# Action Plan for the Ohio River Corridor Conservation Focus Area



November 2023

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# 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
- **ORSANCO-** Ohio River Valley Sanitation Commission
- **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
- USACE- Unites States Army Corps of Engineers
- USDA- United States Department of Agriculture
- USFWS- United States Fish and Wildlife Service
- WVACS- West Virginia Association of Cave Studies
- 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
- 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 and other non-profit conservation organizations working in the area to develop this Action Plan for the Ohio River Corridor 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 95 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; 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 function as a blueprint for conservation for use by other natural resource agencies, local governments, non-governmental organizations and the general public (WVDNR 2015). The SWAP is intended to have a ten-year timeframe and will be updated by 2025.

### Species of Greatest Conservation Need, Habitats and Stresses

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

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

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

### **Conservation Actions**

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

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

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

#### **Conservation Focus Areas and Action Plans**

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

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



#### **Climate Change and Resilience**

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

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

# Monitoring and Adaptive Management

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

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

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



Climate-Smart Conservation Cycle A General Framework for Adaptation Planning and Implementation

# Organization of this Action Plan

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

# How to use this plan

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

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

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

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

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

# **Ohio River Corridor Conservation Focus Area**

## **Overview**

The Ohio River Corridor CFA extends for over 200 miles, following the meanders of the Ohio River and also encompassing many of the shorter tributaries that originate in West Virginia. Completely within the Western Allegheny Plateau Ecoregion, the Ohio River is West Virginia's largest river. Although forming the State's border with Ohio, this portion of the river is entirely within West Virginia. Historically consisting of complex habitats of riffle, runs and pools, the Ohio is now fully constrained by six locks and dams and is heavily used for commercial navigation. Extending back from the floodplain of the Ohio River are low, rolling hills, often lower than 1000 feet in elevation, of shales and sandstones. The original deciduous forest of the floodplains and adjacent areas has been extensively fragmented and altered by large cities including:

- Parkersburg
- Huntington

Fragmentation & alteration has also been impacted by:

- Small towns
- Agricultural areas
- Industrial complexes
  - Coal loading facilities
  - o Chemical plants
  - o Manufacturing plants

No extensive areas of floodplain forest remain along the Ohio River in West Virginia, although there are scattered small woodlots.

Map 2. Overview – North



Map 3. Overview – South



# Habitats

The Ohio River Corridor CFA includes a variety of terrestrial, aquatic, and subterranean habitat types.

## **Terrestrial Habitats**

Eleven of the habitat types described in the SWAP are present in this CFA including Dry-Mesic Oak Forests, which comprise almost one third of the terrestrial habitat types in the CFA. Terrestrial habitats are described in Chapter 3 of the 2015 SWAP.

Table 1. Terrestrial	Habitat	Summary
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Habitat Type	Acres in CFA	Percent of CFA Area	Percent of WV Total for Type
Acidic Rock Outcrops, Cliffs, and Talus	136	0.02%	0.15%
Agriculture	123,468	15.08%	8.60%
Anthropogenic Shrubland & Grassland	9,129	1.12%	5.74%
Calcareous Cliffs and Talus	164	0.02%	1.78%
Developed	98,685	12.05%	8.66%
Dry Calcareous Forests, Woodlands, and Glades	0	0.00%	0.00%
Dry Oak (-Pine) Forests	93,804	11.46%	3.80%
Dry-Mesic Oak Forests	256,065	31.28%	5.13%
Heath-Grass Barrens	0	0.00%	0.00%
High Allegheny Wetlands	0	0.00%	0.00%
Mixed Mesophytic Forests	169,351	20.69%	5.75%
Montane Red Oak Forests	0	0.00%	0.00%
Northern Hardwood Forests	223	0.03%	0.02%
Pine-Oak Rocky Woodlands	0	0.00%	0.00%
Red Spruce Forests	0	0.00%	0.00%
River Floodplains	8,761	1.07%	7.29%
Shale Barrens	0	0.00%	0.00%
Sinkhole and Depression Ponds	0	0.00%	0.00%
Small Stream Riparian Habitats	20,447	2.50%	4.14%
Unresolved	38,477	4.70%	32.96%
Totals	818,708	100.00%	

#### Map 4. Terrestrial Habitats – North



#### Map 5. Terrestrial Habitats – South



#### Aquatic Habitats

Ten of the aquatic habitat types described in the SWAP are present within the Ohio River Corridor CFA, including nearly half of the state's warm, moderate gradient large river habitat. The largest percentage of aquatic habitat type found within the CFA is warm, moderate gradient headwater creeks, which covers 889 miles and 47% of the water ways within the CFA and also comprises nearly a quarter of the total habitat of that type for the state. Aquatic habitats are described in Chapter 3 of the 2015 SWAP.

Habitat Type	Miles in CFA	Percent of CFA Miles	Percent of WV total for Type
Headwater Creek, Low Gradient, Warm	93	4.99%	16.78%
Headwater Creek, Moderate Gradient, Warm	889	47.46%	22.78%
Headwater Creek, High Gradient, Cool	355	18.93%	5.66%
Headwater Creek, High Gradient, Warm	138	7.38%	18.21%
Small River, Low Gradient, Warm	50	2.69%	10.97%
Small River, Moderate Gradient, Warm	12	0.63%	2.17%
Medium River, Low Gradient, Warm	57	3.04%	11.99%
Medium River, Moderate Gradient, Warm	15	0.82%	4.44%
Large River, Low Gradient, Warm	261	13.92%	44.91%
Large River, Moderate Gradient, Warm	3	0.14%	2.38%
Totals	1,874	100.00%	

#### Table 2. Aquatic Habitat Summary

#### Map 6. Aquatic Habitats – North







# Species of Greatest Conservation Need

Table 3 lists the number of SGCN in each taxa listed in the SWAP for the Ohio River Corridor CFA.

Таха	# SGCN
Amphibian	24
Birds	44
Butterflies and Moths	6
Cave Invertebrates	2
Dragonflies and Damselflies	15
Fish	30
Mammals	6
Mussels	46
Plants	59
Reptiles	18
Snails	5
Tiger Beetles	2
Totals	257

The large Ohio River is a unique habitat in West Virginia. The portion in this CFA accounts for 44% of the warm, low gradient river habitat in the State, contains significant amounts of other warmwater habitats, and provides aquatic habitat for a diversity of fish (30 SGCN) and freshwater mussels (46 SGCN).

Freshwater mussel beds in the Ohio River host six species listed under the federal Endangered Species Act. The Greenup and Belleville pools are significant hotspots for the river's freshwater mussel diversity. Tributary backwaters and sloughs harbor a wide diversity of fishes, including the majority of the occurrences in the state for:

- Warmouth
- Orangespotted Sunfish

Floodplain forests, sloughs, backwaters and wetlands, such as at Greenbottom Swamp and on the Ohio River Islands, host breeding birds, amphibians, and plants that are rare or absent elsewhere in the state, such as:

- Streamside and Smallmouth Salamanders
- Smooth Softshell Turtle
- Eastern Spadefoot Toad
- Least Bittern

- Rails
- Prothonotary Warbler

This is an important area for nesting birds, with 44 SGCN including:

- Nesting Bald Eagle
- Nesting Peregrine Falcon

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 fish and mussel populations in this CFA:

- Altered flow
- In-river structures (locks and dams)
- Pre-Clean Water Act water quality degradation
- Dredging
- Excessive bank stabilization and armoring
- Isolation of key habitats from river mainstem
- Pollution received from tributaries
- Intensive industrial and other development along the mainstem Ohio River

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

# **Conservation Actions**

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

- Reconnect fragmented river habitat by modifying operational regimes of the locks and dams to improve aquatic organism passage.
- Reconnect floodplain habitat on priority river sections to allow aquatic organisms access to key habitat areas.
- Implement approaches to maintain high quality stream segments.
- Limit disturbances to the river bottom.
- Protect and restore key wetland, slough and backwater habitats.

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

# **Potential Partners**

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

- WV Department of Environmental Protection
- WV Department of Highways
- USFWS
- US Army Corps of Engineers
- Ohio River Valley Water Sanitation Commission

- Ohio River Basin Fish Habitat Partnership
- Marshal University
- West Virginia Land Trust
- Large corporate landowners along the Ohio River
- Local county planning commissions

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 5 lists the types of programming and assistance each partner provides to landowners. Specific partners are also listed along with conservation actions supported through their programs in the implementation plan for each habitat type.

# **Protected Lands**

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

- Chief Cornstalk WMA
- Greenbottom WMA
- McClintic WMA
- Ohio River Islands National Wildlife Refuge
- Johnson T. James Nature Preserve and Conservation Park

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

In addition, land trusts including West Virginia Land Trust and the Wetlands Reserve Program hold conservation easements that may protect important wildlife habitat and provide additional wildlife conservation opportunities.

Maps 8 and 9 show 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 1- square kilometer 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 communicates 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 communicates also occur on private land outside of public lands and conservation easements. This indicates how important it is for WVDNR and other partners to work with private landowners to restore and protect biodiversity on private lands.









# 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 common species common
- 4. Conserve the full array of habitat types and biological diversity in the state

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

# **Priority Species**

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

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

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

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

Table 4. Priority Species in the CFA

ТАХА	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK
Amphibians	Acris blanchardi	Blanchard's Cricket Frog	SH	G5
Amphibians	Scaphiopus holbrookii	Eastern Spadefoot	S1	G5
Amphibians	Necturus maculosus	Mudpuppy	S4	G5
Amphibians	Ambystoma texanum	Smallmouth Salamander	S1	G5
Amphibians	Ambystoma barbouri	Streamside Salamander	S1	G4
Birds	Falco sparverius	American Kestrel	S3B	G5
Birds	Scolopax minor	American Woodcock	S3B	G5
Birds	Haliaeetus leucocephalus	Bald Eagle	S3B,S3N	G5
Birds	Riparia riparia	Bank Swallow	S2B	G5
Birds	Tyto alba	Barn Owl	S2B,S2N	G5
Birds	Megaceryle alcyon	Belted Kingfisher	S3B	G5
Birds	Vermivora cyanoptera	Blue-winged Warbler	S3B	G5
Birds	Setophaga cerulea	Cerulean Warbler	S2B	G4
Birds	Chaetura pelagica	Chimney Swift	S3B	G5
Birds	Sturnella magna	Eastern Meadowlark	S3B, S2N	G5
Birds	Antrostomus vociferus	Eastern Whip-poor-will	S3B	G5
Birds	Spizella pusilla	Field Sparrow	S3B	G5
Birds	Ardea herodias	Great Blue Heron	S3B,S4N	G5
Birds	Butorides virescens	Green Heron	S3B	G5
Birds	Geothlypis formosa	Kentucky Warbler	S3B	G5
Birds	Ixobrychus exilis	Least Bittern	S1B	G5
Birds	Parkesia motacilla	Louisiana Waterthrush	S3B	G5
Birds	Falco peregrinus	Peregrine Falcon	S2B,S2N	G4

ТАХА	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK
Birds	Setophaga discolor	Prairie Warbler	S3B	G5
Birds	Protonotaria citrea	Prothonotary Warbler	S2B	G5
Birds	Piranga rubra	Summer Tanager	S3B	G5
Birds	Rallus limicola	Virginia Rail	S1B,S1N	G5
Birds	Hylocichla mustelina	Wood Thrush	S3B	G5
Birds	Helmitheros vermivorum	Worm-eating Warbler	S3B	G5
Birds	lcteria virens	Yellow-breasted Chat	S3B	G5
Butterflies & Moths	Lycaena hyllus	Bronze Copper	S2	G5
Crayfish	Fallicambarus fodiens	A Crayfish (digger)	S1	G5
Mammals	Microtus ochrogaster	Prairie Vole	S3	G5
Mammals	Reithrodontomys humulis	Eastern Harvest Mouse	SH	G5
Mammals	Lasiurus cinereus	Hoary Bat	S3	G5
Snails	Webbhelix multilineata	Striped Whitelip	S1	G5
Tiger Beetles	Cicindela formosa generosa	A Tiger Beetle	S1	G5T4
Tiger Beetles	Cicindela scutellaris	A Tiger Beetle	S1	G5
Tiger Beetles	Cicindela marginipennis	Cobblestone Tiger Beetle	S1	G2
Tiger Beetles	Cicindela cursitans	A Tiger Beetle	S1	G4
Tiger Beetles	Cicindela hirticollis	Beach-dune Tiger Beetle	S1	G5
Tiger Beetles	Cicindela cuprascens	A Tiger Beetle	S1	G5
Dragonflies and Damselflies	Sympetrum ambiguum	Blue-faced Meadowhawk	S1	G5
Dragonflies and Damselflies	Gomphus vastus	Cobra Clubtail	S2	G5

ТАХА	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK
Dragonflies and Damselflies	Telebasis byersi	Duckweed Firetail	S1	G5
Dragonflies and Damselflies	Stylurus notatus	Elusive Clubtail	S1S2	G3
Dragonflies and Damselflies	Dromogomphus spoliatus	Flag-tailed Spinyleg	SH	G4G5
Dragonflies and Damselflies	Somatochlora linearis	Mocha Emerald	S3	G5
Dragonflies and Damselflies	Enallagma antennatum	Rainbow Bluet	S1S2	G5
Dragonflies and Damselflies	Neurocordulia molesta	Smoky Shadowdragon	S2	G4
Dragonflies and Damselflies	Neurocordulia obsoleta	Umber Showdragon	S1	G5
Fish	Anguilla rostrata	American Eel	S2	G4
Fish	Ictiobus cyprinellus	Bigmouth Buffalo	S1	G5
Fish	Ictiobus niger	Black Buffalo	S2	G5
Fish	Cycleptus elongatus	Blue Sucker	S1	G3G4
Fish	Umbra limi	Central Mudminnow	S1	G5
Fish	Ammocrypta pellucida	Eastern Sand Darter	S3	G3
Fish	Hiodon alosoides	Goldeye	S1	G5
Fish	Esox americanus vermiculatus	Grass Pickerel	S1S2	G5T5
Fish	Erimystax x-punctatus	Gravel Chub	S1	G4
Fish	Carpiodes velifer	Highfin Carpsucker	S1	G4G5
Fish	Ichthyomyzon greeleyi	Mountain Brook Lamprey	S1	G3G4
Fish	Ichthyomyzon bdellium	Ohio Lamprey	S2S3	G3G4

ТАХА	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK
Fish	Polyodon spathula	Paddlefish	S1	G4
Fish	Lythrurus umbratilis	Redfin Shiner	S3	G5
Fish	Clinostomus elongatus	Redside Dace	S1S2	G3G4
Fish	Moxostoma carinatum	River Redhorse	S3	G4
Fish	Notropis blennius	River Shiner	S2	G5
Fish	Percina phoxocephala	Slenderhead Darter	S1	G5
Fish	Phenacobius mirabilis	Suckermouth Minnow	S3	G5
Fish	Ammocrypta clara	Western Sand Darter	S1	G2G3
Mussels	Elliptio crassidens	Elephant-ear	S2	G5
Mussels	Cyprogenia stegaria	Fanshell	S1	G1Q
Mussels	Fusconaia subrotunda	Long-solid	S3	G3
Mussels	Lampsilis abrupta	Pink Mucket	S1	G2
Mussels	Obovaria subrotunda	Round Hickorynut	S3	G4
Mussels	Plethobasus cyphyus	Sheepnose	S2	G3
Plants	Fraxinus quadrangulata	Blue Ash	S1	G5
Plants	Cicuta bulbifera	Bulb-bearing Water-hemlock	S1	G5
Plants	Spermacoce glabra	Buttonweed	S1	G4G5
Plants	Enemion biternatum	Eastern False Rue-anemone	S1	G5
Plants	Carex albicans var. emmonsii	Emmons's sedge	S1	G5T5
Plants	Hottonia inflata	Featherfoil	S1	G4
Plants	Arundinaria gigantea ssp. gigantea	Giant Cane	S2	G5T5?
Plants	Ampelopsis cordata	Heartleaf Peppervine	S1	G5

ТАХА	SCIENTIFIC NAME	COMMON NAME	S RANK	G RANK
Plants	Trillium flexipes	Nodding Wakerobin	S2	G5
Plants	Ludwigia leptocarpa	River Seedbox	S2	G5
Plants	Gratiola viscidula	Short's Hedgehyssop	S1	G4G5
Plants	Rorippa sessiliflora	Southern Yellow Cress	S1	G5
Plants	Ceratophyllum echinatum	Spineless Hornwort	S1	G4?
Reptiles	Lampropeltis getula nigra	Eastern Black Kingsnake	S2	G5
Reptiles	Terrapene carolina carolina	Eastern Box Turtle	S5	G5T5
Reptiles	Apalone spinifera spinifera	Eastern Spiny Softshell	S4	G5T5
Reptiles	Apalone mutica mutica	Midland Smooth Softshell	S1	G5T5
Reptiles	Graptemys geographica	Northern Map Turtle	S1	G5

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

# Forest and Woodland Habitats

Dry Mesic Oak Forests, Mixed Mesophytic Forests, and Dry Oak (Pine) Forests are the most abundant forest habitat types within the CFA and can be found in patches scattered throughout the area. Northern Hardwood Forests comprise the smallest amount of forest habitat type, covering just 223 acres or 0.03% of the total CFA area with small patches able to be found in the northern portion of the CFA, around the towns of Cameron, Moundsville, and south of Wheeling. A small solitary patch of Northern Hardwood Forest can also be found in the southern portion of the CFA, south of the Mason/Cabell county line. Many of the dry forest types are threatened by invasive species, mesophication (gradual moistening), and lack of fire, while overbrowsing by deer reduces regeneration of oak and other palatable understory species.

Maps 10 and 11 display forest habitat types. The diversity of forest types and habitats across elevational gradients provides opportunities for their conservation within larger forest patches and requires careful management tied to specific site conditions and forest stand characteristics. Intact forest patches may provide core habitat for portion of the SGCN and rare communities, within which the matrix of forest habitat types and corridors may enable forest species to shift and adapt to climate change.

Maps 12 and 13 feature rare rock outcrop, cliff and talus habitats embedded within intact forest patches (based on the Appalachian and Mid-Atlantic Forest Patch Dataset compiled by The Nature Conservancy in 2011). Acidic rock outcrops, cliffs, and talus, and calcareous cliffs and talus occur within the CFA and are most concentrated in the north along sections of the Ohio River and its tributaries, with additional clusters located in the south of the CFA along the Ohio River and various creeks and streams. There are many biodiversity occurrences associated with or in the vicinity of these rare habitat types. These habitats are threatened by nonnative invasive plants, woody encroachment, quarrying and other development. While the majority of rocky habitat species have evolved adaptations to disturbance events; climate change and the increasing occurrence of disturbances could lead to further endangerment of rare species. In addition, there are a several small caves in the northern end of the CFA. Caves may host rare species and are also vulnerable to disturbance. Maintaining intact forest cover around cave, rock outcrops, cliffs and talus habitats may buffer them from stresses and the impacts of climate change, and those in smaller forest patches may be more vulnerable to stresses.

### **Priority Species**

Table 5 lists priority species in the CFA associated with forest and woodland habitats.

