12. LENOWISCO PLANNING REGION LOCAL ACTION PLAN SUMMARY

WILDLIFE ACTION PLAN AND LOCAL SUMMARIES OVERVIEW

Wildlife Action Plan

Virginia is fortunate to contain a wide variety of natural resources and landscapes that provide Virginians with a range of benefits, services, and economic opportunities. Natural resource conservation in Virginia, as in most states, is implemented by government agencies, non-governmental organizations, private institutions, academic institutions, and private citizens. These groups work to enhance the quality of life within the Commonwealth by conserving Virginia's air, land, water, and wildlife. Adequate funding and human capital needed to manage and conserve these valuable resources are not always available. In 2005, Virginia's conservation community first came together to maximize the benefits of their actions and created the state's first Wildlife Action Plan (Action Plan). It was written to prioritize and focus conservation efforts to prevent species from declining to the point where they become threatened or endangered (DGIF 2005). The 2015 Action Plan is an update of the original Plan. The Action Plan must address eight specific elements mandated by Congress. They are:

> *1. Information on the distribution and abundance of species of wildlife, including low and declining populations as the state fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the state's wildlife; and*
>
> *2. Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1); and*
>
> *3. Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats; and*
>
> *4. Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions; and*
>
> *5. Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions; and*
>
> *6. Descriptions of procedures to review the Plan-Strategy at intervals not to exceed ten years; and*
>
> *7. Plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the Plan-Strategy with federal, state, and local agencies and Indian tribes that manage significant land and water areas within the state or*

administer programs that significantly affect the conservation of identified species and habitats.

8. Congress has affirmed through the Wildlife Conservation and Restoration Program (WCRP) and State Wildlife Grants (SWG), that broad public participation is an essential element of developing and implementing these Plans-Strategies, the projects that are carried out while these Plans-Strategies are developed, and the Species in Greatest Need of Conservation (SGCN) that Congress has indicated such programs and projects are intended to emphasize.

Each species included in the 2015 Action Plan (Species of Greatest Conservation Need or SGCN) has been evaluated and prioritized based upon two criteria: degree of imperilment and management opportunity.

To describe imperilment, SGCN are grouped into one of four Tiers: Critical (Tier I), Very High (Tier II), High (Tier III), and Moderate (Tier IV).

Tier I - *Critical Conservation Need. Species face an extremely high risk of extinction or extirpation. Populations of these species are at critically low levels, face immediate threat(s), and/ or occur within an extremely limited range. Intense and immediate management action is needed.*

Tier II - *Very High Conservation Need. Species have a high risk of extinction or extirpation. Populations of these species are at very low levels, face real threat(s), and/ or occur within a very limited distribution. Immediate management is needed for stabilization and recovery.*

Tier III - *High Conservation Need. Extinction or extirpation is possible. Populations of these species are in decline, have declined to low levels, and/ or are restricted in range. Management action is needed to stabilize or increase populations.*

Tier IV - *Moderate Conservation Need. The species may be rare in parts of its range, particularly on the periphery. Populations of these species have demonstrated a declining trend or a declining trend is suspected which, if continued, is likely to qualify this species for a higher tier in the foreseeable future. Long-term planning is necessary to stabilize or increase populations*.

While degree of imperilment is an important consideration, it is often insufficient to prioritize the use of limited human and financial resources. In order to identify and triage conservation opportunities, development of the updated Action Plan (2015) included assigning a Conservation Opportunity Ranking to each species identified within the Plan. Rankings were assigned with input from taxa or species experts (biologists) and other members of Virginia's conservation community. They also are based on conservation or management actions and research needs identified for the species within the 2005 Action Plan. In addition, a literature review was conducted to garner any new information available since the first version of the Action Plan. The three Conservation Opportunity Rankings are described as follows:

A – Managers have identified "on the ground" species or habitat management strategies expected to benefit the species; at least some of which can be implemented with existing resources and are expected to have a reasonable chance of improving the species' conservation status.

B – Managers have only identified research needs for the species or managers have only identified "on the ground" conservation actions that cannot be implemented due to lack of personnel, funding, or other circumstance.

C – Managers have failed to identify "on the ground" actions or research needs that could benefit this species or its habitat or all identified conservation opportunities for a species have been exhausted.

Over 880 SGCN are listed in the 2015 Action Plan and found in varying densities across the state (Figure 1). Of the Plan's SGCN, 23.4 percent are classified as Conservation Opportunity Ranking A; 7.1 percent are classified Conservation Opportunity Ranking B; and 69.5 percent are classified as Conservation Opportunity Ranking C. Additionally, of the 883 SGCN:

- Approximately 25% of the SGCN are already listed as threatened or endangered under the Federal or Virginia Endangered Species Act,
- Approximately 60% are aquatic,
- Approximately 70% are invertebrates, and
- All are impacted by the loss or degradation of their habitats.

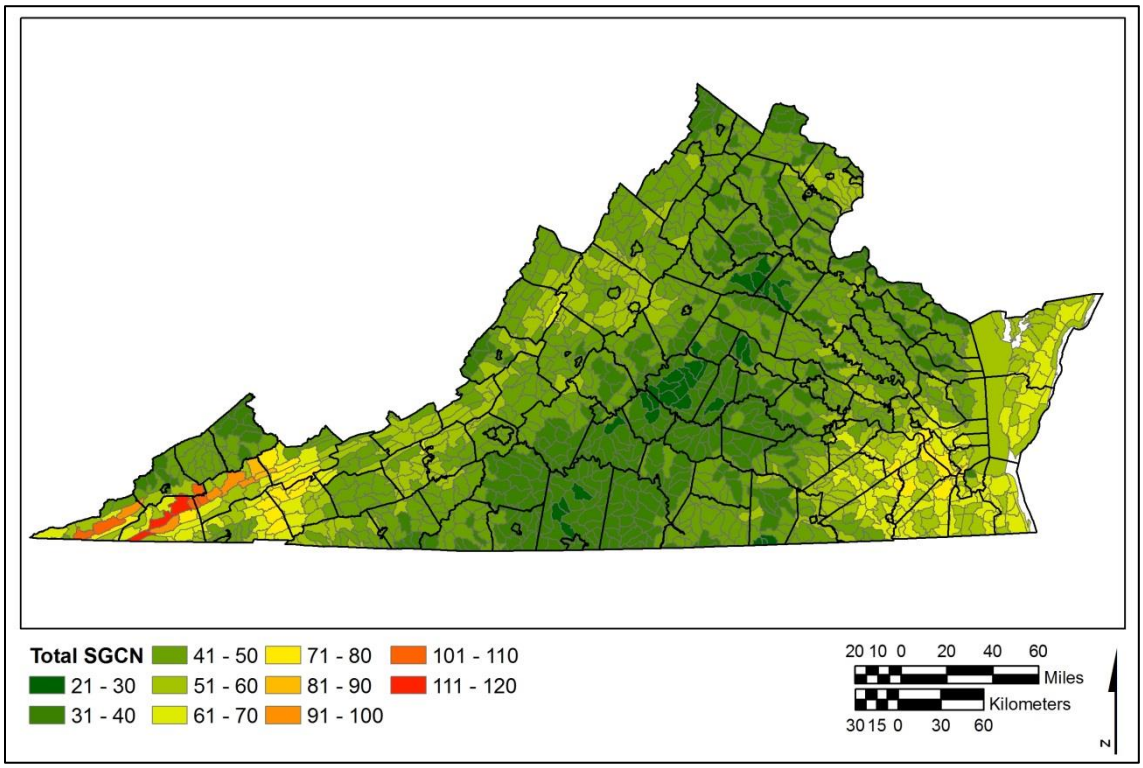

Figure 1. State Distribution of Species of Greatest Conservation Need by HUC12 Watersheds.

Wildlife Action Plan Implementation

Since its creation, the Wildlife Action Plan has helped Virginia acquire over $17 million in new conservation funding through the State Wildlife Grants Program. These resources have been used to implement significant research, advance species recovery efforts via captive propagation, and restore and conserve important wildlife habitats. Despite these successes, many conservation practitioners feel the original Wildlife Action Plan never reached its full potential. One common concern is that it failed to focus at the habitat level where the needs of many species could be addressed at once. Further, many partners indicated the original Action Plan did not provide sufficient details to help prioritize conservation needs and opportunities at a local scale, where many land use decisions are made, and conservation efforts are implemented. Lacking these local insights, it was often difficult for agencies, municipalities, organizations, academic institutions, and landowners to identify and focus on the highest priority wildlife conservation opportunities for their geographic area. To address this concern and make the Action Plan more user-friendly and relevant at a finer scale, this version (2015) of the Action Plan was developed to include locally-based summaries. These summaries identify species that are local priorities, habitats required to conserve those species, regional threats impacting species and habitats, and priority conservation actions that can be taken to address those threats. The goal of these summaries is to facilitate and benefit the work of local governments, conservation groups, landowners, and other members of the conservation community who wish to support wildlife conservation within their regions.

Local Action Plan Summaries

In creating the updated Action Plan, the Virginia Department of Game and Inland Fisheries (DGIF) adopted a model developed by the Virginia Department of Conservation and Recreation (DCR) for the Virginia Outdoors Plan. The Virginia Outdoors Plan describes recreational resource issues for 21 multi-county Recreational Planning Regions. Each Recreational Planning Region is roughly analogous to one of Virginia's 21 local Planning District Commissions (PDC). The PDCs are voluntary associations of local governments intended to foster intergovernmental cooperation by bringing together local officials, agency staff, the public, and partners to discuss common needs and develop solutions to regional issues. With its focus on local-scale actions, the Virginia Outdoors Plan has become an important tool for identifying and addressing local recreational issues. This DCR model was adapted and used in this Action Plan to address wildlife and habitat issues for the benefit of planning region residents. More broadly, the new Action Plan's Local Action Plan Summaries will create a framework that Virginia's diverse conservation community can use to identify issues and locations of mutual conservation interest, enhance collaborative opportunities, develop new conservation resources, and craft "win-win" situations that can be beneficial for both the people and wildlife of Virginia.

LENOWISCO Planning Region Summary Overview

The LENOWISCO Planning Region consists of 888,684 acres (1,389 square miles) and includes the counties of Lee, Scott, and Wise; city of Norton; and towns of Jonesville, Pennington Gap, St. Charles, Clinchport, Duffield, Dungannon, Gate City, Weber City, Nickelsville, Appalachia, Big Stone Gap, Coeburn, Pound, St. Paul, and Wise. The human population in this planning region is estimated to be over 91,000 people. Human populations in all counties and localities have been decreasing. They are not projected to increase (Weldon Cooper Center 2012).

Less developed and more rural areas often provide a diversity of valuable wildlife habitats, which can be degraded or lost as human populations grow or mining and other extractive uses expand. This planning region contains a range of SGCN, including 50 SGCN that have 100 percent of their distribution within LENOWISCO Planning Region. A large majority of these species depend on karst cave and spring habitats. Example species include: Finley's cave amphipod, rayed bean, long-headed cave beetle, Powell River crayfish, pink mucket, Dromedary pearlymussel, and blackside dace. The region also includes a variety of habitats such as spruce fir forests, mixed hardwood and conifer forests, young forests, retired agricultural land, karst, non-tidal wetlands, and warm and cold water streams and riparian habitats (Figure 2).

In developing conservation actions for habitats and priority species within this planning region, a number of factors must be considered to determine how limited resources can be allocated to best effect. A project's likely impact and probability of success, the effectiveness of historic and ongoing conservation actions, as well as logistical, economic, and political factors will all influence the selection and prioritization of conservation actions. Virginia's Wildlife Action Plan advocates a proactive approach that focuses conservation resources to manage species before they become critically imperiled and to implement projects that can simultaneously benefit multiple species and human communities. These factors were considered during development of the conservation actions included in the following sections as well as in analyzing the existing threats facing SGCN and their habitats. Threats and conservation actions are organized based on the habitat types found within this planning region upon which priority SGCN depend.

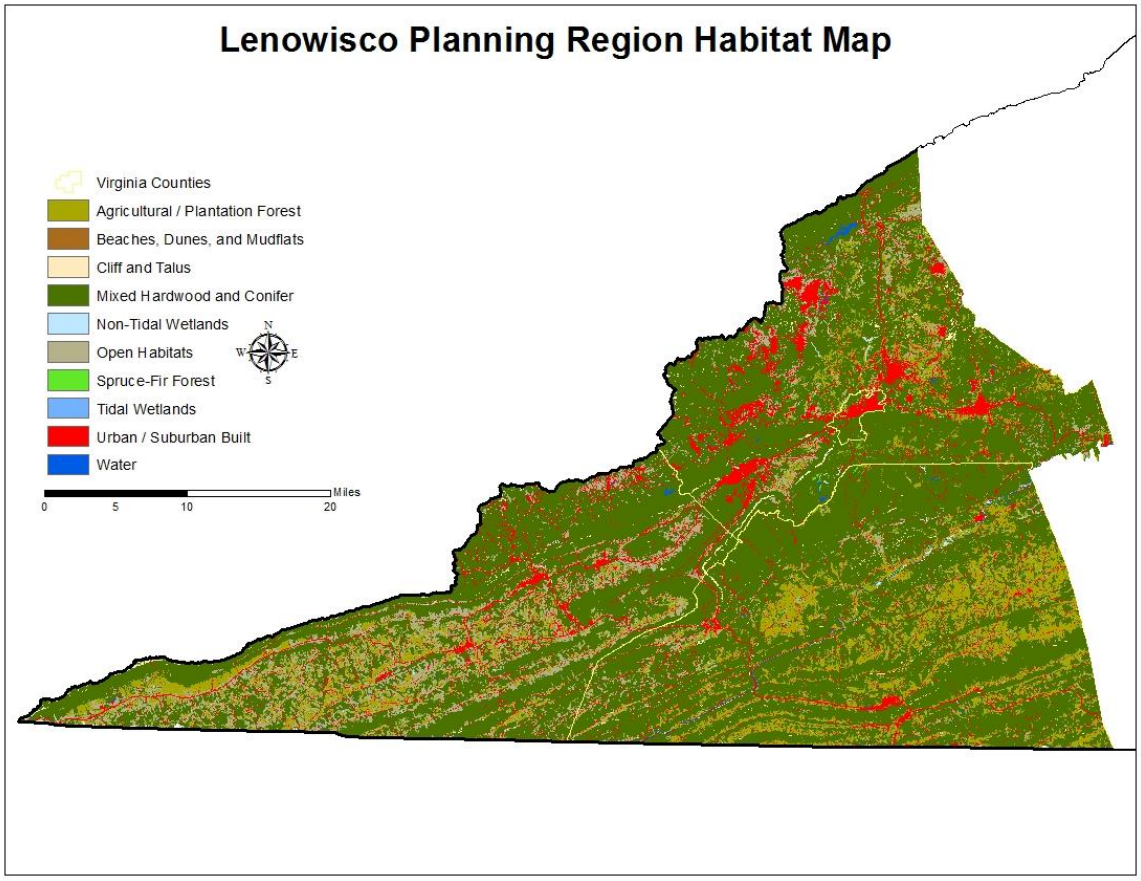

Figure 2. LENOWISCO Planning Region Habitats (Anderson et al. 2013).

