrose	S3	G3G4
Plants	<i>Oryzopsis asperifolia</i>	Roughleaf Ricegrass	S1	G5
Plants	<i>Packera antennariifolia</i>	Shalebarren Ragwort	S3	G4
Plants	<i>Packera plattensis</i>	Prairie Ragwort	S1	G5
Plants	<i>Paronychia argyrocoma</i>	Silvery Nailwort	S3	G4
Plants	<i>Paronychia virginica</i>	Yellow Nailwort	S2	G4
Plants	<i>Paxistima canbyi</i>	Canby's Mountain-lover	S2	G2
Plants	<i>Pellaea glabella</i> ssp. <i>glabella</i>	Smooth Cliffbrake	S2	G5T5
Plants	<i>Pinus resinosa</i>	Red Pine	S1	G5

Plants	<i>Piptatherum canadense</i>	Canada Mountain Ricegrass	S1	G5
Plants	<i>Piptatherum racemosum</i>	Black-seed Mountain Ricegrass	S2	G5
Plants	<i>Platanthera ciliaris</i>	Yellow-fringe Orchid	S3	G5
Plants	<i>Poa saltuensis</i>	Old-pasture Bluegrass	S1	G5
Plants	<i>Prunus alleghaniensis</i> var. <i>alleghaniensis</i>	Allegheny Plum	S3	G4T4
Plants	<i>Rhamnus lanceolata</i> ssp. <i>lanceolata</i>	Lance-leaved Buckthorn	S1	G5T4T5
Plants	<i>Rosa acicularis</i> ssp. <i>sayi</i>	Bristly Rose	S1	G5T5
Plants	<i>Rosa blanda</i> var. <i>blanda</i>	Smooth Rose	S2	G5T5
Plants	<i>Saxifraga michauxii</i>	Cliff Saxifrage	S1	G4G5
Plants	<i>Saxifraga pensylvanica</i>	Eastern Swamp Saxifrage	S2	G5
Plants	<i>Scirpus atrocinctus</i>	Blackgirdle Bulrush	S3	G5
Plants	<i>Scutellaria ovata</i> ssp. <i>ovata</i>	Heart-leaved Skullcap	S1	G5T5
Plants	<i>Scutellaria ovata</i> ssp. <i>virginiana</i>	Heart-leaved Skullcap	S1?	G5TNR
Plants	<i>Scutellaria saxatilis</i>	Rock Skullcap	S2	G3
Plants	<i>Sibbaldiopsis tridentata</i>	Mountain-cinquefoil	S2	G5
Plants	<i>Silene virginica</i> var. <i>robusta</i>	Fire Pink	S1	G5T1Q
Plants	<i>Solidago arguta</i> var. <i>harrisii</i>	Shalebarren Goldenrod	S3	G5T4
Plants	<i>Spiranthes lucida</i>	Shining Ladies'-tresses	S1S2	G5
Plants	<i>Spiranthes tuberosa</i>	Little Ladies'-tresses	S3	G5
Plants	<i>Stenanthium gramineum</i> var. <i>gramineum</i>	Featherbells	S2S3	G4G5T3T5
Plants	<i>Symphoricarpos albus</i> var. <i>albus</i>	Snowberry	S2	G5T5
Plants	<i>Taenidia montana</i>	Mountain-pimpernel	S3	G3
Plants	<i>Taxus canadensis</i>	Canada Yew	S2S3	G5
Plants	<i>Thuja occidentalis</i>	Northern White-cedar	S2	G5
Plants	<i>Trichophorum planifolium</i>	Bashful Bulrush	S1	G4G5
Plants	<i>Trifolium stoloniferum</i>	Running Buffalo Clover	S3	G3
Plants	<i>Trifolium virginicum</i>	Kate's Mountain Clover	S3	G3
Plants	<i>Trillium nivale</i>	Snowy Trillium	S2	G4
Plants	<i>Vaccinium macrocarpon</i>	Large Cranberry	S3	G4
Plants	<i>Vaccinium oxycoccos</i>	Small Cranberry	S3	G5
Plants	<i>Viburnum rafinesquianum</i>	Downy Arrow-wood	S2	G5

