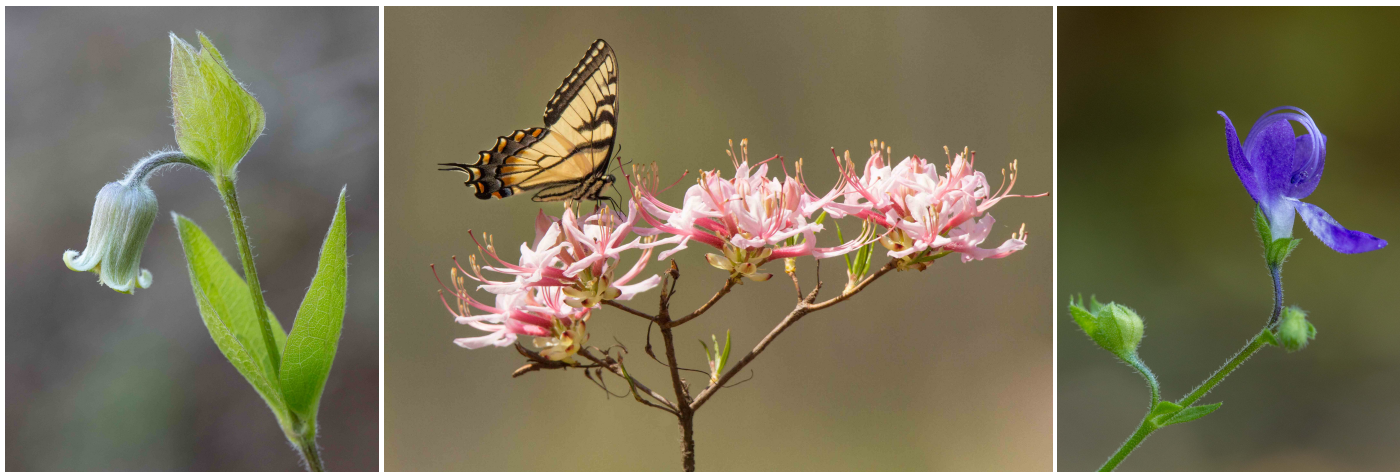




Albemarle County Biodiversity Action Plan June 2018



ALBEMARLE COUNTY BIODIVERSITY ACTION PLAN

June 2018

This report was prepared by the Albemarle County Natural Heritage Committee and County staff, as directed in the Albemarle County Comprehensive Plan approved in June, 2015.

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Acknowledgements

A number of individuals were instrumental in developing this plan. Two people in particular, both former members of the Natural Heritage Committee, merit special attention for their contributions: Tom Olivier and Devin Floyd. Tom Olivier's efforts were crucial in organizing and developing early drafts of this report. Devin Floyd provided keen insight and expertise about native plants and communities, and helped identify key data needed to characterize the landscape of Albemarle County.

Several other people, including former Natural Heritage Committee members and volunteers who support the committee's work, deserve recognition as well. They include Dan Bieker, Rochelle Garwood, Ruth Douglas, Leah Jung, Tom Dierauf, and Manuel Lerdaun.

The work of the Albemarle County Biodiversity Work Group during 2002 -2004 created the foundation for this action plan and the ongoing work of the Natural Heritage Committee. The group's 2004 report on biodiversity in the county is cited often in this plan. Many of the members of the work group are mentioned above. The late Charles "Mo" Stevens deserves particular credit for the knowledge of Albemarle County's flora, fauna, and landscape that he possessed and shared during the Biodiversity Work Group's efforts.

Data provided by the Green Infrastructure Center and Virginia Department of Conservation and Recreation-Division of Natural Heritage were critical in developing this report.

Cover page design and photographs by Emily Luebke. From left to right,

Top row: curlyheads (*Clematis ochroleuca*), eastern tiger swallowtail (*Papilio glaucus*) on wild azalea (*Rhododendron peryclyminoides*), blue curls (*Trichostema dichotomum*)

Second row: eastern box turtle (*Terrapene carolina carolina*), fire pink (*Silene virginica*), song sparrow (*Melospiza melodia*), spring beauty (*Claytonia virginica*)

Third row: Halloween pennant (*Celithemis eponina*), spotted salamander (*Ambystoma maculatum*), juniper hairstreak (*Callophrys gryneus*) on golden ragwort (*Packera aurea*)

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I. BIODIVERSITY

DEFINITION OF BIODIVERSITY

Biodiversity, a contraction of “biological diversity”, has been defined as “the diversity of life in all its forms, and at all levels of organization” (Hunter 1996, 19). Levels of organization include the genetic, population, species, and ecosystem. Living systems at all levels require diverse interacting elements. Conservation of biodiversity is required for the continued existence of Earth’s life forms.

IMPORTANCE OF BIODIVERSITY TO HUMANS

In part, biodiversity is important to us because we consume tangible products of natural systems (e.g. wood products from forests). However, we depend more broadly on the services that ecosystems provide. Ecosystem services refer to the many benefits that humans receive, at no direct economic cost, from natural environments and functioning ecosystems. Some important ecosystem services are listed in Table 1.

TABLE 1. EXAMPLES OF ECOSYSTEM SERVICES. (FROM DAILY 1997)

- purification of air and water
- mitigation of floods and droughts
- detoxification and decomposition of wastes
- generation and renewal of soil and fertility
- pollination of crops and natural vegetation
- control of the vast majority of potential agricultural pests
- dispersal of seeds and translocation of nutrients
- sources of crop varieties, medicines, and industrial enterprise
- protection from the sun's harmful ultraviolet rays
- partial stabilization of climate
- moderation of temperature extremes and the force of winds and waves
- support of diverse human cultures
- provision of aesthetic beauty and intellectual stimulation that lift the human spirit.

Most of the ecosystem services listed in Table 1 support biological functioning. However, the last two entries support the less tangible, what are often referred to as human “quality of life.” Over and over, Albemarle County residents have made clear that they value Nature for its contributions to their quality

of life. This appreciation is reflected in widespread engagement in varied forms of outdoor recreation and efforts to protect viewsheds. Many speakers who appear at public hearings cite the contributions of Albemarle County's rural areas to their quality of life.

Trees Can Be Good for Your Health

A study by Ulrich (1984) found that surgery patients with views of trees from their rooms recovered faster and with less aggressive postoperative treatment than those in rooms with views of a building. Nowak et al. (2014) estimate that removal of air pollution by trees in the U.S. contributes to the "avoidance of over 850 incidences of human mortality and 670,000 incidences of acute respiratory symptoms" per year.

GLOBAL STATE OF BIODIVERSITY

Simple life forms appeared in the oceans about four billion years ago (Marshall 2009). Over time, more complex multicellular forms evolved. Eventually, life forms differentiated into species with ecologically distinct roles. Some colonized land masses. Spatial isolation, local variations in environmental conditions, and evolutionary genetic processes led to different assemblages of species living in different parts of the world.

Planetary living conditions have varied enormously during life's tenure on Earth. Continental land masses have drifted in and out of contact with each other, connecting and disconnecting regional life forms. Long term cyclic variations in the Earth's rotation and orbit have contributed to developments and retreats of glaciers during Ice Ages, forcing major shifts in ranges of species and sometimes causing extinctions (Hannah 2011). Sea levels have fallen and risen 100 meters or more with major planetary cooling and warming phases (Lomolino et al. 2006), converting marine habitats into terrestrial habitats and vice versa. Volcanic activity and meteor crashes at times have had devastating effects on living things.

Studies of the previous disturbances of life on Earth have provided many insights into how species and communities of organisms respond to major environmental alterations. This knowledge of the past will be a resource in facing forthcoming environmental alterations.

The Earth's climate has been unusually warm and stable during the past 10,000 years. During this time, modern distributions and associations of plant and animal species developed. In addition, humans spread over most of the Earth.

Growing numbers of humans and increased use of advancing technologies, including the burning of fossil fuels, have recently altered, and in some cases destroyed, ecosystems present on much of the Earth. We have transported species around the world and have triggered the beginnings of major new shifts in the Earth's climate. Because of our disturbances of natural systems, we apparently have

entered the sixth mass extinction period in the history of life on Earth (Kaplan 2015). Some scientists argue that we have entered a new geologic age, the Anthropocene, one dominated by human activities (Stromberg 2013).

Elevated Extinction Rates

According to evolutionary biologist E.O. Wilson (1992, 346), “In the world as a whole, extinction rates are already hundreds or thousands of times higher than before the coming of man. They cannot be balanced by new evolution in any period of time that has meaning for the human race.”

LOCAL STATE OF BIODIVERSITY

Albemarle County is located in central Virginia, near the East Coast of the United States. Topography is varied, with elevations ranging from approximately 250 feet to 3,250 feet above sea level (Nelson 1962). Most of the county lies in the Piedmont physiographic province, with some elevated areas near the western county border located in the Blue Ridge province (Virginia Department of Conservation and Recreation 2016). Weather is strongly seasonal with January mean low temperatures of about 27° Fahrenheit and July average highs of about 88° Fahrenheit (National Weather Service Forecast Office Baltimore/Washington 2017). Precipitation averages approximately 47 inches per year, with an average of 19 inches of snow per year. Overall, the climate is temperate with deciduous forests being the prevalent natural vegetative cover.

During the last glacial period, boreal forests covered much of the Virginia landscape, with woolly mammoths, mastodons, caribou, and bison present. By about 12,500 years before the present, with glaciers to the north in retreat and temperatures warming, boreal forests also retreated and modern floral and faunal communities began to develop.

Native Americans have lived in Virginia for at least 10,000 years. Fires set by Native Americans and caused by lightning are now believed to have shaped compositions of forests that greeted the first European settlers. Given its complex topography and geology, Albemarle hosts many distinct types of forest and other vegetative communities. A list of many of the natural plant communities occurring in the county is presented in Appendix A.

Over the past three centuries, Albemarle County’s landscape has been subjected to many human disturbances that have affected biodiversity. Essentially, all county forests have been timbered at some point in time. Forest fires have been suppressed, impacting which species comprise the forests and the physical characteristics of the forests. Large areas have been cleared for agriculture. Many streams are silted and some are dammed. Many wetlands have been drained or otherwise lost (Tiner 1984), while some have been heavily impacted by human activities, including the raising of livestock.

In recent decades, in concert with a rapidly growing population, the county has experienced rapid urbanization, rapid suburbanization, and construction of many new homes in rural areas. This development has placed additional stresses on county biodiversity. These new stresses are varied and include fragmentation of rural forests by new houses and related amenities, fertilizer runoff from lawns, more roads, parking lots and other impervious surfaces, and increased activities in natural areas.

With so many disturbances of the Albemarle landscape in recent centuries, many species present at the start of European colonization are no longer present. Table 2 presents a list of some species lost during this time period. Many other species, such as the box turtle (*Terrapene carolina*), are declining.

**TABLE 2. EXAMPLES OF VERTEBRATE SPECIES LOST IN ALBEMARLE COUNTY DURING THE PAST 200 YEARS.
(ADAPTED FROM ALBEMARLE COUNTY BIODIVERSITY WORK GROUP 2004, PAGE 59)**

Bison (<i>Bison bison</i>)
Bewick's wren (<i>Thryomanes bewickii</i>)
Carolina parakeet (<i>Conuropsis carolinensis</i>)
Elk (<i>Cervus canadensis</i>)
Henslow's sparrow (<i>Ammodramus henslowii</i>)
Gray wolf (<i>Canis lupus</i>)
Mountain lion (<i>Puma concolor</i>)
Passenger pigeon (<i>Ectopistes migratorius</i>)
Porcupine (<i>Erethizon dorsatum</i>)

Landscape disturbances also have led to declines in ecosystem services generated by the local landscape. A StreamWatch study (2006) found that water quality in subwatersheds of the Rivanna River basin declined rapidly as population densities increased. A computer simulation of the effects of population growth on Albemarle ecosystem services (Jantz and Manuel 2013) predicted strong declines in carbon sequestration and water purification services in conjunction with continued population growth.

Climate change and non-native invasive species such as autumn olive (*Elaeagnus umbellata*), emerald ash borer (*Agrilus planipennis*), and Japanese stiltgrass (*Microstegium vimineum*) have emerged as major new threats to the conservation of Albemarle's native biodiversity. We face the possibility that by the end of this century the compositions of Albemarle's plant communities will have changed dramatically yet again.

II. ALBEMARLE COUNTY BIODIVERSITY COMMITMENTS

COMPREHENSIVE PLAN

In 1999 Albemarle County adopted a new Natural Resources and Cultural Assets chapter for its Comprehensive Plan (Albemarle County 1999). The chapter included strong new commitments to protect county biological resources. It called for conducting a biological resources inventory, appointing a standing biodiversity committee, and developing an action plan. A 2015 update of the Comprehensive Plan carried forward previous biodiversity conservation commitments (Albemarle County 2015). Appendix B lists Comprehensive Plan goals, objectives, and strategies closely related to biodiversity protection.