Priority Species of Greatest Conservation Need

Of Virginia's 883 SGCN, 178 are believed to either occur, or have recently occurred, within LENOWISCO Planning Region (Appendix A). Of these 179 species, ***161 SGCN are dependent upon habitats provided within LENOWISCO Planning Region (Table2). These species constitute the priority SGCN for the region.*** A summary of SGCN Tier and Conservation Opportunity Rankings is provided in Table 1, while Figure 3 demonstrates the density of the 160 priority species within this region.

Priority SGCNs within this Local Summary include species for which this planning region comprises a significant portion of its range in Virginia. To determine species priority, the authors implemented a 10 percent rule to identify locally important species. Under the 10 percent rule, an SGCN is included in a Local Summary if the planning region provides at least 10 percent of that species' range in Virginia. However, there are several other instances that warrant inclusion on a planning region's priority SGCN list. First, several SGCN occur statewide but in low numbers in each planning region and will never reach the 10 percent threshold in any single planning region. Species that fall in this category were manually added to priority SGCN lists where appropriate. Some species only occur in three or fewer planning regions. These SGCN are also included on priority lists for the planning regions in which they are found due to their rarity in the state and the importance of those few planning regions to their survival. For migrant species

that may only be in Virginia for a matter of days, these migratory habitats are considered critical for their long-term conservation. When these circumstances were identified, specific migratory species were manually added to local SGCN lists as well. Finally, where a species may have a particularly strong population in a relatively small portion of a planning region, the population may be determined to be significant enough to warrant inclusion on the local SGCN list. Again, when these circumstances were identified, species were manually added to the local priority SGCN list.

Table 1. Tier and Conservation Opportunity Ranking Distribution among Priority SGCN.

Tier and Conservation Opportunity Rank	Number of SGCN
Ia	24
Ib	7
Ic	8
IIa	11
IIb	2
IIc	32
IIIa	8
IIIb	6
IIIc	14
IVa	17
IVb	9
IVc	23

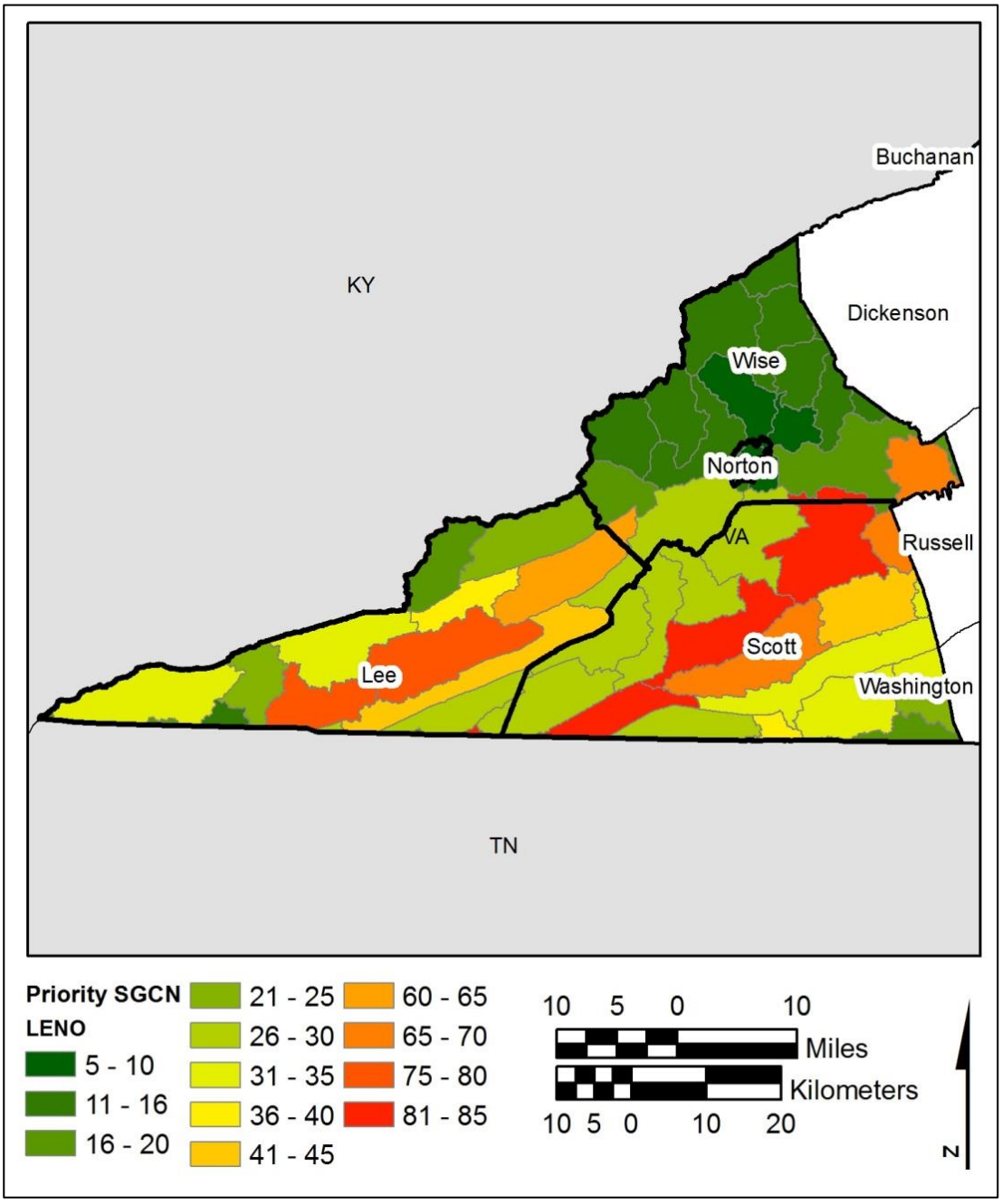

Figure 3. Priority SGCN Density in LENOWISCO Planning Region (HUC12 Watersheds).

Table 2. Priority Species of Greatest Conservation Need Distribution within LENOWISCO Planning Region.

Taxa	Conservation Status	Tier	Opportunity Ranking	Common Name	Scientific Name	Habitat
Amphibian		IV	c	Cumberland Plateau salamander	*Plethodon kentucki*	Mature hardwood forests in the vicinity of rocky outcrops
Amphibian	**CC**	I	a	Eastern hellbender	*Cryptobranchus alleganiensis alleganiensis*	Clean streams and rivers with rocky substrates
Amphibian		II	b	Green salamander	*Aneides aeneus*	Damp, but not wet, crevices in shaded rock outcrops and ledges in forested areas
Amphibian		II	a	Mountain chorus frog	*Pseudacris brachyphona*	Forested areas up to 3500 feet that contain suitable breeding sites
Amphibian		II	c	Southern zigzag salamander	*Plethodon ventralis*	Hardwood forests in the vicinity of rocky outcrops
Bird		III	a	Barn owl	*Tyto alba*	Fields of dense grass. Open and partly open country (grassland, marsh, lightly grazed pasture, hayfields) in a wide variety of situations, often around human habitation.
Bird		III	b	Belted kingfisher	*Megaceryle alcyon*	Primarily along water, both freshwater and marine, including lakes, streams, wooded creeks and rivers, seacoasts, bays, estuaries, and mangroves. Perches in trees, on over hanging branches, posts and utility wires.
Bird		IV	a	Black-and-white warbler	*Mniotilta varia*	Habitat generalist with broad habitat tolerances
Bird		IV	a	Brown thrasher	*Toxostoma rufum*	Thickets and bushy areas in deciduous forest clearings and forest edge, shrubby areas and gardens; in migration and winter also in scrub
Bird		IV	b	Canada warbler	*Cardellina canadensis*	Breeding habitat includes moist thickets of woodland undergrowth (especially aspen-poplar), bogs, tall shrubbery along streams or near swamps, and deciduous second growth.
Bird		II	a	Cerulean warbler	*Setophaga cerulea*	A structurally mature hardwood forest in a mesic or wetter situation, with a closed canopy
Bird		IV	b	Chimney swift	*Chaetura pelagica*	Inhabits rural and urban environments having both an abundance of flying arthropods and suitable roosting/nesting sites
Bird		IV	a	Eastern kingbird	*Tyrannus tyrannus*	Forest edge, open situations with scattered trees and shrubs, cultivated lands with bushes and fencerows, and parks; in winter more closely associated with forest clearings and borders
Bird		IV	a	Eastern meadowlark	*Sturnella magna*	Grasslands, savanna, open fields, pastures, cultivated lands, sometimes marshes

Bird		IV	a	Eastern towhee	*Pipilo erythrophthalmus*	Inhabits forest and swamp edges, regenerating clearcuts, open-canopied forests, particularly those with a well-developed understory, reclaimed strip mines, mid-late successional fields, riparian thickets, overgrown fencerows, shrub/small-tree thickets, and other brushy habitats.
Bird		IV	b	Eastern wood-pewee	*Contopus virens*	Inhabits a wide variety of wooded upland and lowland habitats including deciduous, coniferous, or mixed forests
Bird		IV	a	Field sparrow	*Spizella pusilla*	Old fields, brushy hillsides, overgrown pastures, thorn scrub, deciduous forest edge, sparse second growth, fencerows
Bird		IV	a	Grasshopper sparrow	*Ammodramus savannarum*	Grassland obligate
Bird		IV	a	Gray catbird	*Dumetella carolinensis*	Thickets, dense brushy and shrubby areas, undergrowth of forest edge, hedgerows, and gardens, dense second growth
Bird		IV	b	Green heron	*Butorides virescens*	Swamps, mangroves, marshes, and margins of ponds, rivers, lakes, and lagoons
Bird		III	a	Kentucky warbler	*Geothlypis formosa*	Humid deciduous forest, dense second growth, swamps
Bird		IV	b	Northern Flicker	*Colaptes auratus*	Open forest, both deciduous and coniferous, open woodland, open situations with scattered trees and snags, riparian woodland, pine-oak association, parks
Bird	**ST**	I	a	Peregrine falcon	*Falco peregrinus*	Human structures in the east and cliff sites in the west
Bird		III	a	Ruffed grouse	*Bonasa umbellus*	Dense forest with some deciduous trees, in both wet and relatively dry situations from boreal forest (especially early seral stages dominated by aspen) and northern hardwood ecotone to eastern deciduous forest and oak-savanna woodland.
Bird		II	b	Swainson's warbler	*Limnothlypis swainsonii*	Forested moist lower slopes with a rhododendron shrub layer
Bird		IV	b	Wood thrush	*Hylocichla mustelina*	Deciduous or mixed forests with a dense tree canopy and a fairly well-developed deciduous understory, especially where moist
Bird		III	a	Yellow-billed cuckoo	*Coccyzus americanus*	Open woodland (especially where undergrowth is thick), parks, deciduous riparian woodland
Bird		IV	a	Yellow-breasted chat	*Icteria virens*	Second growth, shrubby old pastures, thickets, bushy areas, scrub, woodland undergrowth, and fence rows, including low wet places near streams, pond edges, or swamps; thickets with few tall trees; early successional stages of forest regeneration; commonly in sites close to human habitation.
Crustacean	**FSSE**	I	c	Big Sandy Crayfish	*Cambarus veteranus*	Warm streams with fast flows and bedrock, cobble, boulder, and sand substrates
Crustacean		II	c	Cumberland cave amphipod	*Stygobromus cumberlandus*	Caves with clean abundant water flowing through the system
Crustacean	**FS**	I	c	Cumberland Gap cave amphipod	*Bactrurus angulus*	Caves with clean abundant water flowing through the system