Plants	<i>Viola septentrionalis</i>	Northern Blue Violet	S2	G5
Plants	<i>Woodsia ilvensis</i>	Rusty Cliff Fern	S2	G5
Plants	<i>Zigadenus elegans</i> ssp. <i>glaucus</i>	Mountain Deathcamas	S1	G5T4T5
Plants	<i>Zigadenus leimanthoides</i>	Pine Barren Deathcamas	S2	G4Q
Reptiles	<i>Agkistrodon contortrix mokasen</i>	Northern Copperhead	S5	G5T5
Reptiles	<i>Carphophis amoenus</i>	Wormsnake	S3	G5
Reptiles	<i>Coluber constrictor constrictor</i>	Northern Black Racer	SNR	G5T5
Reptiles	<i>Crotalus horridus</i>	Timber Rattlesnake	S3	G4
Reptiles	<i>Diadophis punctatus edwardsii</i>	Northern Ring-necked Snake	S5	G5T5
Reptiles	<i>Glyptemys insculpta</i>	Wood Turtle	S3	G4
Reptiles	<i>Heterodon platirhinus</i>	Eastern Hog-nosed Snake	S2	G5
Reptiles	<i>Lampropeltis getula</i>	Eastern Kingsnake	S2	G5
Reptiles	<i>Liochlorophis vernalis</i>	Smooth Greensnake	S5	G5
Reptiles	<i>Plestiodon anthracinus anthracinus</i>	Northern Coal Skink	S2	G5T5
Reptiles	<i>Terrapene carolina carolina</i>	Eastern Box Turtle	S5	G5T5
Reptiles	<i>Virginia valeriae pulchra</i>	Mountain Earthsnake	S2	G5T3T4
Snails	<i>Anguispira clarki</i>	Elfin Tigersnail	S1	GNR
Snails	<i>Discus whitneyi</i>	Forest Disc	S2	G5
Snails	<i>Euchemotrema leai</i>	Lowland Pillsnail	S3	G5
Snails	<i>Gastrocopta holzingeri</i>	Lambda Snaggletooth	S2	G5
Snails	<i>Hendersonia occulta</i>	Cherrystone Drop	S3	G4
Snails	<i>Punctum vitreum</i>	Glass Spot	S2	G5
Snails	<i>Striatura ferrea</i>	Black Striate	S3	G5
Snails	<i>Striatura milium</i>	Flat-ribbed Striate	S2	G5
Snails	<i>Triodopsis anteridon</i>	Carter Threetooth	S3	G3
Snails	<i>Triodopsis picea</i>	Spruce Knob Threetooth	S3	G3
Snails	<i>Triodopsis tennesseensis</i>	Budded Threetooth	S3	G4
Snails	<i>Triodopsis vulgata</i>	Dished Threetooth	S2	G5
Snails	<i>Vallonia excentrica</i>	Iroquois Vallonia	S3	G5
Snails	<i>Vallonia perspectiva</i>	Thin-lip Vallonia	S3	G4G5
Snails	<i>Ventridens arcellus</i>	Golden Dome	S3	G4

Snails	<i>Ventridens coelaxis</i>	Bidentate Dome	S1	G3
Snails	<i>Ventridens collisella</i>	Sculptured Dome	S3	G4G5
Snails	<i>Ventridens virginicus</i>	Split-tooth Dome	S3	G4
Tiger Beetles	<i>Cicindela ancocisconensis</i>	Appalachian Tiger Beetle	S3	G3
Tiger Beetles	<i>Cicindela patruela</i>	Barrens Tiger Beetle	S2S3	G3
Tiger Beetles	<i>Cicindela unipunctata</i>	A Tiger Beetle	S3	G4G5

Appendix 2. Priority SGCN, Stresses, & Actions

Agricultural Lands		
COMMON NAME	Local Stress	Action
American Woodcock	<ul style="list-style-type: none"> Insufficient habitat 	<ul style="list-style-type: none"> Reduce clean farming practices Manage forest to create early successional habitat
Barn Owl	<ul style="list-style-type: none"> Insufficient nest microhabitat Clean farming practices Poisoning 	<ul style="list-style-type: none"> Install and monitor nest boxes, Outreach to landowners to reduce rodenticide use
Bobolink	<ul style="list-style-type: none"> Clean farming practices Nest loss from early haying 	<ul style="list-style-type: none"> Delay hay harvest until after July 15 Prevent conversion of grasslands to croplands
Eastern Meadowlark	<ul style="list-style-type: none"> Clean farming practices Nest loss from early haying 	<ul style="list-style-type: none"> Delay hay harvest until after July 15 Prevent conversion of grasslands to croplands
Field Sparrow	<ul style="list-style-type: none"> Clean farming practices Residential development 	<ul style="list-style-type: none"> Retain or plant shrubs in fields Retain or plant hedgerows
Grasshopper Sparrow	<ul style="list-style-type: none"> Clean farming practices Nest loss from early haying 	<ul style="list-style-type: none"> Delay hay harvest until after July 15 Prevent conversion of grasslands to croplands
Loggerhead Shrike	<ul style="list-style-type: none"> Clean farming practices 	<ul style="list-style-type: none"> Retain or plant hawthorns in pastures Retain or plant hedgerows
Migrant Loggerhead Shrike	<ul style="list-style-type: none"> Clean farming practices 	<ul style="list-style-type: none"> Retain or plant hawthorns in pastures Retain or plant hedgerows
Vesper Sparrow	<ul style="list-style-type: none"> Clean farming practices Nest loss from early haying 	<ul style="list-style-type: none"> Delay hay harvest until after July 15 Prevent conversion of grasslands to croplands