Таха	Scientific Name	Common Name
Birds	Antrostomus vociferus	Eastern Whip-poor-will
Birds	Geothlypis formosa	Kentucky Warbler
Birds	Haliaeetus leucocephalus	Bald Eagle
Birds	Helmitheros vermivorum	Worm-eating Warbler

Table 5. Priority	/ Species i	n Forest and	d Woodland	Habitats
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Таха	Scientific Name	Common Name		
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Birds	Hylocichla mustelina	Wood Thrush		
Birds	Icteria virens	Yellow-breasted Chat		
Birds	Piranga rubra	Summer Tanager		
Birds	Setophaga cerulea	Cerulean Warbler		
Birds	Setophaga discolor	Prairie Warbler		
Birds	Vermivora cyanoptera	Blue-winged Warbler		
Mammals	Lasiurus cinereus	Hoary Bat		
Plants	Enemion biternatum	Eastern False Rue- anemone		
Plants	Fraxinus quadrangulata	Blue Ash		
Plants	Trillium flexipes	Nodding Wakerobin		
Reptiles	Terrapene carolina carolina	Eastern Box Turtle		
Snails	Webbhelix multilineata	Striped Whitelip		















#### Map 13. Intact Forest Patches, Rock Outcrops, Cliffs, Talus, and Biodiversity-South

## Habitat Stresses and Conservation Actions

Table 6 lists stresses impacting species in forest and woodland habitats, and conservation actions landowners and partners can take to address those stresses. In addition to habitat stressors, Eastern box turtles suffer from collection and disease, and would benefit from training for land managers and researchers about appropriate decontamination procedures to reduce the spread of disease.

Habitat Stress	Conservation Action
Deforestation, forest fragmentation, poor forest structure	Protect and manage forest patches for structural and spatial complexity; protect forested buffers around caves, rock outcrops, cliff and talus habitats.
Early successional habitat: Poor forest structure, forest maturation, fire suppression	Use forest management to promote early successional habitat and structural complexity, including gaps and snags
Interior forest: deforestation, fragmentation, poor forest structure	Protect mature forest and promote structural complexity: old growth, small openings, snags, large roosting trees (for Hoary Bat)
Deer browse impacting forest structure and regeneration	Manage local deer populations where abundant
Invasive weeds: deforestation, forest fragmentation, climate change	Maintain forest cover and control invasive weeds, especially around rare habitat features
Incompatible utility corridor management	Improve vegetation management practices and timing in utility corridors; reduce broadcast herbicide applications
Road mortality (Eastern box turtles)	Improve roadways and signage to reduce mortality in critical locations

Table 6. Stresses and Actions in Forest and Woodland Habitats:

In addition to the habitat-linked stresses listed above, direct stresses to priority species include road/collision mortalities for the Eastern Whip-poor-will, and lead poisoning of bald eagles.

Maintaining a diverse population of forest birds requires dynamic forest landscapes with mosaics of age classes and structure. Efforts to manage and restore both early successional and interior forest habitat are needed for priority SGCN. Early successional forest habitat forest restoration can take place in small patches of forest and along forest edges outside of large blocks of interior forests, on degraded lands and actively managed timber lands.

#### 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. However, drought may increase susceptibility to forest pests and pathogens, and drought, as well as disturbances from stronger storms, may enable the spread of nonnative invasive plants. Intense fires or droughts, combined with other stressors, could increase mortality of some species.

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

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

The small areas of northern hardwood forests may be particularly impacted by climate change. Increased heat and moisture stress in summer and fall may interact with acid deposition as well as increases in insect pests and pathogens, storm disturbance and wildfires to stress these forests, reducing species diversity and coverage. Cool, moist sites within areas of complex topography may provide some refuge and buffer the effects of climate change. Some changes in forest composition and structure are likely to occur over time as these different forest types adapt and adjust in response to changes in climate. Conservation actions to reduce existing stresses on forests will aid in building their resilience. Protection of large forest blocks in areas with complex topography, and maintaining natural cover linkages between them, may further enable their adaptation and shifting distribution across the landscape.

Table 7 provides a summary of climate stresses on forest habitats, and actions which could boost their resilience (Swanston et al, 2016). While climate stresses are listed separately, forest and woodland habitats are often impacted by multiple climate stresses occurring simultaneously and actions to boost habitat resilience are intended to address multiple climate stresses. Many of these actions resemble previously listed conservation actions to reduce stress on priority species, meaning that they could have positive outcomes for priority species as well as habitat resilience. WVDNR, land managers, landowners and partners can select the actions best suited to their specific site conditions, management goals and objectives, from the list below or other sources.

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

Table 7. Climate Stresses and Resilience Actions in Forest and Woodland Habitats

## 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.

Action	Partners	Effectiveness Measures
<ul> <li>Forest Habitat, Reserve and Corridor Protection:</li> <li>Conservation Easements</li> <li>Land Acquisition</li> <li>Natural Area designation</li> </ul>	<ul> <li>County Farmland Protection Boards</li> <li>The Nature Conservancy</li> <li>WV Land Trust</li> <li>WVDNR</li> <li>WVDOF Forest Legacy</li> </ul>	<ul> <li>Acres of habitat protected for priority species</li> <li>Abundance and diversity of priority species and habitats</li> </ul>
<ul> <li>Forest Planning &amp; Management:</li> <li>Land Use Plans</li> <li>Forest Management Plans</li> <li>Forest Carbon Programs</li> <li>Cost-Share Programs</li> <li>Sustainable Forestry Certification Programs</li> <li>USDA NRCS Climate Smart Forestry Mitigation Activities</li> </ul>	<ul> <li>AFF</li> <li>ATFS, FSC, SFI</li> <li>Consulting Foresters</li> <li>Forest Carbon Programs</li> <li>Planning Commissions</li> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDOF</li> </ul>	<ul> <li>Acres of habitat protected for priority species</li> <li>Abundance and diversity of priority species and habitats</li> </ul>
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> <li>Consulting Foresters</li> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDOF</li> <li>WVU Extension</li> </ul>	<ul> <li>Acres of habitat restored for priority species</li> <li>Before and after comparison: abundance, diversity, and distribution of priority species</li> </ul>
Monitor and control invasive weeds, promptly revegetate disturbed sites	<ul> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVCA and Conservation Districts</li> <li>WVDOA, WVDOF</li> </ul>	<ul> <li>Acres of habitat protected or restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>

## Table 8. Implementation Plan for Forest and Woodland Habitats

Action	Partners	Effectiveness Measures
Create or maintain early- successional habitat (ESH) to benefit wildlife species through forest management on appropriate sites. Apply GWWA guidelines for large forest patches with > 70% forest cover: • Maintain ESH on 15-20% of forest at any one time, as part of shifting mosaic ESH should include irregular, interspersed clumps of shrubs and/or saplings, grasses and forbs, and widely spaced overstory trees (10-30% canopy cover or 20-40 ft2/acre residual basal area)	<ul> <li>Consulting Foresters</li> <li>NWTF and RGS</li> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDOF</li> <li>WVU Extension</li> </ul>	<ul> <li>Acres of habitat restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Improve or maintain interior forest habitat to benefit wildlife species through forest management activities on appropriate sites: CERW guidelines for large forest patches with > 70% forest cover: Provide heterogenous stand structure and species diversity with 40-90 ft2/acre residual basal area of well-spaced, large diameter trees (favor white oak, hickories, sugar maple) with canopy gaps and well- developed understory vegetation. Mesic north- and east-facing slopes optimal.	<ul> <li>Consulting Foresters</li> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDOF</li> <li>WVU Extension</li> </ul>	<ul> <li>Acres of habitat restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>

Action	Partners	Effectiveness Measures	
Manage deer population where abundant	<ul> <li>Private landowners</li> <li>Public Land Managers</li> <li>WVDNR (hunting licenses)</li> </ul>	<ul> <li>Change in deer population or forest structure</li> <li>Acres of habitat restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>	
Manage utility corridors to reduce wildlife impacts (implement BMPs promoted by the Wildlife Habitat Council, NRCS and other organizations)	<ul> <li>Landowners, partners, and utility companies</li> </ul>	<ul> <li>Acres of habitat restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>	
Public & Landowner Outreach and Demonstration	<ul> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDEP, WVCA and Conservation Districts</li> <li>WVDNR</li> <li>WVDNR, WVDOF</li> <li>WVU Extension</li> </ul>	<ul> <li># Landowners engaged</li> <li># Landowners implementing actions</li> </ul>	

## Human Benefits

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

# Aquatic, Floodplain and Riparian Habitats

A diversity of aquatic habitats in the CFA range from warm, low-gradient headwater streams such as French Creek, Big Run, and Trace Fork, to warm, moderate gradient large sized rivers such as sections of the Ohio River, Kanawha River, and Little Kanawha 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 plants and animal species rely on aquatic habitats such as streams, rivers, and wetlands, as well as their adjacent terrestrial habitats, especially riparian areas and forests. The loss of natural floodplain habitats and riparian corridors often impacts water quality and adjacent aquatic habitat. Improving wildlife habitat in streams and rivers often requires conservation actions to improve adjacent floodplain and riparian habitats. Therefore aquatic, floodplain, wetland, and riparian habitats will be addressed together.

#### **Priority Species**

Tables 9 and 10 list priority species that occur in aquatic, floodplain, wetland and riparian habitats.

Таха	Scientific Name	Common Name	
Amphibians	Ambystoma barbouri	Streamside Salamander	
Crayfish	Fallicambarus fodiens	A Crayfish (digger)	
Fish	Ammocrypta clara	Western Sand Darter	
Fish	Ammocrypta pellucida	Eastern Sand Darter	
Fish	Anguilla rostrata	American Eel	
Fish	Carpiodes velifer	Highfin Carpsucker	
Fish	Clinostomus elongatus	Redside Dace	
Fish	Cycleptus elongatus	Blue Sucker	
Fish	Erimystax x-punctatus	Gravel Chub	
Fish	Esox americanus vermiculatus	Grass Pickerel	
Fish	Etheostoma tippecanoe	Tippecanoe Darter	
Fish	Ichthyomyzon bdellium	Ohio Lamprey	
Fish	Ichthyomyzon greeleyi	Mountain Brook Lamprey	
Fish	Ictiobus cyprinellus	Bigmouth Buffalo	
Fish	Ictiobus niger	Black Buffalo	
Fish	Lythrurus umbratilis	Redfin Shiner	

Table 9. Priority Species in Aquatic Habitats

Таха	Scientific Name	Common Name
Fish	Moxostoma carinatum	River Redhorse
Fish	Notropis blennius	River Shiner
Fish	Percina phoxocephala	Slenderhead Darter
Fish	Phenacobius mirabilis	Suckermouth Minnow
Fish	Polyodon spathula	Paddlefish
Fish	Umbra limi	Central Mudminnow
Mussels	Cyprogenia stegaria	Fanshell
Mussels	Elliptio crassidens	Elephant-ear
Mussels	Fusconaia subrotunda	Long-solid
Mussels	Lampsilis abrupta	Pink Mucket
Mussels	Obovaria subrotunda	Round Hickorynut
Mussels	Plethobasus cyphyus	Sheepnose

# Table 10. Priority Species in Floodplains, Riparian, Pond, and Wetland Habitats

Таха	Scientific Name	Common Name
Amphibians	Acris blanchardi	Blanchard's Cricket Frog
Amphibians	Ambystoma texanum	Smallmouth Salamander
Amphibians	Ambystoma barbouri	Streamside Salamander
Amphibians	Scaphiopus holbrookii	Eastern Spadefoot
Birds	Ardea herodias	Great Blue Heron
Birds	Butorides virescens	Green Heron
Birds	Geothlypis formosa	Kentucky Warbler
Birds	Haliaeetus leucocephalus	Bald Eagle
Birds	lxobrychus exilis	Least Bittern
Birds	Megaceryle alcyon	Belted Kingfisher
Birds	Parkesia motacilla	Louisiana Waterthrush
Birds	Protonotaria citrea	Prothonotary Warbler
Birds	Rallus limicola	Virginia Rail

Таха	Scientific Name	Common Name
Birds	Riparia riparia	Bank Swallow
Birds	Scolopax minor	American Woodcock
Birds	Spizella pusilla	Field Sparrow
Dragonflies and Damselflies	Dromogomphus spoliatus	Flag-tailed Spinyleg
Dragonflies and Damselflies	Enallagma antennatum	Rainbow Bluet
Dragonflies and Damselflies	Gomphus vastus	Cobra Clubtail
Dragonflies and Damselflies	Neurocordulia molesta	Smoky Shadowdragon
Dragonflies and Damselflies	Neurocordulia obsoleta	Umber Showdragon
Dragonflies and Damselflies	Stylurus notatus	Elusive Clubtail
Dragonflies and Damselflies	Somatochlora linearis	Mocha Emerald
Dragonflies and Damselflies	Sympetrum ambiguum	Blue-faced Meadowhawk
Dragonflies and Damselflies	Telebasis byersi	Duckweed Firetail
Mammals	Lasiurus cinereus	Hoary Bat
Plants	Ampelopsis cordata	Heartleaf Peppervine
Plants	Arundinaria gigantea ssp. gigantea	Giant Cane
Plants	Carex albicans var. emmonsii	Emmons's sedge
Plants	Ceratophyllum echinatum	Spineless Hornwort
Plants	Cicuta bulbifera	Bulb-bearing Water- hemlock
Plants	Enemion biternatum	Eastern False Rue-anemone
Plants	Gratiola viscidula	Short's Hedgehyssop
Plants	Hottonia inflata	Featherfoil
Plants	Ludwigia leptocarpa	River Seedbox
Plants	Rorippa sessiliflora	Southern Yellow Cress
Plants	Spermacoce glabra	Buttonweed
Reptiles	Apalone mutica mutica	Midland Smooth Softshell
Reptiles	Apalone spinifera spinifera	Eastern Spiny Softshell
Reptiles	Graptemys geographica	Northern Map Turtle

Таха	Scientific Name	Common Name	
Snails	Webbhelix multilineata	Striped Whitelip	
Tiger Beetles	Cicindela cuprascens	A Tiger Beetle	
Tiger Beetles	Cicindela cursitans	A Tiger Beetle	
Tiger Beetles	Cicindela formosa generosa	A Tiger Beetle	
Tiger Beetles	Cicindela hirticollis	Beach-dune Tiger Beetle	
Tiger Beetles	Cicindela marginipennis	Cobblestone Tiger Beetle	
Tiger Beetles	Cicindela scutellaris	A Tiger Beetle	

Maps 14 and 15 illustrate riparian and floodplain habitats, and maps 16 and 17 indicate mussel streams (mapped by WVDNR in 2018), exemplary wetlands (as assembled by WVDNR in 2015), and biodiversity. 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. River floodplain habitats occur along the Ohio River and major tributaries, with small stream riparian habitats occurring along numerous smaller streams. Small exemplary wetlands such as the Greenbottom Swamp and Lee Creek Oak Swamp can be found throughout the CFA along the Ohio River. A total of 48 streams within the CFA are designated as State Mussel Streams, including Cow Run, Little Wheeling Creek, and the Ohio River. Aquatic and riparian habitats outside of larger forest patches may be more vulnerable to stresses.

## **Rare Plant Communities**

Table 11 lists rare plant communities may be found in aquatic, floodplain, and riparian habitats in this CFA. Note that many of the rare plant communities within the CFA are ranked imperiled or critically imperiled within the state of West Virginia. These plant communities are vulnerable to disturbance and the spread of nonnative invasive plants. Disturbance should be avoided, and nonnative invasive plant infestations should be treated.

Common Name	<b>Relative Abundance</b>	G Rank	S Rank
Ohio River Silver Maple Floodplain Forest	58%	G4?	S2
Ohio River Oak Swamp	58%	G3G4	S2
Buttonbush Shrub Swamp	56%	G4	S3
Giant Bur-Reed Marsh	53%	G4G5	S2
Lizard's Tail Backwater Slough	22%	G3	S2
Marl Swamp Forest	14%	G4	S1
Giant Cane Woodland	67%	G2?	S1

Table 11. Rare Plant Communities in Aquatic, Floodplain and Riparian Habitats.

S Rank (State Rank) and G Rank (Global Rank) Conservation Status: 1= Critically Imperiled, 2 = Imperiled, 3 = Vulnerable, 4 = Apparently Secure, 5 = Secure, S#S# or G#G# indicates range of uncertainty of conservation status.











Map 16. Mussel Streams, Wetlands, and Biodiversity - North



Map 17. Mussel Streams, Wetlands, and Biodiversity – South

#### Map 18. Impaired Streams and Biodiversity – North







## Habitat Stresses and Conservation Actions

Protecting and restoring streamside riparian buffers is an important conservation action that improves water quality as well as both in-stream and riparian habitat for priority bird, fish, mussel, dragonfly/damselfly, and plant species. Direct stresses to priority species include the use of pesticides in surrounding lands effecting amphibians, disturbance of Great Blue Heron rookeries. Mussels would benefit from management of host fish species, barrier removal and re-introduction of extirpated species.

Maps 18 and 19 show the location of impaired streams, along with biodiversity. Numerous streams suffer from impairments, the most common of which are biological, fecal/bacteria, and iron (WVDEP, 2016). Impaired streams found within the CFA include the Ohio River, the lower Kanawha River, and Wheeling Creek (WVDEP, 2016). Many of these impaired streams host clusters of biodiversity and provide habitat for mussels and other priority species. A list of all impaired streams in the CFA and their causes can be found in appendix 4. Improving water quality in these impaired streams is an important conservation action, especially where priority SGCN are present.

Habitat Stress	Conservation Action
Intensive floodplain development- lack of protected habitats including floodplains, islands, shoals, sandbars, sandy beaches and banks, mussel beds, ephemeral and perennial wetlands, forested backwaters and sloughs, upland stream valley forests, and riparian habitat	Habitat protection and restoration
Water quality degradation (organic and chemical pollutants, sedimentation, run-off, dredging)	Pollution control, improved sewage treatment, storm water management, sediment load reductions, plant and protect riparian buffers
Invasive plants	Monitor and control invasive plants

Table 12. Habitat Stresses and Conservation Actions for Aquatic, Floodplain and Riparian Habitat

Habitat Stress	Conservation Action
	Landowner outreach, recreation and access management
Riparian habitat disturbance- armoring for	Plant, fence, maintain forested riparian corridors
stabilization recreation, road crossings, vehicle access on ephemeral streams, altered	Implement forestry BMPs and Streamside Management Zones, even on ephemeral streams
hydrology, increased runoff and stream temperatures	Control vehicle access on ephemeral streams
	Minimize disturbance
	Restore riparian habitat
	Survey to identify priority species habitat and nesting sites
Habitat disturbance around rare species	Landowner outreach
	Minimize disturbance and protect habitat
	Install nest boxes (Prothonotary Warbler)
Boat wakes and recreation on sandy beaches used by turtles for nesting; trash attracts carnivores and increases predation	Reduce boat wakes, recreation and littering on sandy beaches, conduct trash cleanups
Aquatic passage barriers	Modify or remove barriers
Release of nonnative crayfish and other species used as live bait	Discourage or prohibit use of live bait
River channelization	Restore river-floodplain connections and interaction for aquatic organisms to access key habitat
Sand and gravel dredging	Identify priority species and habitats to avoid and work with dredging companies and regulators on avoidance measures. Survey and salvage mussels
	prior to dredging.
Locks and dams altering flow and blocking aquatic organism passage	Work with dam operators and regulators to optimize flow conditions and passage for priority species

Habitat Stress	Conservation Action
Woody encroachment, small habitat patch size	Consider prescribed burning and conduct trial burn(s)
(giant cane)	on portion of habitat

#### Climate Change and Habitat Resilience

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

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

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

Table 13 provides a summary of climate stresses on aquatic, floodplain and riparian habitat, and actions to boost their resilience (Swanston et al., 2016). While climate stresses are listed separately, aquatic, floodplain and riparian habitats are often impacted by multiple climate stresses occurring simultaneously and actions to boost habitat resilience are intended to address multiple climate stresses. Many of these actions reiterate previously listed conservation actions to reduce stress on priority

species and could have positive outcomes for priority species as well as habitat resilience. WVDNR, land managers, landowners and partners can select the actions best suited to their specific site conditions, management goals and objectives, from the list below or other sources.