BIODIVERSITY WORK GROUP

In 2002, the county created the Biodiversity Work Group (BWG). The group included naturalists, researchers, educators, and scientists and was charged with assessing the state of county biological resources. In 2004, the BWG delivered a report (Albemarle County Biodiversity Work Group 2004) with an assessment of the state of Albemarle's biodiversity as well as recommendations for conservation goals and strategies. Among the BWG's recommendations was the creation of a standing biodiversity committee to further biodiversity conservation in the county. The BWG, created as a temporary body, was dissolved after producing its 2004 report.

NATURAL HERITAGE COMMITTEE

In 2005, as recommended by the BWG, the Board of Supervisors appointed a permanent body, the Natural Heritage Committee (NHC). The committee is composed of local naturalists, educators, scientists, and other residents concerned with biodiversity conservation. Since its inception, the NHC has developed data on locations of important biological resources, recommended short term conservation priorities, developed educational materials, collaborated with county Parks and Recreation staff in the design of parks, and collaborated in conducting GIS analyses of the county landscape. The NHC is the standing biodiversity committee called for in the current Comprehensive Plan, approved in June 2015. With this document, the NHC and county staff propose the action plan for biodiversity as called for in the Comprehensive Plan.

NATURAL RESOURCES MANAGER

In 2015, the county hired a Natural Resources Manager, fulfilling a strategy in the Comprehensive Plan. As part of the county's Natural Resources Program, developed in May 2017, the manager provides staff support to the NHC and was heavily involved in developing this report.

III. ACTION PLAN OVERVIEW

PURPOSE

This plan specifies actions to be taken to accomplish county biodiversity protection goals. As specified in the Comprehensive Plan, this action plan is based upon landscape-level analysis of the county. Analyses include information on the distribution of important resources across the landscape and recommended priority areas of the county for conservation. The plan includes maps and other information for use by decision makers and the public. The plan also includes recommendations for policies and incentive programs to promote conservation.

The direction and goals for the plan outlined in the Comprehensive Plan have largely been met. No effort was made to analyze or treat the county's Rural Area and Development Areas separately. Given that the Rural Area occupies approximately 95% of the county's land area, most of the plan's narrative, goals, and recommendations are more applicable in the Rural Area than in more developed areas of the county. A small number of goals and recommendations are area-specific.

PERIODIC UPDATES

Given the continuing evolution of existing threats to biodiversity and the emergence of new ones, our understanding of conservation needs must be updated regularly with action plans adjusted accordingly. This approach implies that actions recommended in one plan cycle will be reviewed and updated using new information to formulate the succeeding plan.

The Comprehensive Plan specifies that the action plan be updated periodically. The NHC proposes that the plan be updated every five years. Actions proposed in this plan include acquisition of information to be used in developing the next action plan.

IV. EXISTING DATASETS AND ANALYSES

Geographic information systems (GIS) and data have played central roles in conservation planning for many years. Appendix E describes some of the existing data and analyses used in developing this report.

As noted earlier, Appendix A presents a list of local natural plant communities, developed by Devin Floyd. Appendix D, provided by Virginia Department of Conservation and Recreation-Division of Natural Heritage, describes some of the rare species, plant communities, and other natural heritage resources found in Albemarle County. Appendix J presents a list of local mammals, developed by Dan Bieker.

Information on distributions of invasive species in the county remains limited. Better information on invasive species distributions in the county is a pressing need. Appendix G provides a list of the twelve most problematic non-native invasive plants in a ten county region that includes Albemarle County, as assessed by Blue Ridge PRISM.

Development of this action plan is simplified by existing studies of locations of important county biological resources, likely movements of species during climate change, most dangerous invasive species, and other issues. Some of these existing analyses are described in Appendix E.

V. LANDSCAPE ANALYSIS

A geographical approach to describing and analyzing the biodiversity resources in Albemarle County is a critical component of this report. It is necessary for comprehensive and effective conservation planning. Habitat of the finest quality cannot adequately support biodiversity if it lacks certain qualities (e.g., is it large enough to support viable populations?) or is isolated from other areas of habitat.

This section of the report addresses biodiversity at a landscape level. It is a coarse grain, or broad-brush look at the county. It is not intended for fine scale or parcel level use. However, this information lays the groundwork for evaluation of projects and efforts that involve parcel level analysis and work.

SPATIAL CHARACTERISTICS OF HABITAT

Biologists and landscape ecologists have extensively studied how the spatial qualities of habitat areas affect the value of that habitat for biodiversity. Forman and Godron (1981, 1986) are among the many information sources that discuss how spatial qualities affect habitat within a landscape. Four characteristics are used in this report to describe and assess forested habitat across Albemarle County. They are: 1) edge and interior habitat, 2) size of habitat areas, 3) shape of habitat areas, and 4) connectivity among areas of habitat.

The concept of edge habitat and interior habitat is crucial in understanding and assessing habitat quality. There is a great deal of literature that describes and documents the biological and ecological differences between conditions along the edge of forests and those in the interior areas of forest (e.g., Yahner 1988, Noss and Cooperrider 1994). Figure 1 illustrates how interior forest and edge habitat were identified and used in this report.

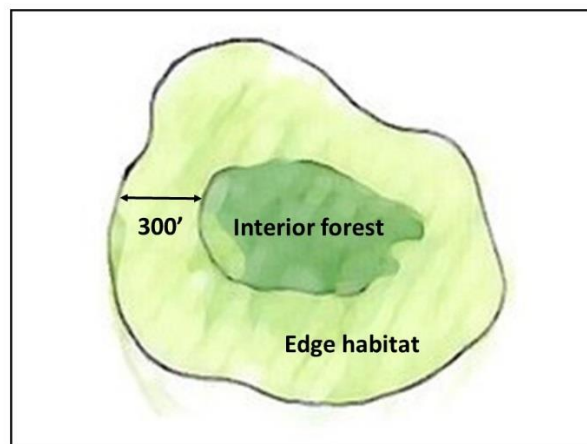


FIGURE 1. A FOREST BLOCK WITH EDGE HABITAT, 300' IN WIDTH, SURROUNDING THE FOREST INTERIOR HABITAT. ADAPTED FROM MMILLERICELAND.WORDPRESS.COM.

As discussed more fully in the “Minimizing Habitat Fragmentation/Maintaining Connectivity” section of this report, interior forest is of great value for the long term conservation of biodiversity in much of central Virginia and eastern North America. Many species that have evolved in forest-dominated landscapes require the habitat conditions that occur only in the interior areas of forest. A number of locally breeding birds are forest interior-dwelling species, such as the wood thrush (*Hylocichla mustelina*), worm-eating warbler (*Helmitheros vermivorus*), and scarlet tanager (*Piranga olivacea*). These three species, in addition to others like Acadian flycatcher (*Empidonax virescens*) and ovenbird (*Seiurus aurocapilla*), are also area-sensitive (Robbins et al. 1989, Whitcomb et al. 1981). This means they need large areas of habitat to reproduce successfully. Other examples of local area-sensitive species, though not strictly limited to forested habitat, include bobcat (*Lynx rufus*) and black bear (*Ursus americanus*).

The size of a habitat area is generally considered the single most important factor in determining its conservation value. The shape of habitat areas and the degree to which they are connected or accessible to each other are also key characteristics.

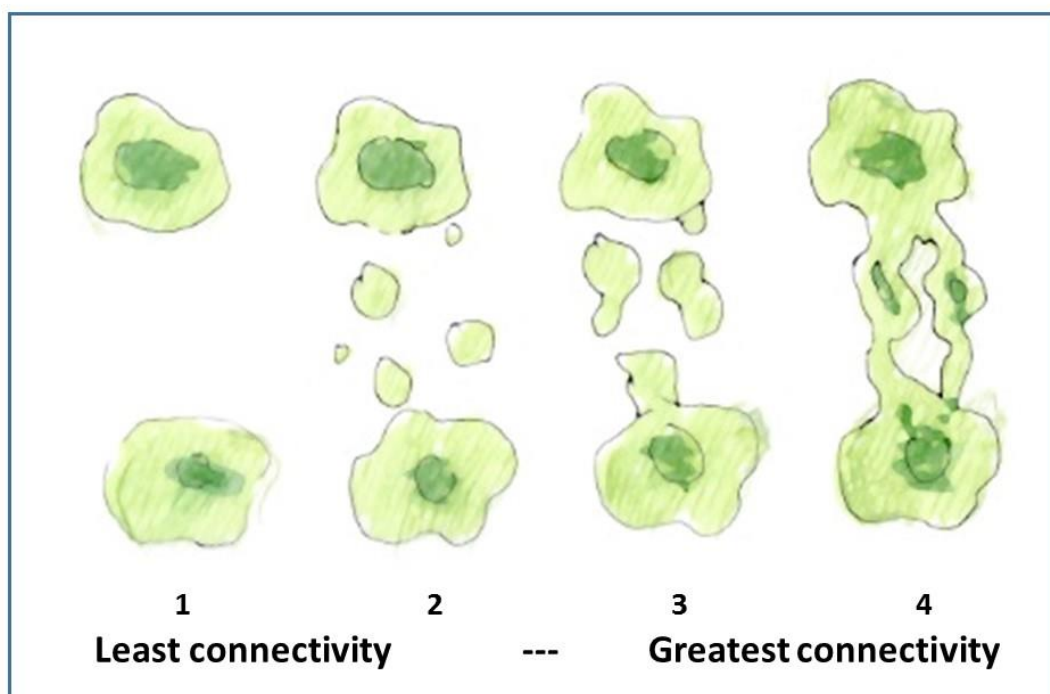


FIGURE 2. FOUR EXAMPLES OF DIFFERING LEVELS OF CONNECTIVITY BETWEEN HABITAT AREAS. ADAPTED FROM MMILLERICELAND.WORDPRESS.COM.

Connectivity of habitat across the landscape is critical for the long term viability of many wildlife populations. Connectivity not only allows for plant dispersal and the movement of individual animals, which is necessary for maintaining populations, but can allow for the geographic range of species to shift

over time in response to climate change and other changing conditions. Functional linkages or connections among habitat within the landscape can, in effect, increase the total area of habitat by making disconnected areas accessible to one another. Harris (1984) and Hudson (1991) are among the numerous sources of information on the issue. Figure 2 illustrates the concept of connectivity among areas of habitat.

The shape of a forest block also affects its value as habitat. The more compact a block, or closer to circular in shape, the greater its value is likely to be. Figure 3 shows a forest block in dark green, surrounded by a dashed circle with a circumference equal in length to the perimeter of the forest block.

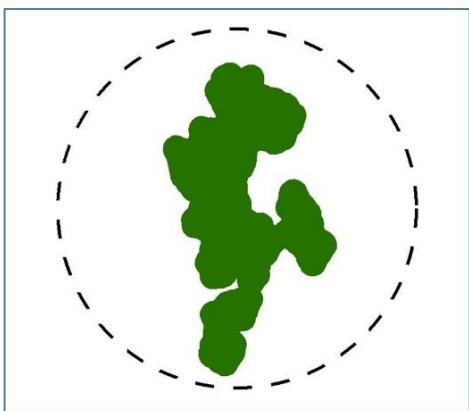


FIGURE 3. THE COMPACTNESS OF FOREST BLOCKS (DARK GREEN), THE DEGREE TO WHICH THEY ARE CIRCULAR IN SHAPE, AFFECTS THEIR VALUE AS HABITAT.



FIGURE 4. A PROXIMITY INDEX FOR A LARGE FOREST BLOCK (DARK GREEN) IS CALCULATED BASED ON THE NUMBER, SIZE, AND DISTANCE OF OTHER FOREST BLOCKS (LARGE AND SMALL) LOCATED WITHIN ONE MILE OF THE FOREST BLOCK (MEASURED FROM EDGE TO EDGE OF THE FORESTS).

SPATIAL DATA

In 2017, the Green Infrastructure Center (GIC) completed a Green Infrastructure Community Planning project for Albemarle County (Firehock 2012, Albemarle County 2017). Two datasets pertinent to this action plan were developed by GIC. Using 2009 land use/land cover data (see Appendix E), GIC identified all forested areas that contain 10 or more acres of interior forest (Figure 1). Interior forest was defined as areas 300 feet or more in distance from any non-forest land cover (i.e. open land, impervious cover, etc.). Pine plantations were identified as a separate type of land cover in the data and were not considered part of the forested areas. (See Appendix E for further discussion.)

Land in the county with tree canopy, including true forest as well as individual large trees in some instances, represents approximately 67% of the county's total land area. Map 1 shows all forest and tree canopy land cover in Albemarle County based on the 2009 data.