Virginia Big-eared Bat	<ul style="list-style-type: none"> • Deforestation • Agricultural activities • Residential and commercial development • Limestone Quarrying 	<ul style="list-style-type: none"> • Cave closure during important life stages • Land protection at cave entrance • Gating of significant caves
Yellow-breasted Chat	<ul style="list-style-type: none"> • Forest maturation • Herbicide use and vegetation management in utility corridors 	<ul style="list-style-type: none"> • Manage forests to create early successional habitat • Develop BMP's for right of way corridor management
Caves and Karst		
COMMON NAME	Local Stress	Action
A Cave Mite (<i>Poecilophysis extraneostella</i>)	<ul style="list-style-type: none"> • Land use changes 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Allegheny Woodrat	<ul style="list-style-type: none"> • Raccoon roundworm • Lack of mast trees 	<ul style="list-style-type: none"> • Keep ridgetops forested • Promote mast producing trees • Manage raccoon populations
An Isopod (<i>Caecidota sinuncus</i>)	<ul style="list-style-type: none"> • Water quality of Mystic Cave watershed 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams • Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks
Cave Flatworm (<i>Geocentrophora cavernicola</i>)	<ul style="list-style-type: none"> • Land use changes 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Cavern Sheet-web Spider	<ul style="list-style-type: none"> • Land use changes 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams

Eastern Small-footed Bat	<ul style="list-style-type: none"> • Agricultural activities • Deforestation near occupied caves 	<ul style="list-style-type: none"> • Maintain cave protections on Thorn Creek WMA
Franz's Cave Amphipod	<ul style="list-style-type: none"> • Water quality of small cave streams and pools 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams • Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks
Germany Valley Cave Millipede	<ul style="list-style-type: none"> • Land use changes around caves 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Grand Caverns Blind Cave Millipede	<ul style="list-style-type: none"> • Land use changes around caves 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Greenbrier Cave Amphipod	<ul style="list-style-type: none"> • Water quality of underground drainage from surface runoff 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams • Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks
Hoffmaster's Cave Flatworm	<ul style="list-style-type: none"> • Water quality of underground drainage from surface runoff 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams • Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks
Indiana Bat	<ul style="list-style-type: none"> • Adjacent industry 	<ul style="list-style-type: none"> • Consult with USFWS prior to timber management operations

Luray Caverns Blind Cave Millipede	<ul style="list-style-type: none"> • Land use changes 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Morrison's Cave Amphipod	<ul style="list-style-type: none"> • Water quality of underground drainage from surface runoff 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams • Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks
Seneca Cave Beetle	<ul style="list-style-type: none"> • • Land use changes around caves 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
South Branch Valley Cave Beetle	<ul style="list-style-type: none"> • Land use changes around caves 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Timber Ridge Cave Beetle	<ul style="list-style-type: none"> • Land use changes around caves 	<ul style="list-style-type: none"> • Educate landowners about living on karst • Install fencing to keep cattle out of streams
Virginia Big-eared Bat	<ul style="list-style-type: none"> • Deforestation around caves • Agricultural activities • Residential and commercial development • Limestone Quarrying 	<ul style="list-style-type: none"> • Cave closure during important life stages • Land protection at cave entrance • Gating of significant caves

Developed Lands		
COMMON NAME	Local Stress	Action
Barn Owl	<ul style="list-style-type: none"> • Insufficient nest microhabitat • Clean farming practices • Poisoning 	<ul style="list-style-type: none"> • Install and monitor nest boxes, outreach to landowners to reduce rodenticides
Common Nighthawk	<ul style="list-style-type: none"> • Rubberized roofs on new construction 	<ul style="list-style-type: none"> • Outreach to owners of gravel roofs, install gravel nest pads on rubberized roofs
Chimney Swift	<ul style="list-style-type: none"> • Chimney capping, turnover of older structures 	<ul style="list-style-type: none"> • Landowner outreach and education • Uncap chimneys • Install swift towers
Peregrine Falcon	<ul style="list-style-type: none"> • Disturbance at nest site(s) 	<ul style="list-style-type: none"> • Survey and monitor for breeding activity, restrict access to cliff sites as needed
Cliffs and Talus		
COMMON NAME	Local Stress	Action
Allegheny Woodrat	<ul style="list-style-type: none"> • Raccoon roundworm • Lack of mast trees 	<ul style="list-style-type: none"> • Maintain or restore forested ridgetops • Promote mast producing trees • Manage raccoon populations
Eastern Small-footed Bat	<ul style="list-style-type: none"> • Industry (quarry) • Deforestation 	<ul style="list-style-type: none"> • Talus slopes are rare habitat that must be preserved
Eastern Spotted Skunk	<ul style="list-style-type: none"> • Fire Suppression • Lack of disturbance in forest succession • Predation 	<ul style="list-style-type: none"> • Use forest and fire management to increase vegetative cover and early successional habitat
Mountain Deathcamas	<p>Threats to clifftop limestone glade habitats including:</p> <ul style="list-style-type: none"> • Nonnative invasive plants • Grazing and mowing • Fire • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of non-native plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species

		<ul style="list-style-type: none"> • Protect habitat from fire • Establish conservation management, easements, and ownership
Prairie Flax	<p>Threats to clifftop limestone glade habitats including:</p> <ul style="list-style-type: none"> • Nonnative invasive plants • Grazing and mowing • Fire • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Protect habitat from fire • Establish conservation management, easements, and ownership
Smoke Hole Bergamot	<p>Threats to clifftop limestone glade habitats including:</p> <ul style="list-style-type: none"> • Nonnative invasive plants • Grazing and mowing • Fire • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Protect habitat from fire • Establish conservation management, easements, and ownership
Yellow Nailwort	<p>Threats to clifftop limestone glade habitats including:</p> <ul style="list-style-type: none"> • Nonnative invasive plants • Grazing and mowing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Protect habitat from fire • Establish conservation management, easements, and ownership

