8. Crater 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 Recreation 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 applicable 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.

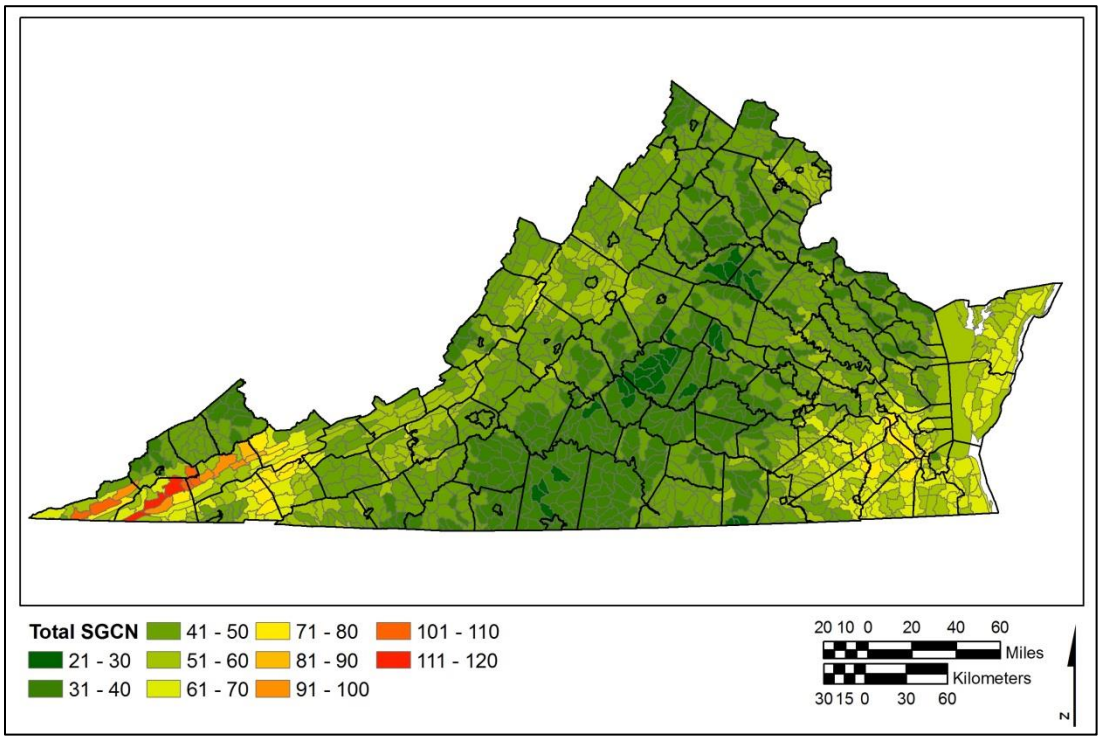

Figure 1. State distribution of Species of Greatest Conservation Need by HUC12 Watersheds.

Wildlife Action Plan Implementation

Since its creation, the 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 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 (DCR 2013). 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.

CRATER LOCAL PLANNING REGION SUMMARY OVERVIEW

The Crater Planning Region consists of 1,653,478 acres (2,584 square miles) and includes the counties of Dinwiddie, Greensville, Prince George, Surry, and Sussex and cities of Colonial Heights, Emporia, Hopewell, and Petersburg. The human population in this planning region is estimated to be almost 174,000 people (U.S. Census Bureau 2015). These counties are projected to experience slight population growth by 2030 (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. This planning region is especially important to the conservation of red cockaded woodpecker found within pine savanna habitat. This savanna habitat is also important to Bachman's sparrow and southern chorus frog, among other species. The region's blackwater systems support a broad range of SGCN such as the blackbanded sunfish, dwarf waterdog, and toplined minnow. Mature pine forest habitat supports the southeastern fox squirrel. The region also includes a variety of other habitat types such as mature mixed hardwood forests, young forests, retired agricultural land, tidal and non-tidal wetlands, and tidally influenced 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.

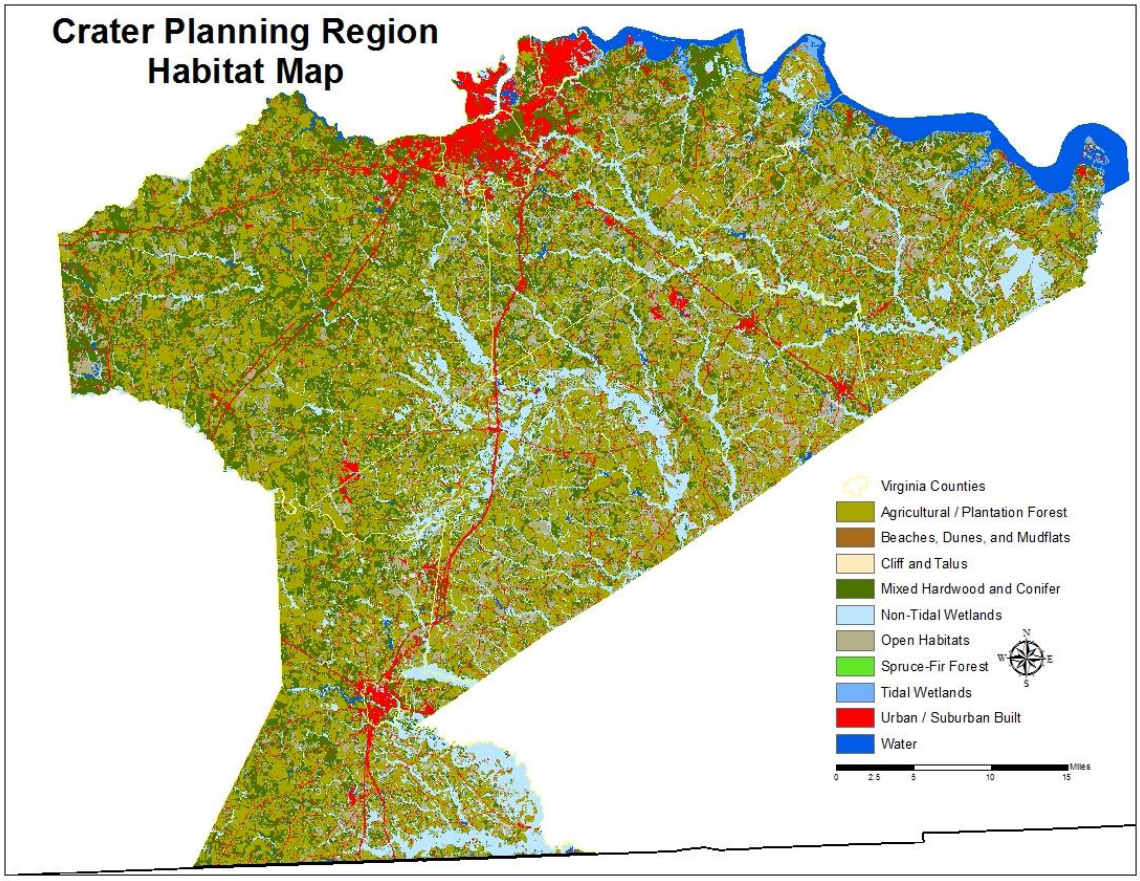

Figure 2. Crater Planning Region Habitats (Anderson et al. 2013).

Priority Species of Greatest Conservation Need

Of Virginia's 883 SGCN, 106 are believed to either occur, or have recently occurred, within the Crater Planning Region (Appendix A). Of these 106 species, ***73 SGCN are dependent upon habitats provided within the Crater Planning Region (Table 2). These species constitute the priority SGCN for the planning region***. A summary of SGCN Tier and Conservation Opportunity Rankings is provided in Table 1 while Figure 3 demonstrates the density of the 73 priority species within this planning 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	9
Ib	1
IIa	4
IIb	1
IIc	2
IIIa	8
IIIb	3
IIIc	3
IVa	21
IVb	9
IVc	12