Crustacean	**FS**	II	c	Cumberland Gap cave isopod	*Caecidotea cumberlandensis*	Caves with clean abundant water flowing through the system
Crustacean		II	c	Finley's cave amphipod	*Stygobromus finleyi*	Caves with clean abundant water flowing through the system
Crustacean		II	c	Lee County cave amphipod	*Stygobromus leensis*	Caves with clean abundant water flowing through the system
Crustacean	**FESE**	III	c	Lee County cave isopod	*Lirceus usdagalun*	Caves with clean abundant water flowing through the system
Crustacean		III	b	Longclaw crayfish	*Cambarus buntingi*	Clean creeks and streams with sand, gravel, clay, or silt substrates
Crustacean	**FS**	II	c	Powell Valley terrestrial isopod	*Amerigoniscus henroti*	Caves with clean abundant water flowing through the system
Crustacean		III	c	Reticulate crayfish	*Orconectes erichsonianus*	Streams with rocky substrates
Crustacean	**FS**	I	a	Rye Cove isopod	*Lirceus culveri*	Caves with clean abundant water flowing through the system
Crustacean	**FS**	II	c	Spiny scale crayfish	*Cambarus jezerinaci*	High elevation high gradient spring fed streams
Crustacean		IV	c	Surgeon crayfish	*Orconectes forceps*	Streams with rocky substrates
Fish	**FS**	I	b	Ashy darter	*Etheostoma cinereum*	Clear cool or warm streams with moderate gradient with rubble and boulder substrates
Fish		IV	c	Blotched chub	*Erimystax insignis*	Clean, cool to warm, streams and rivers with moderate gradient and clean gravel and rubble substrates
Fish	**FS**	II	a	Blotchside logperch	*Percina burtoni*	Clear warm moderate gradient rivers with gravel or rubble substrates
Fish		IV	c	Bluebreast darter	*Etheostoma camurum*	Clear warm streams and rivers with moderate gradient with silt free gravel, rubble, or boulder substrates
Fish		IV	c	Brook silverside	*Labidesthes sicculus*	Clear cool or warm lakes and large rivers and can tolerate various substrates and various amounts of aquatic vegetation
Fish		IV	a	Brook trout	*Salvelinus fontinalis*	Clear, cool, well-oxygenated creeks, small to medium rivers, and lakes
Fish		IV	c	Bullhead minnow	*Pimephales vigilax*	Pools, backwaters, and quiet runs of small to large rivers having continuous flow and low to moderate gradient, over sand, silt, or gravel
Fish		III	c	Channel darter	*Percina copelandi*	Warm rivers with moderate to swift flows and gravel and rubble substrate
Fish	**FS**	III	c	Clinch sculpin	*Cottus sp. 4*	Cold clear spring runs to rivers with moderate to high gradients and unsilted gravel, rubble, and boulder substrates
Fish		III	c	Common mudpuppy	*Necturus maculosus maculosus*	Permanent lakes, ponds, impoundments, streams, and rivers with suitable hiding cover
Fish		IV	c	Dusky darter	*Percina sciera*	Warm streams and rivers with low gradients and unsilted gravel

						substrates
Fish	**FESE**	I	a	Duskytail darter	*Etheostoma percnurum*	Clear, warm, moderate gradient intermontane streams and rivers with clean gravel, rubble, or boulder substrates
Fish	**ST**	IV	c	Emerald shiner	*Notropis atherinoides*	Clear large streams and rivers with low gradient
Fish		III	c	Freshwater drum	*Aplodinotus grunniens*	Warm turbid water in lakes, reservoirs, and pools in low gradient rivers over mud substrate
Fish		IV	c	Logperch	*Percina caprodes*	Warm, moderate gradient, streams and rivers with gravel and rubble substrates
Fish		III	c	Mirror shiner	*Notropis spectrunculus*	Clear warm moderate gradient rivers with gravel or rubble substrates
Fish		III	c	Mountain brook lamprey	*Ichthyomyzon greeleyi*	Cool creeks or streams with moderate flow and clean substrates with access to pool sediments and muddy banks for ammocoetes
Fish		IV	c	Mountain madtom	*Noturus eleutherus*	Clear, warm streams and rivers with gravel and rubble substrates and vegetated riffles
Fish		IV	c	Mountain shiner	*Lythrurus lirus*	Typically in clear, flowing, riffle-pool type creeks and small rivers with moderate gradients and bottom materials ranging from sand- gravel to rubble-boulder
Fish		IV	c	Northern studfish	*Fundulus catenatus*	Cutoff pools, backwaters, and sluggish margins of clear, warm, moderate gradient creeks, streams and rivers with a variety of substrates
Fish		IV	c	Ohio lamprey	*Ichthyomyzon bdellium*	Large warm rivers with clean gravel and rubble substrates and access to low gradient areas with soft substrates and detrital material for ammocoetes
Fish	**ST**	IV	c	Paddlefish	*Polyodon spathula*	Warm medium to large rivers with very low flows
Fish		II	c	Popeye shiner	*Notropis ariommus*	Clear warm moderate gradient rivers with gravel or rubble substrates
Fish		III	b	River redhorse	*Moxostoma carinatum*	Clean streams and rivers with unsilted gravel, rubble, and boulder substrates
Fish		IV	c	Sand shiner	*Notropis stramineus*	Warm streams with low to moderate gradient and clean sand and gravel substrates
Fish		III	b	Sauger	*Sander canadensis*	Cool large streams, rivers, and lakes with a combination of deep swift runs and backwaters
Fish	**FTST**	I	c	Slender chub	*Erimystax cahni*	Clear, open, and swift streams and rivers with unsilted gravel substrates
Fish		IV	c	Speckled darter	*Etheostoma stigmaeum*	Aquatic
Fish	**FTST**	I	b	Spotfin chub	*Erimonax monachus*	Clean medium sized streams and rivers with clean gravel and cobble substrate
Fish	**ST**	III	c	Steelcolor shiner	*Cyprinella whipplei*	Warm low to moderate gradient streams and rivers over a variety of substrates

Fish		IV	c	Stonecat	*Noturus flavus*	Warm streams and rivers with moderate to low gradient with rocky substrates
Fish		IV	b	Swannanoa darter	*Etheostoma swannanoa*	Cool clear streams with moderate to high gradient with clean gravel, rubble, and boulder substrates
Fish		IV	c	Tangerine darter	*Percina aurantiaca*	Clean, cool and warm streams and rivers with moderate gradient and a variety of substrates
Fish	**SE**	I	b	Tennessee dace	*Chrosomus tennesseensis*	Clean creeks with rock, gravel, or silt substrates and stable banks
Fish	**SE**	I	a	Variegate darter	*Etheostoma variatum*	Warm to cool water streams with clean gravel, rubble, or boulder substrates
Fish	**ST**	IV	c	Western sand darter	*Ammocrypta clara*	Warm, low and moderate gradient rivers with sand and sand-gravel substrates
Fish		III	c	Wounded darter	*Etheostoma vulneratum*	Warm moderate gradient streams and rivers with clean gravel and rubble substrate
Fish	**FTST**	I	a	Yellowfin madtom	*Noturus flavipinnis*	Warm, clear streams and rivers with moderate gradient and variety of cover types
FW Mollusk	**FESE**	I	a	Appalachian monkeyface	*Quadrula sparsa*	Medium sized rivers with moderate flow velocity, shallow depth, and mixed substratum of gravel, sand and cobble
FW Mollusk	**FESE**	I	a	Birdwing pearlymussel	*Lemiox rimosus*	Aquatic
FW Mollusk	**ST**	III	a	Black sandshell	*Ligumia recta*	Medium to large rivers with strong currents and sand, gravel, and cobble substrates
FW Mollusk		III	c	Brown walker	*Pomatiopsis cincinnatiensis*	Amphibious - vegetated banks of streams, creeks, and rivers
FW Mollusk		II	c	Coal elimia	*Elimia aterina*	Little is known about this species' habitat needs. It is found in flowing water in the Clinch and Powell Rivers
FW Mollusk	**FESE**	I	b	Cracking pearlymussel	*Hemistena lata*	Medium sized rivers with moderate current and mud, sand, and fine gravel substrates
FW Mollusk		IV	a	Creeper	*Strophitus undulatus*	It is usually found in streams and rivers in a range of flow conditions (rarely in high-gradient streams of mountainous regions) but can tolerate lakes and ponds, particularly in outlets.
FW Mollusk	**FESE**	I	a	Cumberland bean	*Villosa trabalis*	Clear, warm streams and small rivers with moderate to swift currents and unsilted sand, gravel, and rubble substrates
FW Mollusk		IV	a	Cumberland moccasinshell	*Medionidus conradicus*	Small headwater streams with sand and gravel substrates and extends well into medium sized rivers
FW Mollusk	**FESE**	I	a	Cumberland monkeyface	*Quadrula intermedia*	Small to medium sized streams with fast current and silt-free sand, gravel, and rubble substrates
FW Mollusk	**FESE**	I	a	Cumberlandian combshell	*Epioblasma brevidens*	Large creeks to large rivers with gravel, cobble, and boulder substrates

FW Mollusk	**SE**	III	b	Deertoe	*Truncilla truncata*	This species is a generalized in terms of substrate preference, usually occurring in fine gravel mixed with sand and mud. It is also considered a generalist in terms of the size of rivers it inhabits. It is more common in medium-sized rivers but may become numerous in large rivers, where it can live at depths of 12 to 18 feet. It will also establish viable populations in lakes lacking current
FW Mollusk	**FESE**	I	a	Dromedary pearlymussel	*Dromus dromas*	Clean fast moving water with firm, unsilted, sand and gravel substrates
FW Mollusk	**SE**	III	a	Elephant ear	*Elliptio crassidens*	Large creeks to rivers with moderate to swift currents and mud, sand, or rocky substrates
FW Mollusk		II	c	Elktoe	*Alasmidonta marginata*	Small shallow rivers with moderately fast current and sand and gravel substrates
FW Mollusk	**FESE**	I	a	Fanshell	*Cyprogenia stegaria*	Mixed substrates of gravel, sand and cobble
FW Mollusk	**FESE**	I	a	Fine-rayed pigtoe	*Fusconaia cuneolus*	Clear high gradient streams in unsilted gravel and cobble substrates
FW Mollusk	**FC**	II	a	Fluted kidneyshell	*Ptychobranchus subtentum*	Small to medium rivers with swift current and sand, gravel, or cobble substrates
FW Mollusk	**ST**	IV	b	Fragile papershell	*Leptodea fragilis*	This species is tolerant of a variety of aquatic habitats and can be found in small streams in strong current with coarse gravel and sand substrates but also rivers or river-lakes possessing slow current and a firm substrate composed of sand and mud. It can occur at depths of up to 15 or 20 feet but reaches greatest population density at normal water levels of three feet or less in areas such as shallow embayments
FW Mollusk		I	a	Golden riffleshell	*Epioblasma florentina aureola*	Aquatic
FW Mollusk	**FESE**	I	c	Little-winged pearlymussel	*Pegias fabula*	High gradient headwater streams
FW Mollusk		III	a	Longsolid	*Fusconaia subrotunda*	Medium to large rivers with strong currents and sand and gravel substrates
FW Mollusk		IV	a	Mountain creekshell mussel	*Villosa vanuxemensis vanuxemensis*	Very clean small headwaters creeks and streams with sand and gravel substrates and associated with *Justicia* beds
FW Mollusk	**SE**	III	c	Ohio pigtoe	*Pleurobema cordatum*	Medium and large rivers with flow with gravel, cobble, and boulder substrates, but can also tolerate some reservoir environments
FW Mollusk	**FESE**	I	a	Oyster mussel	*Epioblasma capsaeformis*	Warm creeks and rivers with moderate to swift current and sand, gravel, and boulder substrates
FW Mollusk	**ST**	IV	b	Pimple back	*Quadrula pustulosa pustulosa*	This species has generalized habitat preferences and can maintain abundant and viable populations in shallow to deep sections of large reservoirs as well as in small to medium-sized free-flowing rivers. It is usually found in a substrate consisting of coarse gravel, sand, and silt
FW Mollusk		III	b	Pink heelsplitter	*Potamilus alatus*	On a variety of substrates in slow to swiftly flowing wate

FW Mollusk	**FESE**	I	a	Pink mucket	*Lampsilis abrupta*	Either flowing or standing water with gravel, sand, silt, or mud substrates
FW Mollusk		IV	a	Pocketbook mussel	*Lampsilis ovata*	Either flowing or standing water with gravel, sand, silt, or mud substrates
FW Mollusk		IV	c	Proud globe snail	*Mesodon elevatus*	Calcareous river bluffs and ravines with oak, maple, hickory, or sycamore
FW Mollusk	**FESE**	I	a	Purple bean	*Villosa perpurpurea*	Headwaters, creeks, and rivers and can tolerate a variety of currents and substrates
FW Mollusk	**FSSE**	II	a	Pyramid pigtoe	*Pleurobema rubrum*	Medium and large rivers with flow and stable mud or mud/sand substrates
FW Mollusk	**FP**	II	a	Rayed bean	*Villosa fabalis*	Flowing water in headwater creeks with sand and gravel substrates and vegetation
FW Mollusk	**FESE**	I	a	Rough pigtoe	*Pleurobema plenum*	Medium to large rivers with sand, gravel, and cobble substrates
FW Mollusk	**FESE**	I	a	Rough rabbitsfoot	*Quadrula cylindrica strigillata*	Warm medium to large rivers with swift currents and silt, sand, gravel, or cobble substrates
FW Mollusk	**FPST**	II	a	Sheepnose	*Plethobasus cyphyus*	Warm large rivers and reservoirs with gravel and cobble substrates
FW Mollusk	**FESE**	I	a	Shiny pigtoe	*Fusconaia cor*	Moderate to swift current with stable sand, gravel, or cobble substrates
FW Mollusk	**FCST**	II	a	Slabside pearlymussel	*Lexingtonia dolabelloides*	Large creeks to moderate rivers with moderate flow and gravel and sand substrates
FW Mollusk	**SE**	I	b	Slippershell mussel	*Alasmidonta viridis*	Headwater creeks and small streams with constant flow and mud, sand, or gravel substrates and aquatic vegetation
FW Mollusk	**FPSE**	I	a	Snuffbox	*Epioblasma triquetra*	Small to medium sized creeks with swift current and sand, gravel, and cobble substrates
FW Mollusk	**FPSE**	I	b	Spectaclecase	*Cumberlandia monodonta*	Under slab rocks or in crevices beneath bedrock shelves
FW Mollusk	**SE**	II	c	Spider Elimia	*Elimia arachnoidea*	Little is known about this species' habitat needs. It has only been found in small streams
FW Mollusk	**FSST**	III	a	Spiny riversnail	*Io fluvialis*	Large rocks and bedrock outcrops in well-oxygenated shallow water with fast current
FW Mollusk		III	a	Tennessee clubshell	*Pleurobema oviforme*	Creeks and small rivers with moderate flow and sand/ gravel substrates
FW Mollusk	**SE**	II	a	Tennessee heelsplitter	*Lasmigona holstonia*	Small headwater streams with sand or mud substrates
FW Mollusk	**FS**	II	a	Tennessee pigtoe	*Fusconaia barnesiana*	Headwater streams to rivers with moderate to high flow and unsilted gravel/ sand rubble, or boulder substrates
FW Mollusk		IV	c	Three-ridge valvata	*Valvata tricarinata*	Unknown habitat needs in Virginia but in other parts of the country this species is associated with aquatic vegetation
FW Mollusk	**FSSE**	I	a	Unthanks Cave snail	*Holsingeria unthanksensis*	Karst obligate that requires clean water flowing through the system

Insect	**FS**	II	c	A cave beetle	*Pseudanophthalmus seclusus*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Burkes Garden cave beetle	*Pseudanophthalmus hortulanus*	Caves with clean abundant water flowing through the system.
Insect	**FS**	II	c	Cherokee clubtail	*Gomphus consanguis*	Small shady spring fed streams with mud bottoms
Insect	**FS**	II	c	Cumberland Gap cave beetle	*Pseudanophthalmus hirsutus*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Deceptive cave beetle	*Pseudanophthalmus deceptivus*	Caves with clean abundant water flowing through the system
Insect		II	c	Green-faced clubtail	*Gomphus viridifrons*	Large rivers with rocks and moderate current
Insect	**FSSE**	I	c	Holsinger's cave beetle	*Pseudanophthalmus holsingeri*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Little Kennedy Cave beetle	*Pseudanophthalmus cordicollis*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Lobed roachfly	*Tallaperla lobata*	Unknown but stoneflies generally occur in fast flowing water with rocky substrates
Insect	**FS**	II	c	Long-headed cave beetle	*Pseudanophthalmus longiceps*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Overlooked cave beetle	*Pseudanophthalmus praetermissus*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Rotund cave beetle	*Pseudanophthalmus rotundatus*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Saint Paul cave beetle	*Pseudanophthalmus sanctipauli*	Caves with clean abundant water flowing thru the system.
Insect	**FS**	II	c	Silken cave beetle	*Pseudanophthalmus sericus*	Caves with clean abundant water flowing through the system
Insect	**FS**	II	c	Thomas' cave beetle	*Pseudanophthalmus thomasi*	Caves with clean abundant water flowing through the system
Mammal		IV	c	Allegheny woodrat	*Neotoma magister*	Blue Ridge to the west - cliffs dry rocky slopes, talus, and exposed ridges
Mammal		I	c	Eastern small-footed myotis	*Myotis leibii*	Hibernation occurs in solution and fissure caves and mine tunnels (including coal, iron, copper, and talc mines). Situations near the entrance where the air is relatively cold and dry seem to be preferred, though sometimes deeper locations are used. Roost sites often are deep in crevices, or under rocks on the cave floor. Forages over ponds and streams.