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

Table 13. Climate Stresses and Resilience Actions in Aquatic, Floodplain and Riparian Habitat

## Implementation Plan

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

Table 14. Implementation Plan for Aquatic, Floodplain and Riparian Habitats

Action	Partners	Effectiveness Measures
<ul><li>Habitat Protection:</li><li>Conservation Easements</li><li>Land Acquisition</li></ul>	<ul> <li>County Farmland Protection Boards</li> <li>The Nature Conservancy</li> <li>USDA NRCS</li> <li>WV Land Trust</li> <li>WVDNR</li> </ul>	<ul> <li>Acres of aquatic and riparian habitat protected for priority species</li> <li>Abundance and diversity of priority species and habitats</li> </ul>

Action	Partners	Effectiveness Measures
<ul><li>Habitat Protection</li><li>Incentive Programs</li></ul>	• USDA FSA	<ul> <li>Acres of aquatic and riparian habitat protected for priority species</li> <li>Abundance and diversity of priority species and habitats</li> </ul>
<ul><li>Habitat Protection:</li><li>Land Use Planning</li></ul>	<ul> <li>County Planning Commissions</li> </ul>	<ul> <li>Acres of habitat protected through land use planning, floodplain, and stormwater regulations</li> </ul>
In-stream and riparian habitat restoration	<ul> <li>Public Land Managers</li> <li>Trout Unlimited</li> <li>USDA FSA</li> <li>USDA NRCS</li> <li>USFWS Partners for Fish and Wildlife</li> <li>WVDEP</li> </ul>	<ul> <li>Acres or linear feet of instream and riparian habitat restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Planting and fencing stream buffer zones	<ul> <li>Trout Unlimited</li> <li>USDA FSA</li> <li>USDA NRCS</li> <li>USFWS Partners for Fish and Wildlife</li> <li>WVDEP, WVCA and Conservation Districts</li> <li>WVDOF</li> </ul>	<ul> <li>Acres or linear feet of stream buffer zones planted and fenced to protect priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Remove or enlarge aquatic passage barriers	<ul> <li>Trout Unlimited</li> <li>USFWS Partners for Fish and Wildlife</li> <li>WVDEP</li> <li>WVDOH</li> </ul>	<ul> <li># barriers enlarged or removed</li> <li># miles stream opened</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>

Action	Partners	Effectiveness Measures
Improved wastewater and stormwater treatment	<ul> <li>County governments</li> <li>WVDEP</li> <li>WVDHHR</li> </ul>	<ul> <li># wastewater and stormwater systems installed or improved</li> <li>Change in fecal, sediment and other water quality measurements</li> <li>Before and after comparison: abundance &amp; distribution of priority species</li> </ul>
Improve water quality in streams and wetlands	<ul><li>USDA FSA</li><li>USDA NRCS</li><li>WVDEP and WVCA</li></ul>	<ul> <li>Change in water quality measurements</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Monitor and control invasive weeds	<ul> <li>USDA FSA</li> <li>USDA NRCS</li> <li>USFWS Partners for Fish and Wildlife</li> </ul>	<ul> <li>Acres treated</li> <li>Treatment success rate</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Trash clean-ups, especially on sandy beaches	<ul><li>Community groups</li><li>WVDEP</li></ul>	Acres or stream length     treated
Optimize flow conditions through locks and dams for priority species	<ul> <li>Lock and dam operators and regulators</li> </ul>	<ul> <li># species and miles of habitat with improved flow conditions</li> </ul>
Restore river-floodplain connections and interaction	<ul><li>Public Land Managers</li><li>USACE</li></ul>	<ul> <li>Acres or stream length reconnected</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Consider prescribed burning and conduct trial burn(s) to maintain Giant Cane habitat	Public Land Managers	<ul> <li>Acres or stream length treated</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>

Action	Partners	Effectiveness Measures
Public & Landowner Outreach	<ul> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDEP, WVCA and</li></ul>	<ul> <li># Landowners engaged</li> <li># Landowners</li></ul>
and Demonstration	Conservation Districts <li>WVDNR</li> <li>WVDNR, WVDOF</li> <li>WVU Extension</li>	implementing actions

## Human Benefits

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

# Agricultural and Developed Habitats

Agricultural areas are most prominent in the southern portion of the CFA while developed areas are most heavily concentrated around the Huntington, Parkersburg, and Moundsville areas. Many species of wildlife rely on agricultural lands, especially pastures, grasslands and woody vegetation in fallow areas, abandoned fields, field borders, wetlands and wet meadows, and riparian corridors. Some species even rely on habitat in more developed lands in residential and urban areas; this is sometimes because the original habitat is limited or no longer present but are emulated by features in developed areas. Maps 20 and 21 indicate the location of agricultural and developed habitats and illustrates many examples of biodiversity occurrences in and around these areas. Maintaining pastures, fallow fields, woody vegetation, wetlands, and riparian corridors is a priority for SGCN in agricultural habitats.

#### **Priority Species**

Agricultural lands including cultivated crops, pastures, and hayfields, along with adjacent areas of natural vegetation, hedgerows, fallow areas, wetlands and streams provide valuable habitat for several priority grassland bird species in the CFA. Old fields and wet meadows provide habitat for Bronze Copper butterflies. Table 15 provides a list of priority SGCN in the CFA associated with agricultural habitats. Developed areas also provide important habit, most notably for the Chimney Swift.

Таха	Scientific Name	Common Name
Amphibians	Scaphiopus holbrookii	Eastern Spadefoot
Birds	Chaetura pelagica	Chimney Swift
Birds	Falco peregrinus	Peregrine Falcon
Birds	Falco sparverius	American Kestrel
Birds	Scolopax minor	American Woodcock
Birds	Spizella pusilla	Field Sparrow
Birds	Sturnella magna	Eastern Meadowlark
Birds	Tyto alba	Barn Owl
Butterflies and Moths	Lycaena Hyllus	Bronze Copper
Mammals	Microtus ochrogaster	Prairie Vole
Mammals	Reithrodontomys humulis	Eastern Harvest Mouse
Tiger Beetles	Cicindela cursitans	A Tiger Beetle
Tiger Beetles	Cicindela formosa generosa	A Tiger Beetle
Tiger Beetles	Cicindela hirticollis	Beach-dune Tiger Beetle

#### Table 15. Priority Species in Agricultural and Developed Habitats







Map 21. Developed & Agricultural Lands, and Biodiversity – South

## 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 snakes, Barn Owls and other birds of prey. Snakes also suffer from persecution by people, which may be reduced through educational campaigns about their ecological importance. Table 16 lists stresses to wildlife habitat in agricultural areas, and conservation actions to address them.

Habitat Stress	Conservation Action
Conversion to crop agriculture as well as clean	
farming practices: loss of grassland, woody veg.,	Retain or plant shrubs, hedgerows, and hawthorns
pollinator habitat, bird breeding and roosting sites,	in pastures; retain and improve grasslands
fallow fields and wet meadows	
Loss of pollinator habitat	Create and maintain pollinator habitat and nectar resources, including diverse native and non- invasive flowering forbs, shrubs, trees, larval host plants and undisturbed nesting and overwintering areas along field edges, woodlots, water bodies, roads, on fallow fields and other appropriate sites
Wetland loss and degradation in agricultural areas	Protection, restoration and fencing of wetlands
Loss of early successional habitat in and around agricultural land, overgrazing	Retain early successional habitat with healthy grasses and forbs, monitor grazing impacts and prevent overgrazing
Chimney capping, loss of older buildings	Landowner outreach Uncap chimneys, install towers for chimney swifts, retain hollow snags and logs
Rodenticide poisoning: snakes, bald eagle, barn owl	Outreach to landowners to reduce use of second- generation rodenticides
Loss of bird habitat and nesting sites	Landowner outreach and education Install and monitor nest boxes (American Kestrel, Barn Owl)

#### Table 16. Stresses and Actions in Agricultural and Developed Habitats:

## 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 nonnative 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.

Table 17 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 Stress:	Habitat Resilience Action:
<ul> <li>Increased flood frequency and severity, erosion, and sedimentation</li> <li>Increased surface water temperatures, lowflow events, and water quality degradation</li> <li>Increased risk of drought and wildfire</li> <li>Increased competition from nonnative invasive species, pests, and pathogens</li> </ul>	<ul> <li>Maintain soil health and water quality</li> <li>Reduce competition from weeds and invasive species</li> <li>Create pollinator habitat</li> <li>Maintain, restore, and connect aquatic, riparian and forest habitats to buffer against hydrological impacts</li> <li>Adapt farm practices, infrastructure and land uses to changing conditions</li> <li>Reduce and buffer impervious surfaces, and use green infrastructure to absorb runoff and mitigate hydrological impacts</li> </ul>

Table 17. Climate Stresses and Resilience Actions for Agricultural and Developed Habitats

## **Implementation Plan**

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

Table 18. Implementation Plan for Agricultural and Developed Habitats.

Action	Partners	Effectiveness Measures
Habitat Protection: <ul> <li>Conservation Easements</li> </ul>	<ul> <li>County Farmland Protection Boards</li> <li>The Nature Conservancy</li> <li>USDA NRCS</li> <li>WV Land Trust</li> </ul>	<ul> <li>Acres of habitat protected for priority species</li> <li>Abundance and diversity of priority species and habitats</li> </ul>
<ul><li>Habitat Protection</li><li>Incentive Programs</li></ul>	• USDA FSA	<ul> <li>Acres of habitat protected for priority species</li> <li>Abundance and diversity of priority species and habitats</li> </ul>
Reduce clearing of native vegetation; Retain or plant hedgerows and areas with native plants; retain old fields and wet meadows	<ul> <li>USDA NRCS</li> <li>USFWS Partners for Wildlife Program</li> <li>WVDOH</li> </ul>	<ul> <li>Acres or linear feet of native vegetation planted and protected</li> <li>Change in abundance, diversity and distribution of priority species and habitats</li> </ul>

Action	Partners	Effectiveness Measures
Create and maintain pollinator habitat and nectar resources, including diverse native and non-invasive flowering forbs, shrubs, trees, larval host plants and undisturbed nesting and overwintering areas along field edges, woodlots, water bodies, roads, on fallow fields and other appropriate sites.	<ul> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>USFWS Partners for Wildlife Program</li> <li>WVDOH, WVDNR</li> </ul>	<ul> <li>Acres or linear feet of pollinator habitat created or maintained</li> <li>Change in abundance, diversity and distribution of priority species and habitats</li> </ul>
Maintain or restore aquatic, riparian and forest habitat as well as species and structural diversity in natural areas in and around farmland, and enhance connections between them	<ul> <li>Public Land Managers</li> <li>USDA FSA &amp; NRCS</li> </ul>	<ul> <li>Acres of habitat restored for priority species</li> <li>Abundance &amp; distribution of priority species and habitats</li> </ul>
Create early successional habitat	<ul><li>Public Land Managers</li><li>USDA NRCS</li></ul>	<ul> <li>Acres of habitat created</li> <li>Change in abundance, diversity and distribution of priority species and habitats</li> </ul>
Prevent conversion of grasslands to croplands	• USDA FSA	<ul> <li>Acres of grasslands planted and protected</li> <li>Change in abundance, diversity and distribution of priority species and habitats</li> </ul>
Manage utility corridors to reduce wildlife impacts (implement BMPs promoted by the Wildlife Habitat Council, NRCS and other organizations)	<ul> <li>Landowners, partners, and utility companies</li> </ul>	<ul> <li>Acres of habitat restored for priority species</li> <li>Before and after comparison: abundance and diversity of priority species</li> </ul>
Action	Partners	Effectiveness Measures
----------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
Adjust timing and interval of hay harvest	• USDA FSA	<ul> <li>Acres of hay fields under adjusted harvest management</li> <li>Change in abundance, diversity and distribution of priority species and habitats</li> </ul>
USDA NRCS Climate Smart Agricultural Mitigation Activities and Plans to adapt farm practices and infrastructure to changing conditions	<ul> <li>Public Land Managers</li> <li>USDA FSA</li> <li>USDA NRCS</li> </ul>	<ul> <li># practices or acres adapted</li> <li>Change in abundance, diversity, and distribution of priority species</li> </ul>
Outreach to landowners to reduce use of second- generation rodenticides	<ul> <li>Landowners and volunteer groups</li> </ul>	<ul> <li># of landowners engaged</li> <li>Reduction in use of rodenticides</li> <li>Change in abundance, diversity, and distribution of priority species</li> </ul>
Landowner outreach, uncapping chimneys, install swift towers and nest boxes	<ul> <li>Landowners and volunteer groups</li> </ul>	<ul> <li># chimneys uncapped</li> <li># swift towers or nest boxes installed</li> <li>Change in abundance, diversity, and distribution of priority species</li> </ul>
Public & Landowner Outreach and Demonstration	<ul> <li>Public Land Managers</li> <li>USDA NRCS</li> <li>WVDEP, WVCA and Conservation Districts</li> <li>WVDNR</li> <li>WVDNR, WVDOF</li> <li>WVU Extension</li> </ul>	<ul> <li># Landowners engaged</li> <li># Landowners implementing actions</li> </ul>

# Human Benefits

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

# Landscape Resilience and Connectivity

The conservation and resilience actions described previously in this 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. 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).

Maintaining or restoring wildlife populations in a 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 1,000 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. Maps 24 and 25 illustrate areas of high landscape integrity in the CFA. Landscape integrity is estimated to increase with distance from roads, powerlines, development, and other features that fragment the landscape. These high integrity landscapes tend to correspond to larger forest patches and most lie within public lands such as the Chief Cornstalk Wildlife Management Area. There are also landscapes of high integrity in private ownership adjacent to public lands. These areas are important for species movement in response to climate change and are priorities for protection of wildlife habitat.

# Map 24 Landscape Integrity – North



#### Map 25. Landscape Integrity – South



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 devel.

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 <u>http://maps.tnc.org/resilientland/)</u> that identified the following areas:

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

Map 26 is a regional map of resilient and connected landscapes. While the Ohio River Corridor CFA lies outside of the large block of resilient landscapes and flow zones on the eastern side of the state, it does contain small blocks of resilient land which could provide refuge for species adapting to the effects of climate change in the local area. These areas are priorities for protection.



Map 26. Resilient and Connected Landscapes – Regional View



Map 27. Resilient and Connected Landscapes – Detailed View – North



#### Map 28. Resilient and Connected Landscapes – Detailed View – South

Maps 27 and 28 provide a detailed view of the resilient, connected landscapes in the Ohio River Corridor CFA. Resilient patches of land are most abundant in the southern portion of the CFA, with the largest patch surrounding the Chief Cornstalk WMA, a small area of resilient land can also be found in the northern portion of the CFA near the Sand Hill WMA. 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.

Table 19 summarizes conservation actions for climate resilience to address stresses from climate change at a landscape level.

-
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Cli	mate Stress	Conservation Action
•	Changing conditions exacerbating existing stresses on species and habitat Species responding to climate change by shifting locally as well as across the landscape	<ul> <li>Restore, protect and maintain a connected network of resilient landscapes across the landscape for species to adapt and shift locally and regionally in response to climate change</li> </ul>
•	Landscape fragmentation that prevents or constrains species movement	

# **Implementation Plan**

The resilient and connected landscapes in this CFA provide 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 the local scale. The following implementation plan lists specific actions to protect, maintain and restore the network of resilient, connected lands within the CFA.

Table 20.	Implementation	Plan for	Landscape	Resilience a	nd Connectivity

Action	Partners	Effectiveness Measures
<ul> <li>Protection of Resilient,</li> <li>Connected Landscapes</li> <li>Conservation Easements</li> <li>Land Acquisition</li> </ul>	<ul> <li>County Farmland Protection Boards</li> <li>The Nature Conservancy</li> <li>USDA NRCS</li> <li>WV Land Trust</li> <li>WVDNR</li> </ul>	<ul> <li>Acres of habitat protected for priority species in resilient landscapes and climate corridors</li> <li>Abundance &amp; distribution of priority species and habitats</li> </ul>

Action	Partners	Effectiveness Measures
<ul><li>Protection of Resilient,</li><li>Connected Landscapes</li><li>Land use planning</li></ul>	<ul> <li>County Planning Commissions</li> </ul>	<ul> <li>Acres of habitat protected through land use planning in resilient, connected landscapes</li> </ul>
<ul> <li>Protection of Resilient,</li> <li>Connected Landscapes</li> <li>Incentive Programs</li> <li>Forest Carbon projects</li> </ul>	<ul> <li>Consulting Foresters</li> <li>USDA FSA</li> <li>USDA NRCS</li> </ul>	<ul> <li>Acres of habitat protected for priority species in resilient landscapes and climate corridors</li> <li>Abundance &amp; distribution of priority species and habitats</li> </ul>
<ul><li>Protection of Resilient,</li><li>Connected Landscapes</li><li>Restoration, Conservation and Management</li></ul>	<ul> <li>Partner Organizations</li> <li>Private Landowners</li> <li>US Forest Service</li> <li>WV Division of Natural Resources</li> </ul>	<ul> <li>Acres of habitat protected, restored, and maintained in resilient landscapes and climate corridors</li> <li>Abundance &amp; distribution of priority species and habitats</li> </ul>

# Conclusion

# Habitat Conservation Priorities

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

Below is a list of the priority habitats identified by this Action Plan for conservation action within each major habitat type.

- Large, intact forest patches, including interior forest habitat
- Early successional forest habitat
- Small areas of unique, geologically derived habitat including:
  - o Acidic rock outcrops, cliffs and talus
  - o Calcareous cliffs and talus
  - o Karst areas, caves, and their buffer areas and watersheds
- Special aquatic habitats, such as mussel streams
- Small stream riparian and river floodplain habitats, along with associated islands, shoals, sandbars, sandy beaches and banks, ephemeral and perennial wetlands, forested backwaters and sloughs, upland stream valley forests, riparian habitat and forested buffers
- Riparian corridors, wetlands, grasslands and fallow fields, field borders and other areas of natural and woody vegetation within and around agricultural lands

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

# Integration of Conservation Actions

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

# Connecting Conservation Actions for Climate Resilience

As we have seen, conservation actions to relieve stresses on priority species and efforts to boost the resilience of wildlife habitat are essential for enabling climate adaptation. 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 rock outcrops, cliff and talus, and cave habitat buffers enhances the resilience of these habitats and enables forest species to move to optimal sites as conditions change. Conservation of aquatic, riparian and floodplain corridors along with areas of native vegetation in and around agricultural areas, small forest patches and larger blocks of forest habitat can create a local network of resilient, connected lands that merges into the larger regional network. Beyond undertaking conservation actions in the priority habitats listed above, and even beyond protecting the regional network of climate connectors and flow zones, stakeholders are encouraged to restore and protect the connections between these areas in order to maintain an interwoven fabric of natural systems for wildlife within this CFA to thrive long into the future.