Forests containing 100 acres or more of interior forest were identified as large forest blocks. There are 179 large forest blocks in Albemarle County, totaling about 157,143 acres when including both forest interior and edge habitat. (The total number of acres would increase by about 35,000 if the portions of forest blocks that extend beyond the Albemarle County boundary were included.) Large forest blocks thus comprise approximately 34% of the county's total land area. These forest blocks vary greatly in total size (interior and edge area), ranging from 193 acres to more than 10,000 acres. Due to the size of the individual large forest blocks, roughly 86% of their total forested area is comprised of interior forest. Appendix E includes a table summarizing information about size and other characteristics of the large forest blocks.

Small forest blocks contain from 10 acres to 99 acres of interior forest. There are 341 small forest blocks totaling about 32,772 acres in total size (interior and edge), representing approximately 7% of the county's total land area. These small forest block patches range in total size (interior and edge) from 41 acres to 249 acres. Due to the smaller size of the small forest blocks, only about 40% of their total forested area is comprised of interior forest. The difference in the relative amount of interior forest that comprises large forest blocks compared to small forest blocks highlights the importance of large forested areas for conservation.

The degree of connectivity among forest blocks in Albemarle County was quantified by calculating the level of isolation for each large forest block. The number of large and small forest blocks within one mile of each large forest block was determined. Figure 4 illustrates the general method, with six large or small forest blocks occurring within a mile of the large forest block being analyzed (darker green). A proximity index was calculated for each block depending upon the number, size, and proximity of neighboring forested areas. The closer the neighboring forest blocks, the larger the neighbors, and the greater the number of neighbors, the greater the degree of connectivity, and thus a higher value for the proximity index.

A compactness value was calculated for each large forest block by comparing the area of the forest block with the area of a circle with a circumference equal in length to the perimeter of the forest block.

In consultation with the NHC, GIC also mapped six factors to characterize the county's landscape based on physical site characteristics. The factors include geologic chemistry of the soil, elevation, aspect, degree of slope of the land, and the slope/shape of the land (concave vs. convex) along two directional axes. Based on these six factors, 384 unique combinations of landscape classifications are possible at any location, and 325 of the combinations actually occur in the county. Appendix E provides more detail about the landscape data and classification process.

The Nature Conservancy (TNC) has developed methods to assess the landscape of eastern North America to identify terrestrial sites that are likely to be resilient to climate change (Anderson et al. 2016). Resilience refers to the likelihood that plant and animal species will be able to persist in a given location as climate change progresses, even if the assemblage of species present at any given location shifts through time. Spatial data developed by TNC in Anderson et al. are used in this report.

LOCALIZED DATA AND SITES

In addition to the landscape qualities and data described above, two other datasets were used to describe and analyze the Albemarle landscape.

In its 2004 report, the Albemarle County Biodiversity Work Group identified an initial list of 38 Important Sites in the county. These were defined as “locations of special plant communities, unusual habitats, or species rare to scarce in the County.” Since 2004, the NHC has continued to assess these and other important biodiversity locations in the county. There are now 53 Important Sites identified by the NHC. Appendix C provides a complete list and short description of each. The list of sites is based on the cumulative knowledge of current and previous members and supporters of the BWG and NHC. There has not been a comprehensive survey of the county to identify these types of species, plant communities, and habitats.

The Virginia Department of Conservation and Recreation-Division of Natural Heritage (DCR-NH) maintains a variety of data related to species and natural communities that are rare or uncommon at the state and national levels. Appendix D provides more information about these resources in Albemarle County. Of particular interest for this report were three types of features identified by DCR-NH: conservation sites, stream conservation units (SCU), and general locations of rare species or natural communities.

RANKING LARGE FOREST BLOCKS AND IMPORTANT SITES

All large forest blocks and Important Sites in the county were evaluated for their conservation value. Two factors were used to determine the conservation values: biological value and resilience to climate change. Numerical scores were assigned for both biological value and resilience to climate change. The biological scores and resilience scores were combined to create a composite score, indicating overall conservation value. Biological scores account for 90% of the composite score (conservation value) and resilience scores account for 10% of the composite score. Appendix E describes the evaluation method in detail. A brief overview of the methods is given here.

Four factors were used to determine a biological score for each large forest block. The four factors and the relative weight each had in the biological scores are provided in Table 3.

TABLE 3. FACTORS USED IN DETERMINING THE BIOLOGICAL SCORES OF LARGE FOREST BLOCKS.

Factor	Relative Weight in Biological Score
Size of forest block, based on number of acres of interior forest	50%
Degree of connectivity with other forested areas, based on proximity index	25%
Compactness of forest block, based on how close the shape resembles a circle	15%
Number of Important Sites and DCR-NH occurrences within the forest block	10%

Important Sites were also assessed according to their biological value. NHC members assigned scores to the sites based on their knowledge of the sites and using best professional judgment (see Appendix E for more details). Among the primary considerations in evaluating the sites were:

- The number and abundance of rare or unusual species present at the site, including their health and condition
- DCR-NH features present at the site
- Overlap with large forest blocks
- Other considerations, such as the possible presence of wetlands, steep bluffs near streams or rivers, and wooded riparian areas

Resilience to climate change was assessed in the same manner for large forest blocks and Important Sites. Appendix E describes the methodology in detail. TNC data provides a regional perspective on resilience while local landscape characteristics provide site-specific data. The physical landscape affects the types and quality of habitat that occurs, including the likelihood of the habitat remaining viable in the long term. Generally, a diverse physical setting increases habitat diversity and resilience. Local landscape characteristics used in assessing the resilience of forest blocks and Important Sites were 1) size (total acreage), 2) physical heterogeneity (based on the number of unique combinations of local landscape characteristics), and 3) the amount of north-facing aspect, or orientation of the site.

Composite scores for forest blocks and Important Sites can range in value from zero to ten. Higher composite scores indicate higher conservation value. Again, biological scores account for 90% of the composite score and resilience scores account for 10% of the composite score. Map 2 illustrates the large forest blocks in the county and their conservation value based on composite scores.

Ranking the Important Sites allowed the NHC to prioritize them based on their conservation value and the potential for conservation actions that can be taken in the next five years. Twenty-four Important Sites were identified as high priority and are listed in Appendix C. The NHC intends to serve as an advocate for thirteen of the sites, working with landowners and local residents to raise awareness about them, and discuss options for appropriate management and protection.

Albemarle County should take lead responsibility for nine of the Important Sites. Based on pending actions that include development of new county parks, joint planning with the City of Charlottesville and Thomas Jefferson Planning District Commission on a Rivanna River corridor, and updating the Pantops Master Plan, the county is positioned to take actions that could positively influence these sites. Appendix C includes a section that discusses how the Old Mills Complex along the Rivanna River could serve as a case study in conserving an Important Site.

The county and the NHC should share responsibility for two Important Sites. Map 3 shows the generalized location of Important Sites, with the high priority sites highlighted.

GEOGRAPHIC AREAS OF FOCUS

In analyzing the areas where large forest blocks with the greatest conservation value are located (Map 2) in combination with locations of the High Priority Important Sites (Map 3), three areas of the county stand out as having significant conservation value. These areas of Albemarle County should be a focus of conservation efforts during the next five years and are shown on Map 4:

- Northwestern Albemarle - the northwestern portion of the county east of the Blue Ridge Mountains
- Southern Albemarle Mountains - the area surrounding the high priority Important Site of the same name
- The Rivanna River corridor.

Maps 5, 6, and 7 depict each of these focus areas individually. A description of each focus area follows, and each mentions the presence of conservation easements as a benefit in conserving biodiversity. It is important to note that the terms of conservation easements can vary greatly. While all limit the amount of development that can occur, many easements do not address specific natural resources nor require habitat management or protection.

A note regarding Maps: Maps 1 through 4 and Map 10 are suitable for display in 8.5" by 11" format, and are included in the body of the report. Maps 5 through 9 are suitable for display only at a larger scale. They are available in large scale format as part of this report, but are not included in the body of the report.

NORTHWESTERN ALBEMARLE

Northwestern Albemarle contains many large forest blocks that rank high in conservation value (Map 5). This indicates the presence of large forested areas with diverse landscape characteristics. Though some of the forest blocks occur within Shenandoah National Park (SNP), many are outside of the park. Several are adjacent to SNP while others occur farther east.

The presence of SNP offers a tremendous opportunity for conserving biodiversity in parts of Albemarle County. Given its diverse geology and large size, roughly 200,000 acres (with almost 40% of the land being designated wilderness) occurring across eight counties, SNP can serve as a regional anchor of biodiversity. By conserving habitat in Northwestern Albemarle, and maintaining connectivity among these habitats and SNP, lands in the county and SNP can complement one another. Native flora and fauna in the county can help support wildlife populations in SNP, and SNP populations can help maintain viable populations of wildlife in the county.

Several Important Sites occur within Northwestern Albemarle. A number of high priority Important Sites are just to the east, along the Mechums and Moormans Rivers. Three county parks and a small number of other protected lands occur in this area of the county. A large number of landowners have also

placed their property under conservation easement. All of these circumstances combine to create great conservation potential for Northwestern Albemarle.

SOUTHERN ALBEMARLE MOUNTAINS

The Southern Albemarle Mountains also contain many large forest blocks ranking high in conservation value (Map 6), indicating large forested areas with diverse landscape characteristics. A large portion of this area (roughly 21,500 acres) was identified as an Important Site for biodiversity in the 2004 report by the county's Biodiversity Work Group (Appendix A of that report). In its 2007 Annual Report, the county's NHC identified it as one of seven priority sites. It remains a high priority Important Site as identified by the current NHC (see Map 3 and Appendix C), containing five other Important Sites within it (Appendix C).

The Southern Albemarle Mountains contain the highest elevations in Albemarle County east of the Blue Ridge. The forests are home to a large variety of nesting wood warblers and other migratory songbirds. Rich wooded north-facing slopes and ravines harbor a number of plants that are uncommon to rare in Albemarle County.

A significant amount of land is under conservation easement. There are no county parks or other publicly protected land in the immediate area. However, Walnut Creek Park lies just north of the area. The Ragged Mountains and Dudley Mountain also lie to the north, and are rich in biodiversity and conservation value. Maps 2 and 3 illustrate the valuable large forest blocks in place as well as several Important Sites. Some land in these areas are county-owned, providing the potential to establish habitat connectivity between the Southern Albemarle Mountains and the Ragged Mountains/Dudley Mountain area.

RIVANNA RIVER CORRIDOR

The Rivanna River Corridor differs in nature from the two other focus areas. The corridor is defined as the segment of the river from Fluvanna County upstream to the area where Moormans and Mechums Rivers combine to form the South Fork Rivanna River. The portion of the North Fork Rivanna River from its confluence with the South Fork Rivanna River upstream to the general area of Chris Greene Lake Park is also part of the focus area (Maps 3, 7). The river courses through a wide swath of the county. Though it is fed in part by streams and rivers with headwaters in the mountains, the Rivanna flows through some of the county's Development Areas, the City of Charlottesville, and other developed areas before emptying into the James River in Fluvanna County.

There is a long history of use and land disturbance in and around the river, as evidenced in part by the removal of the Woolen Mills Dam in 2007 (Rivanna Conservation Alliance 2017). Many historical, cultural, and recreational resources occur along the river corridor. The Rivanna River is also a critical community resource, providing drinking water to thousands of local residents while also receiving treated wastewater and stormwater runoff.

Despite the heavy use of the river and intense development in some areas, there are many biodiversity resources that remain intact and merit protection. Though this report focuses on terrestrial habitat and

biodiversity, conserving land in the Rivanna River corridor should improve aquatic habitat within the river as well.

Map 7 shows the large number of Important Sites in this focus area. While less forested than the other two focus areas, the river floodplain offers conservation opportunities. In combination with parks, other protected lands, and conservation easements, there is significant potential for strengthening conservation in the Rivanna River Corridor.

Many of the Important Sites in the Rivanna River Corridor focus area have been identified as high priority. Current or pending projects and activities provide an opportunity for the county to take positive conservation steps for these Important Sites and surrounding areas. There is potential for collaboration with other organizations. Several organizations focus their efforts on the Rivanna River and its watershed, including Rivanna Conservation Alliance, Rivanna Water and Sewer Authority, and Rivanna River Basin Commission. A large number of organizations include the Rivanna River as part of a larger area that they serve. Among these organizations are Thomas Jefferson Soil and Water Conservation District, Thomas Jefferson Planning District Commission, and Piedmont Environmental Council.

HABITAT CONNECTIVITY WITHIN AND NEAR FOCUS AREAS

Maintaining and creating connectivity among habitat across the landscape is very important in conserving biodiversity. Over time, there is potential to effectively expand the three focus areas by improving habitat connectivity within each area as well as connecting them with other areas of the county. This will involve both conserving existing habitat and open space (land that will not be developed, or only minimally developed) and providing functional connectivity among them. Rivers and streams have proven to be among the most effective landscape features for providing connectivity. The three focus areas, particularly Northwestern Albemarle and the Southern Albemarle Mountains, present opportunities for maintaining habitat connectivity across county lines.