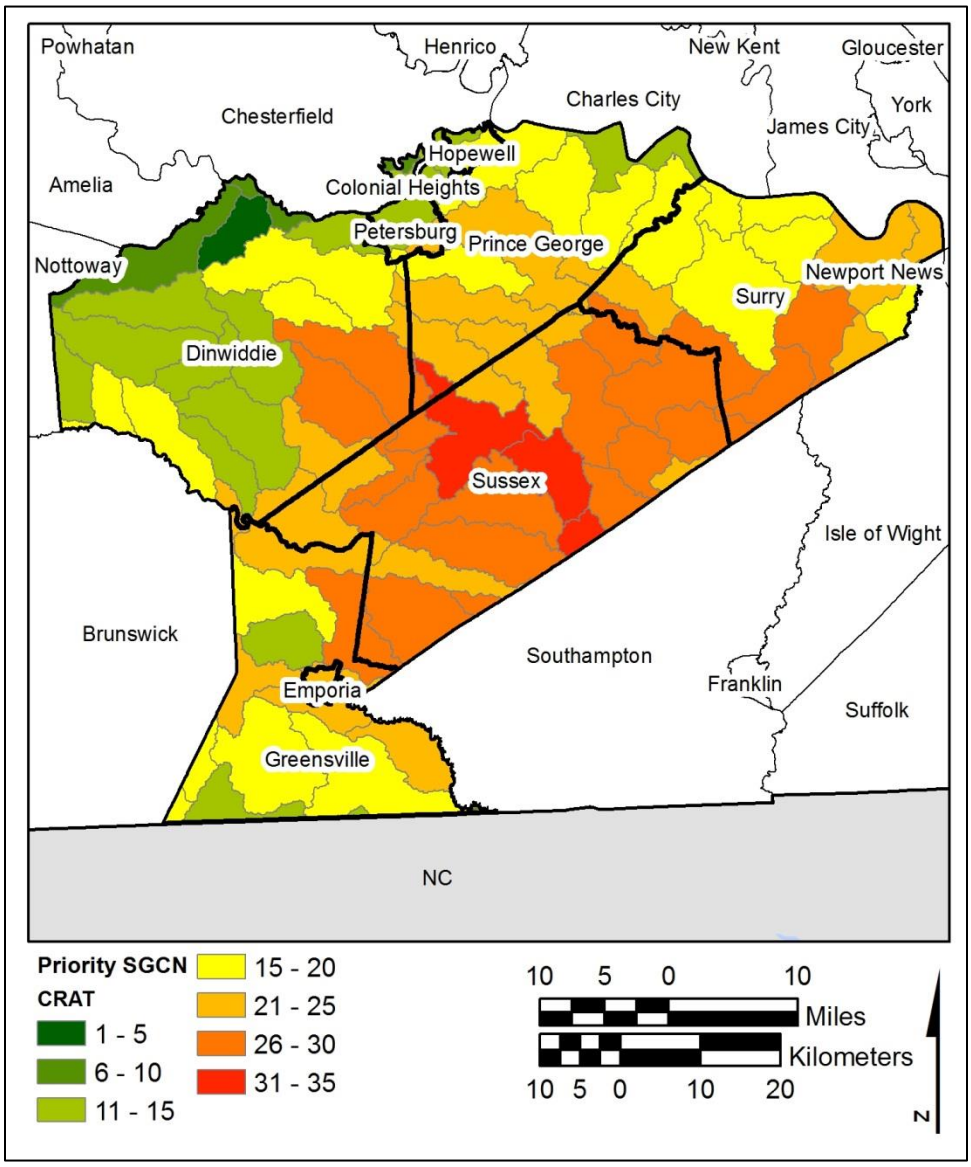

Figure 3. Priority SGCN Density in the Crater Planning Region (HUC12).

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

Taxa	Conservation Status	Tier	Opportunity Ranking	Common Name	Scientific Name	Habitat
Amphibian		III	a	Dwarf waterdog	*Necturus punctatus*	Sluggish streams and blackwater streams with debris
Amphibian		IV	c	Eastern spadefoot	*Scaphiopus holbrookii*	Forest and upland habitat generalist but require soils suitable for digging
Amphibian		IV	a	Greater siren	*Siren lacertina*	Tolerates a variety of warm aquatic habitats with abundant vegetation
Amphibian		III	a	Lesser siren	*Siren intermedia intermedia*	Tolerates a variety of warm aquatic habitats with abundant vegetation
Amphibian		IV	a	Little grass frog	*Pseudacris ocularis*	Most abundant in wetlands within pine savanna habitats
Amphibian	**ST**	II	a	Mabee's salamander	*Ambystoma mabeei*	Pine and hardwood forests with vernal ponds and other water sources suitable for breeding
Amphibian		IV	a	Many-lined salamander	*Stereochilus marginatus*	Gum and cypress swamps as well as other wooded wetlands
Amphibian		II	a	Oak toad	*Anaxyrus quercicus*	Pine savanna
Amphibian		IV	c	Southern chorus frog	*Pseudacris nigrita*	Grassy wet areas within or near pine forests
Bird	**ST**	I	a	Bachman's sparrow	*Peucaea aestivalis*	Pine savanna/ open pine woodlands
Bird		III	c	Bank swallow	*Riparia riparia*	Habitat includes open and partly open situations, frequently near flowing water. Nests are in steep sand, dirt, or gravel banks, in burrows dug near the top of the bank, along the edge of inland water, or along the coast, or in gravel pits, road embankments, etc.
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		III	a	Black-crowned night-heron	*Nycticorax nycticorax*	Variety of marshes, swamps, and wooded streams
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	Chimney swift	*Chaetura pelagica*	Inhabits rural and urban environments having both an abundance of flying arthropods and suitable roosting/nesting sites.
Bird		IV	b	Clapper rail	*Rallus longirostris*	Saltmarshes
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		III	a	Eastern whip-poor-will	*Antrostomus vociferus*	Forest and open woodland, from lowland moist and deciduous forest to montane forest and pine-oak association.
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		III	b	Least bittern	*Ixobrychus exilis exilis*	Freshwater marshes
Bird	**ST**	I	a	Loggerhead shrike	*Lanius ludovicianus*	Grasslands, orchards and open areas with scattered trees
Bird		III	a	Northern bobwhite	*Colinus virginianus*	Early successional habitats including croplands, grasslands, pastures, grass-brush rangelands, and open forests
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	**FESE**	I	a	Red-cockaded woodpecker	*Picoides borealis*	Pine savanna
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.
Bird	**ST**	I	a	Peregrine falcon	*Falco peregrinus*	Human structures in the east and cliff sites in the west
Crustacean	**FS**	III	c	Chowanoke crayfish	*Orconectes virginiensis*	Sluggish streams and swamps with abundance of dead wood on the bottom
Fish		IV	a	Alewife	*Alosa pseudoharengus*	Migratory
Fish		IV	c	American brook lamprey	*Lampetra appendix*	Requires clear flowing water but can tolerate a range of temperatures and substrates
Fish		IV	a	American shad	*Alosa sapidissima*	Large unfragmented migratory rivers for spawning
Fish		I	b	Atlantic sturgeon	*Acipenser oxyrinchus*	Migratory and utilize variety of aquatic and marine habitats
Fish		IV	c	Banded sunfish	*Enneacanthus obesus*	Blackwater swamps, ponds, and streams with thick vegetation
Fish	**SE**	I	a	Blackbanded sunfish	*Enneacanthus chaetodon*	Acidic pools, creeks, and swamps with thick vegetation
Fish		III	c	Ironcolor shiner	*Notropis chalybaeus*	Moderately acidic creeks, streams, and swamps
Fish		IV	c	Lake chubsucker	*Erimyzon sucetta*	Clear to slightly stained warm water ponds, lakes, ditches, and streams
Fish		IV	c	Lined topminnow	*Fundulus lineolatus*	Moderately acidic margins of swamps and creeks with dense vegetation
Fish		IV	c	Mud sunfish	*Acantharchus pomotis*	Swamps, ponds, and slow moving water
Fish		I	a	Roanoke bass	*Ambloplites cavifrons*	Warm large creeks, streams, and small rivers with low gradient and typically clear water.
Fish	**FESE**	II	a	Roanoke logperch	*Percina rex*	Warm clear stream and rivers with low to moderate gradient and unsilted substrate

Fish	**ST**	II	c	Whitemouth shiner	*Notropis alborus*	Clear to somewhat turbid creeks, with varying substrates
FW Mollusk		IV	a	Alewife floater	*Anodonta implicata*	Alewife obligate - coastal streams and lakes with sand or gravel substrates
FW Mollusk	**FSST**	I	a	Atlantic pigtoe	*Fusconaia masoni*	Clean swift waters with stable gravel or sand/ gravel substrate
FW Mollusk		IV	a	Carolina slabshell mussel	*Elliptio congaraea*	Small streams to rivers with swift flow and sandy substrates
FW Mollusk	**FESE**	I	a	Dwarf wedgemussel	*Alasmidonta heterodon*	Clean warm streams and rivers with low to moderate current and unsilted substrates
FW Mollusk		IV	a	Eastern pondmussel	*Ligumia nasuta*	Areas of limited currents and significant amounts of fine organic matter. Can tolerate a wide range of substrates
FW Mollusk		IV	c	Gravel elimia	*Elimia catenaria*	Streams and rivers with high ground water content and good flow
FW Mollusk		IV	b	Northern lance mussel	*Elliptio fisheriana*	Shallow water near stable banks with intact riparian zones and soft substrates
FW Mollusk		IV	c	Ridged lioplax	*Lioplax subcarinata*	Clean water with slow currents and sandy substrates, most often found in rivers with stable shorelines and wide riparian forests
FW Mollusk	**FS**	II	b	Roanoke slabshell	*Elliptio roanokensis*	Deeper channels of relatively fast flowing rivers
FW Mollusk		IV	c	Sharp sprite	*Promenetus exacuous*	No specific habitats have been identified for this aquatic snail but it occurs across most of North America
FW Mollusk		II	a	Yellow lampmussel	*Lampsilis cariosa*	Large streams and rivers with low gradient and sand and gravel substrates
Insect	**FS**	II	c	Rare skipper	*Problema bulenta*	Freshwater and brackish marsh
Mammal		IV	c	Cotton mouse	*Peromyscus gossypinus gossypinus*	Riparian forests
Mammal		IV	c	Marsh rabbit	*Sylvilagus palustris palustris*	Freshwater wetlands
Mammal	**SE**	I	a	Rafinesque's eastern big-eared bat	*Corynorhinus rafinesquii macrotis*	Use hollow trees as well as various types of human structures for roosting
Mammal		III	b	Southeastern fox squirrel	*Sciurus niger niger*	Open mature stands of pine or pine/hardwoods
Mammal		IV	b	Southeastern myotis	*Myotis austroriparius*	Riparian forests with suitable roost structures
Reptile		IV	a	Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	Upland pine habitats