# Next Steps in Implementation

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

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

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

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Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Amphibians	Acris blanchardi	Blanchard's Cricket Frog	SH	G5		
Amphibians	Acris crepitans	Northern Cricket Frog	S2	G5	_	
Amphibians	Ambystoma barbouri	Streamside Salamander	S1	G4		
Amphibians	Ambystoma jeffersonianum	Jefferson Salamander	S2	G4		
Amphibians	Ambystoma texanum	Smallmouth Salamander	S1	G5		
Amphibians	Aneides aeneus	Green Salamander	S3	G3G4	—	
Amphibians	Cryptobranchus alleganiensis	Eastern Hellbender	S2	G3G4	—	
Amphibians	Gyrinophilus porphyriticus duryi	Kentucky Spring Salamander	S3	G5T4T5		
Amphibians	Lithobates pipiens (R. pipiens)	Northern Leopard Frog	S1	G5	—	
Amphibians	Necturus maculosus	Mudpuppy	S4	G5	—	
Amphibians	Plethodon kentucki	Cumberland Plateau	S3	G4		
		Salamander				
Amphibians	Plethodon wehrlei	Wehrle's Salamander	S4	G4		
Amphibians	Pseudotriton montanus diastictus	Midland Mud Salamander	S1	G5T5		
Amphibians	Pseudotriton ruber ruber	(northern) Red Salamander	S3	G5		
Amphibians	Scaphiopus holbrookii	Eastern Spadefoot	S1	G5	—	
Birds	Actitis macularius	Spotted Sandpiper	S2B	G5		
Birds	Ammodramus henslowii	Henslow's Sparrow	S1B	G4	_	
Birds	Ammodramus savannarum	Grasshopper Sparrow	S3B	G5	R	
Birds	Antrostomus carolinensis	Chuck-will's-widow	S1B	G5		
Birds	Antrostomus vociferus	Eastern Whip-poor-will	S3B	G5		At Risk-
						Cons
Birds	Ardea herodias	Great Blue Heron	S3B,S4N	G5		
Birds	Botaurus lentiginosus	American Bittern	S1B,S1N	G4	R	
Birds	Buteo platypterus	Broad-winged Hawk	S3B	G5		
Birds	Butorides virescens	Green Heron	S3B	G5		
Birds	Catharus fuscescens	Veery	S3B	G5		

# Appendix 1. SGCN in the Ohio River Corridor CFA

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Birds	Chaetura pelagica	Chimney Swift	S3B	G5	—	
Birds	Chordeiles minor	Common Nighthawk	S2B	G5	R	
Birds	Circus cyaneus	Northern Harrier	S1B,S3N	G5	—	
Birds	Coccyzus erythropthalmus	Black-billed Cuckoo	S2B	G5	—	
Birds	Colinus virginianus	Northern Bobwhite	S1B, S1N	G5	—	
Birds	Dolichonyx oryzivorus	Bobolink	S3B	G5	R	
Birds	Eremophila alpestris	Horned Lark	S2B,S3N	G5		
Birds	Falco peregrinus	Peregrine Falcon	S2B,S2N	G4	—	
Birds	Falco sparverius	American Kestrel	S3B	G5	—	
Birds	Geothlypis formosa	Kentucky Warbler	S3B	G5	R	
Birds	Haliaeetus leucocephalus	Bald Eagle	S3B,S3N	G5		
Birds	Helmitheros vermivorum	Worm-eating Warbler	S3B	G5	R	
Birds	Hylocichla mustelina	Wood Thrush	S3B	G5	R	At Risk-
						Cons
Birds	Icteria virens	Yellow-breasted Chat	S3B	G5		
Birds	Ixobrychus exilis	Least Bittern	S1B	G5	R	
Birds	Limnothlypis swainsonii	Swainson's Warbler	S3B	G4	—	
Birds	Parkesia motacilla	Louisiana Waterthrush	S3B	G5		
Birds	Petrochelidon pyrrhonota	Cliff Swallow	S3B	G5		
Birds	Piranga rubra	Summer Tanager	S3B	G5	—	
Birds	Podilymbus podiceps	Pied-billed Grebe	S2B,S4N	G5		
Birds	Porzana carolina	Sora	S1B,S1N	G5	—	
Birds	Protonotaria citrea	Prothonotary Warbler	S2B	G5		
Birds	Rallus limicola	Virginia Rail	S1B,S1N	G5		
Birds	Riparia riparia	Bank Swallow	S2B	G5	R	
Birds	Scolopax minor	American Woodcock	S3B	G5	R	
Birds	Setophaga cerulea	Cerulean Warbler	S2B	G4	—	At Risk- Cons
Birds	Setophaga discolor	Prairie Warbler	S3B	G5	R	

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Birds	Spiza americana	Dickcissel	S1B	G5	_	
Birds	Spizella pusilla	Field Sparrow	S3B	G5	R	
Birds	Sturnella magna	Eastern Meadowlark	S3B, S2N	G5	R	
Birds	Tyto alba	Barn Owl	S2B,S2N	G5	—	
Birds	Vermivora cyanoptera	Blue-winged Warbler	S3B	G5		
Butterflies & Moths	Calycopis cecrops	Red-banded Hairstreak	S3	G5		
Butterflies & Moths	Cyllopsis gemma	Gemmed Satyr	S3	G4G5		
Butterflies & Moths	Glaucopsyche I. lygdamus	Silvery Blue	S4	G5T3T4		
Butterflies & Moths	Lycaena hyllus	Bronze Copper	S2	G5		
Butterflies & Moths	Parrhasius m-album	White-m Hairstreak	S2	G5		
Butterflies & Moths	Speyeria idalia	Regal Fritillary	SH	G3		
Butterflies & Moths	Staphylus hayhurstii	Hayhurst's Scallopwing	S1	G5		
Crayfish	Cambarus theepiensis	Coalfields Crayfish	S3	GNR		
Crayfish	Dubius A	Teays Burrowing Crayfish	S2	GNR		
Crayfish	Fallicambarus fodiens	A Crayfish (digger)	S1	G5		
Dragonflies and	Cordulegaster obliqua	Arrowhead Spiketail	S2	G4		
Damselflies						
Dragonflies and	Dromogomphus spoliatus	Flag-tailed Spinyleg	SH	G4G5		
Damselflies						
Dragonflies and	Enallagma antennatum	Rainbow Bluet	S1S2	G5		
Damselflies	restance based			65		
Dragonflies and	Epiaeschna heros	Swamp Darner	53	G5		
Dragonflies and	Comphus quadricolor	Rapids Clubtail	<u> </u>	6364		
Damselflies			55	0304		
Dragonflies and	Gomphus vastus	Cobra Clubtail	S2	G5		
Damselflies						
Dragonflies and	Macromia alleghaniensis	Allegheny River Cruiser	S2S3	G4		
Damselflies						
Dragonflies and	Macromia illinoiensis	Illinois River Cruiser	S3	G5		

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Damselflies						
Dragonflies and	Macromia taeniolata	Royal River Cruiser	S3	G5		
Damselflies						
Dragonflies and	Neurocordulia molesta	Smoky Shadowdragon	S2	G4		
Damselflies						
Dragonflies and	Neurocordulia obsoleta	Umber Showdragon	S1	G5		
Damselflies						
Dragonflies and	Somatochlora linearis	Mocha Emerald	\$3	G5		
Damselflies	Studurus pototus		6160	<u> </u>		
Dragonnies and	Stylurus notatus		5152	63		
Dragonflies and	Sympetrum ambiguum	Blue-faced Meadowbawk	<u>\$1</u>	65		
Damselflies			51	05		
Dragonflies and	Telebasis byersi	Duckweed Firetail	S1	G5		
Damselflies						
Fish	Ameiurus melas	Black Bullhead	S1	G5	—	
Fish	Ameiurus nebulosus	Brown Bullhead	S2	G5		
Fish	Ammocrypta pellucida	Eastern Sand Darter	S3	G3	—	
Fish	Anguilla rostrata	American Eel	S2	G4	R	
Fish	Carpiodes carpio	River Carpsucker	S3	G5		
Fish	Carpiodes velifer	Highfin Carpsucker	S1	G4G5		
Fish	Chrosomus erythrogaster	Southern Redbelly Dace	S2S3	G5		
Fish	Clinostomus elongatus	Redside Dace	S1S2	G3G4		
Fish	Cycleptus elongatus	Blue Sucker	S1	G3G4		
Fish	Erimystax x-punctatus	Gravel Chub	S1	G4		
Fish	Esox americanus vermiculatus	Grass Pickerel	S1S2	G5T5		
Fish	Fundulus diaphanus	Banded Killifish	S2	G5		
Fish	Hiodon alosoides	Goldeye	S1	G5		
Fish	Ichthyomyzon bdellium	Ohio Lamprey	S2S3	G3G4	—	
Fish	Ichthyomyzon greeleyi	Mountain Brook Lamprey	S1	G3G4	—	

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Fish	Ichthyomyzon unicuspis	Silver Lamprey	S2S3	G5		
Fish	Ictiobus cyprinellus	Bigmouth Buffalo	S1	G5		
Fish	Ictiobus niger	Black Buffalo	S2	G5		
Fish	Lepomis gulosus	Warmouth	S1	G5		
Fish	Lepomis humilis	Orangespotted Sunfish	S1	G5		
Fish	Lythrurus umbratilis	Redfin Shiner	S3	G5		
Fish	Macrhybopsis hyostoma	Shoal Chub	S2	G5		
Fish	Macrhybopsis storeriana	Silver Chub	S3	G5		
Fish	Moxostoma carinatum	River Redhorse	S3	G4		
Fish	Notropis blennius	River Shiner	S2	G5		
Fish	Percina copelandi	Channel Darter	S2S3	G4		
Fish	Percina phoxocephala	Slenderhead Darter	S1	G5		
Fish	Percina sciera	Dusky Darter	S3	G5		
Fish	Percina shumardi	River Darter	S1	G5		
Fish	Phenacobius mirabilis	Suckermouth Minnow	S3	G5		
Fish	Pimephales vigilax	Bullhead Minnow	S2	G5		
Fish	Polyodon spathula	Paddlefish	S1	G4		
Fish	Umbra limi	Central Mudminnow	S1	G5		
Mammals	Cryptotis parva	Least Shrew	S2	G5		
Mammals	Lasionycteris noctivagans	Silver-haired Bat	S2	G5		
Mammals	Lasiurus borealis	Eastern Red Bat	S4	G5	R	
Mammals	Lasiurus cinereus	Hoary Bat	S3	G5	—	
Mammals	Microtus ochrogaster	Prairie Vole	S3	G5		
Mammals	Myotis leibii	Eastern Small-footed Bat	S1	G3	—	
Mammals	Myotis lucifugus	Little Brown Myotis	S2*	G3	R	
Mammals	Myotis septentrionalis	Northern Myotis	S2*	G2G3	Т	
Mammals	Ochrotomys nuttalli	Golden Mouse	S2	G5		
Mammals	Reithrodontomys humulis	Eastern Harvest Mouse	SH	G5		
Mammals	Synaptomys cooperi	Southern Bog Lemming	S3	G5		

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Mammals	Zapus hudsonius	Meadow Jumping Mouse	S3	G5		
Mussels	Actinonaias ligamentina	Mucket	S3	G5		
Mussels	Alasmidonta marginata	Elktoe	S1	G4	—	
Mussels	Amblema plicata	Threeridge	S3	G5		
Mussels	Anodontoides ferussacianus	Cylindrical Papershell	S2	G5		
Mussels	Cyclonaias tuberculata	Purple Wartyback	S1	G5		
Mussels	Cyprogenia stegaria	Fanshell	S1	G1Q	E	
Mussels	Ellipsaria lineolata	Butterfly	S2	G4		
Mussels	Elliptio crassidens	Elephant-ear	S2	G5		
Mussels	Elliptio dilatata	Spike	S3	G5		
Mussels	Epioblasma torulosa rangiana	Northern Riffleshell	S1	G2T2	E	
Mussels	Epioblasma triquetra	Snuffbox	S2	G3	E	
Mussels	Fusconaia ebena	Ebonyshell	S3	G4G5		
Mussels	Fusconaia flava	Wabash Pigtoe	S1	G5		
Mussels	Fusconaia subrotunda	Long-solid	S3	G3		At Risk-
						Cons
Mussels	Lampsilis abrupta	Pink Mucket	S1	G2	E	
Mussels	Lampsilis cardium	Plain Pocketbook	S3	G5		
Mussels	Lampsilis fasciola	Wavy-rayed Lampmussel	S3	G5		
Mussels	Lampsilis ovata	Pocketbook	S3	G5		
Mussels	Lampsilis teres	Yellow Sandshell	S1	G5		
Mussels	Lasmigona complanata	White Heelsplitter	S3	G5		
Mussels	Lasmigona compressa	Creek Heelsplitter	S1	G5		
Mussels	Lasmigona costata	Fluted-shell	S3	G5		
Mussels	Leptodea fragilis	Fragile Papershell	S3	G5		
Mussels	Ligumia recta	Black Sandshell	S3	G5	—	
Mussels	Megalonaias nervosa	Washboard	S2	G5		
Mussels	Obliquaria reflexa	Threehorn Wartyback	S3	G5		
Mussels	Obovaria olivaria	Hickorynut	S1	G4		

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Mussels	Obovaria subrotunda	Round Hickorynut	S3	G4		
Mussels	Plethobasus cyphyus	Sheepnose	S2	G3	E	
Mussels	Pleurobema clava	Clubshell	S1	G2	E	
Mussels	Pleurobema cordatum	Ohio Pigtoe	S2	G4		
Mussels	Pleurobema sintoxia	Round Pigtoe	S2	G4G5		
Mussels	Ptychobranchus fasciolaris	Kidneyshell	S3	G4G5		
Mussels	Pyganodon grandis	Giant Floater	S3	G5		
Mussels	Quadrula cylindrica	Rabbitsfoot	SX	G3G4		
Mussels	Quadrula metanevra	Monkeyface	S2	G4		
Mussels	Quadrula nodulata	Wartyback	S1	G4		
Mussels	Quadrula quadrula	Mapleleaf	S3	G5		
Mussels	Simpsonaias ambigua	Salamander Mussel	S2	G3		
Mussels	Strophitus undulatus	Squawfoot	S3	G5		
Mussels	Toxolasma parvus	Lilliput	S2	G5		
Mussels	Tritogonia verrucosa	Pistolgrip	S3	G4G5		
Mussels	Truncilla donaciformis	Fawnsfoot	S1	G5		
Mussels	Truncilla truncata	Deertoe	S2	G5		
Mussels	Uniomerus tetralasmus	Pondhorn	S1	G5		
Mussels	Utterbackia imbecillis	Paper Pondshell	S2	G5		
Mussels	Villosa iris	Rainbow	S2	G5Q		
Plants	Ageratina aromatica var. aromatica	Small White Snakeroot	S1	G5T5		
Plants	Amorpha fruticosa	Tall Indigobush	S2S3	G5		
Plants	Ampelopsis cordata	Heartleaf Peppervine	S1	G5		
Plants	Anemone canadensis	Roundleaf Thimbleweed	S1	G5		
Plants	Arabis hirsuta ssp. pycnocarpa	Hairy Rockcress	S2	G5T5		
Plants	Arabis shortii	Short's Rockcress	S1	G5		
Plants	Arundinaria gigantea ssp. gigantea	Giant Cane	S2	G5T5?		
Plants	Asclepias hirtella	Green Milkweed	S2	G5		
Plants	Carex albicans var. emmonsii	Emmons's sedge	S1	G5T5		

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Plants	Carex bromoides ssp. bromoides	Brome-like Sedge	S3	G5T5		
Plants	Carex planispicata	Flat-spiked Sedge	S2	G4Q		
Plants	Carex seorsa	Weak Stellate Sedge	S2	G4		
Plants	Carex tuckermanii	Tuckerman's Sedge	S1	G4		
Plants	Carex typhina	Cattail Sedge	S2	G5		
Plants	Ceratophyllum echinatum	Spineless Hornwort	S1	G4?		
Plants	Chamaesyce vermiculata	Hairy Spurge	S2	G5		
Plants	Cicuta bulbifera	Bulb-bearing Water-hemlock	S1	G5		
Plants	Corallorhiza wisteriana	Wister's Coralroot, Spring	S2	G5		
		Coralroot				
Plants	Croton glandulosus var.	Vente-conmigo	S3	G5T5		
	septentrionalis					
Plants	Cuscuta indecora var. neuropetala	Dodder	S1	G5T5		
Plants	Cyperus refractus	Reflexed Flatsedge	S3	G5		
Plants	Cyperus squarrosus	Awned Flatsedge	S3	G5		
Plants	Dasistoma macrophylla	Mullein Foxglove	S2	G4		
Plants	Decodon verticillatus	Swamp-loosestrife	S1	G5		
Plants	Eleocharis elliptica	Elliptic Spikerush	S1	G5		
Plants	Eleocharis palustris	Marsh Spikerush	S3	G5		
Plants	Elodea nuttallii	Western Waterweed	S3	G5		
Plants	Elymus trachycaulus ssp.	Slender Wild Rye	S2	G5T5		
	trachycaulus					
Plants	Enemion biternatum	Eastern False Rue-anemone	S1	G5		
Plants	Fraxinus quadrangulata	Blue Ash	S1	G5		
Plants	Galactia volubilis	Downy Milkpea	S2	G5		
Plants	Gratiola viscidula	Short's Hedgehyssop	S1	G4G5		
Plants	Hasteola suaveolens	False Indian-plantain	S3	G4		
Plants	Heteranthera reniformis	Kidneyleaf Mud-plantain	S1	G5		
Plants	Hexalectris spicata var. spicata	Spiked Crested Coralroot	S1	G5T4T5		

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Plants	Hibiscus laevis	Halberd-leaf Rosemallow	S2	G5		
Plants	Hottonia inflata	Featherfoil	S1	G4		
Plants	Juglans cinerea	Butternut	S3	G4		
Plants	Juncus biflorus	Bog Rush	S2	G5		
Plants	Juncus filiformis	Thread Rush	S2	G5		
Plants	Lemna valdiviana	Pale Duckweed	S3	G5		
Plants	Lindernia dubia var. anagallidea	Yellowseed False Pimpernel	S2	G5T4		
Plants	Ludwigia leptocarpa	River Seedbox	S2	G5		
Plants	Lysimachia hybrida	Lowland Loosestrife	S1	G5		
Plants	Lythrum alatum var. alatum	Winged Loosestrife	S2	G5T5		
Plants	Manfreda virginica	Eastern Agave	S1	G5		
Plants	Matteuccia struthiopteris	Ostrich Fern	S2	G5		
Plants	Myosotis macrosperma	Large-seed Forget-me-not	S3	G5		
Plants	Oenothera pilosella ssp. pilosella	Meadow Sundrops	S2	G5T5?		
Plants	Paspalum pubiflorum	Hairy-seed Crowngrass	S1	G5		
Plants	Peltandra virginica	Green Arrow-arum	S2	G5		
Plants	Platanthera psycodes	Lesser Purple Fringed Orchid	S1	G5		
Plants	Potamogeton illinoensis	Illinois Pondweed	S2	G5		
Plants	Quercus shumardii	Shumard Oak	S2	G5		
Plants	Ranunculus pensylvanicus	Bristly Crowfoot	S1	G5		
Plants	Ranunculus pusillus var. pusillus	Low Spearwort	S1	G5T4?		
Plants	Ranunculus sceleratus var.	Cursed Crowfoot	S2	G5T5		
	sceleratus					
Plants	Ribes missouriense	Missouri Gooseberry	S1	G5		
Plants	Rorippa sessiliflora	Southern Yellow Cress	S1	G5		
Plants	Schoenoplectus purshianus	Clubrush, Bulrush	S3	G4G5		
Plants	Scutellaria saxatilis	Rock Skullcap	S2	G3		
Plants	Sida hermaphrodita	Virginia Mallow	S3	G3		
Plants	Silene nivea	Snowy Catchfly	S1	G4?		