GIS tools were used to analyze the degree of habitat connectivity of the forest blocks within each of the three focus areas. Three of the primary factors influencing connectivity are the distance between forest blocks, the type of land cover between the blocks, and the presence or absence of barriers to movement between the blocks. Appendix E describes the connectivity analysis.

The analysis indicates there is potential for connectivity within each focus area. Maps 8 and 9 show the potential connectivity among large forest blocks, small forest blocks, Important Sites, and other features in Northwestern Albemarle and the Southern Albemarle Mountains focus areas, respectively. Map 7, showing forest blocks (large and small), 100 year floodplain, Important Sites, and some of the protected land along the Rivanna River corridor, illustrates areas where improving connectivity is possible.

Map 10 gives an overview, or broad scale view of Albemarle County and areas where greater habitat connectivity could help conserve biodiversity. The three focus areas stand out, especially with the forest blocks shown. The map also highlights the potential for connectivity among the three focus areas. The rivers in Albemarle County have the potential to facilitate connectivity and possibly serve as habitat corridors. Conserving habitat and open space in the county, including connectivity among areas of habitat, should be a priority for Albemarle County.

It should be pointed out that habitat connectivity as described and analyzed in this plan is not specific to any particular species or set of species. Among the thousands of plant and animal species native to the county, their ability to use existing habitat and connectivity will vary significantly. For example, different organisms such as amphibians, birds, flying insects, and plants all use habitat connections in different ways. The connectivity characteristics used in this plan generally reflect terrestrial, forested habitat. While they are appropriate for general analysis and apply to much of the native flora and fauna, they are not applicable to all native species and are not intended to be applied to individual species.

SUMMARY

A Goal and several Recommendations for using a landscape perspective in conserving biodiversity are given below. Other Goals and Recommendations to help conserve biodiversity are included in the “Proposed Actions” section of this report. Appendix F provides a comprehensive list of all Goals and Recommendations contained in this plan.

A landscape level, broad-brush approach was used in this section of the report to highlight areas of the county that have high conservation potential. Although the data and methods available during development of the report focused on forested areas for conservation efforts, almost all areas of the county have conservation value. Many landscape features and habitat types are critical for conservation, including non-forested areas and undeveloped (or lightly developed) open space. The “Proposed Actions” section of this report includes discussion of many specific habitat types and important conservation targets.

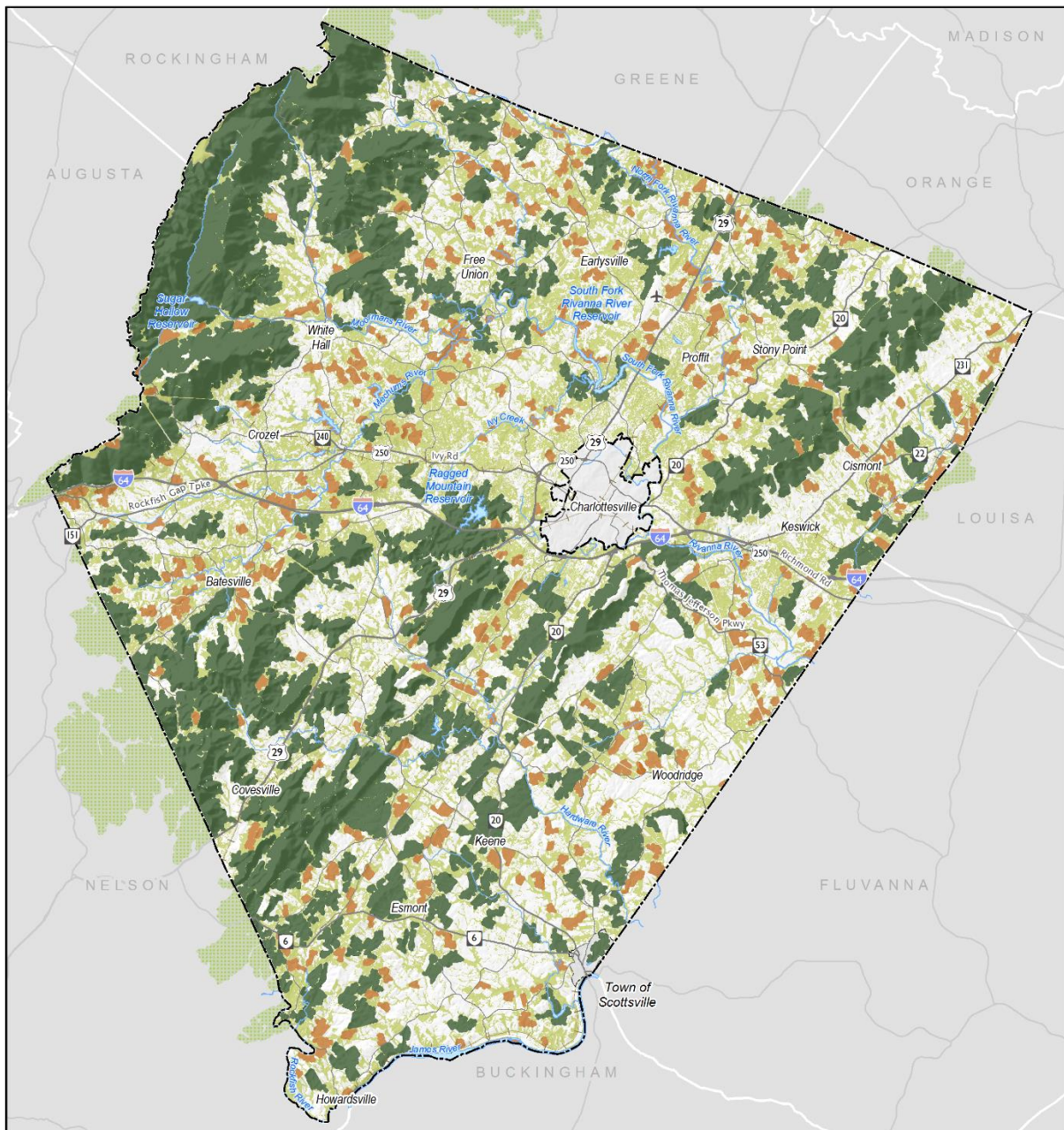
A Note about Recommendations

Characters in square brackets after each recommendation indicate the parties potentially or likely involved in implementing the action. Codes are: “N”: County natural resources staff, Natural Heritage Committee members, and volunteers; “C”: other County staff or decision-makers; “\$”: staff funded by grant or other outside sources; “P”: partner organization; “R”: general county residents. Appendix F provides a list of all Goals and Recommendations contained in this report.

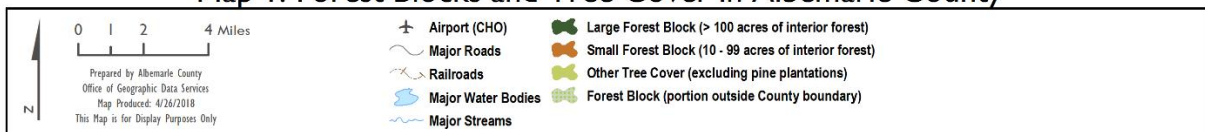
GOAL 1: Recognize the importance of the three conservation focus areas. Prioritize conservation of the land and resources within them and, where possible, connections among them.

RECOMMENDATIONS:

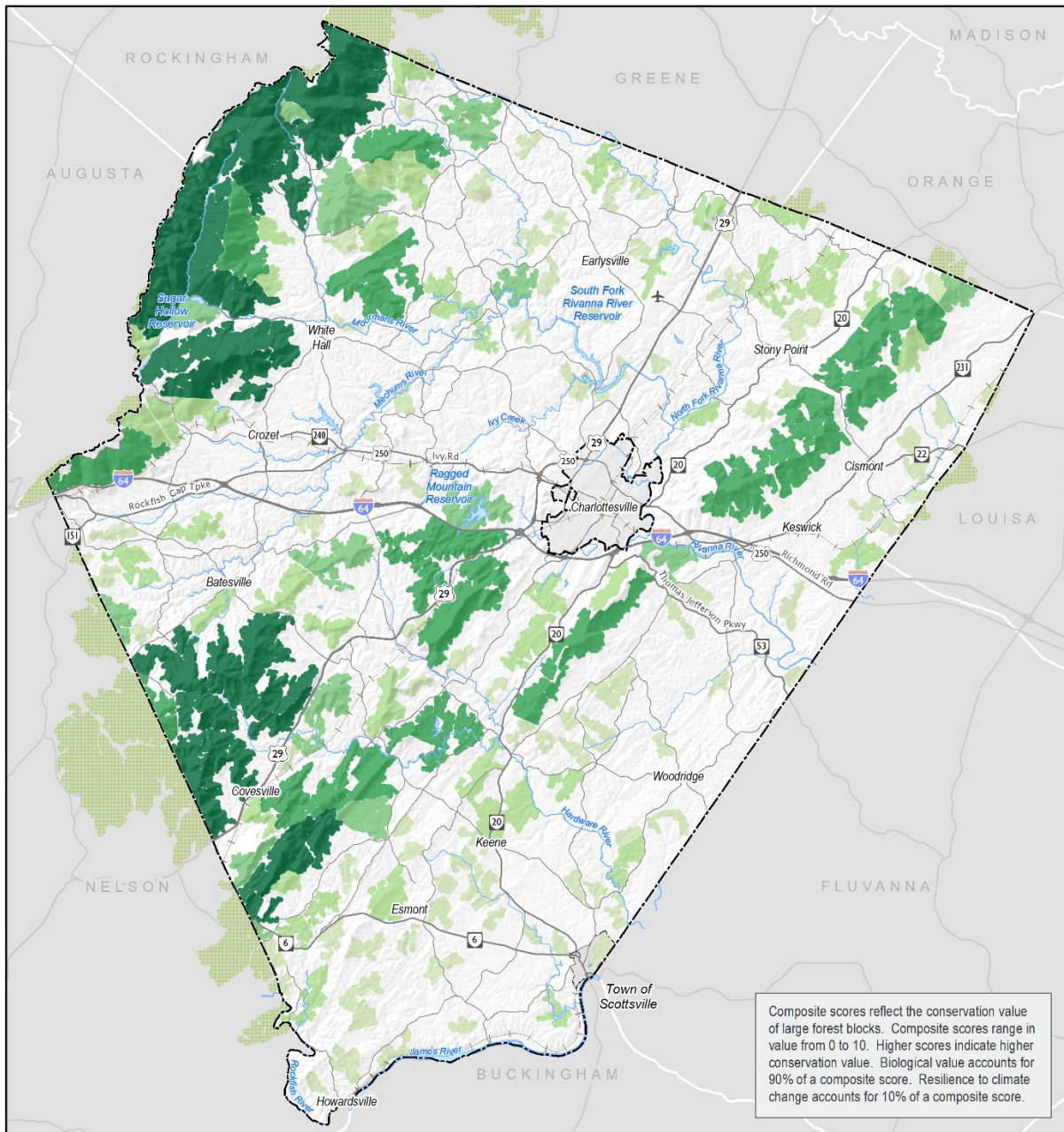
1. Develop strategies to conserve and protect lands in the conservation focus areas. [N,C,P]
2. Use existing conservation tools (e.g. conservation easements) to protect lands in the conservation focus areas, where possible. [C,P]
3. Take appropriate actions to conserve and protect the high priority Important Sites identified in Appendix C. [N,C,P]
4. Use existing conservation tools and develop strategies to protect lands that can serve as habitat corridors or connections among important habitat areas. [N,C,P]
5. Incorporate knowledge about the conservation value of the three conservation focus areas in land use planning and decision-making. [N,C]
6. Educate and inform landowners about the conservation value and importance of conserving Important Sites, with special focus on the high priority sites. [N]
7. Educate and inform the public about the conservation value and importance of conserving lands in the three conservation focus areas. [N,C,P]



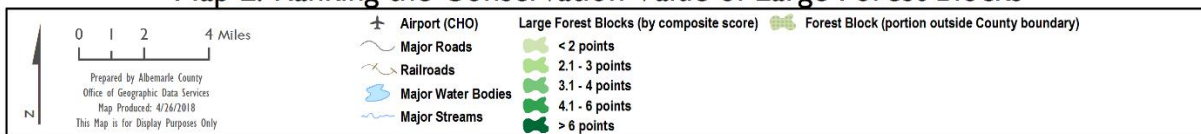
Map I: Forest Blocks and Tree Cover in Albemarle County