Forests and Woodlands		
COMMON NAME	Local Stress	Action
Allegheny Onion	<p>Threats to limestone forest and woodland habitats including:</p> <ul style="list-style-type: none"> • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of non-native plants by limiting ground disturbance and by creating weed free buffers • Treat non-native invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Allegheny Woodrat	<ul style="list-style-type: none"> • Raccoon roundworm • Lack of mast trees 	<ul style="list-style-type: none"> • Maintain and restore forested ridgetops • Forest management to promote mast producing trees • Manage raccoon populations
Barrens Tiger Beetle	<ul style="list-style-type: none"> • Natural succession • Fire suppression 	<ul style="list-style-type: none"> • Forest and fire management to retain and create sandy, open forest
Bashful Bulrush	<p>Threats to limestone forest and woodland habitats include:</p> <ul style="list-style-type: none"> • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance (grazing) and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation easements or acquire properties with management plans
Black-billed Cuckoo	<ul style="list-style-type: none"> • Insufficient habitat • Pesticide exposure 	<ul style="list-style-type: none"> • Create early successional habitat, Reduce aerial application of pesticides

Boreal Fan Moth	<ul style="list-style-type: none"> Gypsy moth spraying 	<ul style="list-style-type: none"> Forest and fire management of high elevation oak forests Monitor larvae sensitivity to <i>Btk</i>
Canada Mountain Ricegrass	<p>Threats to limestone forest and woodland habitats including:</p> <ul style="list-style-type: none"> Nonnative invasive plants Grazing Residential development 	<ul style="list-style-type: none"> Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers Treat nonnative invasive plants without disturbing rare native species Establish conservation management, easements, and ownership
Canby's Mountain-lover	<ul style="list-style-type: none"> Deer and wood rat herbivory Nonnative scale insect pest 	<ul style="list-style-type: none"> Hunt deer around known populations Build deer exclosures Monitor and treat for scale. Control nonnative plant hosts for scale.
Cerulean Warbler	<ul style="list-style-type: none"> Poor forest structure 	<ul style="list-style-type: none"> Manage forests to create suitable habitat as per CERW guidelines
Cooper's Milkvetch	<p>Threats to limestone forest and woodland habitats including:</p> <ul style="list-style-type: none"> Nonnative invasive plants Grazing Residential development 	<ul style="list-style-type: none"> Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers Treat nonnative invasive plants without disturbing rare native species Establish conservation management, easements, and ownership
Eastern Small-footed Bat	<ul style="list-style-type: none"> Agricultural activities Deforestation around caves 	<ul style="list-style-type: none"> Land protection around caves Reduce and educate about agricultural runoff impacts Minimize development within near forested talus slopes

Eastern Spotted Skunk	<ul style="list-style-type: none"> • Fire Suppression • Lack of disturbance in forest succession Predation 	<ul style="list-style-type: none"> • Use forest and fire management to increase vegetative cover and early successional habitat.
False Heather, Woolly Hudsonia	<ul style="list-style-type: none"> • Trampling by foot traffic 	<ul style="list-style-type: none"> • Survey, map, and direct foot traffic away from population
Golden-winged Warbler	<ul style="list-style-type: none"> • Forest maturation, poor forest structure 	<ul style="list-style-type: none"> • Manage forests to create early successional habitat as per GWWA guidelines
Grooved Yellow Flax	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Heart-leaved Skullcap	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Indiana Bat	<ul style="list-style-type: none"> • Agriculture • Deforestation 	<ul style="list-style-type: none"> • Consult with USFWS prior to timber management operations

<p>Lance-leaved Buckthorn</p>	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
<p>Mountain Deathcamas</p>	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
<p>Mountain-pimpernel</p>	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership

Nodding Wild Onion	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Olympia Marble	<ul style="list-style-type: none"> • Gypsy moth spraying 	<ul style="list-style-type: none"> • Work with partners to avoid spraying habitat • Establish conservation management, easements, and ownership of shale ridges • Monitor larvae sensitivity to <i>Btk</i>
Prairie Flax	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Prairie Warbler	<ul style="list-style-type: none"> • Forest maturation • Herbicide use for vegetation management in utility corridors 	<ul style="list-style-type: none"> • Manage forests to create early successional habitat • Develop Right of way corridor BMP's
Red Pine	<ul style="list-style-type: none"> • Insect pests and disease pathogens. 	<ul style="list-style-type: none"> • Monitor stands and consider treatment if pests are found.
Roughleaf Ricegrass	<ul style="list-style-type: none"> • Fire or lack of fire 	<ul style="list-style-type: none"> • Research fire ecology and history of the habitat
Roundleaf Dogwood	<ul style="list-style-type: none"> • Unknown locations and population viability 	<ul style="list-style-type: none"> • Survey locate, relocate populations