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Plants	Sparganium androcladum	Branched Bur-reed	S2S3	G4G5		
Plants	Spermacoce glabra	Buttonweed	S1	G4G5		
Plants	Stachys tenuifolia	Smooth Hedge-nettle	S3	G5		
Plants	Synandra hispidula	Guyandotte Beauty	S1	G4		
Plants	Toxicodendron vernix	Poison-sumac	S2	G5		
Plants	Triadenum tubulosum	Lesser Marsh-st. John's-wort	S1	G4?		
Plants	Trillium flexipes	Nodding Wakerobin	S2	G5		
Plants	Trillium nivale	Snowy Trillium	S2	G4		
Plants	Utricularia gibba	Humped Bladderwort	S2	G5		
Plants	Viola tripartita	Three-parted Yellow Violet	S1	G5		
Plants	Vitis rupestris	Sand Grape	S2	G3		
Plants	Wolffia columbiana	Columbian Watermeal	S1	G5		
Plants	Xyris torta	Slender Yellow-eyed-grass	S2	G5		
Reptiles	Agkistrodon contortrix mokasen	Northern Copperhead	S5	G5T5		
Reptiles	Apalone mutica mutica	Midland Smooth Softshell	S1	G5T5		
Reptiles	Apalone spinifera spinifera	Eastern Spiny Softshell	S4	G5T5		
Reptiles	Carphophis amoenus	Wormsnake	S3	G5		
Reptiles	Coluber constrictor constrictor	Northern Black Racer	SNR	G5T5		
Reptiles	Graptemys geographica	Northern Map Turtle	S1	G5	-	
Reptiles	Heterodon platirhinos	Eastern Hog-nosed Snake	S2	G5	R	
Reptiles	Lampropeltis getula	Eastern Kingsnake	S2	G5		
Reptiles	Liochlorophis vernalis	Smooth Greensnake	S5	G5	-	
Reptiles	Opheodrys aestivus	Rough Greensnake	S2	G5		
Reptiles	Plestiodon laticeps	Broad-headed Skink	S2	G5	—	
Reptiles	Pseudemys concinna	River Cooter	S2	G5		
Reptiles	Regina septemvittata	Queen Snake	S4	G5		
Reptiles	Scincella lateralis	Little Brown Skink	S2	G5		
Reptiles	Terrapene carolina carolina	Eastern Box Turtle	S5	G5T5	R	
Reptiles	Thamnophis sauritus	Eastern Ribbonsnake	S2	G5	_	

Таха	Scientific Name	Common Name	S Rank	G Rank	Federal	USFWS
					Status	at Risk
Reptiles	Virginia valeriae valeriae	Eastern Earthsnake	S2	G5T5		
Snails	Gastrodonta interna	Brown Bellytooth	S3	G5		
Snails	Mesodon mitchellianus	Sealed Globelet	S3	G4		
Snails	Punctum smithi	Lamellate Spot	S2	G4		
Snails	Punctum vitreum	Glass Spot	S2	G5		
Snails	Ventridens arcellus	Golden Dome	S3	G4		
Snails	Vertigo milium	Blade Vertigo	S2	G5		
Snails	Vertigo milium	Blade Vertigo	S2	G5		
Snails	Webbhelix multilineata	Striped Whitelip	S1	G5		
Tiger Beetles	Cicindela cuprascens	A Tiger Beetle	S1	G5		
Tiger Beetles	Cicindela cursitans	A Tiger Beetle	S1	G4		
Tiger Beetles	Cicindela formosa generosa	A Tiger Beetle	S1	G5T4		
Tiger Beetles	Cicindela hirticollis	Beach-dune Tiger Beetle	S1	G5		
Tiger Beetles	Cicindela marginipennis	Cobblestone Tiger Beetle	S1	G2	—	
Tiger Beetles	Cicindela scutellaris	A Tiger Beetle	S1	G5		
Tiger Beetles	Tetracha virginica	Virginia Big-headed Tiger Beetle	S3	G5		

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

Federal Status: R = Rare, T= Threatened, E = Endangered.

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

Agricultural and Developed Habitats				
Common Name	Local Stress	Action		
A Tiger Beetle	Habitat loss	<ul> <li>Data collection efforts.</li> <li>Invasive species removal in open, grassland habitats</li> </ul>		
A Tiger Beetle	Habitat loss	<ul> <li>Restore and maintain sand dunes and pits away from water.</li> <li>Citizen science survey efforts</li> </ul>		
American Kestrel	<ul><li>Insufficient nest microhabitat.</li><li>Residential development</li></ul>	<ul> <li>Nest box installation and monitoring</li> </ul>		
American Woodcock	<ul><li>Insufficient habitat.</li><li>Residential development</li></ul>	<ul><li>Reduce clean farming practices.</li><li>Create early successional habitat</li></ul>		
Barn Owl	<ul><li>Insufficient nest microhabitat.</li><li>Rodenticide poisoning.</li><li>Collision mortality</li></ul>	<ul> <li>Install and monitor nest boxes.</li> <li>Educate landowners regarding rodenticides</li> </ul>		
Beach-dune Tiger Beetle	<ul><li>Habitat loss.</li><li>Flooding.</li><li>Impoundments</li></ul>	<ul><li>Restore and maintain sandbars.</li><li>Riparian corridor BMPs</li></ul>		
Bronze Copper	<ul><li>Development.</li><li>Agricultural intensification.</li><li>Wetland loss</li></ul>	<ul> <li>Conservation and enhancement of open areas for pollinators</li> </ul>		
Chimney Swift	<ul><li>Chimney capping.</li><li>Turnover of older structures</li></ul>	<ul> <li>Landowner outreach and education.</li> <li>Protect known significant migration roosts.</li> <li>Uncap chimneys. Install swift towers</li> </ul>		

# Appendix 2. Priority SGCN, Known Stresses and Actions

Agricultural and Developed Habitats				
Common Name	Local Stress	Action		
Eastern Black Kingsnake	<ul> <li>Persecution.</li> <li>Use of rodenticide.</li> <li>Habitat destruction</li> </ul>	<ul> <li>Reduce the use of rodenticides.</li> <li>Educate landowners about snake ecology and importance of snakes to reduce direct mortality and indirect effects (killing other snakes which reduces prey).</li> <li>Follow mowing BMPs</li> </ul>		
Eastern Harvest Mouse	Agriculture, natural succession	<ul> <li>Create early successional habitat where historically found.</li> <li>IVMPs on ROWs to create dispersal corridors.</li> <li>Assess current distribution status</li> </ul>		
Eastern Meadowlark	<ul> <li>Clean farming practices.</li> <li>Nest failure from incompatible haying practices.</li> <li>Residential development</li> </ul>	<ul> <li>Adjust timing of hay harvest. Reduce conversion of grasslands to croplands.</li> <li>Conservation easements</li> </ul>		
Eastern Spadefoot	<ul> <li>Habitat destruction from residential and industrial development.</li> <li>Habitat alteration and changes in water chemistry.</li> <li>Collection</li> </ul>	<ul> <li>Identify and protect currently occupied habitat.</li> <li>Minimize soil disturbance.</li> <li>Reduce recreational use (ORVs, hiking, etc.)</li> </ul>		
Field Sparrow	<ul><li>Insufficient habitat.</li><li>Clean farming practices.</li><li>Residential development</li></ul>	<ul> <li>Retain or plant shrubs in field and hedgerows.</li> <li>Create early successional habitat</li> </ul>		
Peregrine Falcon	<ul><li>Disturbance at nest sites.</li><li>Collision risk</li></ul>	Engage with property managers to minimize nest disturbance		
Prairie Vole	• Agriculture, mowing	<ul> <li>Restore/maintain grasslands where historically found.</li> <li>Integrated Vegetation Management Plans on right of ways to create dispersal corridors.</li> <li>Assess current distribution status</li> </ul>		

Forest and Woodland Habitats				
Common Name	Local Stress	Action		
Bald Eagle	Lead poisoning	• Encourage usage of non-lead shot		
Blue Ash	Emerald ash borer	Resurvey known stands to assess status.		
Blue-winged Warbler	<ul><li>Insufficient habitat.</li><li>Residential development</li></ul>	<ul> <li>Reduce clean farming practices.</li> <li>Create early successional habitat</li> </ul>		
Bronze Copper	<ul><li>Development.</li><li>Agricultural intensification.</li><li>Wetland loss</li></ul>	<ul> <li>Conservation and enhancement of open areas for pollinators</li> </ul>		
Cerulean Warbler	Poor forest structure	Manage forests to create suitable     habitat as per CERW guidelines		
Eastern False Rue- anemone	<ul><li>Land development.</li><li>Timber harvest</li></ul>	<ul> <li>Protect known occurrence with conservation agreement.</li> <li>Conduct field surveys to locate additional populations.</li> </ul>		
Eastern Whip-poor- will	<ul> <li>Road/collision mortality.</li> <li>Incompatible forest structure.</li> <li>Possible declines in high quality prey</li> </ul>	<ul> <li>Identify high density areas and install highway signage.</li> <li>Manage forests for interior gaps and edges.</li> <li>Long-term monitoring of insect populations</li> </ul>		
Hoary Bat	• Urbanization, habitat degradation	<ul> <li>Documentation of wintering and breeding loctions/habitats along with migratory routes.</li> <li>BMPs that allow for maintenance of large roosting trees and small openings within forested stands</li> </ul>		
Kentucky Warbler	<ul><li>Deer overherbivory.</li><li>Incompatible forest structure</li></ul>	<ul> <li>Reduce deer population.</li> <li>Manage forests for structural and spatial complexity</li> </ul>		

Forest and Woodland Habitats				
Common Name	Local Stress	Action		
Nodding Wakerobin	Unknown status	• Field survey to determine species distribution and threats.		
Prairie Warbler	<ul> <li>Forest maturation.</li> <li>Herbicide use/veg mgmt in utility corridors</li> </ul>	<ul> <li>Manage forests to create early successional habitat.</li> <li>Manage utility corridors to maintain compatible habitat</li> </ul>		
Striped Whitelip	<ul><li>Habitat loss.</li><li>Sustained high water events</li></ul>	Maintain/restore forested river islands and floodplains		
Summer Tanager	Habitat loss and degradation	<ul> <li>Manage forests for interior gaps and edges</li> </ul>		
Wood Thrush	<ul><li>Deer overherbivory.</li><li>Incompatible forest structure.</li><li>Residential development</li></ul>	<ul> <li>Reduce deer population.</li> <li>Manage forests for structural and spatial complexity</li> </ul>		
Worm-eating Warbler	<ul><li>Deer overherbivory.</li><li>Incompatible forest structure.</li><li>Residential development</li></ul>	<ul> <li>Reduce deer population.</li> <li>Manage forests for structural and spatial complexity</li> </ul>		
Yellow-breasted Chat	<ul> <li>Forest maturation.</li> <li>Herbicide use/veg mgmt in utility corridors</li> </ul>	<ul> <li>Manage forests to create early successional habitat.</li> <li>Manage utility corridors to maintain compatible habitat</li> </ul>		

	Aquatic Habitats	
Common Name	Local Stress	Action
A Crayfish (digger)	<ul> <li>Habitat loss/degradation.</li> <li>Groundwater contamination.</li> <li>Invasive/introduced crayfish</li> </ul>	<ul> <li>Bait regulations to limit spread of exotic crayfish.</li> <li>Reduce non-point source pollution.</li> <li>Conservation and management on WMA</li> </ul>
American Eel	Stream passage barriers	Install Eel ladders
Bigmouth Buffalo	<ul><li>River channelization.</li><li>Disconnection of river and floodplain</li></ul>	Riparian restoration
Black Buffalo	<ul> <li>Hybridization with Smallmouth Buffalo.</li> <li>River channelization.</li> <li>Disconnection of river and floodplain</li> </ul>	Riparian restoration
Blue Sucker	<ul> <li>Increased sedimentation.</li> <li>River channelization.</li> <li>Point &amp; nonpoint-source pollution</li> </ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>
Central Mudminnow	<ul> <li>River channelization.</li> <li>Disconnection of river &amp; floodplain.</li> <li>Alterations to wetland/sloth habitats</li> </ul>	<ul> <li>Promote river floodplain interactions.</li> <li>Protect wetland/sloth habitats</li> </ul>
Eastern Sand Darter	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>
Elephant-ear	<ul><li>Habitat loss.</li><li>Loss of host fish</li></ul>	<ul><li>Conservation of known beds.</li><li>Manage host fish species</li></ul>
Fanshell	Extirpated	Potential for future restoration
Grass Pickerel	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Protect wetland and embayment habitats</li> </ul>

	Aquatic Habitats				
Common Name	Local Stress	Action			
Gravel Chub	<ul> <li>Increased sedimentation.</li> <li>River channelization.</li> <li>Point &amp; nonpoint-source pollution</li> </ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>			
Highfin Carpsucker	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Create and/or preserve island and shoal habitats</li> </ul>			
Long-solid	Loss of host Fish interaction	<ul><li>Manage host fish species.</li><li>Potential innoculated release</li></ul>			
Mountain Brook Lamprey	<ul><li>Increased sedimentation.</li><li>Stream passage barriers</li></ul>	<ul> <li>Increase stream connectedness and riparian area restoration</li> </ul>			
Ohio Lamprey	<ul><li> River channelization.</li><li> Increased sedimentation</li></ul>	Promote river habiat compexity			
Paddlefish	<ul> <li>Increased sedimentation.</li> <li>River channelization.</li> <li>Point &amp; nonpoint-source pollution</li> </ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats.</li> <li>Promote river/stream passage.</li> <li>Promote river/flood plain interactions</li> </ul>			
Pink Mucket	<ul><li>Hydroelectric dam.</li><li>Water quality</li></ul>	<ul> <li>Sediment control and water quality improvement</li> </ul>			
Redfin Shiner	<ul><li>Increased sedimentation.</li><li>Increased stream temperatures</li></ul>	Riparian restoration			
Redside Dace	<ul> <li>Increasing stream temperatures.</li> <li>Increased stream sedimentation</li> </ul>	<ul> <li>Restore riparian areas.</li> <li>Mitigate causes of sedimentation.</li> <li>BMPs by resource extraction companies</li> </ul>			
River Redhorse	<ul><li>River channelization.</li><li>Disconnection of river and floodplain</li></ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>			
River Shiner	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>			
Round Hickorynut	Sedimentation and in-stream work	Erosion controls			

Aquatic Habitats				
Common Name	Local Stress	Action		
Sheepnose	Extirpated	Potential for future restoration		
Slenderhead Darter	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>		
Streamside Salamander	<ul> <li>Water quality.</li> <li>ORVs.</li> <li>Reduced precipitation</li> </ul>	<ul> <li>Implement forestry BMPs and Streamside Management Zone standards at ephemeral streams.</li> <li>Reduce pesticide use and other impacts to water quality.</li> <li>Reduce use of motorized vehicles in ephemeral stream beds.</li> </ul>		
Suckermouth Minnow	<ul><li>Increased sedimentation.</li><li>Increased stream temperatures</li></ul>	Riparian restoration		
Tippecanoe Darter	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>		
Western Sand Darter	<ul><li>Increased sedimentation.</li><li>River channelization.</li><li>Point &amp; nonpoint-source pollution</li></ul>	<ul> <li>Create and/or preserve island, shoal, and sandbar habitats</li> </ul>		

Floodplain, Riparian, Pond and Wetland Habitats			
Common Name	Local Stress	Action	
A Tiger Beetle	<ul><li>Habitat loss.</li><li>Flooding.</li><li>Impoundments</li></ul>	<ul> <li>Riparian corridor BMPs.</li> <li>Invasive species removal at shorelines.</li> <li>Citizen science surveys</li> </ul>	
A Tiger Beetle	Habitat loss	<ul> <li>Data collection efforts.</li> <li>Invasive species removal in open, grassland habitats</li> </ul>	
A Tiger Beetle	Habitat loss	<ul> <li>Restore and maintain sand dunes and pits away from water.</li> <li>Citizen science survey efforts</li> </ul>	
American Woodcock	<ul><li>Insufficient habitat.</li><li>Residential development</li></ul>	<ul><li>Reduce clean farming practices.</li><li>Create early successional habitat</li></ul>	
Bald Eagle	Lead poisoning	Encourage usage of non-lead shot	
Bank Swallow	Habitat loss	<ul> <li>Locate breeding colonies and protect nest microhabitat</li> </ul>	
Beach-dune Tiger Beetle	<ul><li>Habitat loss.</li><li>Flooding.</li><li>Impoundments</li></ul>	<ul><li>Restore and maintain sandbars.</li><li>Riparian corridor BMPs</li></ul>	
Belted Kingfisher	<ul><li> Poor water quality.</li><li> Insufficient nest microhabitat</li></ul>	<ul> <li>Identify important waterways and improve water quality</li> </ul>	
Blanchard's Cricket Frog	<ul><li>Agriculture.</li><li>Use of pesticides.</li><li>Loss of wetlands</li></ul>	<ul> <li>Identify currently occupied habitat.</li> <li>Restore populations at historical locations.</li> <li>Reduce pesticide use.</li> <li>Fence livestock out of wetlands</li> </ul>	
Blue-faced Meadowhawk	• Loss of wetlands to development and siltation	Maintain wetlands	
Bulb-bearing Water- hemlock	Unknown status	• Field survey to determine species distribution and threats.	