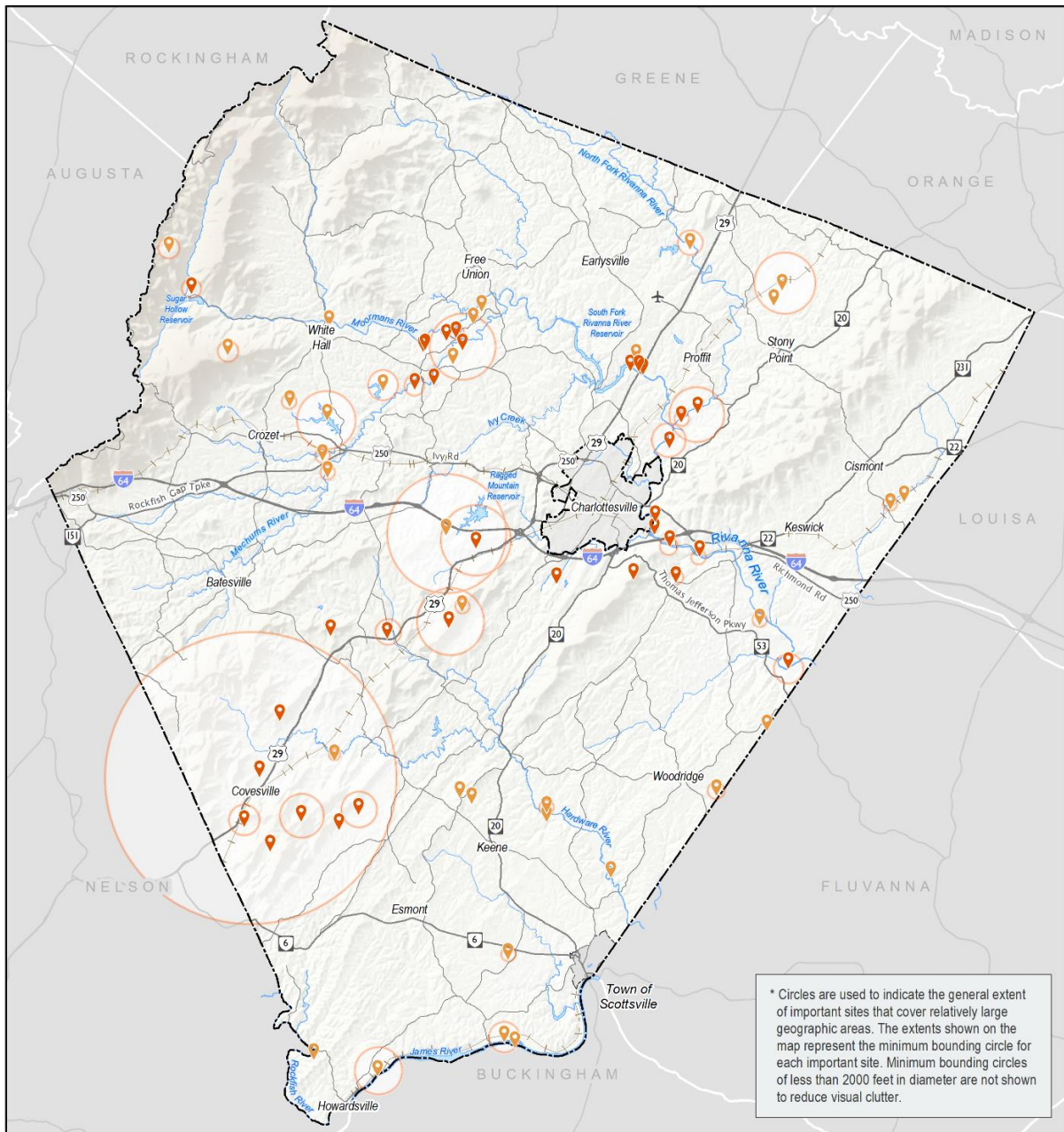
Map 1 illustrates forested areas and tree cover in Albemarle County based on 2009 land cover data. Pine plantations were not included as forest or tree cover in this analysis.



Map 2: Ranking the Conservation Value of Large Forest Blocks



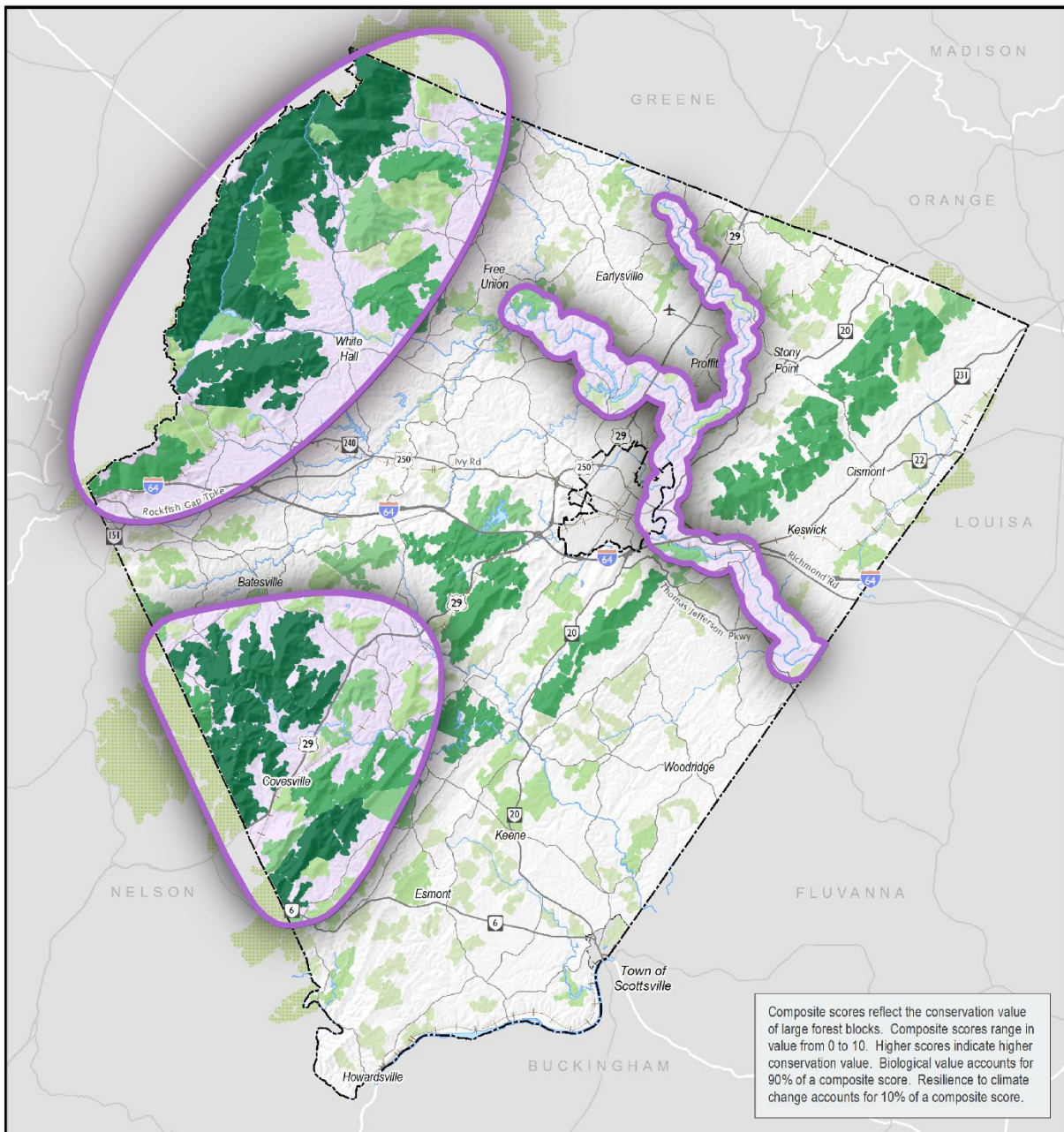
Map 2 illustrates the composite scores of large forest blocks (blocks containing 100 or more acres of interior forest). Forest blocks were identified using 2009 land cover data.



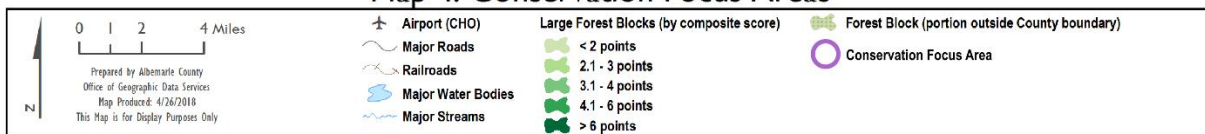
Map 3: General Locations of Important Sites



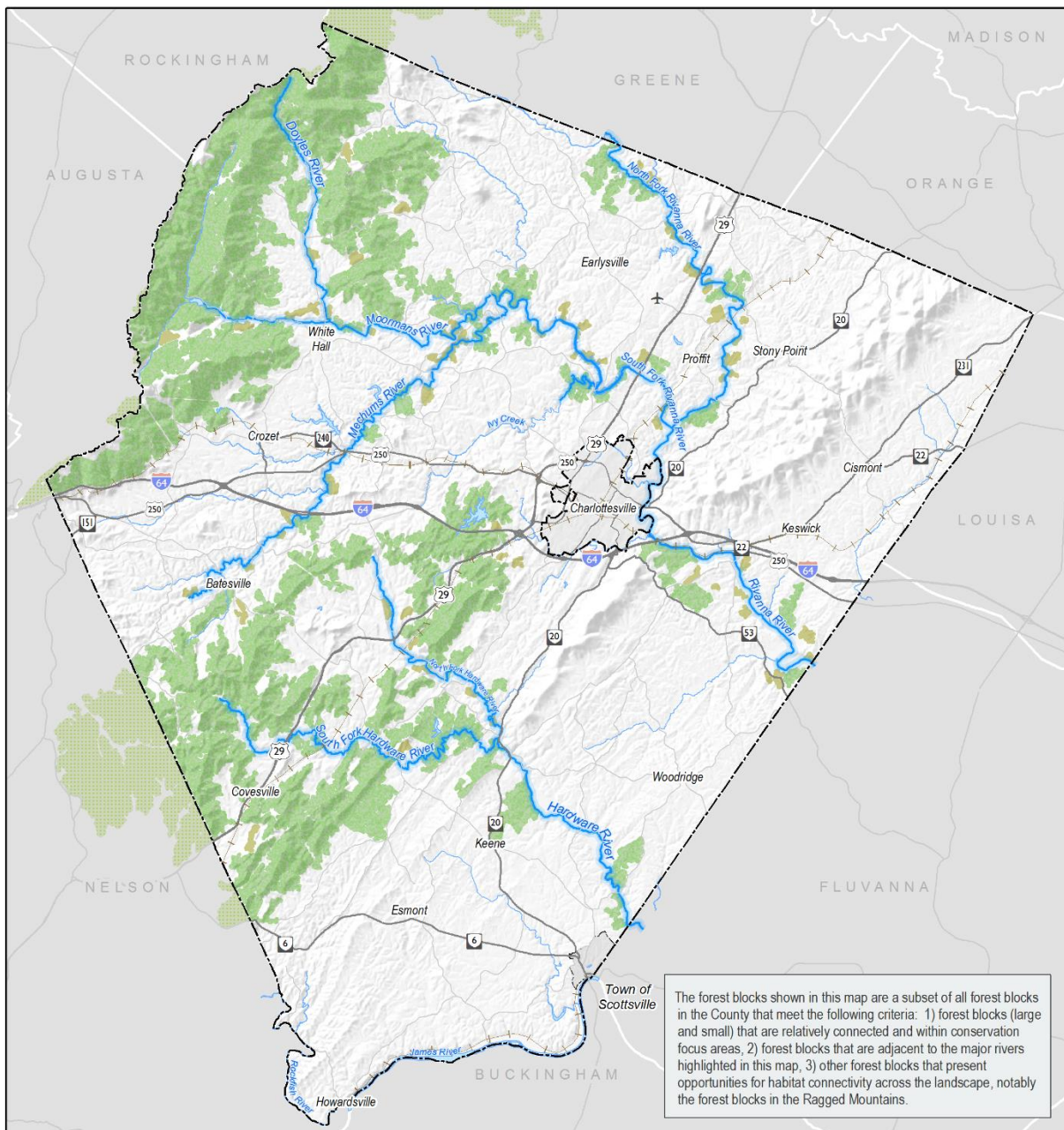
Map 3 shows the general locations of known important sites for biodiversity, as identified by Albemarle County's Natural Heritage Committee. Twenty-four sites were designated by the committee as priorities for committee and/or county attention and action.