Ruffed Grouse	<ul style="list-style-type: none"> • Insufficient habitat • Predation 	<ul style="list-style-type: none"> • Create early successional habitat through forest management
Running Buffalo Clover	<ul style="list-style-type: none"> • Closed canopy and resulting reduced light. 	<ul style="list-style-type: none"> • Canopy thinning to increase light penetration.
Smoke Hole Bergamot	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Smyth's Green Comma	<ul style="list-style-type: none"> • Invasive adelgids on hemlock and fir 	<ul style="list-style-type: none"> • Environmentally sustainable adelgid control if available • Improve integrity of habitat to combat effects of climate change
Spiked Crested Coralroot	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership

Spreading Rockcress	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Tall Larkspur	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Timber Rattlesnake	<ul style="list-style-type: none"> • Loss of basking/ gestation/ denning habitat; 	<ul style="list-style-type: none"> • Use forest management and fire to increase vegetative cover and early successional habitat.
Timber Rattlesnake	<ul style="list-style-type: none"> • Loss of basking/ gestation/ denning habitat; 	<ul style="list-style-type: none"> • Create canopy gaps over gestation and basking sites; • Develop den avoidance guidance.
Variable Sedge	<ul style="list-style-type: none"> • Potential role of fire 	<ul style="list-style-type: none"> • Research fire history and the role of fire in the necessary habitat
Virginia Big-eared Bat	<ul style="list-style-type: none"> • Deforestation around caves • Agricultural activities • Limestone Quarrying 	<ul style="list-style-type: none"> • Cave closure during important life stages • Land protection at cave entrance • Gate significant caves
Wild Lupine, Sundial Lupine	<ul style="list-style-type: none"> • Woody encroachment • Mowing, herbicides along highways 	<ul style="list-style-type: none"> • Forest management to create canopy gaps • Work with DOH to avoid mowing and herbicide use

Wood Thrush	<ul style="list-style-type: none"> • Deer overbrowsing, • Unsuitable forest structure 	<ul style="list-style-type: none"> • Reduce deer population, manage forests for structural and spatial complexity
Worm-eating Warbler	<ul style="list-style-type: none"> • Deer overbrowsing • Unsuitable forest structure, 	<ul style="list-style-type: none"> • Manage forests for structural complexity, reduce deer populations
Yellow Nailwort	<ul style="list-style-type: none"> • Threats to limestone forest and woodland habitats including: • Nonnative invasive plants • Grazing • Residential development 	<ul style="list-style-type: none"> • Protect areas from invasions of nonnative plants by limiting ground disturbance and by creating weed free buffers • Treat nonnative invasive plants without disturbing rare native species • Establish conservation management, easements, and ownership
Heath Grass and Shale Barrens		
COMMON NAME	Local Stress	Action
Columbine Duskywing	<ul style="list-style-type: none"> • Legacy of gypsy moth control • Potential impacts to larval host and nectar resources from invasive species 	<ul style="list-style-type: none"> • Educate partners and landowners about how to avoid spraying habitat • Establish conservation management, easements, and ownership of shale ridges
Olympia Marble	<ul style="list-style-type: none"> • Gypsy moth spraying 	<ul style="list-style-type: none"> • Educate partners and landowners about how to avoid spraying habitat • Establish conservation management, easements, and ownership of shale ridges
Timber Rattlesnake	<ul style="list-style-type: none"> • Loss of basking/ gestation/ denning habitat; 	<ul style="list-style-type: none"> • Create canopy gaps over gestation and basking sites; develop den avoidance guidance.
Variable Sedge	<ul style="list-style-type: none"> • Role of fire in the ecosystem is poorly understood 	<ul style="list-style-type: none"> • Research fire ecology and history of the habitat

Streams and Floodplains		
COMMON NAME	Local Stress	Action
American Eel	<ul style="list-style-type: none"> • Passage barriers between the Sargasso Sea and freshwater maturation areas 	<ul style="list-style-type: none"> • Remove barriers • Install Eel ladders
Appalachian Jewelwing	<ul style="list-style-type: none"> • Loss of riparian vegetation • Degraded water quality 	<ul style="list-style-type: none"> • Establish streamside buffer zones on sensitive streams and upstream
Appalachian Tiger Beetle	<ul style="list-style-type: none"> • Forest fragmentation • Flooding • Siltation 	<ul style="list-style-type: none"> • Establish streamside buffer zones to reduce sedimentation and erosion
Common Shiner	<ul style="list-style-type: none"> • Warming instream water temperatures • Sedimentation • Hybridization and interspecific competition with Striped Shiners 	<ul style="list-style-type: none"> • Establish streamside buffer zones by planting trees and shrubs to reduce sedimentation and erosion • Install fencing to keep cattle out of streams to limit livestock access to streambanks and stream channel • Do not introduce (bait) fish from outside the watershed
Davis' Sedge	<ul style="list-style-type: none"> • Unknown location and population viability 	<ul style="list-style-type: none"> • Survey to locate, relocate populations
Indiana Bat	<ul style="list-style-type: none"> • Agriculture • Deforestation 	<ul style="list-style-type: none"> • USFWS requires management actions within 10 miles of "Priority 1/2" Indiana Bat caves
Louisiana Waterthrush	<ul style="list-style-type: none"> • Stream corridor degradation • Acid deposition • Hemlock wooly adelgid 	<ul style="list-style-type: none"> • Improve pH in streams, treat remaining riparian hemlock stands
Maine Snaketail	<ul style="list-style-type: none"> • Sedimentation • Sewage effluent 	<ul style="list-style-type: none"> • Establish streamside buffer zones by planting trees and shrubs to reduce sedimentation and erosion • Improved wastewater treatment