Floodplain, Riparian, Pond and Wetland Habitats				
Common Name	Local Stress	Action		
Buttonweed	<ul> <li>Altered hydrology.</li> <li>Nonnative invasive plants.</li> <li>Unknown status</li> </ul>	<ul> <li>Monitor populations.</li> <li>Field survey to determine species distribution and threats.</li> </ul>		
Cobblestone Tiger Beetle	<ul><li>Habitat loss.</li><li>High water events.</li><li>Impoundments/dams</li></ul>	<ul> <li>Restoration/protection of forested islands.</li> <li>Long-term monitoring. invasive species removal</li> </ul>		
Cobra Clubtail	<ul><li>Poor water quality.</li><li>Industrialization of riverbanks</li></ul>	<ul> <li>Improve/maintain water quality in Ohio and Kanawha Rivers</li> </ul>		
Duckweed Firetail	<ul><li>Poor water quality.</li><li>Siltation of ponds</li></ul>	Maintain ponds at McClintic WMA		
Eastern Box Turtle	<ul> <li>Collection.</li> <li>Disease.</li> <li>Road Mortality.</li> <li>Habitat destruction.</li> <li>Artificial increase in mesocarnivores</li> </ul>	<ul> <li>Reduce illegal collection.</li> <li>Educate land managers, biologists, and researchers about appropriate decontamination procedures to reduce the spread of disease.</li> <li>Improve road conditions to reduce mortality at identified hot spots.</li> <li>Develop and distribute box turtle BMPs document for urban areas</li> </ul>		
Eastern False Rue- anemone	<ul><li>Land development.</li><li>Timber harvest</li></ul>	<ul> <li>Protect known occurrence with conservation agreement.</li> <li>Conduct field surveys to locate additional populations.</li> </ul>		
Eastern Spadefoot	<ul> <li>Habitat destruction from residential and industrial development.</li> <li>Habitat alteration and changes in water chemistry.</li> <li>Collection</li> </ul>	<ul> <li>Identify and protect currently occupied habitat.</li> <li>Minimize soil disturbance.</li> <li>Reduce recreational use (ORV. hiking. etc.)</li> </ul>		

Floodplain, Riparian, Pond and Wetland Habitats				
Common Name	Local Stress	Action		
Eastern Spiny Softshell	<ul> <li>River channelization.</li> <li>Sedimentation.</li> <li>Recreation.</li> <li>Artificial increase in mesocarnivores</li> </ul>	<ul> <li>Identify important nesting beaches.</li> <li>Reduce human recreation on sandy beaches.</li> <li>Trash clean-up to reduce mesopredators from nesting beaches.</li> <li>Reduce boat wakes near nesting beaches to reduce erosion.</li> <li>Stream bank stabilization and reduction of run-off to improve water quality.</li> <li>Protection of habitat upstream of known populations</li> </ul>		
Elusive Clubtail	<ul><li> Poor water quality.</li><li> Industrialization of riverbanks</li></ul>	Improve/maintain water quality in Ohio and Kanawha Rivers		
Emmons's sedge	Unknown status	• Field survey to determine species distribution and threats.		
Featherfoil	Hydrological disturbance from     adjacent land use	Protect known occurrence with conservation agreement.		
Flag-tailed Spinyleg	<ul> <li>Loss of good water quality</li> </ul>	<ul> <li>Improve municipal/household wastewater systems.</li> <li>Surveys to determine population status</li> </ul>		
Giant Cane	<ul><li>Small patch size.</li><li>Woody encroachment</li></ul>	<ul> <li>Consider prescribed burning.</li> <li>Conduct trial burn in portion of habitat.</li> </ul>		
Great Blue Heron	<ul> <li>Human disturbance at breeding sites.</li> <li>Nest predation and competition for nest sites by bald eagle</li> </ul>	<ul> <li>Protect/buffer known rookeries.</li> <li>Survey for new rookeries</li> </ul>		

Floodplain, Riparian, Pond and Wetland Habitats				
Common Name	Local Stress	Action		
Green Heron	<ul> <li>Human disturbance at breeding sites.</li> <li>Degradation/loss of riparian habitats.</li> <li>Poor water quality</li> </ul>	<ul> <li>Conserve/improve riparian habitats.</li> <li>Improve water quality</li> </ul>		
Heartleaf Peppervine	Unknown status	<ul> <li>Field survey to determine species distribution and threats.</li> </ul>		
Hoary Bat	• Urbanization, habitat degradation	<ul> <li>Documentation of wintering and breeding locations/habitats along with migratory routes.</li> <li>BMPs that allow for maintenance of large roosting trees and small openings within forested stands</li> </ul>		
Kentucky Warbler	<ul><li>Deer overherbivory.</li><li>Incompatible forest structure</li></ul>	<ul> <li>Reduce deer population.</li> <li>Manage forests for structural and spatial complexity</li> </ul>		
Least Bittern	<ul> <li>Habitat loss.</li> <li>Incompatible wetland management</li> </ul>	<ul> <li>Identify and conserve remaining unprotected wetlands.</li> <li>Reduce/eliminate removal of vegetation on wetland margins.</li> <li>Enhance habitat in protected wetlands</li> </ul>		
Louisiana Waterthrush	<ul> <li>Loss of riparian forests.</li> <li>Stream degradation.</li> <li>Acid deposition.</li> <li>Residential development</li> </ul>	<ul> <li>Improve water quality.</li> <li>Conserve riparian and upland stream valley forests.</li> <li>Conservation easements</li> </ul>		
Floodplain, Riparian, Pond and Wetland Habitats				
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Common Name	Local Stress	Action		
Midland Smooth Softshell	<ul> <li>River channelization.</li> <li>Sedimentation.</li> <li>Recreation.</li> <li>Artificial increase in mesocarnivores</li> </ul>	<ul> <li>Identify important nesting beaches.</li> <li>Reduce human recreation on sandy beaches.</li> <li>Trash clean-up to reduce mesopredators from nesting beaches.</li> <li>Reduce boat wakes near nesting beaches to reduce erosion.</li> <li>Stream bank stabilization and reduction of run-off to improve water quality.</li> <li>Protection of habitat upstream of known populations</li> </ul>		
Mocha Emerald	<ul><li>Development.</li><li>Loss of forest cover along small low energy streams</li></ul>	<ul> <li>Maintain sandy stream and river banks</li> </ul>		
Northern Map Turtle	<ul> <li>River channelization.</li> <li>Sedimentation.</li> <li>Recreation.</li> <li>Artificial increase in mesocarnivores</li> </ul>	<ul> <li>Identify important nesting beaches.</li> <li>Reduce human recreation on sandy beaches.</li> <li>Trash clean-up to reduce mesopredators from nesting beaches.</li> <li>Reduce boat wakes near nesting beaches to reduce erosion.</li> <li>Stream bank stabilization and reduction of run-off to improve water quality.</li> <li>Protection of habitat upstream of known populations</li> </ul>		
Prothonotary Warbler	<ul> <li>Riparian habitat loss and degradation</li> </ul>	<ul> <li>Install and monitor nest boxes.</li> <li>Conserve and enhance forested backwaters and sloughs</li> </ul>		

Floodplain, Riparian, Pond and Wetland Habitats			
Common Name	Local Stress	Action	
Rainbow Bluet	<ul> <li>Poor water quality of streams.</li> <li>Loss of stream side vegetation</li> </ul>	<ul> <li>Improve municipal/household wastewater systems.</li> <li>Surveys to determine population status</li> </ul>	
River Seedbox	Unknown status	Field survey to determine species distribution and threats.	
Short's Hedgehyssop	Unknown status	• Field survey to determine species distribution and threats.	
Smallmouth Salamander	<ul> <li>Agriculture.</li> <li>Use of pesticides.</li> <li>Loss of wetlands</li> </ul>	<ul> <li>Reduce pesticide use.</li> <li>Restore and create ephemeral and fishless pools.</li> <li>Minimize soil disturbance, especially in areas surrounding ephemeral wetlands</li> </ul>	
Smoky Shadowdragon	<ul><li>Poor water quality.</li><li>Industrialization of riverbanks</li></ul>	Improve/maintain water quality in Ohio and Kanawha Rivers	
Southern Yellow Cress	Unknown status	Field survey to determine species distribution and threats.	
Spineless Hornwort	Unknown status	Field survey to determine species distribution and threats.	
Streamside Salamander	<ul> <li>Water quality.</li> <li>ORVs.</li> <li>Reduced precipitation</li> </ul>	<ul> <li>Implement forestry BMPs and Streamside Management Zone standards at ephemeral streams.</li> <li>Reduce pesticide use and other impacts to water quality.</li> <li>Reduce use of motorized vehicles in ephemeral stream beds.</li> </ul>	
Striped Whitelip	<ul><li>Habitat loss.</li><li>Sustained high water events</li></ul>	Maintain/restore forested river     islands and floodplains	
Umber Showdragon	<ul> <li>Poor water quality.</li> <li>Industrialization of riverbanks</li> </ul>	Improve/maintain water quality in Ohio and Kanawha Rivers	

Floodplain, Riparian, Pond and Wetland Habitats				
Common Name Local Stress Action				
Virginia Rail	<ul> <li>Habitat loss.</li> <li>Incompatible wetland management</li> </ul>	<ul> <li>Identify, enhance and protect remaining wetlands.</li> <li>Maintain vegetation on wetland buffers</li> </ul>		

## Appendix 3. Habitats on Public Lands

Public Land	Terrestrial Habitat	Aquatic Habitat	
Beech Fork Lake Wildlife Management Area	<ul> <li>Forest and Woodland         <ul> <li>Anthropogenic Shrubland &amp; Grassland</li> <li>Dry-Mesic Oak Forests</li> <li>Dry Oak (Pine) Forests</li> <li>Mixed Mesophytic Forests</li> </ul> </li> <li>Aquatic, Floodplain, and Riparian         <ul> <li>Open Water</li> <li>River Floodplains</li> <li>Small Stream Riparian Habitats</li> </ul> </li> <li>Agricultural and Developed         <ul> <li>Agriculture</li> <li>Developed</li> </ul> </li> </ul>	<ul> <li>Headwater Creek, Low Gradient, Warm</li> <li>Headwater Creek, Moderate Gradient, Warm</li> <li>Headwater Creek, High Gradient, Warm</li> <li>Small River, Low Gradient, Warm</li> </ul>	
Blennerhassett Island Historical State Park	<ul> <li>Forest and Woodland         <ul> <li>Anthropogenic Shrubland &amp; Grassland</li> </ul> </li> <li>Aquatic, Floodplain, and Riparian         <ul> <li>Open Water</li> <li>River Floodplains</li> </ul> </li> <li>Agricultural and Developed         <ul> <li>Agriculture</li> </ul> </li> </ul>	• N/A	
Burches Run Wildlife Management Area	<ul> <li>Forest and Woodland         <ul> <li>Dry-Mesic Oak Forests</li> <li>Dry Oak (Pine) Forests</li> <li>Mixed Mesophytic Forests</li> </ul> </li> <li>Aquatic, Floodplain, and Riparian         <ul> <li>Open Water</li> <li>Small Stream Riparian Habitats</li> </ul> </li> <li>Agricultural and Developed         <ul> <li>Agriculture</li> <li>Developed</li> </ul> </li> </ul>	<ul> <li>Headwater Creek, Low Gradient, Warm</li> <li>Headwater Creek, Moderate Gradient, Warm</li> <li>Headwater Creek, High Gradient, Cool</li> </ul>	

Public Land	Terrestrial Habitat	Aquatic Habitat
Chief Cornstalk	Forest and Woodland	Headwater Creek, Moderate
Wildlife	Anthropogenic Shrubland &	Gradient, Warm
Management Area	Grassland	Headwater Creek, High Gradient,
	Dry-Mesic Oak Forests	Cool
	Dry Oak (Pine) Forests	Headwater Creek, High Gradient,
	Mixed Mesophytic Forests	Warm
	Aguatic, Floodplain, and	
	Riparian	
	Open Water	
	Small Stream Riparian	
	habitats	
	Agricultural and Developed	
	Agriculture	
	Developed	
Green Bottom	Forest and Woodland	Headwater Creek, Low Gradient,
Wildlife	Anthropogenic Shrubland &	Warm
Management Area	Grassland	Headwater Creek, Moderate
-	Dry-Mesic Oak Forests	Gradient, Warm
	<ul> <li>Mixed Mesophytic Forests</li> </ul>	Headwater Creek, High Gradient,
	Aquatic, Floodplain, and	Warm
	Riparian	Small River, Low Gradient, Warm
	Open Water	
	Biver Floodplains	
	Small Stream Rinarian	
	Habitats	
	Agricultural and Developed	
	Agriculture	
	Developed	
McCausland	Forest and Woodland	Headwater Creek. Moderate
Wildlife	Anthronogenic Shruhland &	Gradient, Warm
Management Area	Grassland	
0	Dry-Mesic Oak Forests	
	Dry Oak (Pine) Forests	
	Mixed Mesophytic Forests	
	Aquatic, Floodplain, and	
	Riparian	
	Open Water	
	River Floodplains	
	Small Stream Rinarian	
	Habitats	
	Agricultural and Developed	
	Agriculture	
	Developed	
	<ul><li>Agriculture</li><li>Developed</li></ul>	

Public Land	Terrestrial Habitat	Aquatic Habitat
McClintic Wildlife	Forest and Woodland	Headwater Creek, Low Gradient,
Management Area	<ul> <li>Anthropogenic Shrubland &amp;</li> </ul>	Warm
	Grassland	Headwater Creek, Moderate
	<ul> <li>Dry-Mesic Oak Forests</li> </ul>	Gradient, Warm
	<ul> <li>Dr Oak (Pine) Forests</li> </ul>	<ul> <li>Small River, Low Gradient, Warm</li> </ul>
	<ul> <li>Mixed Mesophytic Forests</li> </ul>	
	<ul> <li>Aquatic, Floodplain, and</li> </ul>	
	Riparian	
	Open Water	
	River Floodplains	
	Small Stream Riparian	
	Habitats	
	<ul> <li>Agricultural and Developed</li> </ul>	
	Agriculture	
	Developed	
Mill Creek Wildlife	Forest and Woodland	Headwater Creek, Moderate
Management Area	<ul> <li>Anthropogenic Shrubland &amp;</li> </ul>	Gradient, Warm
	Grassland	
	<ul> <li>Dry-Mesic Oak Forests</li> </ul>	
	<ul> <li>Dry Oak (Pine) Forests</li> </ul>	
	<ul> <li>Mixed Mesophytic Forests</li> </ul>	
	<ul> <li>Aquatic, Floodplain, and</li> </ul>	
	Riparian	
	Small Stream Riparian	
	Habitats	
	<ul> <li>Agricultural and Developed</li> </ul>	
	Agriculture	
	Developed	
Ohio River Islands	Forest and Woodland	Headwater Creek, Low Gradient,
National Wildlife	<ul> <li>Anthropogenic Shrubland &amp;</li> </ul>	Warm
Refuge	Grassland	Headwater Creek, Moderate
	Dry-Mesic Oak Forests	Gradient, Warm
	<ul> <li>Dry Oak (Pine) Forests</li> </ul>	<ul> <li>Headwater Creek, High Gradient,</li> </ul>
	Mixed Mesophytic Forests	Cool
	Aquatic, Floodplain, and Riparian	<ul> <li>Headwater Creek, High Gradient,</li> </ul>
	Open Water	warm
	River Floodplains	<ul> <li>Small River, Moderate Gradient, Cool</li> </ul>
	Small Stream Riparian	COOI Madium Disan Law Cradiant
	Habitats	<ul> <li>iviedium River, Low Gradient,</li> <li>Warm</li> </ul>
	Agricultural and Developed	Wdilli
	Agriculture	<ul> <li>Large River, Low Gradient, warm</li> </ul>
	Developed	

Public Land	Terrestrial Habitat	Aquatic Habitat	
Rollins Lake	Forest and Woodland	Small River, Low Gradient, Warm	
Wildlife	Mixed Mesophytic Forests		
Management Area	• Aquatic, Floodplain, and		
	Riparian		
	Open Water		
	River Floodplains		
	Agricultural and Developed		
	Agriculture		
	Developed		
Sand Hill Wildlife	Forest and Woodland	Headwater Creek, High Gradient,	
Management Area	<ul> <li>Anthropogenic Shrubland &amp;</li> </ul>	Cool	
	Grassland		
	<ul> <li>Dry-Mesic Oak Forests</li> </ul>		
	<ul> <li>Dry Oak (Pine) Forests</li> </ul>		
	<ul> <li>Mixed Mesophytic Forests</li> </ul>		
	Aquatic, Floodplain, and		
	Riparian		
	Small Stream Riparian		
	Habitats		
	Agricultural and Developed		
	Developed		
Tu-Endie-Wei State	Aquatic, Floodplain, and Riparian	• N/A	
Park	Open Water		
	Agricultural and Developed		
	Developed		
Turkey Run Lake	Forest and Woodland	Headwater Creek, Moderate Creek,	
Wildlife	<ul> <li>Dry-Mesic Oak Forests</li> </ul>	Warm	
Management Area	<ul> <li>Dry Oak (Pine) Forests</li> </ul>		
	<ul> <li>Mixed Mesophytic Forests</li> </ul>		
	<ul> <li>Aquatic, Floodplain, and</li> </ul>		
	Riparian		
	Open Water		
	Small Stream Riparian		
	Habitats		
	Agricultural and Developed		
	Agriculture		
	Developed		

## Appendix 4. Impaired Streams

Reach Code	AUID	Common Name	Impairments
05030201001941	WVO-57-C_00	AlumCaveRun	Iron
05030201001982	WVO-53-H_00	AtwardRun	Iron
05030202001355	WVO-32-C_00	BarRun	Bio, Fecal, Iron
N/A	WVOG-5.3-A-	BarboursvilleLake	Chlorophyll,
	(L1)_00		Phosphorus
05030106001487	WVO-83-A-1.3_00	BartlettsRun	Fecal
05090101000027	WVO-9-F_00	BearHollowCreek	Bio
05030202000536	WVO-36-H_00	BeattyRun	Bio, Fecal, Iron
05090102000096	WVO-2-H_01	BeechFork	Bio
05070102000156	WVOGM-4_00	BigCabellCreek	Bio
05030106001261	WVO-88-I-1_00	BigRun	Fecal
05030203002655	WVO-50_00	BigRun	Bio, Fecal
05070204000344	WVBS_00	BigSandyRiver	Iron
05030106001449	WVO-86_00	BoggsRun	Bio, Fecal, Iron
05030202001168	WVO-49_00	BriscoeRun	Bio, Fecal, Iron
05030106001403	WVO-88-E.9_02	BrittRun	Fecal
05030106001402	WVO-88-E.9_01	BrittRun	Fecal
05030202000028	WVO-25_00	BroadRun	Fecal, Iron
05030106002880	WVO-86-A_00	BrownsRun	Bio, Fecal, Iron
05030201000741	WVO-69-H_00	BrushRun	Fecal, Iron
05090102000115	WVO-2-C_00	BuffaloCreek	Bio
05030106001476	WVO-83-C_00	BurchRun	Fecal
05030106001262	WVO-88-I_02	BurchRun	Fecal
05030106001259	WVO-88-I_01	BurchRun	Fecal
05030106002759	WVO-87_00	CaldwellRun	Bio, Fecal, Iron
05090102000312	WVO-2-G_00	CampCreek	Bio
05030202001340	WVO-34_00	CedarRun	Bio, Fecal
05030202001254	WVO-36-E_00	CherrycampRun	Iron
05030202001241	WVO-38-B_00	ClaylickRun	Iron
05030202001253	WVO-36-D-1_00	CockleRun	Iron
05030106001853	WVO-77-A_01	ConnerRun	Bio
05050008000344	WVK-10-A_00	CooperFork	Fecal, Iron
05030201000019	WVO-55_00	CowCreek	Bio, Fecal, Iron
05030201002180	WVO-66_00	CowHollowRun	Bio, Fecal, Iron
05030202000053	WVO-32-D_00	CowRun	Bio, Fecal, Iron
05090101001512	WVO-13_01	CrabCreek	Bio
05030202000547	WVO-20.5_00	CrookedCreek	Fecal, Iron
05030202000549	WVO-36-D_00	CrookedFork	Bio, Fecal, Iron
05070102000512	WVOG-3_00	DavisCreek	Bio
05030201000755	WVO-69-A_00	DoolinRun	Bio, Fecal, Iron
05070102000811	WVOG-3-0.5A_00	EdensBranch	Bio
05050008000176	WVK-16_00	EighteenmileCreek	Bio, Fecal, Iron
05090101000040	WVO-10_00	EighteenmileCreek	Bio
05030202001554	WVO-21-D_00	FallentimberBranch	Iron
05030202001513	WVO-32-B_00	FallsRun	Iron
05030106000006	WVO-77_01	FishCreek	Bio
05030106001498	WVO-81_00	FishRun	Fecal