Reptile		IV	a	Mudsnake	*Farancia abacura abacura*	Wetland generalist as long as aquatic salamanders are present
Reptile		IV	a	Rainbow snake	*Farancia erytrogramma erytrogramma*	Riparian forest - eel obligate
Reptile		IV	a	Scarletsnake	*Cemophora coccinea copei*	Forest generalist but require soils suitable for digging
Reptile	**CC**	III	a	Spotted turtle	*Clemmys guttata*	Freshwater swamps and marshes
Reptile		IV	b	Yellow-bellied slider	*Trachemys scripta scripta*	A variety of freshwater habitats including rivers, ponds, lakes, and roadside ditches

** 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 Crater 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. The conservation mechanisms range from conservation easements to state parks to state wildlife management areas, and National Wildlife Refuges (NWR). Significant conservation assets, in terms of size, include:

- James River National Wildlife Refuge,
- Hog Island Wildlife Management Area
- Big Woods Wildlife Management Area,
- Piney Grove Preserve,
- Petersburg National Battlefield Park, and
- Chippokes Plantation State Park.

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. In addition to supporting mission functions, lands on the Fort Pickett Military Reservation and the Fort Lee Military Reservation also support a diversity of wildlife and habitats.

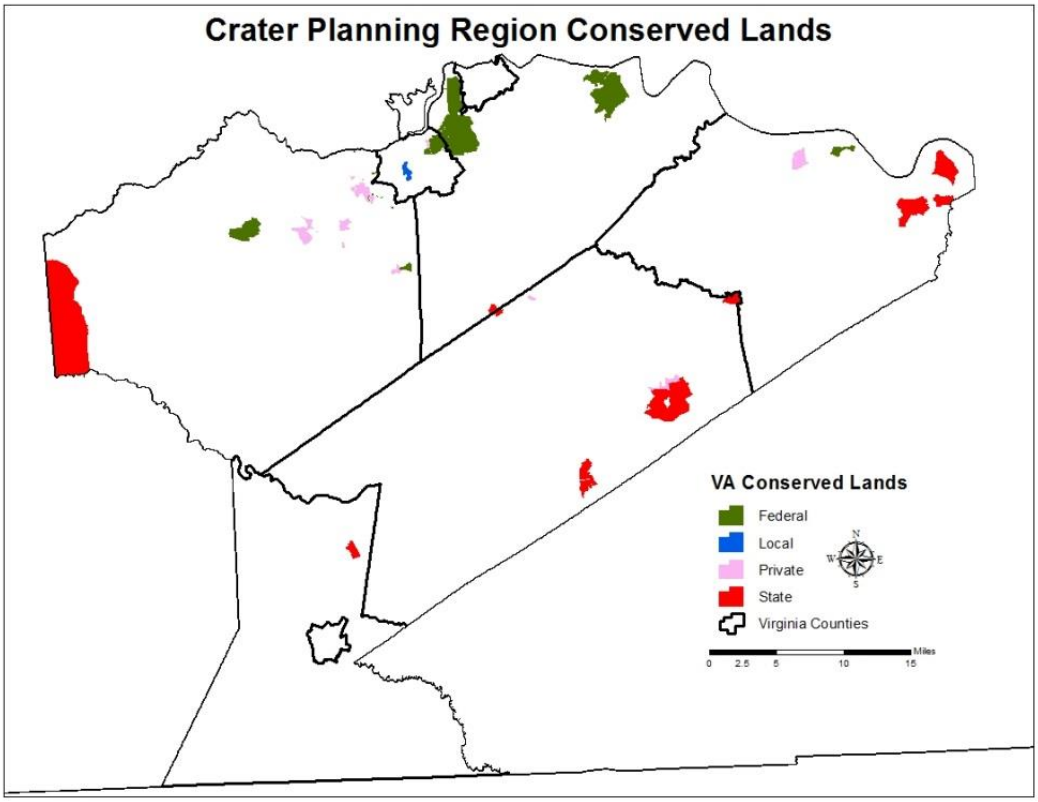

Figure 4. Conservation Lands in the Crater Planning Region (DCR, Natural Heritage 2014).

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 additional 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 Crater Planning Region

Although Crater Planning Region is further inland than other coastal planning regions, climate change and resulting sea-level rise and storm-related events may affect areas within the region. A report published by the Virginia Institute of Marine Science (VIMS) (2013) used climate scenarios from the Intergovernmental Panel on Climate Change to determine a range of sea-level rise projections for Virginia. Based on this analysis, a range of approximately 1.5 feet to over 7 feet of sea-level rise is projected in the state by 2100, and the report recommends considering a foot and a half of sea-level rise over the next 20 to 50 years for planning purposes (VIMS 2013). Tropical storm events also are projected to become more intense (VIMS 2013; Staudinger et al. 2015). Sea-level rise and more intense storm events are likely to increase shoreline erosion, facilitate salt water intrusion, destroy habitats and ecological systems, and increase storm water overflows and sewage contamination (VIMS 2013). VIMS also estimates that given these projections, approximately 30 miles of coastline within this planning region will be vulnerable to sea-level rise (shoreline in Charles City, Chesterfield, Prince George, and Surry) (VIMS 2013; Titus 2010).

Changes in temperature and precipitation will also negatively affect habitats and SCGN in the Crater 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).

Increased temperatures may lead to heat stress for species and decreased water quality and dissolved oxygen content as well as 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 Crater 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 Crater Planning Region priority SGCN and other species. Many of these activities are also expected to benefit landowners and communities.

Table 3. Summary of Conservation Strategies and Actions for Crater Planning Region.

Conservation Strategies	Conservation Actions	Threats Addressed	Economic/ Human Benefits	Priority Areas
Maintain and restore wetland habitats	1) Work with appropriate entities on wetlands permitting process to ensure adequate mitigation and restoration procedures are in place; 2) Implement living shorelines where feasible; 3) Establish or enhance vegetative buffer areas inland of existing wetlands; 4) Utilize relevant data (e.g., Virginia Department of Conservation and Recreation's wetlands catalog) to identify priority areas for conservation, acquisition, and restoration; and 5) Control invasive species.	Water quality degradation, habitat/ land use conversion, climate change, non-native and exotic invasive species	Flood control; filtration services; erosion and sediment control; supports recreational and commercial fisheries; ecotourism/ wildlife watching and fishing/ hunting opportunities	Watershed with priority wetlands and areas adjacent to priority watershed that allow inland migration of wetlands
Enhance, maintain and restore aquatic and shoreline habitats	1) Work with landowners to implement small acreage grazing systems; 2) Repair/ replace failing septic systems; 3) Establish riparian vegetative buffers along waterways; 4) Establish waste storage facilities to better manage animal waste and prevent flow into rivers; 5) Establish retention ponds or features to manage and slow urban storm water runoff; 6) Work to prevent pet waste from entering waterways; 7) Continue to identify impaired waters within the planning region; 8) Restore aquatic connections; 9) Monitor and address invasive species impacts; and 10) 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, 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	Beaver Pond Creek, Cypress Swamp, Little Nottoway River, Mill Swamp, Raccoon Creek, Rattlesnake Swamp, Three Creek, Upper Nottoway River
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; and 5) Monitor and control invasive species.	Land use change and conversion, invasive species, climate change	Flood control; water quality; and ecotourism/ wildlife viewing/other outdoor recreation	Forest patches adjacent to already protected parcels

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	Pine savannas not already protected

Maintain and Restore Wetland Habitats

Tidal and non-tidal wetlands are found throughout the Crater Planning Region. In addition to providing habitat for a diversity of aquatic and terrestrial species, wetlands help maintain water quality and quantity within a watershed, limit erosion caused by floods, and provide recreational opportunities for hunters, anglers, and wildlife watchers. Non-tidal marshes are the most common wetland type in this area (Table 4). These wetlands provide valuable habitats for the marsh rabbit, black crowned night herons, yellow rails, and a variety of other species.

Table 4. Wetland Acreage in Crater Planning Region (Anderson et al. 2013).

Wetland Type	Total Acres	Percent of Planning Region
Non-Tidal Wetlands	170,189.50	13.70%
Tidal Wetlands	7,418.56	0.60%

Threats

The health and quality of tidal and non-tidal wetlands are affected by a variety of issues, both natural and anthropogenic. As the quality of a wetland degrades, so does the value of that wetland to Virginia's wildlife.