<p>Pearl Dace</p>	<ul style="list-style-type: none"> • Increasing instream temperatures • Spring diversions • Habitat alterations • Sedimentation 	<ul style="list-style-type: none"> • Establish riparian areas by not mowing, planting crops, disturbing soil, or grazing livestock to the edge of streambanks • Perform tree plantings to create overhead canopy cover and reduce sedimentation • Install fencing to keep cattle out of streams to limit livestock access to streambanks and stream channel
<p>Wood Turtle</p>	<ul style="list-style-type: none"> • Degradation or lack of nesting habitat • Loss of instream habitat 	<ul style="list-style-type: none"> • Create or establish instream woody habitat features

Appendix 3: Terrestrial, Aquatic and Subterranean Habitats in Public Lands

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

Public Land	Terrestrial Habitat	Aquatic Habitat
	<ul style="list-style-type: none"> • Small Stream Riparian Habitats • Agricultural and Developed • Developed 	

Public Land	Karst Feature Count	Biologically Significant Cave Count
Thorn Creek Wildlife Management Area	11	3
Potomac Wildlife Management Area	103	3

Appendix 4. Partners and Assistance Provided

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

Partner	Role/Assistance Provided
<p>West Virginia University Extension Service (WVU Extension):</p> <ul style="list-style-type: none"> • Forestry https://extension.wvu.edu/natural-resources/forestry • Wildlife https://extension.wvu.edu/natural-resources/wildlife 	<ul style="list-style-type: none"> • Landowner technical assistance and information on financial assistance for forest and wildlife management • Training workshops and conferences on forestry Best Management Practices and safety practices
<p>US Fish and Wildlife Service (USFWS)</p> <ul style="list-style-type: none"> • Partners for Fish and Wildlife Program https://www.fws.gov/northeast/ecologicalservices/partners.html 	<ul style="list-style-type: none"> • Provides technical and financial assistance to private landowners for restoration and enhancement of fish and wildlife habitat for the benefit of Federal Trust species (Migratory Birds, Threatened and Endangered, and At-Risk Species) • CFA is part of the Upper Potomac Priority Area • Efforts focus on controlling non-native invasive plants, managing livestock access to forests, wetland restoration, riparian buffer planting and fencing, in-stream habitat improvement, aquatic passage barrier removal, and creating pollinator habitat • Work in coordination with the USDA Natural Resources Conservation Service farm bill programs, Trout Unlimited and other partners
<p>US Fish and Wildlife Service (USFWS)</p> <ul style="list-style-type: none"> • Appalachian Fish and Wildlife Conservation Office https://www.fws.gov/northeast/apco/ 	<ul style="list-style-type: none"> • Works with partners to restore rivers, wetlands and aquatic species in collaboration with Partners for Fish and Wildlife Program, National Fish Habitat Partnership and National Fish Passage Program • Provides technical assistance to private landowners to restore and enhance fish and wildlife habitat • Conducts outreach and education on aquatic resources with youth and their families

Partner	Role/Assistance Provided
<p>USDA Natural Resources Conservation Service: https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/programs/financial/</p> <ul style="list-style-type: none"> • Environmental Quality Incentive Program (EQIP) • Conservation Stewardship Program (CSP) • Agricultural Conservation Easement Program (ACEP) 	<ul style="list-style-type: none"> • EQIP provides cost-share to forest and agricultural landowners targeting needs such as reduction of nutrient, sediment and pesticide pollution and wildlife habitat enhancement, including stream buffers • EQIP funds in the Potomac Valley Conservation District have been prioritized for improved grazing and pasture 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 • CSP provides payments to farm and forest landowners for actively managing, maintaining, and expanding conservation activities to enhance natural resources and improve their business operations. CSP targets include forest management, riparian areas and wildlife habitat. • Ruffed Grouse Habitat Initiative in the Potomac Valley Conservation District to create early successional forest habitat for species including ruffed grouse, wild turkey, cerulean warbler and other neotropical migrants • ACEP can be used for both agricultural land easements and wetland reserve easements to protect farmland and associated habitat
<p>USDA Farm Service Agency https://www.fsa.usda.gov/state-offices/West-Virginia/programs/index</p> <ul style="list-style-type: none"> • Conservation Reserve Program (CRP) • Conservation Reserve Enhancement Program (CREP) 	<ul style="list-style-type: none"> • CRP provides rental payments to participating agricultural producers to safeguard environmentally sensitive land, conserve water quality, control soil erosion and enhance wildlife habitat, including floodplain wetlands. • CREP provides extra incentives and payments to eligible producers in the Potomac watershed (including this CFA) to reduce soil erosion and pollution, improve water quality, and enhance terrestrial and aquatic wildlife habitat through practices such as riparian buffers and wetland restoration