Reach Code	AUID	Common Name	Impairments
05030201000278	WVO-69_00	FishingCreek	Bio, Fecal, Iron
05050008000896	WVK-19_00	FiveAndTwentyMileCreek	Fecal, Iron
05050008000967	WVK-6_00	FivemileCreek	Fecal, Iron
05090101001608	WVO-3_00	FourpoleCreek	Bio, Fecal
05030201000035	WVO-57_02	FrenchCreek	Fecal, Iron
05030201008711	WVO-57_01	FrenchCreek	Fecal, Iron
05030106001480	WVO-83-B.5_00	FrenchRun	Fecal
05070102000174	WVOGM-6_00	FudgesCreek	Bio
05030106004480	WVO-87-A_00	GeorgeRun	Fecal
05030106002916	WVO-88-H_00	GrandstaffRun	Fecal
05030202005370	WVO-32-D-1-A_00	GrassRun	Iron
05030106000112	WVO-83_00	GraveCreek	Bio, Fecal, Iron
05030202001195	WVO-44-B-4_00	GunnersRun	Bio, Fecal
05090101001587	WVO-9_01	GuyanCreek	Bio
05070102000001	WVOG-lo_01	GuyandotteRiver(lower)	Fecal, Iron
05030201005910	WVO-57-A_00	HenryCampRun	Iron
05030203002921	WVO-50-D_00	HoglandRun	Bio, Fecal, Iron
05030106001257	WVO-88-H.5_00	HollidaysRun	Fecal
05030201000761	WVO-69-D_00	HuppRun	Iron
05030202001226	WVO-43-H_00	JerrysRun	Fecal, Iron
05030202001210	WVO-43-D-2_00	JesseRun	Bio, Iron
05030106001454	WVO-85_02	JimRun	Fecal
05030106001454	WVO-85_01	JimRun	Bio, Fecal
05030202001223	WVO-43-K_00	JoshusFork	Fecal, Iron
05050008000995	WVK-lo_01	KanawhaRiver(lower)	Dioxin, PCBs
05050008000995	WVK-lo_02	KanawhaRiver(lower)	Dioxin, PCBs
N/A	WVK-1-(L1)_00	KrodelLake	Chlorophyll,
			Phosphorus
05090102000306	WVO-2-0.1A_00	KroutCreek	Bio
05030202001215	WVO-43-D-3_00	LampsRun	Iron
05030106001494	WVO-83-A-1-A_00	LeachRun	Iron
05030202000584	WVO-32-D-2_00	LeftFork/CowRun	Bio, Fecal, Iron
05030201000037	WVO-57-F_00	LeftFork/FrenchCreek	Fecal, Iron
05030202001212	WVO-43-D-2-B_00	LeftFork/JesseRun	Iron
05030106001481	WVO-83-B.4_00	LickRun	Fecal
05030202001347	WVO-32-A_00	LickRun	Iron
05030201001967	WVO-55-F_00	LimestoneRun	Iron
05030202003998	WVO-26_00	LittleBroadRun	Bio, Fecal, Iron
05070102000359	WVOGM-3_00	LittleCabellCreek	Bio
05030201000327	WVO-69-C_00	LittleFishingCreek	Bio, Fecal, Iron
05050008000971	WVK-6-A_00	LittleFivemileCreek	Fecal, Iron, DO
05030203002676	WVLK_01	LittleKanawhaRiver	Fecal, Iron
05030202000042	WVO-31_00	LittleMillCreek	Bio, Fecal, Iron
05030202000197	WVO-43-D_00	LittlePondCreek	Fecal, Iron
05030202005140	WVO-48-A_00	LittlePondRun	Bio, Fecal, Iron
05030202003616	WVO-38_00	LittleSandyCreek	Fecal, Iron
05050008000947	WVK-13_00	LittleSixteenmileCreek	Fecal, Iron
05030106001493	WVO-83-A-1.1_00	LittleTomsRun	Fecal
05030106000215	WVO-88-D_00	LittleWheelingCreek	Fecal, Iron

Reach Code	AUID	Common Name	Impairments
05030201000776	WVO-57-B_00	LongRun	Iron
05030202001203	WVO-44-B-3_00	LongRun	Iron
05030202001231	WVO-43-C_00	LongRun	Iron
05050008000972	WVK-6-C_00	LowerFivemileCreek	Iron
05050008000960	WVK-9-B_00_c	LowerNinemileCreek	Iron
	WVO-21-(L1)_00	McClinticPonds	Phosphorus
05090101001592	WVO-9-B_00	McCowanBranch	Bio
05030106001495	WVO-83-A-0.5_00	McLainRun	Iron
05030106001486	WVO-83-A-1.2_00	MeetinghouseHollow	Iron
05090101001522	WVO-13-D_00	MiddleFork/CrabCreek	Bio
05030202001189	WVO-44-A-1_00	MiddleFork/SouthFork/LeeCreek	Fecal, Iron
05030106000128	WVO-83-A_00	MiddleGraveCreek	Bio, Fecal, Iron
05030201002043	WVOMI_01	MiddleIslandCreek	Fecal, Iron
05070102000344	WVOGM-8_00	MillCreek	Bio
05030202004802	WVO-32_00	MillCreek	Bio, Fecal, Iron
05030202000571	WVO-22_00	MillRun	Bio, Fecal, Iron
05030106001456	WVO-84-A.8_00	MolleysHollow	Fecal
05030201003619	WVO-69-G_00	MoneyRun	Iron
05070102000066	WVOGM_01	MudRiver	Bio
05090101001508	WVO-13-A_00	MudRun	Bio
05090101001562	WVO-10-D_01	MudRun	Bio
05030201001489	WVO-72-D_00	MudRun	Iron
05050008000327	WVK-9_00	NinemileCreek	Fecal, Iron
05090101000587	WVO-7_01	NinemileCreek	Bio
05030106000670	WVO-83-E_00	NorthFork/GraveCreek	Bio, Fecal, Iron
05030202000223	WVO-44-B_00	NorthFork/LeeCreek	Bio, Fecal, Iron
05030106000675	WVO-83-A-1.6_00	NorthFork/MiddleGraveCreek	Fecal
05090101004538	WVO-lo_03	OhioRiver(lower)	Dioxin, PCBs,
05090101000065	WVO-lo_04	OhioRiver(lower)	Iron, Dioxin, PCBs,
05000101000008	$W//O_{-10}$ 02		Dioxin PCBs
05090101000008	WVO-I0_02		Dioxin, PCBs
03090101000000	WWO-10_01	Chior(wer(lower)	Bacteria
05030201000276	WVO-mn_08	OhioRiver(middlenorth)	Dioxin, PCBs, Bacteria
05030201002176	WVO-mn_06	OhioRiver(middlenorth)	Dioxin, PCBs, Bacteria
05030201001288	WVO-mn_03	OhioRiver(middlenorth)	Dioxin, PCBs
05030201006712	WVO-mn_01	OhioRiver(middlenorth)	Iron, Dioxin, PCBs, Bacteria
05030201006310	WVO-mn_11	OhioRiver(middlenorth)	Dioxin, PCBs, Bacteria
05030201006476	WVO-mn_10	OhioRiver(middlenorth)	Dioxin, PCBs
05030201000344	WVO-mn_09	OhioRiver(middlenorth)	Dioxin, PCBs
05030201000275	WVO-mn_07	OhioRiver(middlenorth)	Dioxin, PCBs
05030201000271	WVO-mn_05	OhioRiver(middlenorth)	Dioxin, PCBs
05030201006650	WVO-mn_04	OhioRiver(middlenorth)	Dioxin, PCBs, Bacteria
05030201000024	WVO-mn_02	OhioRiver(middlenorth)	Iron, Dioxin, PCBs

Reach Code	AUID	Common Name	Impairments
05030202001597	WVO-ms_02	OhioRiver(middlesouth)	Iron, Dioxin, PCBs,
			Bacteria
05030202001600	WVO-ms_03	OhioRiver(middlesouth)	Iron, Dioxin, PCBs
05030202005392	WVO-ms_06	OhioRiver(middlesouth)	Iron, Dioxin, PCBs,
			Bacteria
05030202000247	WVO-ms_04	OhioRiver(middlesouth)	Iron, Dioxin, PCBs,
05020202000247	W/\/O mc_05	ObioRiver(middlesouth)	Iron Diovin PCRs
05030202000247	$W/O ms_{00}$	OhioRiver(middlesouth)	Iron Dioxin, PCBs,
03030202000023	WWO-III5_01	Onlorwer(middlesouth)	Bacteria
05030106000130	WVO-us 01	OhioRiver(UpperSouth)	Dioxin. PCBs.
			Bacteria
05030202000009	WVO-21_00	OldtownCreek	Bio, Fecal, Iron
05030202000064	WVO-32-H_00	ParchmentCreek	Bio, Fecal, Iron
05030203002667	WVO-50-B_00	PlumRun	Bio, Fecal
05050008000954	WVK-11_00	PondBranch	Bio, Fecal, Iron
05030202000194	WVO-43_00	PondCreek	Bio, Fecal, Iron
05030202000573	WVO-48_00	PondRun	Bio, Fecal, Iron
05030202001573	WVO-21-A_00	PotterCreek	Bio
05030201000796	WVO-72_00	ProctorCreek	Iron
05030202001551	WVO-21-B.5_00	RayburnCreek	Iron
05090102000319	WVO-2-G-1_00	RightFork/CampCreek	Bio
05030202000055	WVO-32-D-1_00	RightFork/CowRun	Fecal, Iron
05030201001943	WVO-57-E_00	RightFork/FrenchCreek	Fecal, Iron
05030202001214	WVO-43-D-2-A_00	RightFork/JesseRun	Iron
05030202000043	WVO-31-A_00	RightFork/LittleMillCreek(HuffRun)	Iron
05030202001245	WVO-38-A_00	RoadforkRun	Fecal, Iron
05030202001570	WVO-21-B_00	RobinsonRun	Fecal, Iron
05090101001548	WVO-10-A_00	RockyFork	Bio
05030202002253	WVO-46_00	SandyCreek	Bio, Fecal, Iron
05030202000144	WVO-36_00	SandyCreek	Bio, Fecal, Iron
05030201006735	WVO-57-D_00	SchultzRun	Iron
05030202001534	WVO-25-A_00	SeamanRun	Iron
05090101000009	WVO-6_00	SevenmileCreek	Bio
05050008000952	WVK-13-A_00	ShadyFork	Iron
05030201006205	WVO-55-G_00	SharpsRun	Iron
05050008000295	WVK-14_00	SixteenmileCreek	Fecal, Iron
05090101000052	WVO-11_01	SixteenmileCreek	Bio
05050008000933	WVK-14-0.2A_00	SlatyHollow	Iron
05030201001964	WVO-55-C_00	SledRun	Iron
05030202000590	WVO-24_00	SlidingHillCreek	Bio, Fecal, Iron
05030202000221	WVO-44-A_00	SouthFork/LeeCreek	Bio, Fecal, Iron
05030202004202	WVO-33_00	SpringCreek	Bio, Fecal
05090101001573	WVO-9-A_00	SpurlockCreek	Bio
05030201006555	WVO-69-F_00	StateRun	Iron
05030202004303	WVO-34-B_00	StedmanRun	Iron
05090101001529	WVO-11-A_00	StonecoalRun	Bio
05030202000595	WVO-36-C_00	StraightFork	Fecal
05030201001622	WVO-63_00	SugarcampRun	Fecal, Iron

Reach Code	AUID	Common Name	Impairments
05030202000596	WVO-32-K_00	SycamoreCreek	Bio, Fecal, Iron
05070102000793	WVOGM-1.5_00	TanyardBranch	Bio
05030202000604	WVO-23_00	TenmileCreek	Bio, Fecal, Iron
05050008000203	WVK-12_00	ThirteenmileCreek	Fecal, Iron
05050008000304	WVK-5_00	ThreemileCreek(North)	Fecal, Iron
05050008000977	WVK-4_00	ThreemileCreek(South)	Bio, Fecal, Iron
05030106000685	WVO-83-A-1_00	TomsRun	Fecal, Iron
05030202000606	WVO-36-G_00	TraceFork	Bio, Fecal
05030202001563	WVO-21-C_00	TraceFork	Fecal, Iron
05030202001549	WVO-21-0.5A_00	TurkeyRun	Bio, Fecal, Iron
05030202001770	WVO-37-(L1)_00	TurkeyRunLake	Iron, Chlorophyll,
			Phosphorus,
			Sedimentat,
05000102000204	M/V/O 2 01	TwolyopoloCrook	l ropnic_St
05090102000294	WVO-2_01	TwelvepoleCreek	Bio, Fecal, Iron
05050008000050	W//K 0 0 5 0 00	INT/NinomileCrockPM0.27	
05020202004722	WV/O 22 C 4 00		Iron
05000101001585	$W/VO_{-9}E_{-2}00$	UNT/Barkunkwo.78	Bio
05030203002804	W/V/O-50-0.2A_00	LINT/BigBupBM0.20	Iron
05030106001263	W/V/O-88-L1-A_00		Focal
05030106001203	W/V/O-86-C_00	UNT/BoggsRupRM2.69	Rio Chloride
05030202001535	W/VO-00-C_00	UNT/BroadBunBM5 39	Iron
05030202001535	W/VO-25-U_00	UNT/BroadRunRM6.15	Iron
05030202001330	W/VO-23-11_00	UNT/CedarRunRM2 11	Iron
05050202001342	WVC 04 Γ_00	UNT/CooperForkRM1 41	Iron
05050008000347	W//K-10-A-6_00		Iron
05030202001356	WVR 10 A 0_00	UNT/CowRunRM1 17	Iron
05030202004840	WVO-20 5-A 00	UNT/CrookedCreekRM1 53	Iron
05030202001577	WVO-20.5-B 00	UNT/CrookedCreekRM2.03	Iron
05030202001576	WVO-20.5-C 00	UNT/CrookedCreekRM4.34	Iron
05030202001575	WVO-20.5-F 00	UNT/CrookedCreekRM6.52	Iron
05030202004905	WVO-20.5-G 00	UNT/CrookedCreekRM8.05	Iron
05030106001500	WVO-81-B 00	UNT/FishRunRM0.79	Fecal
05050008000976	WVK-6-A.5_00	UNT/FivemileCreekRM2.40	Iron
05030106001673	WVO-83-A.1_00	UNT/GraveCreekRM2.41	Fecal
05030202001213	WVO-43-D-2-	UNT/JesseRunRM0.44	Iron
	0.5A_00		
05030202001361	WVO-32-D-2-E_00	UNT/LeftForkRM2.51/CowRun	Iron
05030202001350	WVO-32-A-10_00	UNT/LickRunRM4.74	Iron
05030202004822	WVO-31-0.9A_00	UNT/LittleMillCreekRM5.93	Iron
05050008000962	WVK-9-B-2_00	UNT/LowerNinemileCreekRM2.83	Iron
05030202001515	WVO-32-A.3_00	UNT/MillCreekRM2.36	Iron
05030202004407	WVO-22-A_00	UNT/MillRunRM1.77	Iron
05030202004440	WVO-22-B_00	UNT/MillRunRM1.81	Iron
05030202004318	WVO-22-C_00	UNT/MillRunRM2.22	Iron
05030202004311	WVO-22-D_00	UNT/MillRunRM3.13	Iron
05030202002438	WVO-44-B-2.2_00	UNT/NorthForkRM10.17/LeeCreek	Iron
05030202002538	WVO-44-B-0.8_00	UNT/NorthForkRM2.61/LeeCreek	Iron

Reach Code	AUID	Common Name	Impairments
05030202001550	WVO-21-B.3_00	UNT/OldtownCreekRM11.50	Iron
05030202001568	WVO-21-B.8_00	UNT/OldtownCreekRM13.95	Iron
05030202001555	WVO-21-E_00	UNT/OldtownCreekRM18.16	Iron
05030202001558	WVO-21-H_00	UNT/OldtownCreekRM19.38	Iron
05030202004675	WVO-21-0.2A_00	UNT/OldtownCreekRM2.00	Iron
05030202001556	WVO-21-I_00	UNT/OldtownCreekRM20.03	Iron
05050008000957	WVK-11-0.5A_00	UNT/PondBranchRM1.74	Fecal, Iron
05050008000958	WVK-11-0.6A_00	UNT/PondBranchRM1.88	Iron
05030201002718	WVO-72-A.9_00	UNT/ProctorCreekRM5.96	Iron
05030202004398	WVO-21-B-0.9_00	UNT/RobinsonRunRM2.42	Bio, Fecal, Iron
05030202001571	WVO-21-B-2_00	UNT/RobinsonRunRM3.33	Fecal, Iron
05030202001177	WVO-46-G_00	UNT/SandyCreekRM3.91	Iron
05030202001176	WVO-46-H_00	UNT/SandyCreekRM4.06	Iron
05030202002257	WVO-46-I_00	UNT/SandyCreekRM4.41	Iron
05030202001174	WVO-46-J_00	UNT/SandyCreekRM4.97	Bio, Fecal, Iron
05050008000943	WVK-14-A.5_00	UNT/SixteenmileCreekRM8.16	Iron
05030202001540	WVO-24-A_00	UNT/SlidingHillCreekRM1.35	Bio, Fecal, Iron
05030202005325	WVO-33-C_00	UNT/SpringCreekRM2.21	Iron
05030202004161	WVO-23-A_00	UNT/TenmileCreekRM2.68	Iron
05030202004103	WVO-23-B.5_00	UNT/TenmileCreekRM4.13	Fecal, Iron
05030202001546	WVO-23-C_00	UNT/TenmileCreekRM5.33	Bio, Iron
05030202001547	WVO-23-H_00	UNT/TenmileCreekRM8.02	Iron
05050008001080	WVK-5-B_00	UNT/ThreemileCreekRM2.61	Iron
05050008001081	WVK-5-F_00	UNT/ThreemileCreekRM7.11	Iron
05050008002045	WVK-5-H_00	UNT/ThreemileCreekRM8.65	Iron
05030202004622	WVO-21-C-1_00	UNT/TraceForkRM0.72	Iron
05030202001565	WVO-21-C-2_00	UNT/TraceForkRM1.59	Iron
05030202001566	WVO-21-C-4_00	UNT/TraceForkRM2.97	Iron
05090102000293	WVO-2-A.1_00	UNT/TwelvepoleCreekRM5.72	Bio
05050008001146	WVK-10-A-1-B_00	UNT/UNTRM0.39/CooperForkRM1.41	Iron
05030202001541	WVO-24-A-1_00	UNT/UNTRM1.12/SlidingHillCreekRM 1.35	Iron
05030202003945	WVO-24-A-5_00	UNT/UNTRM3.75/SlidingHillCreekRM 1.35	Iron
05030202004212	WVO-27-A_00	UNT/WestCreekRM1.59	Iron
05030202001531	WVO-27-B_00	UNT/WestCreekRM1.69	Iron
05030202001532	WVO-27-E_00	UNT/WestCreekRM3.08	Iron
05030106001490	WVO-83-A-2-A_00	UNT/WhitneyRunRM0.33	Fecal, Iron
05030202001206	WVO-44-B-2-G_00	UNT/WoodyardsRunRM2.03	Iron
05050008000969	WVK-6-B_00	UpperFivemileCreek	Iron
05050008000329	WVK-9-A_00	UpperNinemileCreek	Bio, Fecal, Iron
05030202001180	WVO-46-A_00	VaughtsRun	Bio, Fecal, Iron
05030202001236	WVO-41_00	WashingtonRun	Bio, Fecal, Iron
05030106001492	WVO-83-A-1.5_00	WellsRun	Fecal
05030202000615	WVO-27_00	WestCreek	Fecal, Iron
05030106000136	WVO-88_00	WheelingCreek	Fecal
05030106002845	WVO-88-H-2_00	WherryRun	Fecal
05030106004410	WVO-83-A-2_00	WhitneyRun	Bio, Fecal, Iron
05030203002668	WVO-50-A_00	WilliamsCreek	Fecal, Iron

Reach Code	AUID	Common Name	Impairments
05030201001503	WVO-70_00	WilliamsRun	Fecal, Iron
05030202001186	WVO-44-A-2_00	WillowRun	Fecal, Iron
05070102000225	WVOGM-6-0.5A_00	WireBranch	Bio
05030202001205	WVO-44-B-2_00	WoodyardsRun	Fecal, Iron

## **Appendix 5. Partners and Assistance Provided**

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

Partner	Role/Assistance Provided
American Forest Foundation (AFF) <u>https://www.forestfoundation.org/</u> <u>https://www.familyforestcarbon.org/</u>	<ul> <li>The American Forest Foundation's mission is to deliver meaningful conservation impact through the empowerment of family forest landowners.</li> <li>The American Tree Farm System (ATFS) recognizes landowners for their good stewardship and adhering to the ATFS Standards of Sustainability while meeting their own goals and objectives for their land.</li> <li>The Family Forest Carbon Program focuses on two specific practices: Growing Mature Forests (encouraging Forest Management Plans) and Enhancing the Future Forest (control of competing vegetation to improve regeneration before or after a regeneration harvest)</li> </ul>
Appalachian Mountains Joint Venture <u>https://amjv.org/</u>	• The Appalachian Mountains Joint Venture (AMJV) is a regional partnership of state and federal agencies, conservation organizations and universities who work to restore and sustain viable populations of native birds and their habitats in the Appalachian Mountains. AMJV works with partners to provide private landowners with guidance and opportunities to improve habitat for birds and other wildlife.