Mammal	**FESE**	II	a	Gray bat	*Myotis grisescens*	Winter roosts are in deep vertical caves with domed halls. Large summer colonies utilize caves that trap warm air and provide restricted rooms or domed ceilings; maternity caves often have a stream flowing through them and are separate from the caves used in summer by males. Forage along steams flowing through forested areas.
Mammal	**FESE**	I	b	Indiana bat	*Myotis sodalis*	West of Shenandoah River - winter site specific caves, summer forested areas containing trees with scaly or shaggy bark as well as dead trees
Mammal		IV	c	Long-tailed shrew	*Sorex dispar dispar*	West of Shenandoah talus slopes, rock slides and cliffs surrounded by forests
Other Aquatic Invertebrate	**FS**	I	c	Powell Valley planarian	*Sphalloplana consimilis*	Caves with clean abundant water flowing through the system
Other Terrestrial Invertebrate	**FS**	II	c	A cave pseudoscorpion	*Kleptochthonius binoculatus*	Caves with clean abundant water flowing through the system
Other Terrestrial Invertebrate	**FS**	II	c	A cave pseudoscorpion	*Kleptochthonius proximosetus*	Caves with clean abundant water flowing through the system
Other Terrestrial Invertebrate	**FS**	II	c	A cave pseudoscorpion	*Kleptochthonius similis*	Caves with clean abundant water flowing through the system
Other Terrestrial Invertebrate	**FS**	II	c	A millipede	*Brachoria dentata*	No habitats have been identified for this species
Other Terrestrial Invertebrate	**FS**	II	c	Cedar millipede	*Brachoria cedra*	No habitats have been identified for this species
Other Terrestrial Invertebrate	**FS**	II	c	Gertsch's cave pseudoscorpion	*Kleptochthonius gertschi*	Caves with clean abundant water flowing through the system
Other Terrestrial Invertebrate	**FS**	II	c	Lutz's cave pseudoscorpion	*Kleptochthonius lutzi*	Caves with clean abundant water flowing through the system
Other Terrestrial Invertebrate	**FS**	II	c	Valentine's cave pseudoscorpion	*Microcreagris valentinei*	Caves with clean abundant water flowing through the system
Reptile		III	c	Cumberland slider	*Trachemys scripta troostii*	A variety of freshwater habitats including rivers, ponds, lakes, and roadside ditches

Reptile	III	c	Eastern black kingsnake	*Lampropeltis getula nigra*	This species is known to utilize various habitats including Dry rocky hills, open woods, dry prairies, stream valleys, and many other habitats.
Reptile	IV	a	Northern map turtle	*Graptemys geographica*	Clear flowing water with gravel substrates
Reptile	IV	a	Spiny softshell	*Apalone spinifera spinifera*	Clean clear rivers with flowing water and sand substrates
Reptile	IV	a	Stripe-necked musk turtle	*Sternotherus minor peltifer*	Warm streams with fast flows and rock and cobble substrates

** Federal Endangered (FE), State Endangered (SE), Federal Threatened (FT), State Threatened (ST), Federal Species of Concern (FS), Federal Candidate (FC), Federal Proposed (FP), and Species of Collection Concern (CC).

Conserved Lands in the LENOWISCO Planning Region

Recognizing the importance of the local habitats to resident and migratory wildlife, state, federal, and private entities have made significant investments to conserve lands within this planning region. Conservation mechanisms range from national forests to state parks and wildlife management areas to conservation easements. Significant conservation assets, in terms of size, include:

- George Washington and Jefferson National Forests,
- Cumberland Gap National Historical Park,
- Natural Tunnel State Park,
- Wilderness Road State Park, and
- The Cedars State Natural Area Preserve.

These properties contain a diversity of open water, forest, agricultural, and wetland habitats (Figure 4). They have been conserved to provide a range of conservation, recreational, and economic benefits such as habitat protection and restoration, ecotourism, and fishing and hunting opportunities.

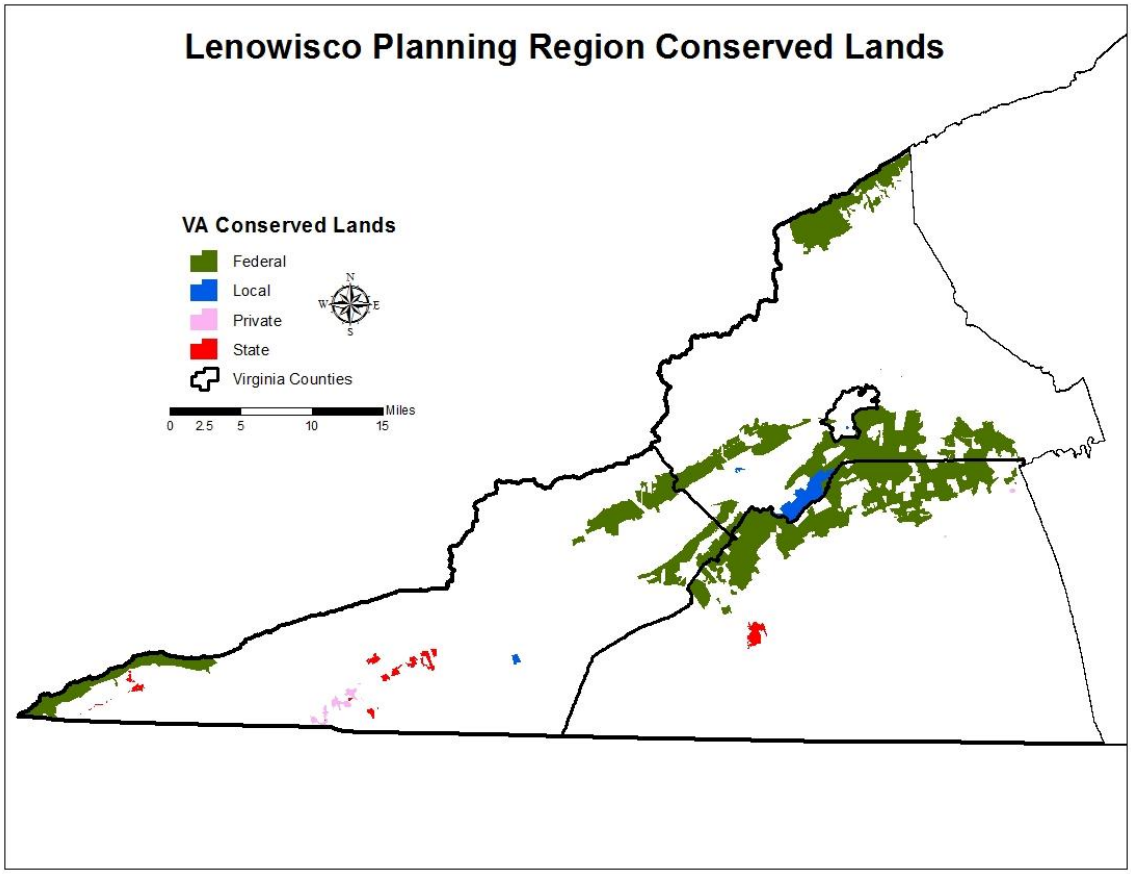

Figure 4. Conservation Lands in LENOWISCO Planning Region (DCR, Natural Heritage 2014).

These properties serve as an important component of wildlife conservation efforts on within Crater Planning Region. Healthy and important habitats have been conserved within their boundaries; however, working to conserve other lands could be beneficial for many SGCN and habitats within the region. Although there may be concern over the economic and social impacts of putting lands into conservation, many of these areas provide recreation and ecotourism benefits (DCR 2013; Carver and Caudill 2013). Through these mechanisms local economies could be bolstered; however, insufficient data exist to fully describe the benefits and drawbacks of lands held in conservation within the planning region. To balance these interests, especially as conditions change, it will be critical for the conservation community to actively engage with local governments and stakeholders to ensure that conservation spending is beneficial for both wildlife and localities.

Climate Change Impacts in the LENOWISCO Planning Region

Changes in temperature and precipitation will likely negatively affect habitats and SCGN in the LENOWISCO Planning Region. Based on scientific reports and research, it is clear that temperatures in the state will get warmer. The National Climate Assessment (NCA) is a national climate assessment that provides state level information. The NCA indicates Virginia's average temperature could increase by as much as 7°F by 2100 (Melilo et al. 2014). Earlier models used for Virginia's 2008 Climate Action Plan project that average temperatures may increase by 3.1°C (5.6°F) by the end of the century in Virginia (Governor's Commission on Climate Change 2008).

Temperature changes are likely to be even greater in the Appalachians than at lower elevations due to a range of factors such as snow albedo, water vapor changes and latent heat release, aerosols, among others (Staudinger et al. 2015). Projections also indicate a likely increase in summer high temperatures and longer growing seasons (Staudinger et al. 2015). These changes could affect depth of snow pack and earlier snow melt.

Increased temperatures may lead to heat stress for species and affect water temperature, temperature regime timing, and associated behaviors as well as potentially resulting in changes to food availability (Boicourt and Johnson 2011; Kane 2013). Temperature increases may also be problematic for species at the edge of their ranges. For example, if species are at the more southern end of their range, they may not survive significant increases in temperature that are greater than they can withstand (Pyke et al., 2008). Warmer temperatures may also result in warmer waters, which could favor parasites and other pests in aquatic environments (Pyke et al. 2008; Najjar et al. 2010; Kane 2013). Additionally, if temperatures and precipitation change such that season length is altered, fish and other species reproductive cycles and other phenological processes may be affected. Ecological conditions may also be altered, including food supplies and sympatric animal behaviors (e.g., fish migrations and nest building).

CONSERVATION THREATS AND ACTIONS FOR WILDLIFE AND HABITATS IN THE LENOWISCO PLANNING REGION

The following sections on threats, conservation actions, and conservation priorities are subdivided based on habitat type. Key habitat conservation strategies, actions, threats, and other impacts are summarized in Table 3. In many cases, actions taken to protect or enhance habitat will positively affect many LENOWISCO Planning Region priority SGCN and other species. Many of these activities are also expected to benefit landowners and communities.

Table 1. Summary Conservation Strategies and Actions for LENOWISCO Planning Region.

Conservation Strategy	Conservation Action	Threats Addressed	Economic/ Human Benefits	Priority Areas
Protect karst habitats	1) Maintain vegetative cover within watersheds where subterranean species occur; 2) Establish vegetative buffers around springs and sinkholes; 3) Minimize nutrients and sediments flowing into the system; 4) Establish parks, greenways, or other conserved lands above karst systems; 5) Develop water conservation and use strategies to help minimize groundwater depletion; and 6) Better control fecal matter and sewage.	Commercial/residential water consumption, sedimentation and pollutants; protection of cave entrances	Drinking water quality; sustainability of private landowner wells and residential water supply	Areas underlain by karst geology. Additional areas include Rye Cove, Cedar and Copper Creek
Enhance, maintain, and restore aquatic and riparian habitats	1) Establish vegetative and/ or forested buffers along streams and sinkholes as well as in agricultural, urban and residential areas; 2) Restore/stabilize eroding stream banks; 3) Reclaim/ revegetate disturbed forest lands and abandoned mine lands; 4) Exclude livestock from streams; 5) Improve pasture and loafing lot management to prevent manure-tainted runoff from flowing into streams; 6) Repair or replace failing septic systems and eliminating "straight pipes;" 7) Implement urban storm water management BMPs; 8) Preventing pet waste from entering streams; 9) Continue to identify impaired waters within the planning region; 10) Remove barriers to aquatic connections; 11) Monitor and address invasive species impacts; and 12) Adopt land use practices or policies through zoning or other means to help improve the health of aquatic systems.	Sedimentation, contaminants loading, water chemistry alteration, temperature regime alteration, stream nutrient dynamics alteration, land use changes, water withdrawals, climate change, invasive species	Address TMDL concerns by reducing amounts of sediment, nutrients, pesticides, and other pollutants that enter water ways; sustain sport fisheries and recreation opportunities; contribute to clean water supply	Big Moccasin Creek, Blue Springs Branch, Cove Creek, Dowell Branch, Hiltons Creek, North Fork Holston River, Possum Creek, Guest River, Straight Creek Additional creeks that support a high number of SGCN include: Copper Crek, Clinch River, Powell River, Wallen Creek, Blackwater Creek, maybe Town Creek

Maintain and restore forest habitat	1) Protect land through acquisition, easement, incentives, or other mechanisms; 2) Implement vegetative buffers around extractive practices and development; 3) Work with state and federal agencies to ensure implementation of appropriate best management practices; 4) Maintain forest health to help ensure forest viability; 5) Conduct prescribed burns; 6) Monitor and control invasive species; and 7) Conduct pest and pathogen control.	Land use change and conversion, invasive species, climate change	Flood control; water quality; ecotourism/ wildlife viewing/other outdoor recreation	Forest patches adjacent to already protected parcels ; ridge to ridge forested connectors through valleys
Maintain and restore open habitats	1) Restore native grasses, shrubs, and forbs; 2) Maintain existing open habitats with periodic disturbance (e.g., prescribed burning, mowing, disking, etc.); and 3) Conserve, via acquisition, easement, collaboration, or agreement, patches from 20 acres to 100 or more acres.	Land use changes, invasive species	Conservation of native pollinators; erosion control; sequestration of nutrients, pesticides, and other pollutants before they enter rivers or karst systems; game animal habitat support (quail, grouse, rabbits, deer, elk)	Areas supporting SGCN that are not already protected

Protect Karst Habitats

The LENOWISCO Planning Region contains cave/ karst habitats that are relatively unique in Virginia. These features are created by complex interactions of water, bedrock, vegetation, and soils. Karst areas contain sinkholes, sinking and losing streams, caves, and large flow springs (DCR website 2015). Because cave entrances and karst habitats are sensitive systems, exact locations of karst habitats are not provided in this Action Plan; however, general areas that contain karst features are provided in Figure 5. Karst systems provide important habitats for many SGCN, including the Finley's cave amphipod, rotund cave beetle, deceptive cave beetle, Powell Valley planarian, and a wide variety other important species. Others species such as the Indiana bat depend on karst habitat and are endangered throughout their range. Caves in this planning region provide crucial winter habitat for some bat species.