1. Water Quality: Wetlands help filter nutrients and other pollutants from watersheds, but they are also sensitive to activities that impair water quality and overload the system (Hemond and Benoit 1986). When best management practices (BMP) are not implemented upstream, runoff laden with nutrients, sediment, and other pollutants enter the system in concentrations that hinder the wetland's filtering capacity. Storm water runoff from urban and developed areas also contributes to water quality issues that degrade wetlands (Hemond and Benoit 1986). Nutrient pollution and sedimentation are important issues for tidal and non-tidal wetlands throughout the planning region.

2. Land Use Changes: One of the most significant threats to tidal and non-tidal wetlands is conversion to other uses and hardening of shorelines that can harm wetland integrity and function. As more areas are developed for additional human uses, wetland areas will likely be lost.

3. Invasive Species: Invasive species often degrade the quality of tidal wetland habitat through damage or loss to wetland vegetation. Mute swans out-compete native species by consuming significant amounts of emergent and submerged aquatic vegetation (DGIF 2012). Mute swans can also destroy vegetation by uprooting it, thereby limiting the effectiveness of wetland restoration (DGIF 2012). Invasive plant species such as *Phragmites* can overtake wetlands, changing vegetative composition to a monoculture and diminishing wetland function and value. Examples of invasive species affecting non-tidal wetlands include: *Phragmites*, purple loosestrife, Japanese stilt grass, and exotic invertebrates.

4. Climate Change: As sea levels rise, marshes can be inundated and convert to shallow open water habitats or non-tidal and brackish wetlands may convert to higher salinity marshes. Shallow open water habitats and salt marshes likely will not support the same vegetative composition as the non-tidal and tidal wetlands in this planning region, affecting the wildlife species that depended on these

habitats (CCSP 2009). Additionally, as storms become more intense, more frequent inundation may also pose problems for vegetation and fish and wildlife species with low salinity tolerances (CCSP 2009).

Conservation Management Actions

A number of actions can be taken to address threats affecting wetlands in the Crater Planning Region. To address development and fill impacts, the federal government and the Commonwealth of Virginia have established an extensive wetlands permitting process to help landowners and developers avoid impacts to wetlands while pursuing their management objectives. The Virginia Tidal Wetlands Act gives authority to the Virginia Marine Resource Commission (VMRC) to issue tidal wetland permits with the option to for local governments to assume this responsibility (DEQ 2011). The U.S. Army Corps of Engineers has authority to issue permits for impacts to non-tidal wetlands through the federal Clean Water Act, while DEQ has authority under Virginia's State Water Control Law. Permits are issued through a Joint Permit Application Process that can be initiated with DEQ (DEQ 2011). Mitigation to compensate for wetland loss is often required under these permits. However, wetlands restoration to reestablish or rebuild former wetland areas or restore functions to a degraded wetland also are voluntary conservation actions agencies and conservation partners can implement outside of required wetlands mitigation and are an important component to protecting wetlands (DEQ 2011). These types of conservation actions also help provide migration corridors for migratory birds that depend on wetlands for nesting, roosting, and foraging. Various programs implemented by the Natural Resources Conservation Service (NRCS) and other partners also provide guidance related to conserving wetlands, establishing oyster reefs, and implementing other actions.

In certain situations, living shorelines can be a viable alternative to hardened or armored shorelines. By using native vegetation, oyster reefs, dune restoration, rock sills, bank grading, or other more natural methods, living shorelines can help protect private property from erosion while also providing opportunities for wetlands to migrate inland as conditions change (Kane 2011) (VIMS 2010). Establishing or protecting vegetative buffers upland of wetlands also is important to protect health of the existing wetlands as well as to provide a potential inland migration route as conditions change (Kane 2011). The protection of additional wetland areas through acquisition, easement, or agreement would allow for further conservation of this important habitat and associated SGCN. Finally, working to limit invasive plants and animals that might degrade the quality of these habitats will be important conservation actions.

Priority areas for wetlands protection and restoration within the Crater Planning Region include those wetlands that are inland of tidal wetlands that may provide some opportunity for inland migration as sea levels rise. These more inland areas also allow for large wetland complexes to be protected, ensuring larger habitat patches remain available for wildlife. Areas identified by conservation partners, such as the Virginia Department of Conservation and Recreation (DCR), as outstanding opportunities for conservation should also be considered priorities for protection and conservation. An initial review of the Virginia Wetlands Catalog identifies priority wetlands for conservation and restoration (Weber and Bulluck 2014). Designation of these areas was based on several factors, including existing plant and animal diversity, presence of significant natural communities, presence of natural lands providing ecosystem services, presence of corridors and stream buffers, proximity to conserved lands, inclusion within or downstream of healthy watersheds, and location of drinking water sources (Figure 5) (Weber and Bulluck 2014). DCR also designates potential restoration sites, identified based on similar factors as

conservation areas, but also including consideration of inclusion within degraded watersheds, proximity to impaired waters, location of existing wetland mitigation banks, presence of prior converted and farmed wetlands, and inclusion of stream reaches with lower aquatic biodiversity (Figure 6) (Weber and Bulluck 2014). The wetlands catalog indicates healthy wetlands occur throughout the planning region. Wetlands adjacent to conserved lands have a higher priority. Likewise, wetland restoration opportunities also occur throughout the region. Restoration efforts should focus on wetlands adjacent to either conserved lands or adjacent or upstream from healthy wetlands. Restoration priority areas are extensive in Surry and Dinwiddie counties and in some cases are adjacent to already protected lands.

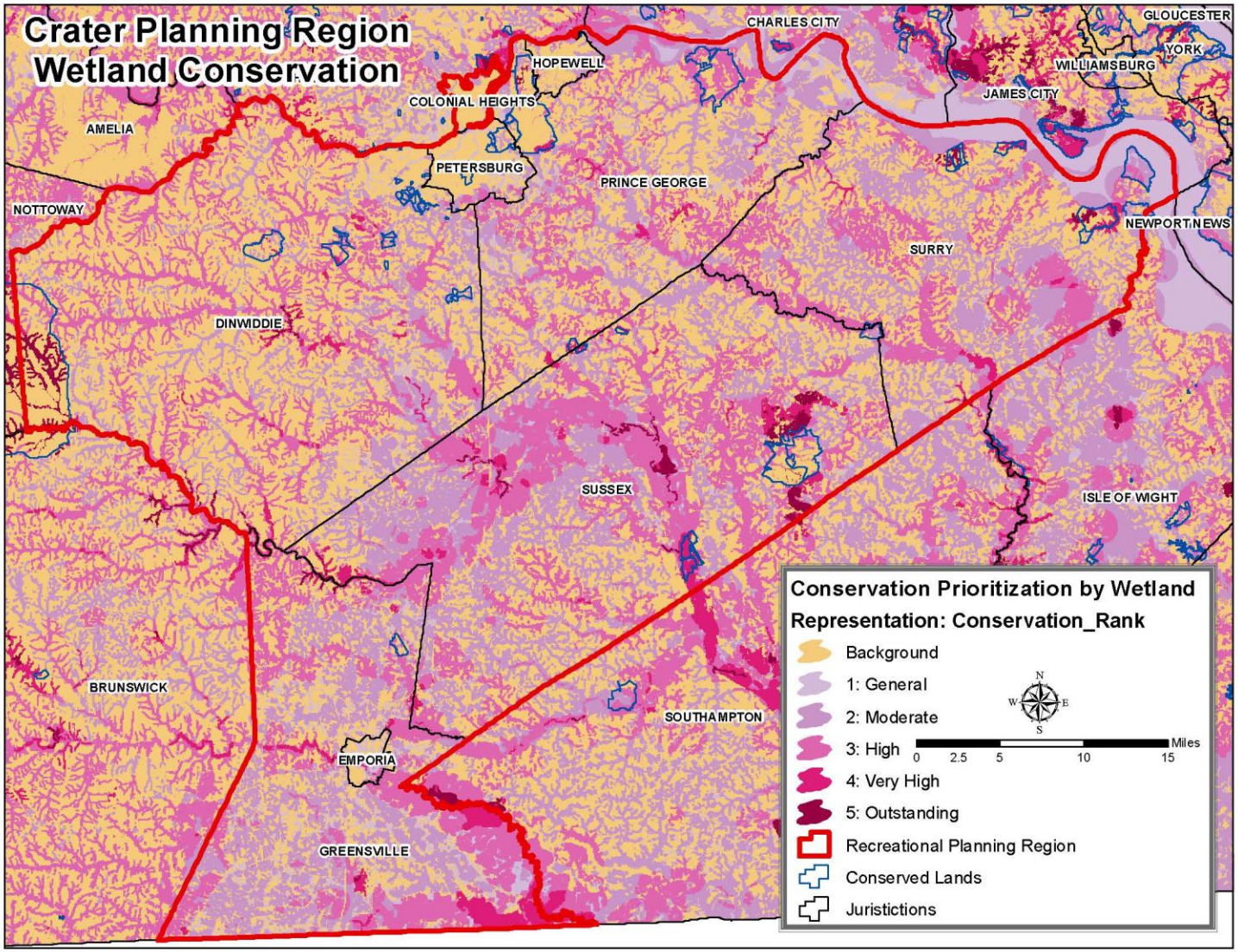

Figure 5. Wetland Conservation Priority Areas in Crater Planning Region (Weber and Bulluck 2014).