Partner	Role/Assistance Provided
<p>WV Division of Natural Resources (WVDNR) http://www.wvdnr.gov/wildlife/wdpintro.shtm</p>	<ul style="list-style-type: none"> • Identify, survey and monitor SGCN and rare communities • Technical assistance on habitat management for SGCN • Facilitating partnerships to manage habitat for SGCN • Provide letters of support for partner proposals and grant applications seeking to benefit SGCN • Education, outreach and teaching resources on SGCN and their habitat • Field guides, Landscaping and Management guidelines • Fish, game and wildlife research and management • Fishing and river access • Wildlife Management Areas
<p>WV Department of Environmental Protection (WVDEP)</p> <ul style="list-style-type: none"> • Nonpoint Source Program https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx • Watershed Based Plans https://dep.wv.gov/WWE/Programs/nonptsource/WBP/Pages/WBP.aspx • Chesapeake Bay Program https://dep.wv.gov/WWE/watershed/wqmonitoring/Pages/ChesapeakeBay.aspx • Save Our Streams Program https://dep.wv.gov/WWE/getinvolved/sos/Pages/default.aspx • Rehabilitation Environmental Action Plan (REAP) https://dep.wv.gov/environmental-advocate/reap/Pages/default.aspx • WVDEP Youth Environmental Program (YEP) https://dep.wv.gov/environmental-advocate/yep/Pages/default.aspx 	<ul style="list-style-type: none"> • Supports partners and citizen-based watershed organizations in restoring impaired watersheds • Provides assistance in proper installation and maintenance of Best Management Practices • Provides funding for projects by watershed groups and partners to improve water quality in watersheds listed as impaired, with Watershed Based Plans, including the Lost River Watershed in this CFA • WV Chesapeake Bay funding for water quality improvements through the CFA • Practices include wastewater treatment, agricultural BMPs, rain gardens for stormwater runoff, streambank restoration, and community outreach • Save our Streams provides training for volunteers to monitor local wadable streams and rivers • REAP provides communities with technical, financial and resource assistance in cleanup efforts. • YEP organizes youth and volunteer groups for hands-on conservation projects

Partner	Role/Assistance Provided
<p>WV Conservation Agency (WVCA) http://www.wvca.us/</p>	<ul style="list-style-type: none"> • Promotes the protection and conservation of West Virginia’s soil, land, water and related resources • Works with WVDEP on to improve water quality through the Non-Point Source and Chesapeake Bay programs • Works with Conservation Districts to implement Agricultural Best Management Practices, such as invasive species management and exclusion fencing to protect streams, wetlands and other environmentally sensitive areas • Potomac Valley Conservation District, in partnership with NRCS, hosts Local Work Group to identify and prioritize resource concerns and evaluate EQIP applications for funding through the NRCS Focal Conservation Approach (FCA).
<p>WV Division of Forestry http://www.wvforestry.com/</p>	<ul style="list-style-type: none"> • Oversees the Managed Timberland Program to provide tax incentives for landowners who manage their forest land sustainably according to a management plan • Oversee timber sales and Best Management Practices • Provides training workshops for loggers on safety and Best Management Practices • Maintains list of consulting foresters who can help landowners with Forest Stewardship Plans to enhance wildlife habitat • Assists watershed groups and other partners on riparian planting in the Chesapeake Bay watershed • Protection of large private forest tracts through Forest Legacy Program
<p>WV Department of Health and Human Resources (WVDHHR) On-Site Sewage Program https://www.wvdhhr.org/phs/sewage/index.asp</p>	<ul style="list-style-type: none"> • Provides rule interpretation and technical assistance on conventional and non-conventional on-site sewage systems, including information on septic systems, installers, permits, fees and loan programs.
<p>County Commissions and Organizations</p> <ul style="list-style-type: none"> • Grant County http://www.grantcountywv.org/ • Pendleton County https://pencowv.com/ 	<ul style="list-style-type: none"> • Economic and Community Development, Tourism, Parks and Recreation, Floodplain Management