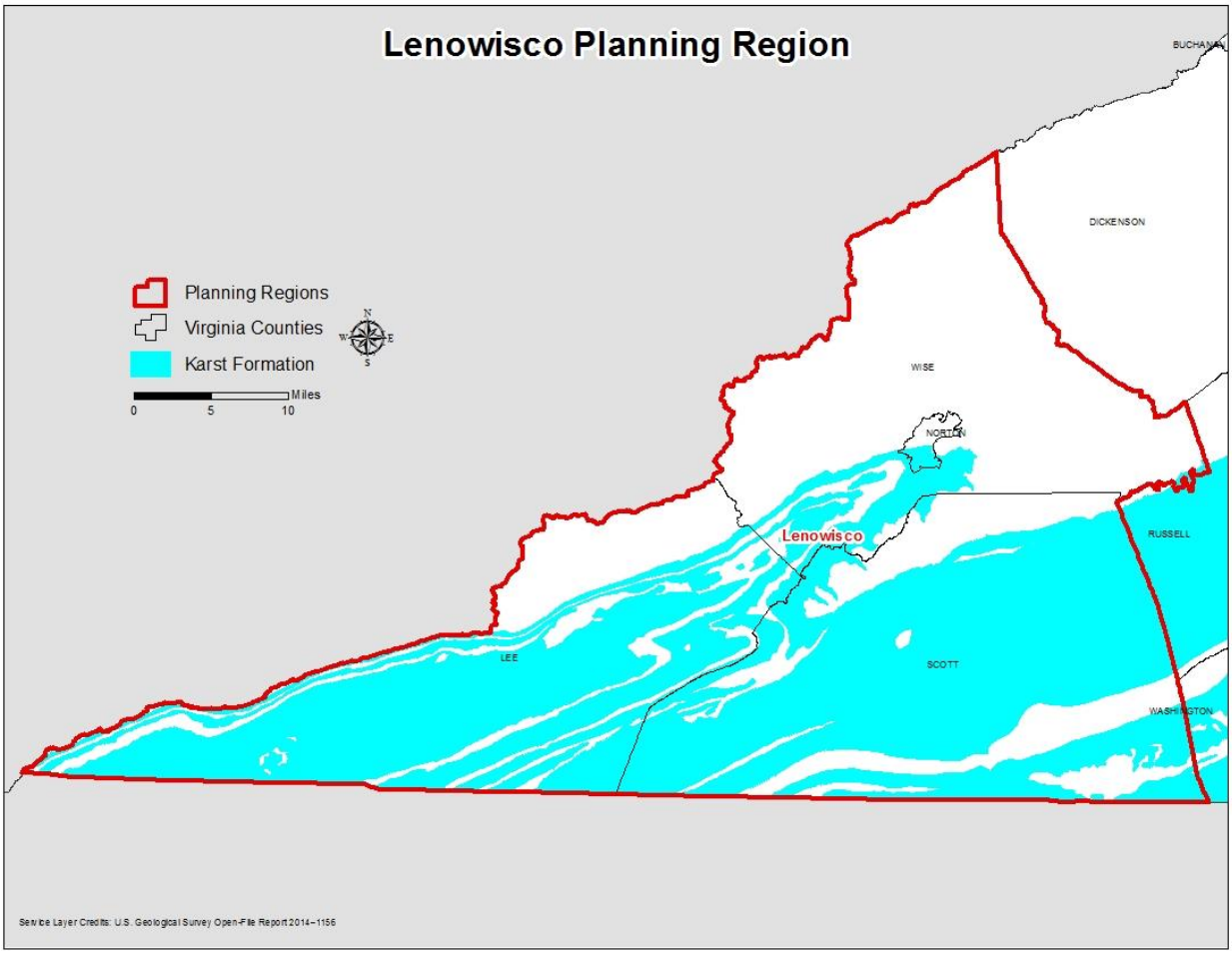

Figure 5. Karst Areas in LENOWISCO Planning Region (Weary and Doctor 2014).

Threats

Threats are primarily water-related for karst systems.

1. Water Quality Degradation: Water is the most critical element influencing the health of a karst system. The quality of water entering, and flowing through, Virginia's karst systems is affected

by a variety of issues. Nutrient pollution, especially from nitrogen and phosphorus, is a significant cause of water degradation as well as bacteria, fertilizer, and pesticides (DCR 2008). Nutrients often enter aquatic systems from lands without adequate best management practices (BMP), storm water runoff controls, or adequate waste treatment practices. Water quality degradation of karst systems also often occurs when sinkholes are used as disposal sites. Development and resulting pollutant-laden runoff also negatively affect water quality (DCR 2008).

2. Altered Hydrology: Development, which also likely plays a role in degraded water quality in the areas where karst occurs, can also result in altered hydrology which can affect water quantity and flows. The amount of water flowing through the system is also important. Withdrawals for human use have the potential to degrade subterranean habitats, diminish cave hydrology and humidity, and change surface topography.

3. Climate Change: Changes to precipitation regimes that may cause more intense storm events could exacerbate already existing water quality problems. Higher amounts of precipitation in a short time frame could dramatically affect storm water runoff and nutrient run off from impervious surfaces. It is important to note, however, that while the overall contaminants loading may increase during storm events, the actual concentrations to which animals and plants are exposed often go down during storm events. If these contaminants are not deposited instream, they may not become highly bioavailable and have a relatively lower impact.

Conservation Management Actions

The most efficient and cost effective means of conserving the integrity of karst and cave habitats is to focus on preserving the quality and quantity of water flowing into these systems. To improve water quality, important management actions include: minimizing use of fertilizers and pesticides near karst sites, minimizing runoff and other pollutants around the areas, preventing disposal of residential or agricultural waste near these sites, and ensuring vegetative buffer areas where there are extractive or other intensive land uses (Veni et al. 2001). It is also important to prevent sewage from community or municipal sewer systems from contaminating ecologically sensitive groundwater systems in karst areas (B. Beaty, The Nature Conservancy, personal communication, 2015). Vegetative buffers around sinkholes and entrances work to maintain the quality of water flowing into karst systems and provide vegetative cover in areas underlain by karst geology. However, it is important to note that it can be difficult to identify surface areas above the subterranean system well enough to install appropriate buffer areas.

To ensure adequate water quantity in karst areas, vegetative buffers around sinkholes and entrances will also be helpful as well as maintaining vegetative cover in areas underlain by karst geology. At the time of this writing, it is important to note that it can be difficult to identify surface areas above the subterranean system well enough to install appropriate buffer areas. Working with residents and municipalities to develop water conservation strategies will be important to control water withdrawals in the area (Veni et al. 2001).

Adopting land use practices or policies through zoning or other guidelines focused on karst systems may also help protect and improve the health of karst systems in sensitive areas. Establishing protected areas around these karst systems may also be valuable. Additionally, local government policies or ordinances

could include overlay districts, karst feature buffers, geotechnical surveys when in area that could contain karst systems, and/ or performance standards for development (Belo 2003).

Climate-Smart Management Actions

Karst systems are vulnerable to stressors such as poor water quality and changes to water flow that may be exacerbated by climate change. When considering planting vegetative buffers, managers will need to understand how conditions may change in the area and work with appropriate vegetation. Vegetation species that are better able to withstand these conditions may be better suited to help mitigate the impacts of flooding and increased runoff. Minimizing impervious surface (see following section) will be even more important under climate change. If precipitation and storm events become more intense, then there likely will be more storm water runoff.

Enhance, Maintain, and Restore Aquatic and Riparian Habitats

Aquatic systems in the LENOWISCO Planning Region include cold and warm water rivers, streams, and creeks. Large river systems include the Clinch, Holston, and Powell Rivers. Approximately 2,815 acres (0.32 percent) of the planning region are considered aquatic (Anderson et al. 2013). Additionally, over 90 percent of the planning region's SGCN are aquatic. These systems provide important habitat for numerous species of wildlife, fish, and invertebrates. Priority SGCN that depend on these habitats include many mussels, snails, crayfish, and fish species, such as the rayed bean, Powell River crayfish, blackside dace, Western sand darter, brook trout, pink mucket (pearlymussel), paddlefish, and dromedary pearlymussel.

Threats

Aquatic and riparian habitats within the LENOWISCO Planning Region face multiple threats from water quality related issues to issues related to habitat destruction and bank destabilization to invasive species.

1. Water Quality Degradation: Pollution is a significant threat to aquatic species and riparian habitats within the LENOWISCO Planning Region. Polluting materials include fertilizers, eroded sediment, and human and animal waste flowing into the region's creeks and rivers from storm water runoff, failing septic systems, and agricultural practices that do not conform to standard best management practices (DEQ 2014). In many cases, watersheds have insufficient riparian buffers and vegetative areas to stop these materials from flowing into the creek or stream (ACJV 2005). Once present in aquatic systems, these materials may concentrate in sediment and bottom-dwelling organisms where they can result in reduced levels of dissolved oxygen and altered pH levels (Chesapeake Bay Foundation 2014). In addition to the impacts on aquatic life, many of these substances pose a risk to human health and local economies (Chesapeake Bay Foundation 2014).

2. Impervious Surface: Impervious surfaces (i.e., land covers that do not permit water to permeate the ground) give a useful measure of the environmental condition of an area. In a developed watershed there is often significant impervious surface cover; thus, a greater amount of surface water, often laden with pollutants, arrives into a stream at a faster rate than in less developed

watersheds, increasing the likelihood of more frequent and severe flooding. Substantial amounts of impervious surface area can also lead to degradation of water quality, changes in hydrology, habitat structure, and aquatic biodiversity. Additionally, impervious surfaces often run along areas that directly interact with the stream or river through flooding, geomorphology, or material inputs. Although LENOWISCO has some areas with a high percentage of impervious surface cover, the majority of the planning region has a low percentage of impervious surface cover (Figure 6).

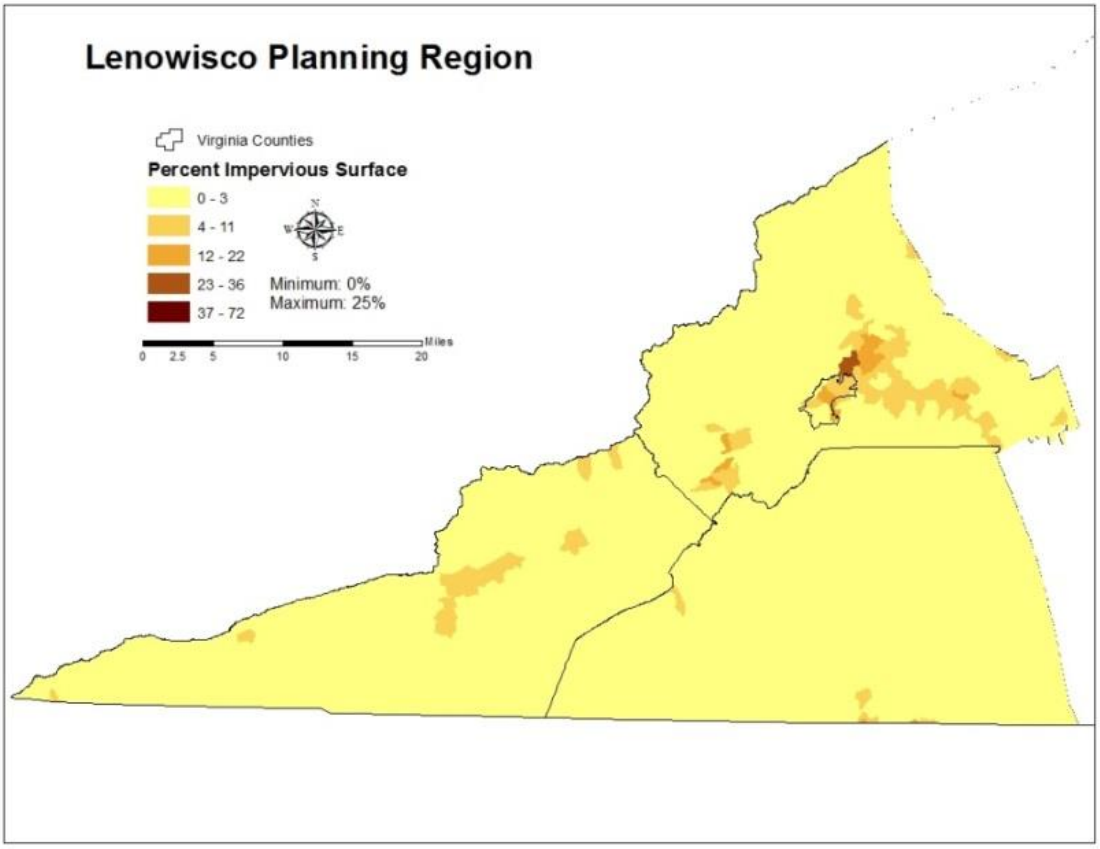

Figure 6. Impervious Surface Cover in Cumberland Plateau Planning Region (SARP 2014).