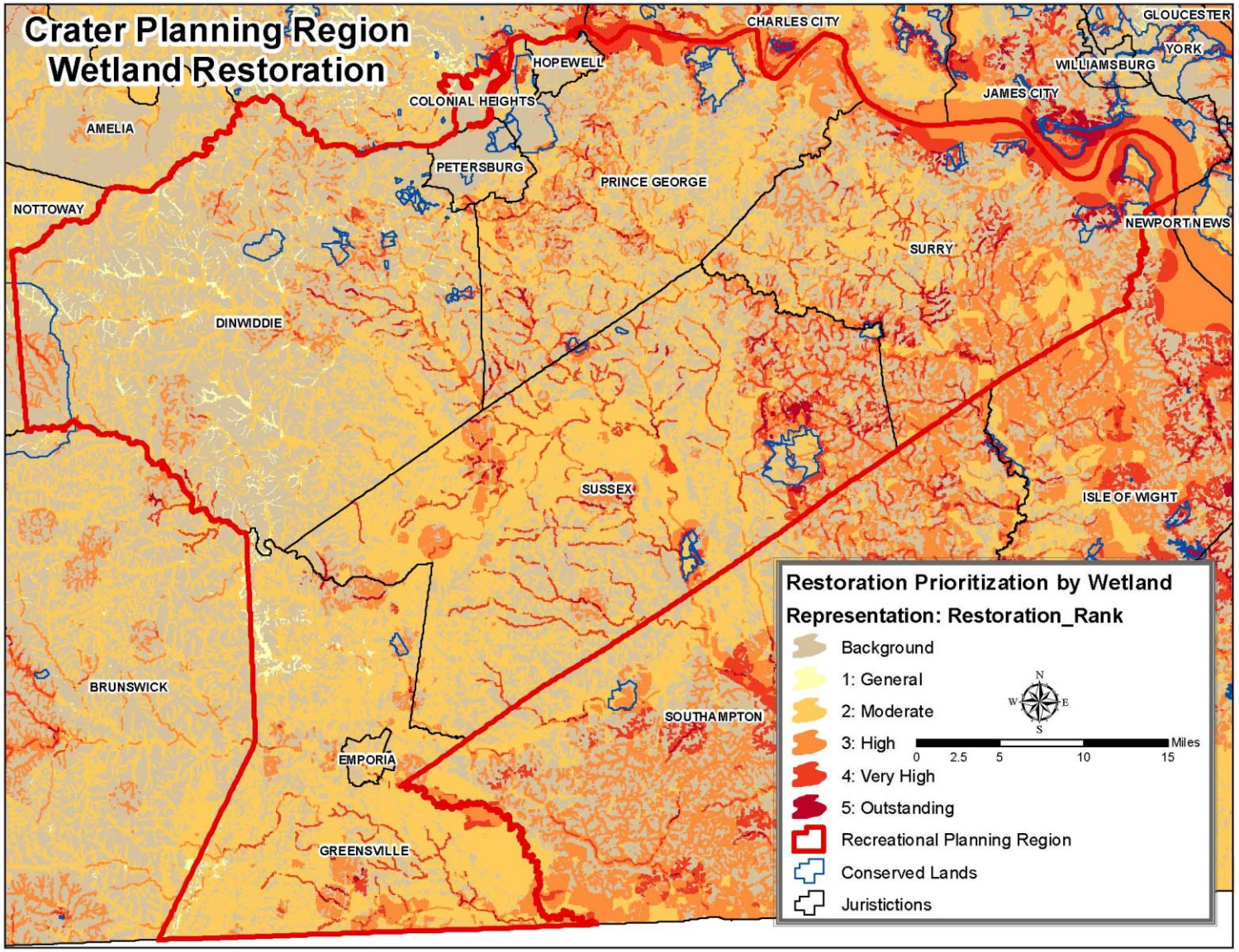

Figure 6. Wetland Restoration Priority Areas in Crater Planning Region (Weber and Bulluck 2014).

Climate-Smart Management Actions

Additional wetlands climate-related conservation actions include: restoring and enhancing vegetation within the wetlands to support changing conditions (e.g., using vegetation species that can withstand a broader array of conditions like more frequent inundation and higher salinity levels), restoration of wetlands to increase their elevation along the coast where feasible or needed, and enhancement of wetland migration by targeted restoration or acquisition in areas where wetlands may migrate (both inland and upstream).

Enhance, Maintain, and Restore Aquatic and Riparian Habitats

Aquatic systems in the Crater Planning Region include tidal and non-tidal freshwater creeks and streams. These systems provide important habitat for numerous species of wildlife, fish, and invertebrates. The Crater Planning Region also contains some of the best examples of Virginia's remaining blackwater habitats. Blackwater streams occur south of the James River, and they consist of sandy soils with tannin stained waters and little suspended clay sediment. They often are associated with bald cypress and tupelo as well as other bottomland hardwoods, but they also may have small, shrubby sloughs and shrub and herb layers (Anderson et al. 2013). Approximately 40,850 acres (3.3 percent) of the planning region is considered aquatic (Anderson et al. 2013). Priority SGCN that depend on these aquatic systems within this planning region include the blackbanded sunfish, Chowanoke crayfish, toplined minnow, dwarf wedge mussel, and ridged lioplax snail.

Threats

Aquatic and riparian habitats within the Crater Planning Region face multiple threats from water quality related issues to invasive species.

1. Water Quality Degradation: Pollution is the most significant threat to aquatic species and riparian habitats within the Crater 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. Much of the Crater Planning Region has a low percentage of impervious surface cover, however; the larger population center has a higher percentage of impervious surfaces (Figure 7).

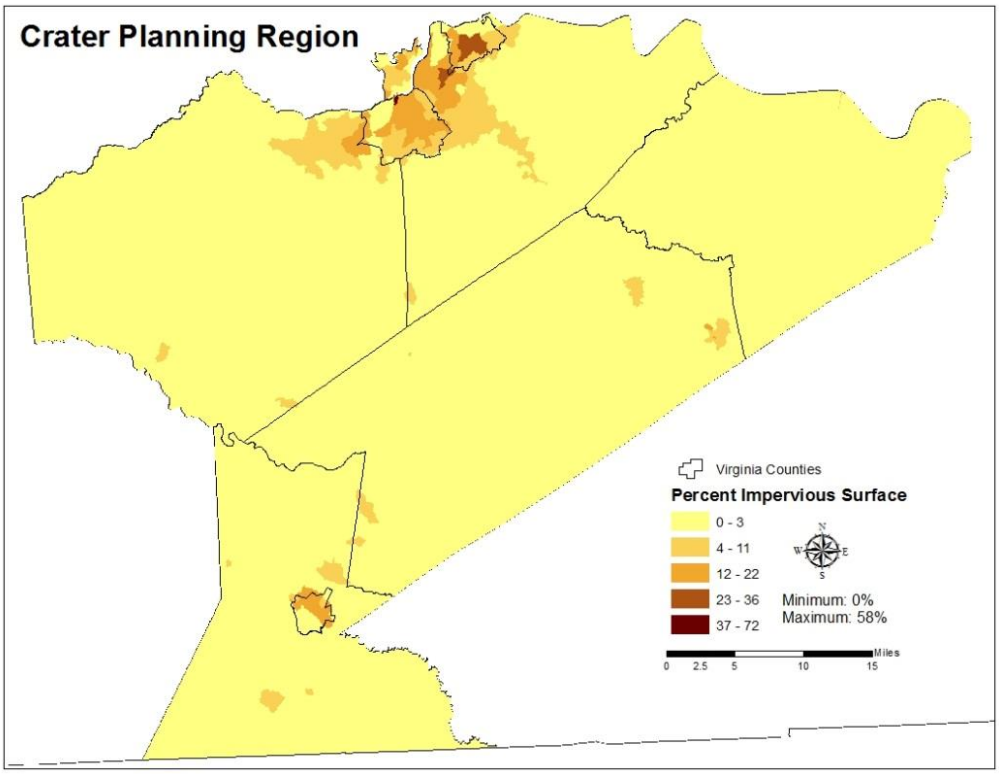

Figure 7. Impervious Surface Cover in Crater Planning Region (SARP 2014).

3. Invasive Species: Additional threats to aquatic systems within Crater Planning Region include invasive species, such as blue catfish, mute swans, Asian carp (e.g., big head carp and grass carp) that either consume native species or consume aquatic vegetation that alter the quality of these aquatic habitats and invasive species that impair waterways.

4. 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.

5. Water Withdrawals: Water withdrawals for human and land uses can also alter stream hydrology and cause stress to aquatic species that depend on specific water levels and flow rates. Additionally, over-use of groundwater could lead to saltwater intrusion into the

aquifer that could degrade the quality of both subterranean and surface water.

6. Climate change: Climate change will also affect aquatic systems in this planning region. Changes in temperature and precipitation regimes could result in drier more drought prone summers. Water temperatures may also be affected, resulting in potential harm to fish and other aquatic species.