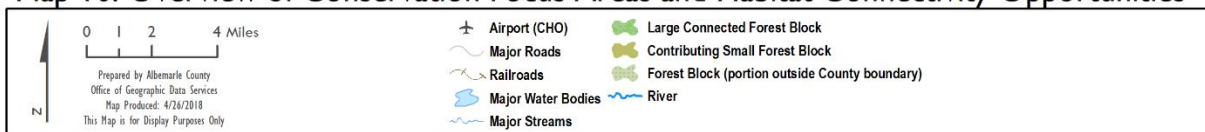
Map 4: Conservation Focus Areas



Map 4 depicts the three areas in Albemarle County that should be a focus of conservation activity and attention.



Map 10: Overview of Conservation Focus Areas and Habitat Connectivity Opportunities



Map 10 highlights the three conservation focus areas and opportunities for habitat connectivity among them. Note the network of rivers that could play a significant role in connecting different areas of the county.

VI. PROTECTION ACTION OPTIONS

Distinct kinds of actions can be used to help conserve biodiversity. Many of the actions listed below are incorporated in the goals and recommendations found throughout Section VII. Some options include:

1. Financial incentives and subsidies for conservation practices and activities.
2. Open space protection programs.
3. Public education on conservation issues.
4. Partnerships with organizations with expertise and resources in areas of conservation need, to increase the effectiveness of conservation actions.
5. Ordinances aimed at protecting natural resources.
6. Policies aimed at protecting natural resources.

Legal and political feasibilities, financial costs, and effectiveness of action options may vary greatly with the conservation needs addressed. Policies that do not make conservation the highest and best use of a property will likely be unsuccessful in protecting resources in the long term. The land use of properties often changes through time until reaching its highest economic value for the range of uses that are allowed.

VII. PROPOSED ACTIONS

PROTECTION OF OPEN SPACE HABITAT AREAS

If biodiversity in Albemarle County is to be protected, preservation of sufficient areas of open space (land which cannot be developed, or only minimally developed) is needed. The open space should not be heavily disturbed (i.e., highly impacted by human activity) and should represent a cross section of physical landscape conditions. If existing ecosystems are to be preserved, these protected, representative landscape areas should include areas currently occupied by native plant and animal communities.

Most county biological resources occur in the open spaces of the rural areas. However, allowable land uses in rural areas continue to degrade and sometimes destroy patches of habitat. For example, approximately 45,000 unused residential development rights are estimated to exist in rural areas (Albemarle County Comprehensive Plan, Chapter 7, p. 18). On average, from 1994-2013, 203 new residences were built each year in county rural areas (Albemarle County Comprehensive Plan, Chapter 7, Figure 7). Figure 5 illustrates there has been consistent residential development pressure throughout the county during the past decade, including in the Rural Area. Development pressure in the county's Development Areas is increasing. Including other types of residential buildings in Figure 5 (e.g., multi-family units) would illustrate the growing pressure.

Agriculture requires pastures and open fields, and these support vegetation far different from native land cover. Commercial forestry can manage forests in ways that maintain most of the biological value of forest habitats. However, some management schemes (e.g. pine plantations) provide minimal value as habitat. While efforts to encourage development in the county's Development Areas are necessary, those efforts alone do not guarantee that the Rural Area lands are safe from threats to natural resources and biodiversity.

Public lands and the ways they are managed play an important role in protecting important open space and wildlife habitat. County parks and other public lands contribute significantly to conserving biodiversity and other natural resources in Albemarle County. Shenandoah National Park (SNP) occupies almost 15,000 acres in the county, providing a physically diverse landscape and large, contiguous area of habitat that is vital for long term viability of biodiversity in the region. In considering Albemarle County alone though, SNP occupies only about 3% of the total land area (slightly more than 464,000 acres). While a tremendously valuable asset, the presence of SNP is not sufficient to conserve and protect biodiversity in Albemarle County. Resources and actions of the county and SNP should serve to complement one another in conserving local biodiversity and other natural resources in the long term.

Permanent conservation and open space easements are widely-accepted tools for protecting open space on private land. A conservation easement is a legally binding agreement between a landowner and a governmental or nonprofit organization to protect the resources of the land. Typically, an easement extinguishes most or all unused residential development rights associated with the property. Commonly, the easement document specifies that the landowner will avoid activities that would

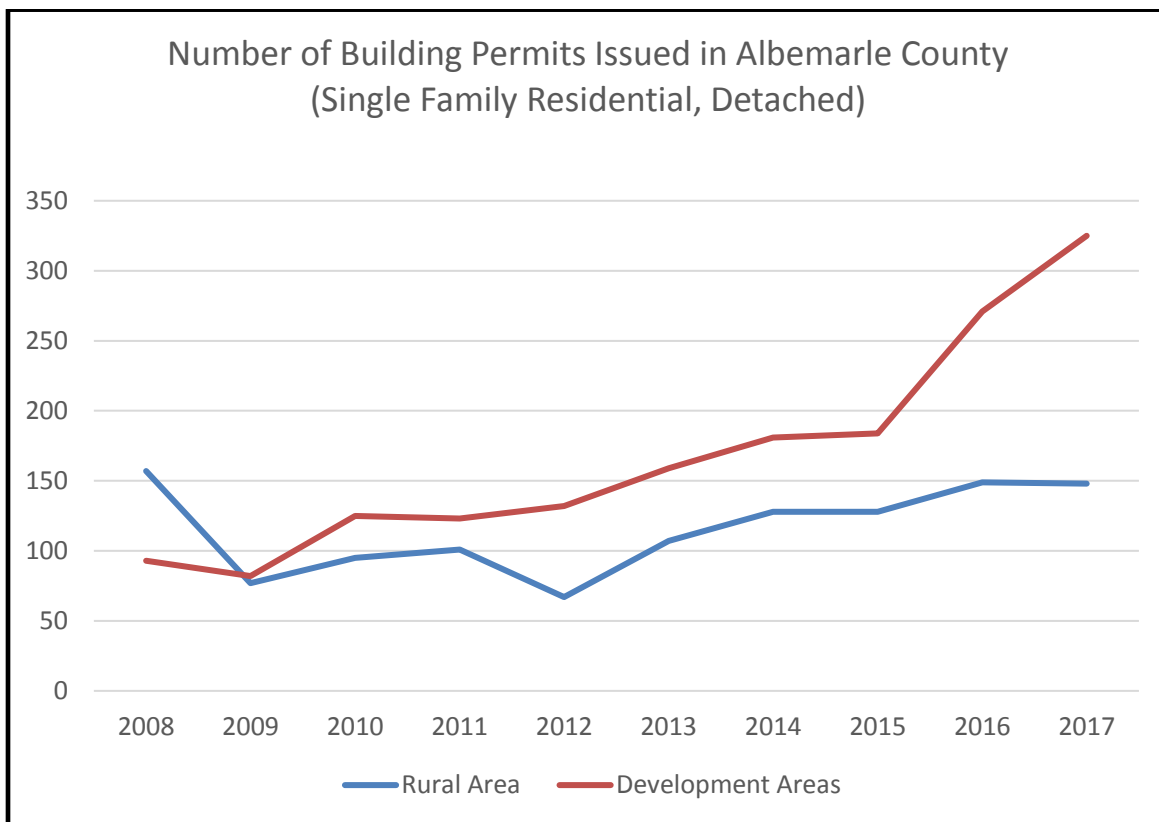


FIGURE 5. NUMBER OF BUILDING PERMITS ISSUED EACH YEAR SINCE 2008 IN ALBEMARLE COUNTY, FOR SINGLE FAMILY RESIDENTIAL DETACHED UNITS. DATA ARE FROM ANNUAL YEAR END BUILDING REPORTS DEVELOPED BY STAFF OF COMMUNITY DEVELOPMENT DEPARTMENT.

damage natural, historic, or other resources on the property. The easement holding organization is responsible for monitoring and enforcing terms of the easement. Federal and Virginia tax benefits may be available to those who donate permanent easements on their properties.

The conservation value of such easements varies greatly. Some easements do little more than extinguish residential development rights. Easements with assured biodiversity conservation value must explicitly recognize the importance of protecting natural resources present on the eased property. The county's Public Recreation Facilities Authority (PRFA) has accepted some easements with strong commitments to natural resources. The county's Acquisition of Conservation Easement (ACE) program pays landowners to place their properties in easements. Landowners considering easements must compete for acceptance into the ACE program. However, ACE program criteria for evaluating prospective easements place little value on protection of biodiversity.

A new challenge to the use of easements in conservation has emerged in recent years. With climate change, habitats of properties under conservation easements may become unsuited to organisms that

currently live there, undermining some of the value of the easements. On the other hand, in the face of climate change, easements should continue supporting ecosystems that provide important services. Moreover, if easements in the county include properties with diverse physical landscape features, the easements should help promote future county biodiversity, albeit diversity in biological communities with altered species compositions. Conservation implications of climate change are further discussed elsewhere in this action plan.

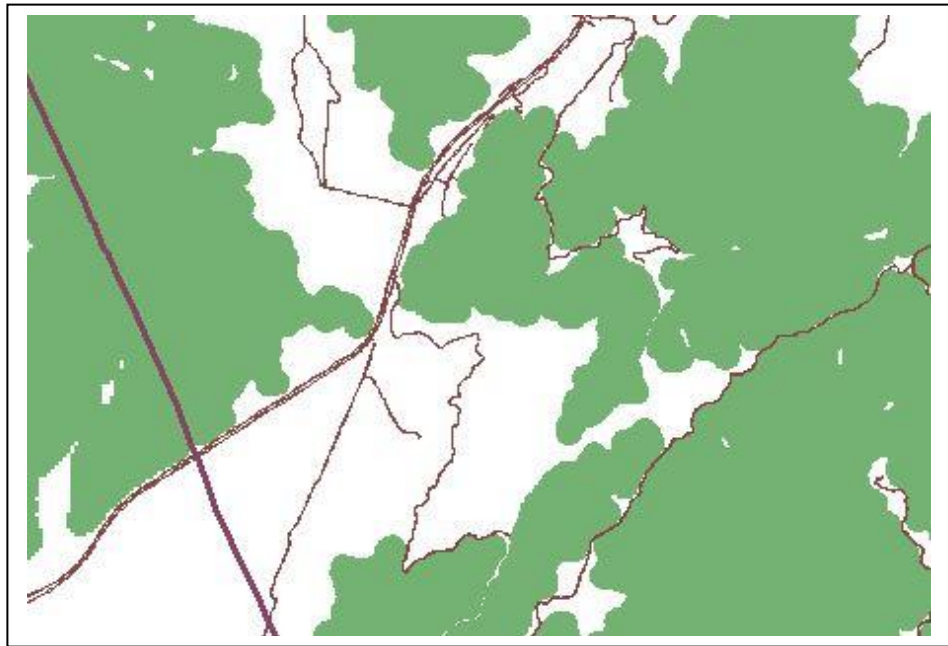


FIGURE 6. LARGE FOREST BLOCKS (IN GREEN) SURROUNDING ROUTE 29 NEAR NELSON COUNTY BORDER (PURPLE), FROM GREEN INFRASTRUCTURE CENTER ANALYSES.

Conservation easements or other permanent protection of land is not always possible. Albemarle County offers two voluntary programs for short term protection of land in the Rural Area. Both programs provide tax benefits to landowners that participate in them. Landowners may join (or form) an Agricultural & Forestal District (Albemarle County 2017). There is a ten-year commitment to refrain from converting farm, forest land, or other open space to more intense commercial, industrial, or residential uses (though limited subdivision may be possible). Open Space Use Agreements with the county (Albemarle County 2017) are similar but prohibit any subdivision of property. While these programs require little if any habitat protection, they reduce land development for a period of time.

GOAL 2: Promote conservation easements for areas of important biological resources or physical landscape conditions.

RECOMMENDATIONS:

1. Promote the county's ACE and PRFA conservation easement programs. Promote and support conservation easement programs of other organizations. [N,C,P]
2. Revise ACE and PRFA easement-acceptance criteria to reflect biodiversity values and conservation needs. Incorporate data from this report and the NHC in assessing biodiversity values. [N,C]
3. Ensure that all easements held by the county include terms that protect specifically identified biodiversity and other natural resources identified on the property. [N,C]

GOAL 3: Conduct outreach and educate the public and landowners on the importance of preserving habitat areas and managing land wisely. Provide more opportunities and incentives for landowners to conserve biodiversity and other resources.

RECOMMENDATIONS:

1. Investigate changes to the Land Use Valuation program to encourage conservation. Consider reducing the minimum acreage requirement for Open Space use to 5 acres, from the current 20 acre minimum. [N,C]
2. Contact the landowners of Important Sites throughout Albemarle County to educate and inform them of the biodiversity resources on and near their property. Develop relationships and encourage conservation of the land. [N]
3. Conduct landowner workshops and other events aimed at educating target audiences and the general public and promoting conservation. [N,C,P]
4. Serve as an information source and clearinghouse for landowners. Promote conservation efforts on the part landowners and the general public. [N]

(Refer to the Education section of this report for additional recommendations related to this Goal.)