Partner	Role/Assistance Provided
<p>Land Conservation Organizations</p> <ul style="list-style-type: none"> • Land Trust of the Eastern Panhandle https://www.landtrustepwv.org/ • Potomac Conservancy https://potomac.org/ • County Farmland Protection Boards http://wvfp.org/ • West Virginia Land Trust https://www.wvlandtrust.org/ 	<ul style="list-style-type: none"> • Conservation easements to protect farms, forests and riparian areas
<p>The Nature Conservancy https://www.nature.org/en-us/about-us/where-we-work/united-states/west-virginia/</p>	<ul style="list-style-type: none"> • Assist land conservation organizations with forest and land protection and restoration • Assist landowners with protection and improved management of large forest tracts through Working Woodlands program
<p>Trout Unlimited</p> <ul style="list-style-type: none"> • http://www.wvtu.org/ • http://www.tu.org/ 	<ul style="list-style-type: none"> • Restoring brook trout populations in small watersheds such as Thorn Creek, Big Run, Seneca Creek and Upper North Fork • Plans and implements restoration projects with landowners and in coordination with USFWS Partners program and USDA Natural Resource Conservation Service and Forest Service, and other partners • Projects focus on riparian corridor and in-stream habitat restoration, invasive weed treatment and aquatic passage barrier removal/replacement to benefit brook trout and other wildlife species
<p>American Forest Foundation: My Land Plan https://mylandplan.org/</p>	<ul style="list-style-type: none"> • Woodland owners planning tool for forest management
<p>National Wild Turkey Federation (NWTf) https://www.nwtf.org/</p>	<ul style="list-style-type: none"> • Provides information to landowners on hunting and habitat management for wild turkey and other wildlife • Partners with state and federal agencies on hunting access and habitat management for wild turkey and other wildlife species
<p>Ruffed Grouse Society/American Woodcock Society (RGS) https://ruffedgrousesociety.org/#</p>	<ul style="list-style-type: none"> • Creates healthy forest habitat for the benefit of ruffed grouse, American woodcock and other forest wildlife • Works with landowners and government agencies to develop critical habitat using scientific management practices
<p>West Virginia Association for Cave Studies (WVACS) https://www.wvacs.org/</p>	<ul style="list-style-type: none"> • Contributes to cave surveys and research • Hosts cave scientists and graduate students pursuing cave research at field stations in Greenbrier County

Partner	Role/Assistance Provided
<p>West Virginia Cave Conservancy https://wvcc.net/</p>	<ul style="list-style-type: none"> • Manages caves to protect sensitive cave resources and environments • Educates and provides expertise to landowners, developers, local governments and the public on the value of cave and karst resources • Organizes cave and karst conservation projects including sinkhole cleanups and livestock barrier fences. • Preserves access to significant caves through ownership and management agreements • Sponsor research and survey projects on WVCC caves
<p>Cave Conservancy of the Virginias (CCV) https://caveconservancyofvirginia.org/</p>	<ul style="list-style-type: none"> • Promoting conservation, management, knowledge and acquisition of caves and karst resources in Virginia and West Virginia • Contributes to educational, research and environmental protection projects • Funds a variety of cave and karst education, outreach, research, cleanup and acquisition projects. • Provides research scholarships and stipends for graduate and undergraduate students • Supports <i>Project Underground</i> environmental education program to promote a better understand of caves and karst lands.
<p>Master Naturalists Program http://mnofwv.org/</p>	<ul style="list-style-type: none"> • Training interested people in the fundamentals of natural history, nature interpretation and teaching. • Instilling an appreciation of the importance of responsible environmental stewardship. • Providing a corps of highly qualified volunteers to assist government agencies, schools, and non-government organizations with research, outdoor recreation development, and environmental education and protection

Appendix 5. Resources

<p>West Virginia's Phase 3 Watershed Implementation Plan for the Chesapeake Bay Total Maximum Daily Load (TMDL) http://www.wvca.us/bay/files/bay_documents/1298_WV_WIP3_final_082319.pdf</p>
<p>West Virginia's Chesapeake Bay Program Web resources to restore streams, reduce runoff and improve water quality, focusing on agriculture, urban stormwater, homeowners and forestry. http://www.wvchesapeakebay.us/</p>
<p>Long Range Plan for Natural Resource Management in the Potomac Valley Conservation District Summarizes natural resources conditions and ranks resource concerns that could be addressed through NRCS technical and financial assistance. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/wv/programs/financial/eqip/?cid=nrcseprd1167606</p>
<p>Living on Karst- A Reference Guide for Landowners in Limestone Regions http://www.livingonkarst.org/living_on_karst.htm</p>
<p>Guidelines for Cave and Karst Protection- IUCN https://www.iucn.org/content/guidelines-cave-and-karst-protection-0</p>
<p>A Guide to Responsible Caving, by the National Speleological Society https://caves.org/brochure/Guide_to_Resp_Caving_2016.pdf</p>
<p>National Wild Turkey Foundation- Landowner's Toolbox https://www.nwtf.org/conservation/category/landowners-tool-box Wildlife Habitat Council Integrated Vegetation Management Project Guidance for Infrastructure Corridors: https://www.wildlifehc.org/wp-content/uploads/2015/11/WHC-Integrated-Vegetation-Management-Project-Guidance.pdf</p>
<p>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</p>
<p>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</p>

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, 2nd edition, 2016, published by the USDA Forest Service, Northern Research Station
<https://www.nrs.fs.fed.us/pubs/52760>

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Appendix 6. Initial Project Plan

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

- **Threat to be addressed:**
 - Sedimentation, stream bank erosion, riparian deforestation
- **Species and Habitats that will benefit:**
 - Target: wood turtles
 - 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
- **Actions to be taken:**
 - Initial partner meeting in 2020 to develop timeline and budget
- **Partners involved:**
 - George Washington National Forest
 - USDA NRCS, FSA
 - WVCA, WVDEP
 - USFWS Partners for Fish and Wildlife program
 - Trout Unlimited
 - WVDNR (technical assistance)