Partner	Role/Assistance Provided
Cave Conservancy of the Virginias (CCV) <u>https://caveconservancyofvirginia.org/</u> M aster Naturalists Program <u>http://mnofwv.org/</u>	<ul> <li>Promoting conservation, management, knowledge and acquisition of caves and karst resources in Virginia and West Virginia</li> <li>Contributes to educational, research and environmental protection projects</li> <li>Funds a variety of cave and karst education, outreach, research, cleanup and acquisition projects.</li> <li>Provides research scholarships and stipends for graduate and undergraduate students</li> <li>Supports <i>Project Underground</i> environmental education program to promote a better understand of caves and karst lands. Training interested people in the fundamentals of natural history, nature interpretation and teaching.</li> <li>Instilling an appreciation of the importance of responsible environmental stewardship.</li> <li>Providing a corps of highly qualified volunteers to assist government agencies, schools and non-government organizations with research, outdoor recreation and protection</li> <li>Developing Forest Stewardship Plans</li> </ul>
Consulting Foresters https://wvforestry.com/forestry- consultants/	<ul> <li>Promoting Forest stewardship Huns</li> <li>Promoting Forestry BMPs</li> <li>Designing forest management practices to achieve landowner goals and ecological objectives</li> <li>Assisting landowners with developing forest carbon projects aimed at achieving verifiable carbon sequestration through improved forest management practices</li> </ul>
County Farmland Protection Boards <u>http://wvfp.org/</u>	<ul> <li>County Farmland Protection Boards and West Virginia Agricultural Land Protection Authority are authorized through WV Department of Agriculture, under the Voluntary Farmland Protection Act, to</li> <li>Assist in sustaining the farming community</li> <li>Provide sources of agricultural products within the state for citizens of the state</li> <li>Control the urban expansion which is consuming the agricultural land, topsoil and woodland of the state</li> <li>Curb the spread of urban blight and deterioration</li> <li>Protect agricultural land and woodland as open-space land</li> <li>Enhance tourism</li> <li>Protect worthwhile community values, institutions &amp; landscapes which are inseparably associated with traditional farming</li> </ul>

Partner	Role/Assistance Provided
<ul> <li>Forest Certification Programs:</li> <li>American Tree Farm System (ATFS) <u>https://www.treefarmsystem.org/</u></li> <li>Sustainable Forestry Initiative (SFI) <u>https://www.forests.org/</u> <u>https://www.wvfa.org/sfi/</u></li> <li>Forest Stewardship Council (FSC) <u>https://fsc.org/en</u></li> </ul>	<ul> <li>Resources, assistance and certification for sustainable forest management on public and private lands</li> </ul>
Master Naturalists Program <u>http://mnofwv.org/</u>	<ul> <li>Training interested people in the fundamentals of natural history, nature interpretation and teaching.</li> <li>Instilling an appreciation of the importance of responsible environmental stewardship.</li> <li>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</li> </ul>
National Speleological Society (NSS) https://caves.org/	<ul> <li>Promotes safe and responsible caving practices, effective cave and karst management, speleology and conservation.</li> <li>Members work together in NSS grottos (i.e, chapters), regions, surveys and sections to develop ideas and pursue projects in the areas of speleology, as well as cave conservation, management, preservation, restoration, exploration, surveying, rescue, equipment, techniques and education.</li> </ul>
National Speleological Society (NSS) https://caves.org/	<ul> <li>Promotes safe and responsible caving practices, effective cave and karst management, speleology, and conservation.</li> <li>Members work together in NSS grottos (i.e, chapters), regions, surveys, and sections to develop ideas and pursue projects in the areas of speleology, as well as cave conservation, management, preservation, restoration, exploration, surveying, rescue, equipment, techniques, and education.</li> </ul>
National Wild Turkey Federation (NWTF) https://www.nwtf.org/	<ul> <li>Provides information to landowners on hunting and habitat management for wild turkey and other wildlife</li> <li>Partners with state and federal agencies on hunting access and habitat management for wild turkey and other wildlife species</li> </ul>

Partner	Role/Assistance Provided
Ohio River Valley Water Sanitation Commission (ORSANCO) <u>http://www.orsanco.org/</u>	<ul> <li>Since 1948, ORSANCO and its member states have cooperated to improve water quality in the Ohio River Basin, ensuring the river can be used for drinking, industrial supplies and recreational purposes; and can support a healthy and diverse aquatic community. ORSANCO operates monitoring programs to check for pollutants and toxins that may interfere with specific uses of the river.</li> </ul>
Outdoor Heritage Conservation Fund (OHCF) <u>https://commerce.wv.gov/boards- commissions/outdoor-heritage-</u> <u>conservation-fund/</u>	<ul> <li>The Outdoor Heritage Conservation Fund (OHCF) protects lands that host West Virginia's wild and wonderful natural resources. The OHCF's land- protection projects can include important wildlife habitats, working forests and farmlands, as well as hunting, fishing, and outdoor recreational areas. The OHCF is working to protect the best of our natural resources for all West Virginians.</li> </ul>
Ruffed Grouse Society/American Woodcock Society (RGS) • <u>https://ruffedgrousesociety.org/#</u>	<ul> <li>Creates healthy forest habitat for the benefit of ruffed grouse, American woodcock and other forest wildlife</li> <li>Works with landowners and government agencies to develop critical habitat using scientific management practices</li> <li>RGS works with the forest product industry, including landowners, foresters, loggers, and forest product manufacturers, to scale up capacity building, investment and conservation benefits from working forests to the landscape scale.</li> <li><u>https://ruffedgrousesociety.org/the-ruffed-grouse-society-model-of-working-forests/</u></li> </ul>
The Conservation Fund (TCF) <u>https://www.conservationfund.org/</u> <u>where-we-work/west-virginia</u>	<ul> <li>Works with public, private and nonprofit partners to protect America's legacy of land and water resources through land acquisition, sustainable community and economic development, and leadership training, emphasizing the integration of economic and environmental goals.</li> </ul>
The Nature Conservancy (TNC) https://www.nature.org/en-us/about- us/where-we-work/united-states/west- virginia/	<ul> <li>Assist public land managers with land protection, management and restoration to maintain landscape resilience and connectivity</li> <li>Assist private landowners with land protection and improved management, including conservation easements and forest carbon projects</li> <li>Manages a network of nature preserves and conservation easements for conservation and recreation</li> </ul>

Partner	Role/Assistance Provided
Trout Unlimited (TU) • <u>http://www.wvtu.org/</u> <u>http://www.tu.org/</u>	<ul> <li>Plans and implements restoration projects with landowners and in coordination with USFWS Partners program and USDA Natural Resource Conservation Service and Forest Service and other partners</li> <li>Projects focus on riparian corridor and in-stream habitat restoration, invasive weed treatment and aquatic passage barrier removal/replacement to benefit brook trout and other wildlife species</li> </ul>
US Army Corps of Engineers (USACE): Great Lakes and Ohio River Division <u>https://www.lrd.usace.army.mil/</u>	<ul> <li>The Great Lakes and Ohio River Division civil works missions provide navigation, flood risk management, environmental, emergency response, recreation, hydropower, water supply and regulatory permits.</li> </ul>
<ul> <li>Environmental Stewardship <u>https://www.lrd.usace.army.mil/Miss</u> <u>ions/Environmental/</u></li> <li>Flood Risk Management: <u>https://www.lrd.usace.army.mil/Miss</u> <u>ions/Civil-Works/Flood-Risk- Management/</u></li> </ul>	<ul> <li>Through Environmental Stewardship, ACOE works to restore degraded ecosystem structure, function and dynamic processes to a more natural condition through large-scale ecosystem restoration projects</li> <li>Flood risk management includes operation of dams, reservoirs and levees along the Ohio River and its tributaries</li> </ul>
US Fish and Wildlife Service (USFWS) Partners for Fish and Wildlife Program <u>https://www.fws.gov/northeast/ecologic</u> <u>alservices/partners.html</u>	<ul> <li>Provides technical and financial assistance to private landowners for restoration and enhancement of fish and wildlife habitat for the benefit of Federal Trust species (Migratory Birds, Threatened and Endangered and At-Risk Species)</li> <li>Efforts focus on controlling nonnative invasive plants, managing livestock access to forests, wetland restoration, riparian buffer planting and fencing, in- stream habitat improvement, aquatic passage barrier removal and creating pollinator habitat</li> <li>Works in coordination with the USDA Natural Resources Conservation Service farm bill programs, Trout Unlimited and other partners</li> </ul>

Partner	Role/Assistance Provided
<ul> <li>USDA Farm Service Agency (FSA) <u>https://www.fsa.usda.gov/state-offices/West-Virginia/programs/index</u></li> <li>Conservation Reserve Program (CRP)</li> <li>Conservation Reserve Enhancement Program (CREP)</li> <li>State Acres for Wildlife Enhancement (SAFE)</li> <li>Farmable Wetlands Program (FWP)</li> <li>Grasslands Reserve Program (GRP)</li> </ul>	<ul> <li>CRP provides rental payments to agricultural producers participating voluntarily to safeguard environmentally sensitive land, conserve water quality, control soil erosion and enhance wildlife habitat, including floodplain wetlands.</li> <li>CREP provides extra incentives and payments to eligible producers to reduce soil erosion and pollution, improve water quality and enhance terrestrial and aquatic wildlife habitat through practices such as riparian buffers and wetland restoration</li> <li>The State Acres for Wildlife Enhancement (SAFE) Initiative provides farmers and landowners with assistance to establish wetlands, grasses and trees to enhance important wildlife populations by creating critical habitat and food sources, while protecting soil and water health.</li> <li>The Farmable Wetlands Program (FWP) provides farmers and ranchers annual rental payments in return for restoration wetlands and wetland buffers zones.</li> <li>The Grassland Reserve Program (GRP) provides farmers a rental payment to voluntarily prevent grazing and pasture land from being converted into cropland or urban development.</li> </ul>

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

Partner	Role/Assistance Provided
West Virginia Cave Conservancy <u>https://wvcc.net/</u>	<ul> <li>Manages caves to protect sensitive cave resources and environments</li> <li>Educates and provides expertise to landowners, developers, local governments and the public on the value of cave and karst resources</li> <li>Organizes cave and karst conservation projects including sinkhole cleanups and livestock barrier fences.</li> <li>Preserves access to significant caves through ownership and management agreements</li> <li>Sponsor research and survey projects on WVCC caves</li> </ul>
West Virginia Land Trust (WVLT) https://www.wvlandtrust.org/	<ul> <li>WVLT's mission is to protect land with significant conservation values through the use of conservation easements and real estate acquisitions, and by working with a statewide network of partners to build a passionate land conservation movement in the state.</li> </ul>
West Virginia Scenic Trails Association (WVSTA) https://www.wvscenictrails.org/	<ul> <li>Serves the outdoor community by building and maintaining the Allegheny Trail and other trails in partnership and cooperation with landowners, managers, and others.</li> <li>Maintains, preserves, protects, and promotes this challenging and scenic foot trail (that will exceed 300 miles) running southward from the Mason-Dixon Line through WV and VA to the Appalachian Trail.</li> <li>Furthers the conservation of wild pristine lands and wildlife and protect areas of natural beauty and historic interest through stewardship</li> </ul>
<ul> <li>West Virginia University Extension</li> <li>Service (WVU Extension):</li> <li>Forestry</li> <li><u>https://extension.wvu.edu/natural-resources/forestry</u></li> <li>Wildlife</li> <li><u>https://extension.wvu.edu/natural-resources/wildlife</u></li> </ul>	<ul> <li>Landowner technical assistance and information on financial assistance for forest and wildlife management</li> <li>Training workshops and conferences on forestry Best Management Practices and safety practices</li> </ul>

Partner	Role/Assistance Provided
<ul> <li>WV Conservation Agency (WVCA) and Conservation Districts</li> <li><u>http://www.wvca.us</u></li> <li>Ag Enhancement Program (AgEP)</li> <li>Non-Point Source Program</li> <li>Stream Partners Program</li> </ul>	<ul> <li>The Ag Enhancement Program (AgEP), administered by Conservation Districts and the WVCA, offers technical and financial assistance to implement conservation best management practices for the reduction of nutrients and sediment entering waterways and increasing farm profitability and sustainability. Practices may include invasive species management and exclusion fencing to protect streams, wetlands and other environmentally sensitive areas.</li> <li>Through Conservation Districts, the statewide Non- Point Source Program uses federal Clean Water Act, Section programs to reduce nonpoint source pollution related to agriculture, construction and urban stormwater management.</li> <li>Through the Stream Partners Program, WVDNR, WVCA, WVDOF and WVDEP provide grants up to \$5,000 to citizens' groups who want to improve, restore, protect, study or celebrate the state's rivers and streams.</li> </ul>
WV Department of Environmental	
Protection (WVDEP)	
<ul> <li>Nonpoint source Program <u>https://dep.wv.gov/WWE/Programs/</u> <u>nonptsource/Pages/home.aspx</u></li> <li>Watershed Based Plans <u>https://dep.wv.gov/WWE/Programs/</u> <u>nonptsource/WBP/Pages/WBP.aspx</u></li> <li>Save Our Streams Program <u>https://dep.wv.gov/WWE/getinvolve</u> <u>d/sos/Pages/default.aspx</u></li> <li>Rehabilitation Environmental Action Plan (REAP) <u>https://dep.wv.gov/environmental-advocate/reap/Pages/default.aspx</u></li> <li>WVDEP Youth Environmental Program (YEP) <u>https://dep.wv.gov/environmental-advocate/yep/Pages/default.aspx</u></li> </ul>	<ul> <li>Supports partners and citizen-based watershed organizations in restoring impaired watersheds</li> <li>Provides assistance in proper installation and maintenance of Best Management Practices</li> <li>Provides funding for projects by watershed groups and partners to improve water quality in watersheds listed as impaired, including the Greenbrier River and many tributaries</li> <li>Practices include wastewater treatment, agricultural BMPs, rain gardens for stormwater runoff, streambank restoration and community outreach</li> <li>Save our Streams provides training for volunteers to monitor local wadable streams and rivers</li> <li>REAP provides communities with technical, financial and resource assistance in cleanup efforts.</li> <li>YEP organizes youth and volunteer groups for hands- on conservation projects</li> </ul>
<ul> <li>WV Department of Health and Human Resources (WVDHHR)</li> <li>On-Site Sewage Program <u>https://www.wvdhhr.org/phs/sewage/in</u> <u>dex.asp</u></li> </ul>	<ul> <li>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.</li> </ul>

Partner	Role/Assistance Provided	
WV Division of Forestry (WVDOF) http://www.wvforestry.com/	<ul> <li>Oversees the Managed Timberland Program to provide tax incentives for landowners who manage their forest land sustainably according to a management plan</li> <li>Oversee timber sales and Best Management Practices</li> <li>Provides training workshops for loggers on safety and Best Management Practices</li> <li>Maintains list of consulting foresters who can help landowners with Forest Stewardship Plans to enhance wildlife habitat</li> </ul>	
	<ul> <li>Protection of large private forest tracts through Forest Legacy Program</li> </ul>	
WV Division of Natural Resources (WVDNR) <u>http://www.wvdnr.gov</u>	<ul> <li>Identification of SGCN and rare communities</li> <li>Education, outreach and teaching resources</li> <li>Field guides, Landscaping and Management guidelines</li> <li>Fish and game management</li> <li>Habitat restoration assistance</li> <li>Natural Areas Program</li> </ul>	

## **Appendix 6. Resources**

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

Long Range Plan for the Northern Panhandle, Upper Ohio, Little Kanawha, Western, and Guyan Conservation Districts

Summarize natural resources conditions and concerns that could be addressed through technical and financial assistance by NRCS and partners. Available at:

https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/wv/programs/financial/eqip/?cid=nrcseprd11676 06

Living on Karst- A Reference Guide for Landowners in Limestone Regions

http://www.livingonkarst.org/living\_on\_karst.htm

Guidelines for Cave and Karst Protection- IUCN

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

A Guide to Responsible Caving, by the National Speleological Society

https://caves.org/brochure/Guide to Resp Caving 2016.pdf

National Wild Turkey Foundation- Landowner's Toolbox

https://www.nwtf.org/conservation/category/landownershttps://caves.org/brochure/Guide\_to\_Resp\_C aving\_2016.pdf-tool-box

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

http://amjv.org/wp-content/uploads/2018/06/cerulean\_guide\_1-pg\_layout.pdf

Best Management Practices for Golden-winged Warbler Habitats in the Appalachian Region: A Guide for Land Managers and Landowners.

http://gwwa.org/resources/GWWA-APPLRegionalGuide\_130808\_lo-res.pdf

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

West Virginia Pollinator Handbook – A Field Office Technical Guide Reference to management of pollinators and their habitats. Developed by WV NRCS Ecological Sciences in conjunction with WV Division of Natural Resources and the Xerces Society for Invertebrate Conservation.

http://xerces.org/sites/default/files/publications/12-049.pdf

West Virginia Invasive Species Strategic Plan and Voluntary Guidelines, 2014

https://eos.ucs.uri.edu/seagrant\_Linked\_Documents/mdu/2014-09\_RO\_Anderson\_M\_INV-3b.pdf

Fighting Invasive Plants in West Virginia

http://www.wvnps.org/FightingInvasives.pdf

Brochures about Aquatic Invasive Species, Forest Pests and Pathogens, and Invasive Plant Species

https://www.nrcs.usda.gov/wps/portal/nrcs/main/wv/technical/ecoscience/invasive/

American Forest Foundation: Woodland owners planning tool for forest management

https://mylandplan.org/

The Nature Conservancy Resilient Land Mapping Tool and Documents:

http://maps.tnc.org/resilientland/

USDA Forest Service, Northern Research Station's Climate Change Atlas: documentation of current and possible future distribution of 134 tree species and 147 bird species in the Eastern United States

https://www.fs.fed.us/nrs/atlas/

USDA NRCS Climate-Smart Forestry and Agriculture Mitigation Practices

While NRCS offers a broad suite of voluntary conservation activities, the agency identifies a sub-set as critical to climate change mitigation. When applied appropriately, these activities may deliver <u>quantifiable reductions</u> in greenhouse gas emissions and/or increases in carbon sequestration. Many offer co-benefits and ancillary benefits that help operations build climate change resilience while addressing other natural resource concerns such as soil health, water quality, pollinator and wildlife habitat and air quality.

https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/climate/climate-smartmitigation-activities

Rudnick, D.A. et al. 2012. The Role of Landscape Connectivity in Planning and Implementing Conservation and Restoration Priorities. Ecological Society of America. <u>https://applcc.org/cooperative/our-organization/rudnick-et-al.-2012-the-role-of-landscapeconnectivity-in-planning-and-implementing-conservation-and-restoration-priorities</u>

Adaptation Workbook: A climate change tool for land management and conservation, created by the Northern Institute of Applied Climate Science:

https://adaptationworkbook.org/

U.S. Climate Resilience Toolkit, a website designed to help people find and use tools, information, and subject matter expertise to build climate resilience. The Toolkit offers information from all across the U.S. federal government in one easy-to-use location.

https://toolkit.climate.gov/tool/climate-smart-conservation-putting-adaptation-principles-practice

Forest Adaptation Resources: climate change tools and approaches for land managers, 2<sup>nd</sup> edition, 2016, published by the USDA Forest Service, Northern Research Station

https://www.nrs.fs.fed.us/pubs/52760

Adaptation Resources for Agriculture: Responding to Climate Variability and Change in the Midwest and Northeast. U.S. Department of Agriculture.

https://www.climatehubs.usda.gov/sites/default/files/AdaptationResourcesForAgriculture.pdf