Conservation Management Actions

Water Quality Improvement Plans have been developed by partners for the Virginia Department of Environmental Quality (DEQ). Watersheds within the planning region that have Water Quality Improvement Plans include: Beaverpond Creek (MapTech and New River-Highlands 2005), Cypress Swamp (MapTech and New River-Highlands 2005), Little Nottoway River (MapTech and New River-Highlands 2005), Mill Swamp (Working Group 2013), Raccoon Creek (MapTech and New River-Highlands 2005), Rattlesnake Swamp (MapTech and New River-Highlands 2005), Three Creek (Working Group 2013), and Upper Nottoway River (MapTech and New River-Highlands 2005) (Figure 8).

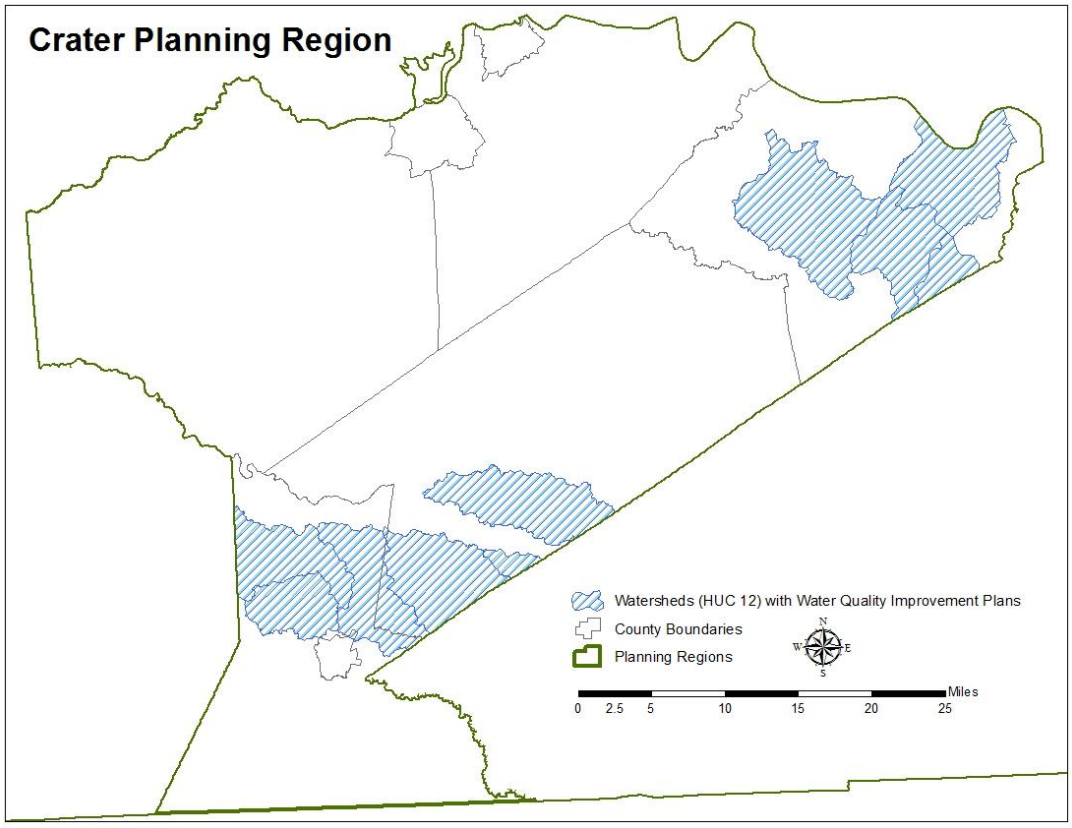

Figure 8. Watersheds with Water Quality Improvement Plans.

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

- Establishing riparian vegetative buffers along waterways;

- Reforesting erodible pasture lands and establishing permanent vegetative cover on critical areas;
- Establishing waste storage facilities (such as dairy lagoons or waste sheds) to better manage animal waste and prevent flow into the river;
- Establishing retention ponds, impoundments, or other features to manage and slow storm water runoff from cropland, pastures, forests, and barren lands;
- Working with landowners to implement small acreage grazing systems;
- Repairing or replacing failing septic systems and pit privies; and
- Working to prevent pet and kennel waste from entering waterways and establishing a pet litter program to encourage owners to clean up pet waste.

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 9).

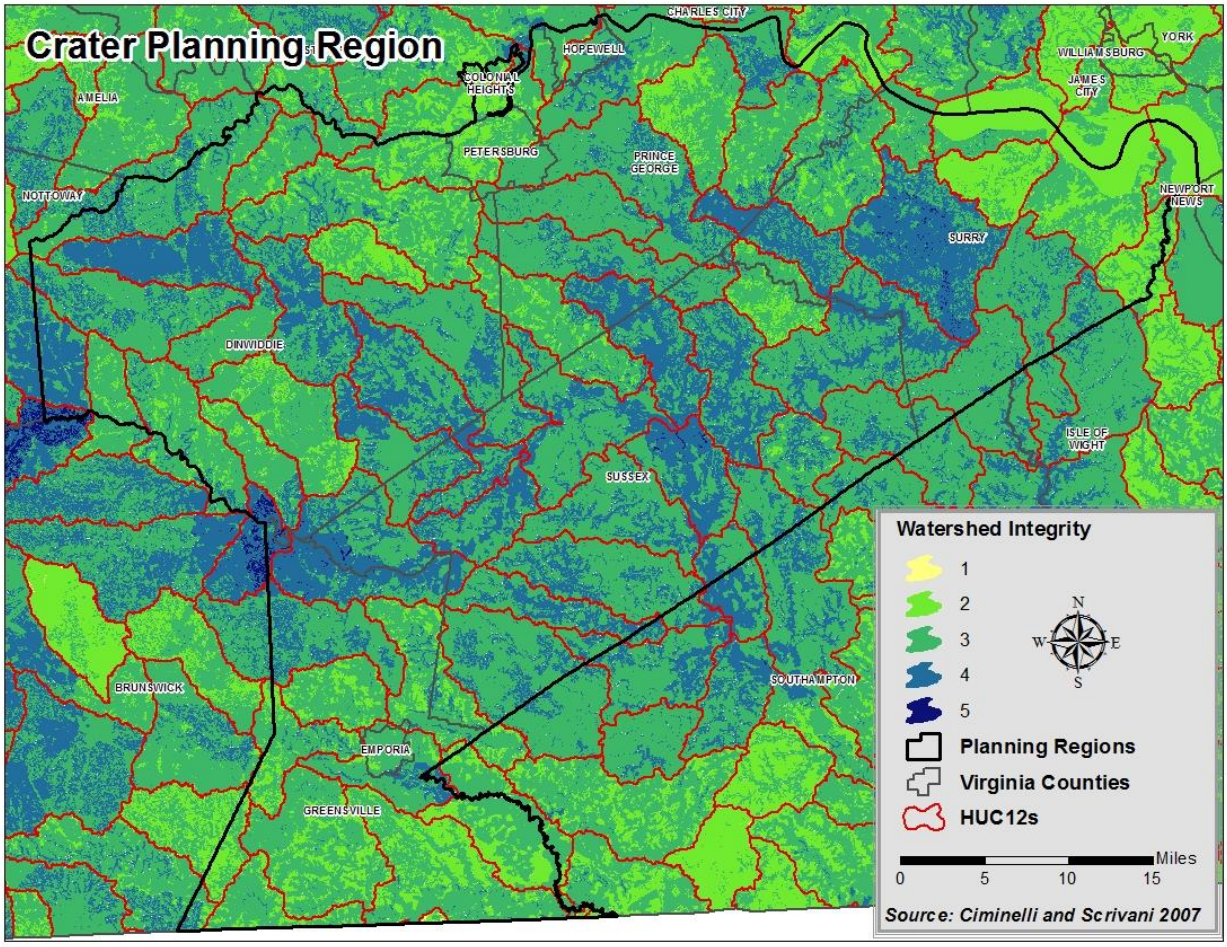

Figure 9. Watershed Integrity Model for Crater Planning Region (Ciminelli and Scrivani 2007).

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;
- Reducing impervious surface by replacing with more porous materials or vegetation; and
- Working to enhance the health of upland forests and grassland habitats.

Additionally, many agencies help landowners in the Crater 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.

Stream restoration and connectivity projects (e.g., removing dams and culverts or modifying them to allow for passage) help improve and provide additional aquatic habitats for fish species within the state; however, there are many dams, and not all can or should be removed. Priority watersheds that would benefit from enhanced connectivity have been identified by the Chesapeake Bay Fish Prioritization Tool and the Southeast Aquatic Connectivity Assessment Tool (Figure 9) (Martin and Apse 2013).

Additional actions to improve aquatic systems in the Crater Planning Region include: restoring aquatic connections (i.e., removing culverts, dams, etc.), monitoring and addressing invasive species impacts as well as promoting efforts to rinse boats and trailers on site, and working with the planning region to adopt land 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.