3. Habitat Conversion and Alteration: Rivers are fragmented by dams, culverts, and other impediments that limit the connectivity of these aquatic habitats. This fragmentation can prevent aquatic species from accessing important aquatic habitats crucial to various life stages. Channelization, shoreline alteration, and extractive land use practices can alter aquatic habitats in terms of changes to hydrology, chemistry, and water temperature. These practices may also directly alter habitats through loss of vegetative riparian cover, filling of streams, or hardening of stream banks.

4. Invasive Species: Invasive species such as white perch threaten western warm water streams and rivers. Invasive species are less of a direct threat to fish within cold water systems, but

invasive species cause significant impacts to the forests surrounding these systems. Defoliation by the emerald ash borer, gypsy moth, hemlock woody adelgid, and southern pine beetle can alter river and stream hydrology and temperature, especially important to cold water streams.

5. Stream pH: Fish species are sensitive to water pH, and pH can play a role in species richness. Waters flowing through the non-karst areas in this planning region have experienced acid deposition over decades, making the waters more acidic and potentially harming or extirpating aquatic species such as brook trout (Webb 2014). Streams may also become more alkaline due to mine runoff and underground mine pumping, which can also alter stream habitat.

6. Climate Change: Climate change will also affect both warm and cold water streams. Changes to precipitation regimes and temperatures will result in changes to flow patterns, erosion rates, and water temperatures, both in terms of absolute levels and the timing of peaks and gradients.

Conservation Management Actions

Water Quality Improvement Plans have been developed by the Virginia Department of Environmental Quality (DEQ) and various partners. Watersheds within the planning region that have Water Quality Improvement Plans include: Big Moccasin Creek, Blue Springs Branch, Cove Creek, Dowell Branch, Hiltons Creek, North Fork Holston River, and Possum Creek (MapTech 2013); Guest River (Lonesome Pine Soil and Water Conservation District 2014); and Straight Creek (Virginia Mining Issues Group 2007) (Figure 7).

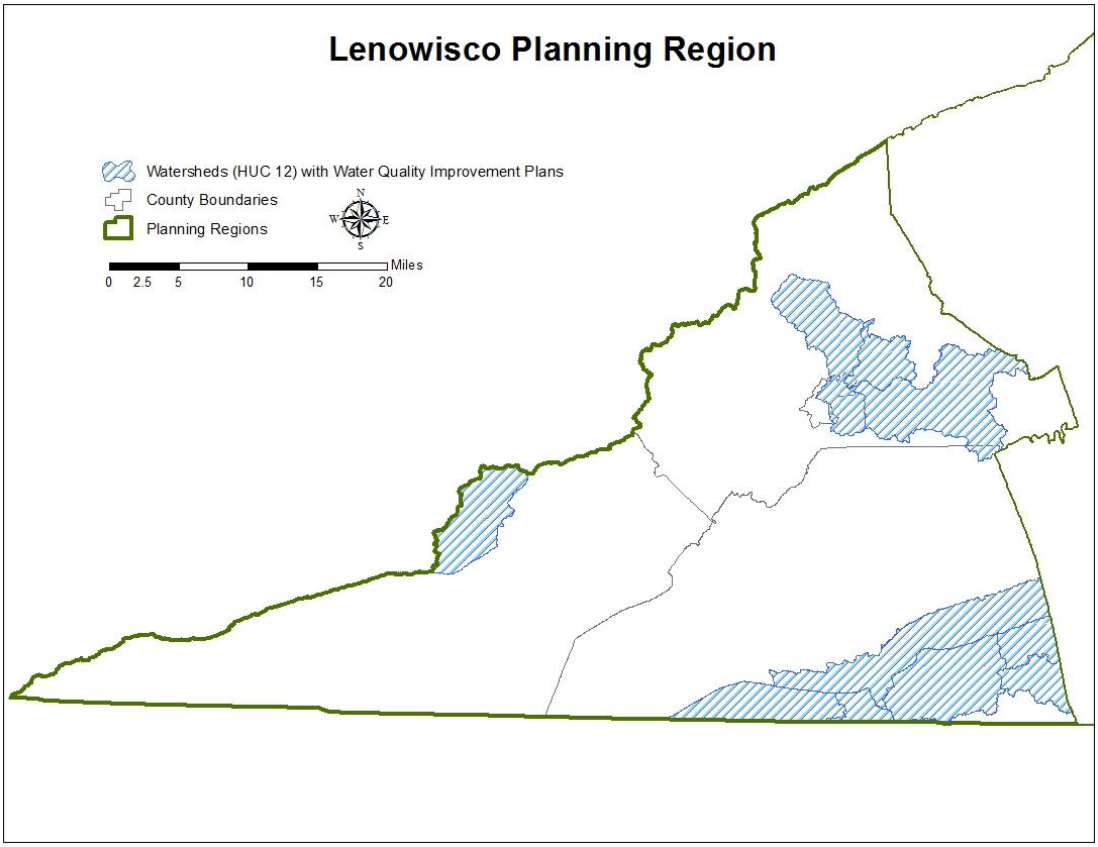

Figure 7. Watersheds with Water Quality Improvement Plans.

Each of these watersheds is designated as being impaired, and the primary actions needed to improve water quality within these watersheds include:

- Establishing vegetative and/ or forested buffers along streams and sinkholes as well as in agricultural, urban and residential areas;
- Restoring/stabilizing eroding stream banks
- Reclaiming/revegetating disturbed forest lands; a
- Excluding livestock from streams;
- Improving pasture and loafing lot management to prevent manure-tainted runoff from flowing into streams;
- Repairing or replacing failing septic systems and eliminating “straight pipes” discharging human waste into streams;
- Implementing storm water management BMPs;
- Restoring/reclaiming abandoned mine lands; and
- Preventing pet waste from entering streams.

Members of Virginia’s conservation community may consider working in other watersheds of local significance that may not have a Water Quality Improvement Plan. The Virginia Watershed Integrity Model identifies high value watersheds within the planning region for conservation based on their proximity to headwater streams, drinking water source protection, and biological integrity indices

(Ciminelli and Scrivani 2007). These areas provide a starting point for identifying additional areas to focus conservation efforts (Figure 8).

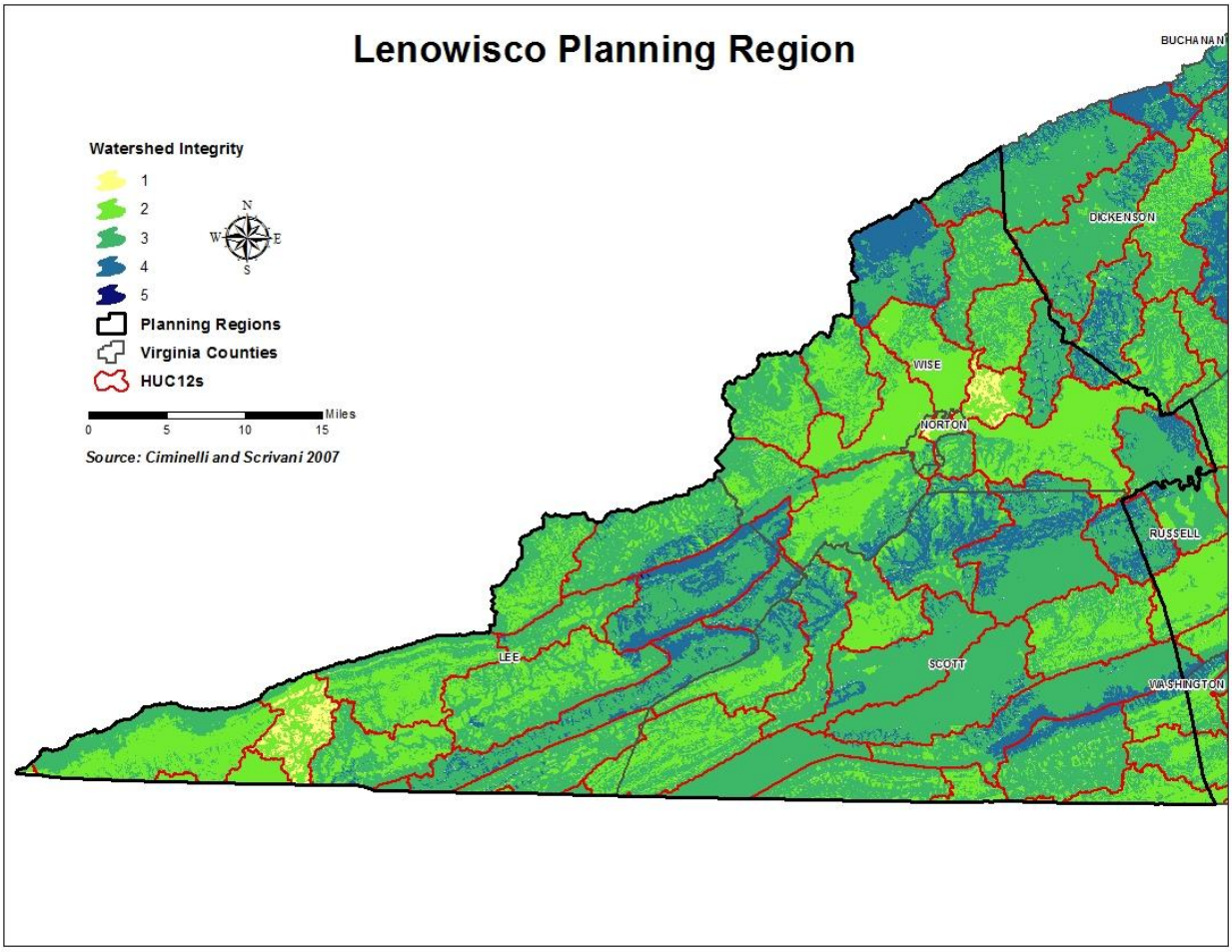

Figure 8. Watershed Integrity Model for LENOWISCO Planning Region (Ciminelli and Scrivani 2007).

Several conservation actions common to most water quality and instream habitat enhancement plans can be implemented with little chance of ill consequence to wildlife or human communities downstream in these areas. Some of the most beneficial actions would include:

- Working with landowners to exclude livestock from streams;
- Restoring or enhancing vegetated riparian buffers; and
- Working to enhance the health of upland forests and grassland habitats.

Additionally, many agencies help landowners in the LENOWISCO Planning Region establish vegetative buffers along waterways flowing through their properties. The Virginia Department of Forestry (DOF), Virginia Department of Agriculture and Consumer Services (VDACS), and DCR have established BMPs for various land uses which, if implemented serve to minimize land use impacts upon adjacent and downstream waters. In addition, landowners are encouraged to work with DOF through the Forest Stewardship Program to utilize timber production BMPs, such as implementation of buffers and careful planning of roads and stream crossings, and agricultural producers are encouraged to work with VDACS

and the local Soil and Water Conservation Districts to control erosion and limit runoff through the various available programs (DOF 2014; DCR 2014). NRCS provides landowners with other opportunities, including the Environmental Quality Incentives Program.

Additional actions to improve aquatic systems in the LENOWISCO Planning Region include: restoring aquatic connections (i.e., removing culverts, dams, etc.), monitoring and addressing invasive species impacts, and working with the planning region to adopt use practices or policies through zoning or other guidelines (e.g., impervious surface limits) to help improve the health of aquatic systems within and downstream of regions that have significant impervious surface areas. Additionally, land acquisitions or easements that will help protect the land surrounding creeks should also be considered.

Climate-Smart Management Actions

When planting, restoring, or maintaining riparian buffers, managers should consider how conditions may change in the area and work with appropriate vegetation. For example, if stream flow is expected to become erratic due to increased precipitation or more frequent flooding as is projected to occur, native tree and shrub species that can tolerate flood conditions and inundation should be included in the selected plant species. Utilizing native species that may provide better erosion control (broader, deeper roots) than other species should be encouraged. Techniques and tools may be needed (e.g., fencing, biomats, etc.) to ensure success. Additionally, as stream temperatures will likely increase and hydrologic regimes may shift, it will be important to focus on maintaining and/ or improving stream connectivity to ensure aquatic organism can move to preferred habitats as these conditions change. Minimizing impervious surface will be even more important under climate change as increased storm intensity will likely result in increased levels of stormwater runoff. Improving stormwater control methods, to ensure they accommodate predicted changes in precipitation and flow, could help minimize the future impacts of storm water under climate change (Kane 2013).

Conserve and Manage Forest Habitats

Mixed hardwood and conifer forests make up approximately two thirds of the LENOWISCO Planning Region and are important for a broad range of species (Table 4). Within this forest type, young forests make up a specific age class of forest, loosely defined as referring to areas dominated by woody seedlings and saplings (Oehler et al. 2006). Previously, young forests may have been referred to as an early successional habitat for eastern portions of North America. The young forest component (age class) in most of the forests within the planning region is lacking, which will impact the tree species present within these forests in the future. Lack of young forest habitat has detrimental effects on the wildlife species that depend on this forest stage for survival. Spruce-fir forests make up a small percentage of the forest types within this planning region, while the majority of the forested lands are made up of mixed hardwoods and conifers. These forests help protect water resources within the region and provide habitat for species such as the proud globe snail, green salamander, southern zigzag salamander, mountain chorus frog, Swainson's warbler, cerulean warbler, ruffed grouse and Indiana bat in the summer months, among other species.

Table 4. Forest Acreage Totals in LENOWISCO Planning Region (Anderson et al. 2013).

Forest Type	Acres	Percent of Planning Region
Spruce Fir	138.33	0.02%
Mixed Hardwood and Conifer	601,609.53	67.69%

Threats

Forests within this planning region face a range of threats.

1. Land Use Changes and Conversion: The largest threat to spruce fir and mixed hardwood and conifer forests within the LENOWISCO Planning Region is fragmentation, due to expanding residential and commercial development and resulting roads. In many cases, the losses can be complete and have profound impacts on local wildlife species composition, water quality, and outdoor recreational opportunities. If established BMPs are followed, impacts to waterways and adjoining properties can be prevented or mitigated such as through implementation of vegetative buffer areas (see below). Mining and other extractive uses also degrade habitat and affect species composition and water quality.