GOAL 4: Promote management of county-owned and other public lands in a manner that conserves and enhances biodiversity and other natural resources.

RECOMMENDATIONS:

1. Identify opportunities for habitat restoration or improved land management of school grounds and other county-owned property. [N,C,P]
2. Acquire lands appropriate for natural areas in the county park system. (The William S. D. Woods Natural Heritage Area is an excellent example.) [N,C,P]
3. Continue emphasizing management that conserves and enhances biodiversity at county parks. [N,C]

MINIMIZING HABITAT FRAGMENTATION/MAINTAINING CONNECTIVITY

Habitat fragmentation is the breakup of large habitat patches into smaller patches. Agriculture, forestry, roads, residences, and commercial developments all have contributed to extensive fragmentation of Albemarle County habitats. Aquatic habitat is commonly fragmented by dams, small or inadequate culverts, and other barriers that prevent the movement of water and aquatic organisms.

The negative impacts of habitat fragmentation on biodiversity have long been known and extensively studied (Harris 1984, Saunders et. al. 1991). Fragmentation usually results in a decrease in the size of habitat patches, a decrease in total habitat area, increased isolation of habitat patches, and an increase in the amount of edge habitat.

The consequences of fragmentation are varied. Small wildlife populations occupying small habitat patches are more likely to go extinct due to chance events. Biodiversity contained in small patches tends to be reduced compared to that of large patches.

Fragmentation can sever habitat connections between local, neighborhood populations. If movements between local populations of a species living in different patches is limited, inbreeding and loss of genetic variability will take place in patch populations over time. In the long term though, adaptation by natural selection to local conditions will occur in isolated populations without disruption by genes of immigrants adapted to other conditions. Fragmentation may limit the spread of diseases.

Fragmentation can also affect forest habitat characteristics. The edges of forest patches may be drier or harbor species specialized for edge conditions. Large, compact forest blocks may be required to provide the forest interior habitat that was typical of Albemarle's landscape prior to European colonization and that is required by some species. Large forest-dwelling animals may require large forested areas to support viable populations. Populations in large patches may also be more resilient in the face of stressors, such as climate change.

Species differ greatly in their habitat requirements and patterns and methods of dispersal. As a result, a given landscape may support different degrees of connectivity for populations of different species. For example, many birds, plants with wind-borne seeds and large, generalized mammals may move freely between forest patches separated by farmlands but some other species (e.g. salamanders) might avoid or fail at such movements. Dams can fragment habitats of organisms living in streams and rivers, but fragmentation in nearby forests may have little or nothing to do with stream fragmentation.

Given the prevalence of extensive forests prior to European colonization and the presence of native flora and fauna adapted to them, protecting large forest blocks should be an aim of the action plan. Corridors of forest land connecting large forest blocks could provide movement opportunities for some forest-dwelling species. Sufficiently forested riparian buffers can serve as movement corridors and protect water quality. Hilty et al. (2006) review many of the issues surrounding terrestrial movement corridors.



FIGURE 7. BLACK BEARS NEXT TO I-64 GUARD RAIL NEAR AFTON MOUNTAIN. PHOTO: VIRGINIA TRANSPORTATION RESEARCH COUNCIL.

Roads are dangerous to wildlife and can strongly impede animal movements. A recently completed study (Donaldson 2017) found that over two hundred deer carcasses were removed each year from the 30-mile segment of I-64 in Albemarle County. On average nine black bear are killed each year in the same road segment. Such collisions are costly in dollars; a study and report to Congress by the Federal Highway Administration (2008) estimates the average cost of a deer-vehicle collision as \$8,388.

Donaldson also found that waterway crossings can be designed to promote animal movements in riparian areas under the crossings. Road underpasses in the county are known to be used for movements by some species often involved in accidents with vehicles, making the underpasses cost effective (Donaldson 2005).

The large Southern Albemarle Mountains Important Site, a high priority Important Site and earlier recognized as a priority conservation area (Albemarle County Natural Heritage Committee 2007), is bisected by Route 29. It appears to be a prime candidate for a wildlife crossing.

Dispersal mechanisms of many of Albemarle County's native species, especially those occupying specialized, normally isolated habitat patches, need further review.

GOAL 5: Minimize or reduce habitat fragmentation county-wide and maintain habitat connectivity.

RECOMMENDATIONS:

1. Target areas containing large forest blocks and promote their protection through conservation easements and other habitat protection tools. [N,C,P]
2. Target areas of forested and other habitat corridors connecting large forest blocks and promote their protection. [N,C,P]

3. Promote protection of forested and other habitat corridors with road and waterway crossings favorable to animal movements and prioritize these corridors for conservation. [N,C,P,\$]
4. Investigate a Route 29 underpass in southern Albemarle County to better connect eastern and western portions of the Southern Albemarle Mountains Important Site, a conservation priority area. [N,C,P,\$]
5. Gather information and knowledge for future action plans: [N]
 - a) Map rivers and streams interrupted by dams.
 - b) Develop a database of dispersal mechanisms of key species at Important Sites.



FIGURE 8. "BAR-CODED" PARCELS.

LIMITING BIOLOGICAL EFFECTS OF PARCEL SUBDIVISIONS

Subdivision of land parcels into smaller parcels is conceptually distinct from habitat fragmentation. Adam Downing of the Virginia Cooperative Extension Service refers to the phenomenon as “parcelization,” (Downing 2016) and distinguishes it from habitat fragmentation. However, parcelization often leads to habitat fragmentation. After subdivision of a large parcel covered in deciduous woods, the quality and ecological value of the deciduous woods may be severely impacted, if not lost, as portions of the former parcel are converted to other uses (e.g., residences, agriculture, pine plantation). The deciduous woods left on one parcel may no longer provide forest interior habitat. Ironically, the small size of new parcels often limits profitable use of them in farming and forestry.

Where natural features such as steep forested mountains or streams occur, land is often subdivided into strips as narrow as 100 feet wide to maximize development rights (see Figure 8). This creates parcels that are generally not usable except for residential purposes and complicates land management activities. Once land is divided, it is very unlikely it will be reconstituted into a large parcel again. If rare types of habitat or other valuable resources are present, it is difficult, if not impossible, to secure a conservation easement to protect the resources on several smaller parcels rather than fewer larger

parcels. Obtaining permission to monitor conditions and resources over time also becomes much more challenging.

Physical features on the land such as roads, dams, and power lines divide areas of habitat, usually reducing the total amount of habitat and negatively impacting the remaining habitat. Large forested blocks often become fragmented by the gradual development of roads. In rural areas, large tracts of land often contain logging roads, trails, and farm roads. As properties are sold and/or subdivided, these roads and trails often become official roads, even though they were not originally developed to meet current road standards in terms of their proximity to streams and minimizing impacts to critical slopes. When subdivision occurs, roads often become public and must meet standards for public roads.

Farm roads are not regulated under the county's Water Protection Ordinance, which includes an Erosion & Sediment Control Program (identical to state regulations), Stormwater Management Program (similar to state regulations), and stream buffer requirements. In terms of habitat fragmentation, the impact of paved roads is often worse than the impact of gravel roads. Paved roads often serve to open large areas of farmland and natural habitat to the potential for development.

GOAL 6: Improve policies for subdivision of properties to help prevent habitat fragmentation and maintain parcels of sufficient size for agriculture and forestry.

RECOMMENDATIONS:

1. Unless parcels are clustered (as in the following recommendation, for example), establish a minimum length-to-width ratio for newly subdivided parcels, to discourage "barcoding." [C]
2. Encourage Rural Preservation Developments with small building lots of two acres or less and the remainder of the land preserved as open space. [C]

GOAL 7: Reduce the impact of rural roads and other fragmenting features on habitat.

RECOMMENDATIONS:

1. Identify locations where the fragmenting effects of roads can be reduced or eliminated. Develop means for wildlife to pass safely under roads at strategic locations. Identify areas where reduced vehicle speed, traffic signs, or other steps will reduce wildlife mortality. Intersections of roads and riparian corridors are of particular importance. [N,C,P]
2. Paving of gravel roads in rural areas should be discouraged, particularly where paving would promote development or fragment forest blocks and habitat corridors. [N,C,P]
3. Where possible, prevent new public roads and other infrastructure from bisecting forest blocks and habitat corridors. [N,C,P]
4. Conduct a survey of all public roads in the county to identify opportunities for improving stream habitat and aquatic connectivity where roads cross streams. [N,C,P]
5. Promote the use of open arch and other open bottom structures for road crossings of streams. [N,C,P]

INVASIVE SPECIES

An exotic species is a species that lives outside of its native range. An invasive species is an exotic species that causes harm. Invasive species may be transported by humans to new locations. In some cases, the transport is deliberate (e.g. garden plantings) but in others it is accidental (e.g. in packing material for items shipped across the globe). Once established, the spread of invasive species may be facilitated by a lack of predators or other biological controls in their new locations. Additionally, invasive species may be adapted to recent landscape changes that stress native species.

Invasive species may 1) reduce or eliminate native species through competition, 2) prey on native species, 3) introduce infectious diseases to native species, 4) in combination with dense deer populations, disturb forest succession, 5) harm agricultural and forestal industries, and 6) cause human health issues. The reduction or elimination of certain native species can affect other native species (e.g. the loss of host plants for butterflies or moths).

Uncontrolled invasive species infestations can radically alter local biological communities. Control methods include 1) manual removal, 2) applications of chemicals toxic to the invasive species, 3) biological controls, 4) quarantines of areas with infestations, and 5) extermination of native hosts infected with exotic diseases.

Control of invasive species usually is most feasible when invasive populations are small. Manual control methods may be feasible for small populations. However, the efficacy of manual removals is limited with plants that can regrow from roots or other tissues left in the soil when above ground structures are removed. If native species are not planted after manual removal, the ground disturbance caused by removing the invasive often facilitates further invasion by the same or different invasive species.

Chemicals may control large infestations and are generally safe and effective when used properly and all label instructions are followed. If not used properly though, chemicals can harm nearby native species and present health hazards to humans applying control chemicals. Chemical treatments can also be expensive. Spot treatments can be effective in controlling some invasive plants. For instance, applying herbicide to freshly cut stems of woody plants like autumn olive (*Elaeagnus umbellata*) and tree of heaven (*Ailanthus altissima*) is an often used technique. There are a wide variety of Integrated Pest Management approaches that use multiple methods of controlling invasive species and other “pests.”

Biological controls, if available, may be the only feasible means of controlling already common, widely distributed invasive species. Biological controls frequently are exotic species themselves and require research in federal quarantined facilities for years before being released. Even after a period of research, introduction of biological controls may involve risk. Quarantines are one of the only regulatory tools available for the control of invasives, but may be expensive to enforce and of limited value for species that readily disperse long distances. Exterminating hosts of exotic diseases may be difficult, expensive and politically distasteful.

For some county invasive species, control may be impossible or only marginally possible. In targeting invasive species for control efforts, a triage system may be required. A triage system would separate 1)

invasive species that cause limited, tolerable harm, 2) invasive species that cause serious harm but currently are uncontrollable, and 3) seriously harmful invasive species that may be controllable and thus priority targets for control efforts.

TABLE 4. EXAMPLES OF INVASIVE SPECIES IN VIRGINIA.

1. Chestnut blight. Caused by fungus (*Cryphonectria parasitica*) introduced from Japanese nursery stock in the early 1900's. Decimated most American chestnut (*Castanea dentata*) populations.
2. Gypsy moth (*Lymantria dispar*). Introduced from Europe in the 1860's, the gypsy moth has spread across much of northeastern U.S. and the Southern Appalachians. Can cause severe defoliation in deciduous forests when population levels are high.
3. Oriental bittersweet (*Celastrus orbiculatus*). Introduced as ornamental from Asia. Grows rapidly, strangling or smothering shrubs and trees.
4. Tree-of-heaven (*Ailanthus altissima*). Introduced as ornamental from China. Rapidly colonizes old fields, disturbed sites, chemically inhibits other plants.
5. Wavyleaf grass (*Oplismenus hirtellus*). Apparently from Russia, occurs in multiple Albemarle locations. Forms dense understory in forests.
6. Emerald ash borer (*Agrilus planipennis*). Asian insect now in Albemarle County. VDOF expects this insect to decimate local populations of ash trees (*Fraxinus* spp.).
7. Hemlock woolly adelgid (*Adelges tsugae*). Asian aphid-like insect kills eastern hemlocks (*Tsuga canadensis*) and Carolina hemlocks (*T. caroliniana*) and has eliminated hemlocks from many habitat patches.
8. Northern snakehead (*Channa argus*). Fish from Asia. Predator competes with native species.

Beyond the triage approach, other factors come into play in attempting to control invasives. Financial costs, time and effort required, and other practical considerations are obvious. The likelihood of success must be considered as well, which is often affected by the abundance of invasives on site and their presence (or absence) on neighboring lands.