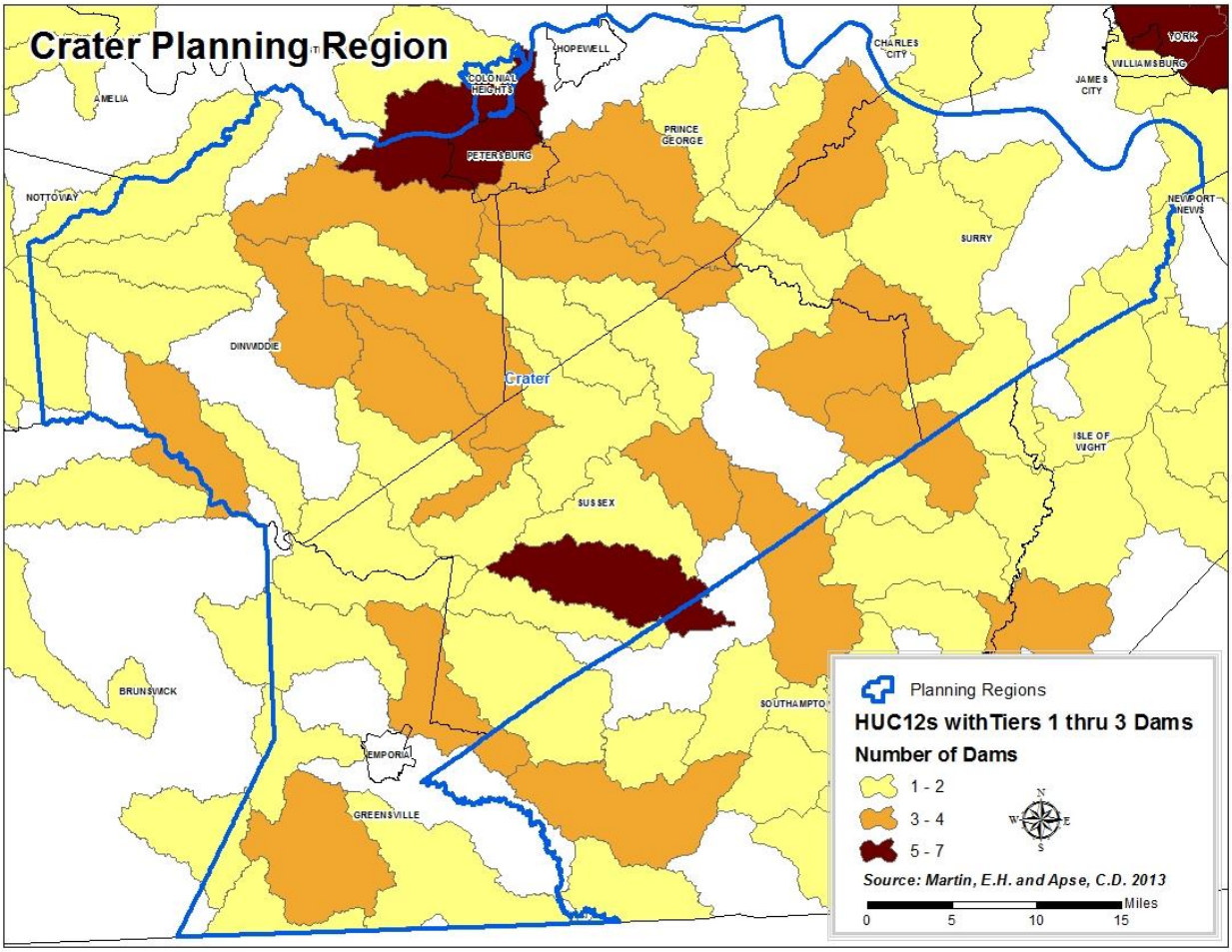

Figure 10. HUC12 Watersheds with Priority Dams for Removal/ Modification for Enhanced Connectivity (Martin and Apse 2013).

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. 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.

Because sea-level rise will likely be an issue, tree and shrub species that have a broader salinity tolerance should be considered. Techniques and tools may be needed (e.g., fencing, biomats, etc.) to ensure success. 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 account for 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 over a fourth of Crater Planning Region and are important for a broad range of species (Table 5). Within this forest type the majority of the trees are mature. Young forest habitat can be 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. Lack of young forest habitat has detrimental effects on the wildlife species that depend on this forest stage for survival. Mixed hardwood and conifer forests help protect water resources within the region and provide habitat for species such as the northern scarletsnake, Rafinesque's big-eared bat, eastern spadefoot toad and southeastern fox squirrel.

Table 5. Forest Acreage Totals in Crater Planning Region (Anderson et al. 2013).

Forest Type	Acres	Percent of Planning Region
Mixed Hardwood and Conifer	327,078.87	26.33%

Threats

Forests within this planning region face a range of threats.

1. Land Use Changes and Conversion: The largest threat to mixed hardwood and conifer forests within Crater Planning Region is fragmentation, mainly due to expanding residential and commercial development and resulting roads. In many cases with urban or commercial development, the losses can be complete and have profound impacts on local wildlife species composition, water quality, and outdoor recreational opportunities. In other situations, such as conversion to pine plantations, the mixed forest habitat is lost, but the newly planted forest can be managed for several years to provide open young forest habitats that support a diversity of landowner goals, wildlife species, and 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).

2. Invasive Species: Invasive plant species such as privet and Japanese stilt grass and pests are also a significant problem in this region. Of particular note is the gypsy moth. Although more prevalent in the western portion of the state, it may still affect oaks and other species within these forests (DOF 2014).

3. 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 and an increase in incidence of pests.

Conservation Management Actions

Actions for conserving mixed hardwood and conifer forests in Crater 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, personal communication, 2015). BMPs also recommend building roads on areas with minimum slope and minimizing or avoiding stream crossings (DOF 2014). The *Water Quality Improvement Plan to Reduce Bacteria in Darden Mill Run, Mill Swamp, and Three Creek* developed for DEQ specifically highlights reforesting areas around eroding crop lands and pastures within the Three Creek watershed to help decrease sediment run off as well as provide wildlife habitat (Working Group 2013).

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 their spread. Some of these forest habitats should be managed with thinning and prescribed burns to minimize outbreaks while also improving quality of wildlife habitats (Brooks and Lusk 2008; DOF 2014).

Climate-Smart Management Actions

To best manage forests in the Crater 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 higher salinities, increased temperatures, and drought, among other impacts. Managers may wish to consult recently available climate data through DGIF as well as 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 may want to provide refugia for SGCN as habitat is lost as well as establishing corridors both north/ south and east/west 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 generally comprised of post-agricultural lands, pine savannas, and barrens and glades and make up approximately 129,900 acres (10.5 percent) of this 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. This planning region contains some of the best examples of longleaf pine savanna in Virginia. Long leaf pine savanna habitat is a regionally significant resource necessary to the conserve the red cockaded woodpecker, Bachman's sparrow, southern chorus frog, and other species.

Threats

Changing land use patterns has played a large role in the loss of open forests 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 development (where habitats are converted for human use) and natural succession (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, and privet. These species can out-compete native open habitat species and take over the landscape. Some species 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).

3. Pine Savannas: Threats to pine savannas include lack of opportunities for restoration due to limited acreage and proximity to population centers, which limits controlled burns that are needed to maintain these forests.

Conservation Management Actions

DGIF has recognized that the loss of open habitats, such as glades, savannas, and post-agricultural areas has caused significant declines in several Action Plan species, including the red cockaded woodpecker, the northern bobwhite, field sparrows, eastern towhees, brown thrashers, prairie warblers, and monarch butterflies. The loss of these habitats has likely contributed to the declines in native pollinator species such as bumblebees (Xerces Society 2011). To address this issue, Virginia has become a leader in the Northern Bobwhite Conservation Initiative (NBCI). DGIF contributes to this national effort by leading

the Virginia Quail Recovery Initiative (QRI), which is a robust, state-based, multi-partner effort dedicated to conserving and restoring open habitats within Virginia. Both the NBCI and the QRI have determined that Sussex County and Greenville County offer some of the best opportunities for restoring open habitats that support a diversity of open habitat species (DGIF 2007).

Agriculture and forestry are significant industries in Virginia, and landowners are important conservation partners. The QRI was created to find opportunities that help private landowners meet their economic goals while also contributing to the conservation and recovery of important wildlife and pollinator species. QRI efforts within this planning region focus on helping landowners manage retired agricultural lands and forested areas to benefit open habitat species, and DGIF provides information for landowners on its quail website (DGIF 2015).

For landowners seeking to improve the habitat quality of pastures and field edges, the QRI generally recommends removing nonnative grasses and invasive species. In many instances, a sufficient seedbank of native species will exist in the soil to allow the restoration of native plant communities and replanting will likely not be required. Once a native plant community has been established, the QRI recommends managing these habitats either through burning, disking, or (least favorable) mowing. Additionally, within *Managing Pines for Profit and Wildlife* biologists describe landowner opportunities to create a commercially viable forest plot that also benefits open habitat species such as quail. Recommendations are provided for site preparation, planting density, pre-commercial thinning, hardwood and grass suppression, commercial thinning, and post-thinning management (Puckett et al. 2008).