2. Lack of Young Forest Conditions: During recent decades, managers of federal and state-owned forests have managed properties for mature forest conditions. While mature forests provide habitat for a variety of species, the lack of young forest conditions in the western parts of Virginia has curtailed distribution of many species that rely upon open habitats. Forests with balanced age classes are critical for the health of the forest and the survival of forest dependent wildlife species.

3. Invasive Species: Invasive plant species and pests are also a significant problem in this region. Of particular note are the hemlock wooly adelgid and the gypsy moth, which has a significant effect on the ecology of oak-hickory forests (DOF 2014).

4. Climate Change: More intense storm events, higher temperatures, and the potential for droughts may exacerbate existing stressors as well as damage intact forests and result in more forest fires, an increase in incidence of pests, and more damage from wind and ice storms.

Conservation Management Actions

Actions for conserving mixed hardwood and conifer forests (the majority of the spruce fir forests in the planning region are already under some form of conservation) in the LENOWISCO Planning Region may include working to conserve, either through acquisition, easement, cooperative management, or incentives, intact forest patches capable of supporting a variety of Action Plan species. Land protection will help reduce conversion of forests to development. Additionally, working with landowners to ensure BMPs such as vegetative buffers are in place around agricultural or timber harvest areas will help prevent erosion and run off of sediments and nutrients into adjacent streams. Research demonstrates that vegetative riparian buffers can filter significant amounts of nutrient run off from timber operations and agricultural fields (DOF 2014). Some BMPs recommend a 50 foot buffer and allow some timber harvest within the buffers, while other BMPs encourage a 100 foot buffer with no harvest (DOF 2014; A. Ewing, Virginia Department of Game and Inland Fisheries, 2015). BMPs also recommend building roads on areas with minimum slope and minimizing or avoiding stream crossings (DOF 2014).

Several agencies, including DGIF, the NRCS, DOF, and the USFS advocate that efforts be expanded to create young forest habitats on public lands. Managing forests via silvicultural practices and/or through the use of fire are the most economical options to create these desired conditions.

Working to maintain forest health (balance age classes and diversity of tree species) is also integral to ensuring forest habitat is available to be conserved and protected. DOF makes several key recommendations that relate to habitat health, including but not limited to using species within their native ranges, if feasible using a mix of tree species to help minimize susceptibility to pests, preventing unnecessary site disturbance, and protecting unusual (rare) forest habitats (DOF 2014). In terms of invasive species and pests, monitoring and control will be important to prevent its spread. Some of these forest habitats should be managed with thinning and prescribed burns to minimize outbreaks (Brooks and Lusk 2008; DOF 2014).

Climate-Smart Management Actions

To best manage forests in the LENOWISCO Planning Region as the climate changes, it will be imperative to understand how climate may affect potential future composition of forests in Virginia and how that may affect SCGN. Conservation and management efforts may need to focus on trees that can better withstand increased temperatures and drought, among other impacts. Providing forest habitat at elevation gradients for species migration also will be an important factor for enhancing resilience to climate change. Managers may wish to consult the U.S. Forest Service's tree atlas when planning management and conservation of these forests. Additionally, harvest guidelines may need to be revised, depending on projections for future tree composition. Invasive species monitoring and prevention will also become even more important to include in forest management as climate change may favor some tree pests, diseases, and invasive species.

In terms of considering how to best manage for birds, mammals, and other species that depend on these forests, managers will want to try to provide refugia for SGCN as habitat is lost as well as establishing corridors both north/ south, east/west, and at high/low elevations between protected areas to assist with species movements as conditions change (King and Finch 2013). Some SGCN will not be able to migrate without contiguous forests, so some species may still be lost, but implementing conservation management actions and developing corridors can help provide can them the best chance at continued existence. It will also be important to work to maintain species diversity and continue to reduce existing stressors that will likely exacerbate impacts from climate change (McKelvey et al. 2013).

Maintain and Restore Open Habitats

Open habitats represent an assortment of habitat types that are botanically characterized by grasses, forbs, and shrubs. Trees may be present but they tend to be widely spaced and crowns do not form a canopy. DGIF biologists and partners have indicated several varieties of open habitats are important for Action Plan species. Open habitats are often comprised of post-agricultural lands, glades, and barrens and make up approximately 84,750 acres (9.5 percent) of the planning region (Anderson et al. 2013). These habitats are becoming rare in Virginia as agriculture and timber harvest practices change; however, they are important to a range of species that depend on these areas for nesting, feeding,

protection, etc. These habitats provide habitat for a variety of birds such as the barn owl, Eastern meadowlark, grasshopper sparrow, among others, within the planning region.

Threats

Changing land use patterns has played a large role in the loss of open habitats as has alteration to natural disturbance regimes.

1. Land Use Changes: Dozens of open habitat species have been affected by changing land use and agricultural practices that resulted in either degraded or destroyed open habitats. The most serious threats to remaining open habitats within the planning region involve either development (where habitats are converted for human use) or natural succession driven by a loss of natural or historical disturbance regimes (where trees are allowed to dominate and the site eventually becomes forest).

2. Invasive Species: Invasive species are also problematic, especially tree of heaven, Japanese stilt grass, garlic mustard, autumn olive, and privet. These species can out-compete native open habitat species and take over the landscape. Some such as tree of heaven can change the landscape from an open habitat to a more closed habitat relatively quickly due to its ability to spread and colonize areas rapidly (VISWG 2012). Japanese stilt grass also grows quickly and in mats that can crowd out native grasses. It also alters soil pH inhibiting growth of other native plants (VISWG 2012).

Conservation Management Actions

Specific management practices could include the removal of non-native grasses, encouraging the growth of native warm-season grasses, shrubs and forbs, and periodic disturbance (e.g., burning, mowing, disking, managed grazing, etc.) to maintain the early successional communities and prevent the growth of forest trees (DGIF 2015). Opportunities also exist with forest managers. Silviculture creates young forest conditions that can be managed to provide open habitat opportunities for the first 10 to 15 years after harvest (WMI 2014). Additional actions include working to protect open land patches at a minimum of 20 acres (Wolter et al. 2006). Focus also should be placed on protecting circular or square patches rather than rectangular areas to minimize edge effect (Wolter et al. 2006). For pine savannas, thinning and prescribed burns are critical to preserve this open habitat.

Climate-Smart Management Actions

Changes in temperature and precipitation regimes could negatively affect open lands as temperatures increase and summers become drier and more drought prone. However, research demonstrates that many species that make up open habitats are already relatively drought tolerant, meaning that open lands may not be as affected by climate change as other habitats if they can maintain their diverse make up of vegetation species (Craine et al. 2012). Climate change also may benefit some open habitat areas due to warmer temperatures, drier conditions, and more stress on water demanding plant species. It is important to note that if there is extended severe drought, open lands may succumb over time (Craine et al. 2012). To maintain diversity and help build resiliency in open lands within this planning region, it will be important to implement the management options above, especially focusing on removing non-

natives and ensuring a diverse mix of vegetation species. Working to protect and preserve larger tracts of grasslands will help provide refugia for the species that depend on this habitat.

Effectiveness Measures Examples

As discussed within the Action Plan's Introduction (see Measuring the Effectiveness of Conservation Actions), it is increasingly important for the conservation community to demonstrate the effectiveness of conservation actions. Elected officials, budget authorities, private donors, and members of the public want to know that their investments in wildlife conservation are having the desired effects. During 2011, the Association of Fish and Wildlife Agencies developed and tested a series of effectiveness measures meant to support the Wildlife Action Plan implementation and the State Wildlife Grants program (AFWA 2011).

Virginia's 2015 Wildlife Action Plan describes a diversity of conservation actions that should help keep species from becoming endangered. The majority of these involve habitat protection, habitat restoration, controlling invasive species, or implementing efforts to keep pollutants from flowing into Virginia's waterways. Important data that can demonstrate the effectiveness of these conservation actions can include the following:

Conservation Action	Indicators of Effectiveness
Creation of Vegetative/ Forest Buffers along Streams or Wetlands	• Before/ after photos of project site; • Photos documenting changes as vegetation matures over multiple years; • Before/ after measurements of sedimentation immediately downstream of site; and • Changes in the number and diversity of species utilizing the site.
Control of Invasive Plants	• Before/ after photos of project site; • Photos documenting changes as restored vegetation matures over multiple years; and • Before/ after comparison of the number and diversity of species utilizing the site.
Remove Cattle from Streams	• Before/ after photos of project site; • Photos of alternative watering systems (if appropriate) • Photos documenting changes in shoreline as restored vegetation matures over multiple years; • Before/ after comparison of sediment and water chemistry immediately downstream of site; and • Before/ after comparison of the number and diversity of species utilizing the site.
Creating or Improving Open Habitats	• Before/after photos of project site; • Photos documenting changes to the site as the vegetation matures; and • Before/ after comparison of the number and diversity of species utilizing the site.

CONCLUSION

The development of the Virginia Wildlife Action Plan presented a unique opportunity for the Commonwealth—an opportunity not only to assess the condition and status of the state's wildlife and habitat resources, but to provide a shared vision and purpose in the management and conservation of this "common wealth." The true value of this initiative is this recognition of common interests and the enhancement of existing and fostering of new partnerships to address issues of mutual concern. The Action Plan's long-term success will depend on the implementation of the recommended actions by partners across the state and the effectiveness with which conservation partners collectively manage these natural resources.

This Local Action Plan Summary aims to prioritize species, habitats, and conservation actions within this planning region, so that partners working within this region can use limited resources to the greatest effect. However, Virginia faces serious issues. Not addressing these problems would risk more species becoming threatened or endangered, the quality of our land and water would decline, and Virginians could lose important pieces of our natural heritage that contribute to our quality of life. However, there are significant conservation opportunities to benefit wildlife and people in the planning region. Our problems are not insurmountable, and most can be addressed with proven conservation management techniques.

Working to maintain and protect existing high quality habitat will be a priority before restoration; however, restoration is still an important action and necessary in many cases. Within the LENOWISCO Planning Region, priority conservation opportunities include:

- Protecting karst habitats.
- Protecting the quantity and quality of water.
- Maintain and conserve patches of spruce fir and mixed hardwood conifer forests.
- Enhance and protect open habitats.

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APPENDIX A. COMPLETE LIST OF SPECIES OF GREATEST CONSERVATION NEED IN LENOWISCO PLANNING REGION

Complete SGCN list for the LENOWISCO Planning Region (SGCN=178). Table includes federal and state statuses, Wildlife Action Plan Tier, and Conservation Opportunity Rankings. Species are listed in alphabetical order by taxa.

Taxa	Conservation Status	Tier	Opportunity Ranking	Common Name	Scientific Name
Amphibian		IV	c	Blue Ridge dusky salamander	*Desmognathus orestes*
Amphibian		III	a	Common mudpuppy	*Necturus maculosus maculosus*
Amphibian		IV	c	Cumberland Plateau salamander	*Plethodon kentucki*
Amphibian	**CC**	I	a	Eastern hellbender	*Cryptobranchus alleganiensis alleganiensis*
Amphibian		II	b	Green salamander	*Aneides aeneus*
Amphibian		IV	a	Jefferson salamander	*Ambystoma jeffersonianum*
Amphibian		II	a	Mountain chorus frog	*Pseudacris brachyphona*
Amphibian		II	c	Southern zigzag salamander	*Plethodon ventralis*
Bird		II	a	American black duck	*Anas rubripes*
Bird		II	a	American woodcock	*Scolopax minor*
Bird	**FSST**	I	c	Appalachian grizzled skipper	*Pyrgus wyandot*
Bird		III	a	Barn owl	*Tyto alba*
Bird		III	b	Belted kingfisher	*Megaceryle lcyon*
Bird		IV	a	Black-and-white warbler	*Mniotilta varia*
Bird		IV	a	Brown thrasher	*Toxostoma rufum*
Bird		IV	b	Canada warbler	*Wilsonia canadensis*
Bird		II	a	Cerulean warbler	*Dendroica cerulea*
Bird		IV	b	Chimney swift	*Chaetura pelagica*
Bird		IV	a	Eastern kingbird	*Tyrannus tyrannus*
Bird		IV	a	Eastern meadowlark	*Sturnella magna*
Bird		IV	a	Eastern towhee	*Pipilo erythrophthalmus*
Bird		IV	b	Eastern wood-pewee	*Contopus virens*
Bird		IV	a	Field sparrow	*Spizella pusilla*
Bird		I	a	Golden-winged warbler	*Vermivora chrysoptera*
Bird		IV	a	Grasshopper sparrow	*Ammodramus savannarum*
Bird		IV	a	Gray catbird	*Dumetella carolinensis*
Bird		IV	b	Green heron	*Butorides virescens*
Bird		III	a	Kentucky warbler	*Oporornis formosus*
Bird		III	a	Northern bobwhite	*Colinus virginianus*

Bird		III	a	Northern harrier	*Circus cyaneus*
Bird		IV	c	Northern rough-winged swallow	*Stelgidopteryx serripennis*
Bird	**ST**	I	a	Peregrine falcon	*Falco peregrinus*
Bird	**FS**	I	c	Regal fritillary	*Speyeria idalia idalia*
Bird		III	a	Ruffed grouse	*Bonasa umbellus*
Bird		II	b	Swainson's warbler	*Limnothlypis swainsonii*
Bird		IV	b	Virginia rail	*Rallus limicola*
Bird		IV	b	Wood thrush	*Hylocichla mustelina*
Bird		III	a	Yellow-billed cuckoo	*Coccyzus americanus*
Bird		IV	a	Yellow-breasted chat	*Icteria virens*
Crustaceans	**FSSE**	I	c	Big Sandy Crayfish	*Cambarus veteranus*
Crustaceans		II	c	Cumberland cave amphipod	*Stygobromus cumberlandus*
Crustaceans	**FS**	I	c	Cumberland Gap cave amphipod	*Bactrurus angulus*
Crustaceans	**FS**	II	c	Cumberland Gap cave isopod	*Caecidotea cumberlandensis*
Crustaceans		II	c	Finley's cave amphipod	*Stygobromus finleyi*
Crustaceans		II	c	Lee County cave amphipod	*Stygobromus leensis*
Crustaceans	**FESE**	III	c	Lee County cave isopod	*Lirceus usdagalun*
Crustaceans		III	b	Longclaw crayfish	*Cambarus buntingi*
Crustaceans	**FS**	II	c	Powell Valley terrestrial isopod	*Amerigoniscus henroti*
Crustaceans		III	c	Reticulate crayfish	*Orconectes erichsonianus*
Crustaceans	**FS**	I	a	Rye Cove isopod	*Lirceus culveri*
Crustaceans	**FS**	II	c	Spiny scale crayfish	*Cambarus jezerinaci*
Crustaceans		IV	c	Surgeon crayfish	*Orconectes forceps*
Fish		IV	c	American brook lamprey	*Lampetra appendix*
Fish	**FS**	I	b	Ashy darter	*Etheostoma cinereum*
Fish		IV	c	Blotched chub	*Erimystax insignis*
Fish	**FS**	II	a	Blotchside logperch	*Percina burtoni*
Fish		IV	c	Bluebreast darter	*Etheostoma camurum*
Fish		IV	c	Brook silverside	*Labidesthes sicculus*
Fish		IV	a	Brook trout	*Salvelinus fontinalis*
Fish		IV	c	Bullhead minnow	*Pimephales vigilax*
Fish		III	c	Channel darter	*Percina copelandi*
Fish	**FS**	III	c	Clinch sculpin	*Cottus sp. 4*
Fish		IV	c	Dusky darter	*Percina sciera*
Fish	**FESE**	I	a	Duskytail darter	*Etheostoma percnurum*
Fish	**ST**	IV	c	Emerald shiner	*Notropis atherinoides*
Fish		III	c	Freshwater drum	*Aplodinotus grunniens*

Fish		IV	c	Logperch	*Percina caprodes*
Fish		III	c	Mirror shiner	*Notropis spectrunculus*
Fish		III	c	Mountain brook lamprey	*Ichthyomyzon greeleyi*
Fish		IV	c	Mountain madtom	*Noturus eleutherus*
Fish		IV	c	Mountain shiner	*Lythrurus lirus*
Fish		IV	c	Northern studfish	*Fundulus catenatus*
Fish		IV	c	Ohio lamprey	*Ichthyomyzon bdellium*
Fish	**ST**	IV	c	Paddlefish	*Polyodon spathula*
Fish		II	c	Popeye shiner	*Notropis ariommus*
Fish		III	b	River redhorse	*Moxostoma carinatum*
Fish		IV	c	Sand shiner	*Notropis stramineus*
Fish		III	b	Sauger	*Sander canadensis*
Fish		IV	c	Sharpnose darter	*Percina oxyrhynchus*
Fish	**FTST**	I	c	Slender chub	*Erimystax cahni*
Fish		IV	c	Speckled darter	*Etheostoma stigmaeum*
Fish	**FTST**	I	b	Spotfin chub	*Erimonax monachus*
Fish	**ST**	III	c	Steelcolor shiner	*Cyprinella whipplei*
Fish		IV	c	Stonecat	*Noturus flavus*
Fish		IV	b	Swannanoa darter	*Etheostoma swannanoa*
Fish		IV	c	Tangerine darter	*Percina aurantiaca*
Fish	**SE**	I	b	Tennessee dace	*Chrosomus tennesseensis*
Fish	**SE**	I	a	Variegate darter	*Etheostoma variatum*
Fish	**ST**	IV	c	Western sand darter	*Ammocrypta clara*
Fish		III	c	Wounded darter	*Etheostoma vulneratum*
Fish	**FTST**	I	a	Yellowfin madtom	*Noturus flavipinnis*
FW Mollusks	**FESE**	I	a	Appalachian monkeyface	*Quadrula sparsa*
FW Mollusks	**FESE**	I	a	Birdwing pearlymussel	*Lemiox rimosus*
FW Mollusks	**ST**	III	a	Black sandshell	*Ligumia recta*
FW Mollusks		III	c	Blue Ridge springsnail	*Fontigens orolibas*
FW Mollusks		III	c	Brown walker	*Pomatiopsis cincinnatiensis*
FW Mollusks		II	c	Coal elimia	*Elimia aterina*
FW Mollusks	**FESE**	I	b	Cracking pearlymussel	*Hemistena lata*
FW Mollusks		IV	a	Creeper	*Strophitus undulatus*
FW Mollusks	**FESE**	I	a	Cumberland bean	*Villosa trabalis*
FW Mollusks		IV	a	Cumberland moccasinshell	*Medionidus conradicus*
FW Mollusks	**FESE**	I	a	Cumberland monkeyface	*Quadrula intermedia*
FW Mollusks	**FESE**	I	a	Cumberlandian combshell	*Epioblasma brevidens*

FW Mollusks	**SE**	III	b	Deertoe	*Truncilla truncata*
FW Mollusks	**FESE**	I	a	Dromedary pearlymussel	*Dromus dromas*
FW Mollusks	**SE**	III	a	Elephant ear	*Elliptio crassidens*
FW Mollusks		II	c	Elktoe	*Alasmidonta marginata*
FW Mollusks	**FESE**	I	a	Fanshell	*Cyprogenia stegaria*
FW Mollusks	**FESE**	I	a	Fine-rayed pigtoe	*Fusconaia cuneolus*
FW Mollusks	**FC**	II	a	Fluted kidneyshell	*Ptychobranchus subtentum*
FW Mollusks	**ST**	IV	b	Fragile papershell	*Leptodea fragilis*
FW Mollusks	**FESE**	I	c	Little-winged pearlymussel	*Pegias fabula*
FW Mollusks		III	a	Longsolid	*Fusconaia subrotunda*
FW Mollusks		IV	a	Mountain creekshell mussel	*Villosa vanuxemensis vanuxemensis*
FW Mollusks	**SE**	III	c	Ohio pigtoe	*Pleurobema cordatum*
FW Mollusks	**FESE**	I	a	Oyster mussel	*Epioblasma capsaeformis*
FW Mollusks	**ST**	IV	b	Pimple back	*Quadrula pustulosa pustulosa*
FW Mollusks	**FESE**	I	a	Pink mucket	*Lampsilis abrupta*
FW Mollusks		IV	a	Pocketbook mussel	*Lampsilis ovata*
FW Mollusks	**FESE**	I	a	Purple bean	*Villosa perpurpurea*
FW Mollusks	**FSSE**	II	a	Pyramid pigtoe	*Pleurobema rubrum*
FW Mollusks	**FP**	II	a	Rayed bean	*Villosa fabalis*
FW Mollusks	**FESE**	I	a	Rough pigtoe	*Pleurobema plenum*
FW Mollusks	**FESE**	I	a	Rough rabbitsfoot	*Quadrula cylindrica strigillata*
FW Mollusks	**FPST**	II	a	Sheepnose	*Plethobasus cyphyus*
FW Mollusks	**FESE**	I	a	Shiny pigtoe	*Fusconaia cor*
FW Mollusks	**FCST**	II	a	Slabside pearlymussel	*Lexingtonia dolabelloides*
FW Mollusks	**SE**	I	b	Slippershell mussel	*Alasmidonta viridis*
FW Mollusks	**FPSE**	I	a	Snuffbox	*Epioblasma triquetra*
FW Mollusks	**FPSE**	I	b	Spectaclecase	*Cumberlandia monodonta*
FW Mollusks	**SE**	II	c	Spider Elimia	*Elimia arachnoidea*
FW Mollusks	**FSST**	III	a	Spiny riversnail	*Io fluvialis*
FW Mollusks	**SE**	II	a	Tennessee heelsplitter	*Lasmigona holstonia*
FW Mollusks	**FS**	II	a	Tennessee pigtoe	*Fusconaia barnesiana*
FW Mollusks		IV	c	Three-ridge valvata	*Valvata tricarinata*
FW Mollusks	**FSSE**	I	a	Unthanks Cave snail	*Holsingeria unthanksensis*
Insect	**FS**	II	c	A cave beetle	*Pseudanophthalmus seclusus*
Insect	**FS**	II	c	Burkes Garden cave beetle	*Pseudanophthalmus hortulanus*
Insect	**FS**	II	c	Cherokee clubtail	*Gomphus consanguis*
Insect	**FS**	II	c	Cumberland Gap cave beetle	*Pseudanophthalmus hirsutus*

Insect	**FS**	II	c	Deceptive cave beetle	*Pseudanophthalmus deceptivus*
Insect		II	c	Green-faced clubtail	*Gomphus viridifrons*
Insect	**FSSE**	I	c	Holsinger's cave beetle	*Pseudanophthalmus holsingeri*
Insect	**FS**	II	c	Little Kennedy Cave beetle	*Pseudanophthalmus cordicollis*
Insect	**FS**	II	c	Lobed roachfly	*Tallaperla lobata*
Insect	**FS**	II	c	Long-headed cave beetle	*Pseudanophthalmus longiceps*
Insect	**FS**	II	c	Overlooked cave beetle	*Pseudanophthalmus praetermissus*
Insect	**FS**	II	c	Rotund cave beetle	*Pseudanophthalmus rotundatus*
Insect	**FS**	II	c	Saint Paul cave beetle	*Pseudanophthalmus sanctipauli*
Insect	**FS**	II	c	Silken cave beetle	*Pseudanophthalmus sericus*
Insect		III	a	Tennessee clubshell	*Pleurobema oviforme*
Insect	**FS**	II	c	Thomas' cave beetle	*Pseudanophthalmus thomasi*
Mammal		IV	c	Allegheny woodrat	*Neotoma magister*
Mammal		IV	c	Appalachian cottontail	*Sylvilagus obscurus*
Mammal		I	c	Eastern small-footed myotis	*Myotis leibii*
Mammal		IV	c	Eastern spotted skunk	*Spilogale putorius putorius*
Mammal	**FESE**	II	a	Gray bat	*Myotis grisescens*
Mammal	**FESE**	I	b	Indiana myotis	*Myotis sodalis*
Mammal		IV	c	Long-tailed shrew	*Sorex dispar dispar*
Mammal	**FESE**	II	a	Virginia big-eared bat	*Corynorhinus townsendii virginianus*
Other Aquatic Invertebrates	**FS**	I	c	Powell Valley planarian	*Sphalloplana consimilis*
Other Terrestrial Invertebrates	**FS**	II	c	A cave pseudoscorpion	*Kleptochthonius binoculatus*
Other Terrestrial Invertebrates	**FS**	II	c	A cave pseudoscorpion	*Kleptochthonius proximosetus*
Other Terrestrial Invertebrates	**FS**	II	c	A cave pseudoscorpion	*Kleptochthonius similis*
Other Terrestrial Invertebrates	**FS**	II	c	A millipede	*Brachoria dentata*
Other Terrestrial Invertebrates	**FS**	II	c	Cedar millipede	*Brachoria cedra*
Other Terrestrial Invertebrates	**FS**	II	c	Gertsch's cave pseudoscorpion	*Kleptochthonius gertschi*
Other Terrestrial Invertebrates	**FS**	II	c	Lutz's cave pseudoscorpion	*Kleptochthonius lutzi*
Other Terrestrial Invertebrates		IV	c	Proud globe snail	*Mesodon elevatus*

Other Terrestrial Invertebrates	**FS**	II	c	Valentine's cave pseudoscorpion	*Microcreagris valentinei*
Reptile		III	c	Cumberland slider	*Trachemys scripta troostii*
Reptile		III	c	Eastern black kingsnake	*Lampropeltis getula nigra*
Reptile		III	a	Eastern box turtle	*Terrapene carolina carolina*
Reptile		IV	c	Eastern hog-nosed snake	*Heterodon platirhinos*
Reptile		IV	a	Northern map turtle	*Graptemys geographica*
Reptile		IV	a	Queen snake	*Regina septemvittata*
Reptile		IV	a	Spiny softshell	*Apalone spinifera spinifera*
Reptile		IV	a	Stripe-necked musk turtle	*Sternotherus minor peltifer*
Reptile	**CC**	IV	a	Timber rattlesnake	*Crotalus horridus (timber)*

APPENDIX B. SGCN SPATIAL ANALYSIS METHODS

Analysis Units

The species data was analyzed within three spatial units for Virginia: county, planning region, and hydrologic unit (HUC12). The source spatial data for these units were provided by Virginia Department of Game and Inland Fisheries (DGIF). The analysis extent was constrained to that of the Virginia counties, so that portions of the planning region and HUC12 units falling outside of the county boundaries were eliminated from the analysis. Each of the 21 planning region units was assigned an alphabetic code (e.g. Accomack-Northampton = "ACNO"). Nottoway County does not fall within the jurisdiction of any Virginia planning region and was not included in any of our analyses.

Species Data

The source data for the species analysis consisted of three datasets, all of which were provided by DGIF: aquatic tier I-II plus species, terrestrial potential and confirmed species, and peer-reviewed HUC12 species. Within these datasets, individual species are identified by Biota of Virginia (BOVA) code.

Methods

Aquatic Species

The aquatic species are represented in the source dataset by linear stream segments, or reaches. For each BOVA code present, the total length was calculated for all assigned reaches within the analysis extent. The dataset was then divided by the three analysis units, and the total BOVA length was summarized again by county, planning region, and HUC12. The BOVA percent of total length was calculated by dividing the species length for the analysis unit by the total species length.

Terrestrial Species

The terrestrial species are represented in the source dataset by area. For each BOVA code present, the total area was calculated within the analysis extent. The dataset was then divided by the three analysis units, and the total BOVA area was summarized again by county, planning region, and HUC12. The BOVA percent of total area was calculated by dividing the species area for the analysis unit by the total species area in Virginia.

Peer-Reviewed HUC12 Species

The peer-reviewed species are represented in the source dataset by 6th order hydrologic units. For each BOVA code present, the total area was calculated within the analysis extent. The dataset was then divided by the county and planning region analysis units, and the total BOVA area was summarized by county, planning region, and HUC12. The BOVA percent of total area was calculated by dividing the species area for the analysis unit by the total species area.

Priority SGCN

For each planning region, priority species were identified as those SGCNs with a total planning region unit area or length ≥ 10% of the total SGCN area or length for Virginia. SGCN unit calculations were drawn from only one of the source datasets: if an SGCN was present in both the aquatic dataset and the HUC12 dataset, then the aquatic dataset took preference; and if an SGCN was present in the terrestrial dataset and the HUC12 dataset, then the terrestrial dataset took preference.