This planning region also contains some of the best examples of remaining long-leaf pine savanna in Virginia, which provide habitat for the southeastern fox squirrel. Almost all of these sites are owned and managed by government agencies or The Nature Conservancy. Although once a critical economic commodity for Virginia's maritime industries, the economic value of long-leaf pine has been overshadowed by the faster growing, and more commercially viable, loblolly pine. As such, few individual landowners have the economic ability to restore large areas of long-leaf pine on their properties to maintain savanna conditions. Opportunities to create new savanna habitats within this planning region will depend upon the conservation community acquiring properties with suitable soil conditions and managing these properties for savanna conditions. Properties near or adjacent to existing savannas should be considered a conservation priority.

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). 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 habitats 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. Additionally, 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.
Installation of Living Shorelines	• Before/ after photos of project site; • Photos documenting changes as vegetation matures over multiple years; • Before/ after measurements of shoreline loss; and • Before/ after comparison of 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 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 opportunities to do valuable things for 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 Crater Planning Region, priority conservation opportunities include:

- Protecting and restoring tidal and non-tidal wetlands;
- Improving the quality and quantity of water in creeks and rivers through best management practices and water quality improvement mechanisms;
- Conserving tracts of mature hardwood forests; and
- Protecting and restoring open habitats.

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

Complete SGCN list for the Crater Planning Region (SGCN=106). 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	**ST**	II	a	Barking treefrog	*Hyla gratiosa*
Amphibian		III	a	Carpenter frog	*Lithobates virgatipes*
Amphibian		III	a	Dwarf waterdog	*Necturus punctatus*
Amphibian		IV	a	Eastern mud salamander	*Pseudotriton montanus montanus*
Amphibian		IV	c	Eastern spadefoot	*Scaphiopus holbrookii*
Amphibian		IV	a	Greater siren	*Siren lacertina*
Amphibian		III	a	Lesser siren	*Siren intermedia intermedia*
Amphibian		IV	a	Little grass frog	*Pseudacris ocularis*
Amphibian	**ST**	II	a	Mabee's salamander	*Ambystoma mabeei*
Amphibian		IV	a	Many-lined salamander	*Stereochilus marginatus*
Amphibian		II	a	Oak toad	*Anaxyrus quercicus*
Amphibian		IV	c	Southern chorus frog	*Pseudacris nigrita*
Bird		II	a	American black duck	*Anas rubripes*
Bird		II	a	American woodcock	*Scolopax minor*
Bird	**ST**	I	a	Bachman's sparrow	*Aimophila aestivalis*
Bird		III	c	Bank swallow	*Riparia riparia*
Bird		III	a	Barn owl	*Tyto alba*
Bird		III	b	Belted kingfisher	*Megaceryle lcyon*
Bird		IV	a	Bicknell's thrush	*Catharus bicknelli*
Bird	**SE**	I	a	Black rail	*Laterallus jamaicensis*
Bird		IV	a	Black-and-white warbler	*Mniotilta varia*
Bird		III	a	Black-crowned night-heron	*Nycticorax nycticorax*
Bird		IV	a	Brown thrasher	*Toxostoma rufum*
Bird		IV	b	Chimney swift	*Chaetura pelagica*
Bird		IV	b	Clapper rail	*Rallus longirostris*
Bird		II	a	Common tern	*Sterna hirundo*
Bird		IV	a	Dunlin	*Calidris alpina hudsonia*
Bird		IV	a	Eastern kingbird	*Tyrannus tyrannus*
Bird		IV	a	Eastern meadowlark	*Sturnella magna*

Bird		IV	a	Eastern towhee	*Pipilo erythrophthalmus*
Bird		III	a	Eastern Whip-poor-will	*Caprimulgus vociferus*
Bird		IV	b	Eastern wood-pewee	*Contopus virens*
Bird		IV	a	Field sparrow	*Spizella pusilla*
Bird		III	a	Forster's tern	*Sterna forsteri*
Bird		IV	a	Grasshopper sparrow	*Ammodramus savannarum*
Bird		IV	a	Gray catbird	*Dumetella carolinensis*
Bird		IV	a	Greater scaup	*Aythya marila*
Bird		IV	b	Green heron	*Butorides virescens*
Bird		III	a	Kentucky warbler	*Oporornis formosus*
Bird		II	b	King rail	*Rallus elegans*
Bird		III	b	Least bittern	*Ixobrychus exilis*
Bird		III	a	Least tern	*Sterna antillarum*
Bird	**ST**	I	a	Loggerhead shrike	*Lanius ludovicianus*
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	**FESE**	I	a	Red-cockaded woodpecker	*Picoides borealis*
Bird		IV	a	Short-billed dowitcher	*Limnodromus griseus*
Bird		II	b	Swainson's warbler	*Limnothlypis swainsonii*
Bird		IV	b	Wood thrush	*Hylocichla mustelina*
Bird		III	a	Yellow-billed cuckoo	*Coccyzus americanus*
Bird		IV	a	Yellow-breasted chat	*Icteria virens*
Crustacean	**FS**	III	c	Chowanoke crayfish	*Orconectes virginiensis*
Fish		IV	a	Alewife	*Alosa pseudoharengus*
Fish		IV	c	American brook lamprey	*Lampetra appendix*
Fish		III	a	American eel	*Anguilla rostrata*
Fish		IV	a	American shad	*Alosa sapidissima*
Fish		I	b	Atlantic sturgeon	*Acipenser oxyrinchus*
Fish		IV	c	Banded sunfish	*Enneacanthus obesus*
Fish	**SE**	I	a	Blackbanded sunfish	*Enneacanthus chaetodon*
Fish		I	a	Bridle shiner	*Notropis bifrenatus*
Fish		III	c	Ironcolor shiner	*Notropis chalybaeus*
Fish		IV	c	Lake chubsucker	*Erimyzon sucetta*
Fish		IV	c	Least brook lamprey	*Lampetra aepyptera*
Fish		IV	c	Lined topminnow	*Fundulus lineolatus*

Fish		IV	c	Mud sunfish	*Acantharchus pomotis*
Fish		I	a	Roanoke bass	*Ambloplites cavifrons*
Fish	**FESE**	II	a	Roanoke logperch	*Percina rex*
Fish	**ST**	II	c	Whitemouth shiner	*Notropis alborus*
FW Mollusk		IV	a	Alewife floater	*Anodonta implicata*
FW Mollusk	**FSST**	I	a	Atlantic pigtoe	*Fusconaia masoni*
FW Mollusk		IV	c	Atlantic spike	*Elliptio producta*
FW Mollusk		IV	c	Carolina lance mussel	*Elliptio angustata*
FW Mollusk		IV	a	Carolina slabshell mussel	*Elliptio congaraea*
FW Mollusk		IV	a	Creeper	*Strophitus undulatus*
FW Mollusk	**FESE**	I	a	Dwarf wedgemussel	*Alasmidonta heterodon*
FW Mollusk		IV	a	Eastern pondmussel	*Ligumia nasuta*
FW Mollusk		IV	c	Gravel elimia	*Elimia catenaria*
FW Mollusk	**ST**	II	a	Green Floater	*Lasmigona subviridis*
FW Mollusk		IV	b	Northern lance mussel	*Elliptio fisheriana*
FW Mollusk		III	a	Notched rainbow	*Villosa constricta*
FW Mollusk		IV	c	Ridged lioplax	*Lioplax subcarinata*
FW Mollusk	**FS**	II	b	Roanoke slabshell	*Elliptio roanokensis*
FW Mollusk		IV	c	Sharp sprite	*Promenetus exacuous*
FW Mollusk		IV	a	Triangle floater	*Alasmidonta undulata*
FW Mollusk		II	a	Yellow lampmussel	*Lampsilis cariosa*
FW Mollusk	**FS**	II	a	Yellow lance	*Elliptio lanceolata*
Insect	**FS**	II	c	Rare skipper	*Problema bulenta*
Mammal		IV	c	Cotton mouse	*Peromyscus gossypinus gossypinus*
Mammal		IV	c	Marsh rabbit	*Sylvilagus palustris palustris*
Mammal	**SE**	I	a	Rafinesque's eastern big-eared bat	*Corynorhinus rafinesquii macrotis*
Mammal		III	b	Southeastern fox squirrel	*Sciurus niger niger*
Mammal		IV	b	Southeastern myotis	*Myotis austroriparius*
Reptile		IV	a	Common ribbonsnake	*Thamnophis sauritus sauritus*
Reptile		III	a	Eastern box turtle	*Terrapene carolina carolina*
Reptile		IV	c	Eastern hog-nosed snake	*Heterodon platirhinos*
Reptile		IV	a	Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*
Reptile		IV	a	Mudsnake	*Farancia abacura abacura*

Reptile	**CC**	II	a	Northern diamondback terrapin	*Malaclemys terrapin terrapin*
Reptile		IV	a	Queen snake	*Regina septemvittata*
Reptile		IV	a	Rainbow snake	*Farancia erytrogramma erytrogramma*
Reptile		IV	a	Scarletsnake	*Cemophora coccinea copei*
Reptile		IV	c	Southeastern crowned snake	*Tantilla coronata*
Reptile	**CC**	III	a	Spotted turtle	*Clemmys guttata*
Reptile		IV	b	Yellow-bellied slider	*Trachemys scripta scripta*

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.