At present, there is little or no data on occurrences of invasive species in much of Albemarle County. Once more detailed spatial data becomes available, locations of invasive infestations should be a factor in setting priorities for control programs. Natural areas, parks, and other public lands may be reasonable target areas for controlling invasive species.

Given the prevalence of forests on undisturbed Albemarle open spaces, protecting forests is an important conservation goal. Harmful, relatively controllable invasive species that threaten forests,

such as Japanese barberry (*Berberis thunbergii*), should be high priorities in invasive species control programs. Success in such programs is likely to require efforts that span human generations.

Some exotic species will persist and become integrated into the ecosystems of their new locations. The Italian honeybee (*Apis mellifera*) is an example of an exotic species in Virginia whose presence is widely valued.

The Blue Ridge Partnership for Regional Invasive Species Management (Blue Ridge PRISM) is a recently formed nonprofit organization focused on the control of non-native invasive plant species in a multi-county region that includes Albemarle County. Appendix G contains a list of the organization's "Terrible Twelve" invasive species. The Natural Heritage Committee and the Blue Ridge PRISM are partners in supporting one another's efforts to control invasive species, particularly through education.

The Early Detection and Distribution Mapping System (EDDMapS) is an organization that supports online recording of invasive species distribution data (Early Detection & Distribution Mapping System 2017). The Virginia Department of Forestry is among providers of information to their database.



FIGURE 9. INVASIVE SPECIES IMPACTING ALBEMARLE COUNTY. LEFT, KUDZU COMPLETELY COVERING AND SMOTHERING FIELDS AND FOREST. RIGHT, THE RECENTLY ARRIVED EMERALD ASH BORER, A SIGNIFICANT AND OMINOUS THREAT TO ASH TREES. PHOTOS: CENTER FOR URBAN HABITATS.

GOAL 8: Manage invasive species to limit their spread.

RECOMMENDATIONS:

1. Continue a partnership with Blue Ridge PRISM. [N,P]
 - a. Educate the public regarding invasive species.
 - b. Implement methods of controlling the "Terrible Twelve" species (see Appendix G).
2. Support control of invasive species in and near biologically important areas and on county-owned properties. [N,C,P,R]

3. Develop county-wide data sets on invasive species occurrences. [N,P,\$]
 - a. Participate in EDDMapS invasive observation recordings.
 - b. Partner with VDOF, Blue Ridge PRISM, or others as opportunities arise in developing county-wide data on invasive species occurrences.
 - c. Investigate tools to use in documenting occurrences of invasive species in Albemarle. The Mid-Atlantic Early Detection Network (MAEDN) is one such tool.
4. Periodically examine invasive species biocontrol possibilities. [N]
5. Require the use of locally native plants for landscaping on county-owned land or projects. Recommend the use of locally native plants on projects on private land that require county approval. [N,C,R]
6. Educate and promote the use of locally native plants for gardening and landscaping on private lands. [N,C,R]
7. Working with other organizations, conduct workshops on the control of invasive species. [N,C,P]

CLIMATE CHANGE

The release of “greenhouse gases” into the atmosphere through human activities is causing rapid global climate change (Intergovernmental Panel on Climate Change 2014). Releases of carbon dioxide by fossil fuel burning and methane by livestock are two major contributors.

Many scientific organizations have modeled climate changes during the remainder of the twenty-first century. Models of the Intergovernmental Panel on Climate Change (2001) are among the best known. Climate change projections commonly include 1) systematic temperature increases, 2) more variable precipitation, 3) more extreme storms, and 4) regional variations in changes. Early recognizers of the impacts of climate change on biodiversity conservation included (Harris and Cropper, Jr. 1992) and (Peters and Lovejoy 1992).

Many uncertainties exist in climate change projections. Climate change processes are extremely complex; some uncertainties occur because models necessarily are incomplete and include simplifying assumptions. Some forecast uncertainties stem from uncertainties about the extent of future human efforts to contain climate change. In other words, future human activity could either help reduce the scope and effects of climate change or exacerbate the problems. In addition, biological and climate systems can behave in complex, nonlinear ways that we now do not foresee.

During climate change, native species may become poorly adapted to places where they currently live. In response, species may: 1) genetically adapt to change, 2) move to climatically more favorable places (nearby or distant), or 3) become locally extinct. The prevalence of some diseases, particularly insect-borne diseases, may increase with climate change. Competition with invasive species well suited to the altered climate may add to the stresses on native species.

A key implication of climate change is that native species might not be conserved by protecting places where they currently live. We should anticipate that some currently native species will adapt by moving

out of Albemarle County and some species now native to nearby areas will adapt by moving into Albemarle County. We may find some vacated niches in local ecosystems filled by exotic species.

A consequence of past climatic change is the development of refugia, areas of habitat that support isolated or relict populations of plants or animals unable to shift geographically in response to changing conditions. For example, some high elevation areas of the southern Appalachian Mountains support plant populations, including tree species such as spruce (*Picea* spp.) and fir (*Abies* spp.), that are geographically disjunct from their nearest populations. During previous Ice Age periods, these plants were likely widespread, but moved northward over time as the climate warmed. High elevation areas provided suitable habitat and climatic conditions, and small, isolated populations remain in these areas today. Providing potential refugia for species currently present in Albemarle needs to be considered in planning for biodiversity conservation.

Projected Virginia Species Climate Change Range Shifts

In the analyses of impacts of climate change on plant and animal species in Virginia by Kane et al. (2013), the suitability of Virginia landscapes for currently native species undergoes many changes. For example, the climate will become generally less favorable for northern red oak (*Quercus rubra*). Brook trout (*Salvelinus fontinalis*) are expected to disappear from the state. The distribution of cypress trees (*Taxodium* spp.) is expected to expand.

In the face of changes stemming from the combination of invasive species and climate change, county biodiversity protection efforts should not focus simply on conserving current native species. Protecting open spaces and healthy landscapes, and the ecosystem services they provide, should be key goals of county efforts in adapting to climate change. It is recognized that protecting the diverse underlying geological conditions present in the landscape is important to conserving biodiversity (Hjort et al. 2015).

With sufficient habitat connectivity between Albemarle County and Shenandoah National Park, the park could play a key role in county biodiversity climate change adaptations. The altitudinal variations and complex topography provide altitudinal gradients, north facing slopes, and deep ravines, all of which could provide at least temporary refuges from temperature increases for many species. The park's mountains are oriented largely in a south-north direction and provide a corridor for species that shift ranges northward as temperatures increase. In addition, water runoff from the park supports many streams and riparian areas. Riparian areas could provide movement corridors from lowland areas in the county to cooler climates in the park.

Data and studies from a number of organizations can inform and assist efforts in planning how to adapt to climate change. Some examples include:

- The Nature Conservancy conducted a landscape-level analysis of resilience to climate change across eastern North America (The Nature Conservancy 2017, Anderson et al. 2016).
- The National Wildlife Federation (Kane et al. 2013) projected potential shifts in species ranges in Virginia in response to climate change.

- The Virginia Department of Game and Inland Fisheries, the National Wildlife Federation, and Virginia Conservation Network collaborated in developing a “Strategy for Safeguarding Species of Greatest Conservation Need from the Effects of Climate Change” (2009).
- Climate change will undoubtedly have great effects on agriculture. The Virginia Cooperative Extension has begun advising farmers on the impacts of climate change and farming adaptations (Easton and Faulkner 2014).
- The Wildlife Conservation Society has established a fund that supports biodiversity climate change adaptation projects (Wildlife Conservation Society 2017).

Climate change will affect operations of organizations that have little or nothing to do with natural resources. Recognizing this, the Environmental Protection Agency developed a workbook (United States Environmental Protection Agency 2014) that spells out processes by which organizations can develop risk-based climate change adaptation plans. In a more specialized approach, the University of Washington and King County, Washington developed a guidebook for local, regional and state government preparations for climate change (University of Washington & King County Washington 2007). In 2015, King County adopted a climate change strategic action plan (King County, Washington 2015).

GOAL 9: Develop strategies for biodiversity conservation during climate change.

RECOMMENDATIONS:

1. Acknowledge the key role of Shenandoah National Park in county climate change adaptation strategies. [N]
2. Maintain, improve, and promote biological connections to Shenandoah National Park and among other important large habitat areas identified in this report. [N,C,P]
3. Identify and protect potential climate change refugia. [N,C,P,\$]
4. Reduce climate-change stresses due to human activities (e.g. provide shade to denuded stream banks with tree buffers). [N,C,R]
5. Educate the public generally about climate change. Develop information pertinent to Albemarle County. [N,C,P]
6. Monitor: [N, C]
 - a. Climate change projections.
 - b. Species range shifts (local projections, observed shifts).
 - c. Disease agents.
 - d. Anticipated impacts on agricultural and forestal industries, local water supplies.
7. Conduct a county-wide climate change preparedness assessment, as outlined in Strategy 8a of the Comprehensive Plan. Biodiversity and natural resources should be a key component of the assessment. [N,C]
8. Use the ACE program and other applicable state or regional programs to acquire open space properties that can function as movement corridors connecting land in the county to Shenandoah National Park or as climate change refugia. [N,P]

ECOSYSTEM SPECIFIC CONSERVATION PROPOSALS

FORESTS

A range of factors are causing broad disturbances in composition and function of Albemarle forests. These factors include habitat and parcel fragmentation, invasive species (especially disease-causing organisms), and climate change. These broad factors are discussed elsewhere in the action plan.

More narrowly, fire suppression is affecting forest compositions. Fire intolerant species such as red maple (*Acer rubrum*) and American beech (*Fagus grandifolia*) are increasing. Fire suppression may be contributing to a general decline of oaks in Virginia forests. Populations of fire-adapted understory plants are also impacted by a lack of fire. Given the widespread occurrence today of buildings, power lines, and other structures in areas with forests, attempting to recreate pre-colonial fire regimes seems impractical. As a result, we foresee an expanding presence of shade-tolerant species in Albemarle forests.

The large population of white-tailed deer (*Odocoileus virginianus*) in the region is a threat to forests. The high density of browsing deer in some areas limits growth of young trees and succession of abandoned fields back to forests. In the past, wolves (*Canis lupus*) must have had an important role in limiting deer densities in Albemarle County. Today, hunting by humans, predation on fawns by bobcats (*Lynx rufus*) and coyotes (*Canis latrans*), diseases (e.g. epizootic hemorrhagic disease), and food shortages all contribute to deer mortality. These factors have done little to limit the deer population at the county or regional levels in the recent past. They can sometimes help reduce the presence of deer in certain localized areas.

Control of deer numbers by human hunters has become less feasible in many rural areas of the county due to the presence of many new homes and small parcel sizes of recently subdivided parcels. Deer hunting is regulated by the VA Department of Game and Inland Fisheries (VDGIF).



FIGURE 10. FORESTS IN ALBEMARLE COUNTY. LEFT PHOTO: CENTER FOR URBAN HABITATS, RIGHT PHOTO: SCOTT CLARK.

GOAL 10: Identify, restore, and protect large forested areas.

RECOMMENDATIONS:

1. Investigate and support regional efforts to preserve large natural areas in the Piedmont with a minimal human presence. [C,P]
2. Implement burning regimes aimed at promoting biodiversity for forests on county properties. [C,P]

GOAL 11: Maintain feasibility of deer hunting by humans as a means of promoting forest regeneration.

RECOMMENDATIONS:

1. Work with VDGIF to identify areas of high deer population and as a key partner in developing strategies for management. [N,C,P]
2. Investigate methods of controlling local deer populations, such as periodic “deer culling” with sharp shooters on county-owned properties. [C,P]
3. Propose creation of a Wildlife Management Area in Albemarle County in the Virginia Outdoors Plan. [N,C,P]
4. Do not develop policies that would discourage or restrict hunting in rural areas of Albemarle County. [C,P]

Outcrops, Bluffs, and other Xeric Habitats

Unusually dry or xeric places often support distinct plant communities.

Local river bluffs, such as those along the Rivanna and Mechums Rivers, are known in our area for spectacular wildflowers including smallflower phacelia (*Phacelia dubia*), trout lilies (*Erythronium americanum*), Canada lilies (*Lilium canadense*), and bloodroot (*Sanguinaria canadensis*). Steep slopes, particularly with sandy soils, can provide habitats for rare species such as turkeybeard (*Xerophyllum asphodeloides*).

Piedmont mafic barren is a globally significant habitat type that occurs in Albemarle County. Examples exist in the Ragged Mountains as well as on Dudley, Chalk, and Appleberry Mountains. These sites display shallow soils and exposed mafic rock. Mafic rocks are igneous rocks high in magnesium and iron content.

These sites are exceedingly fragile and even a small amount of disturbance, including light foot traffic, can have permanent impacts. Currently the biggest threats at these sites are invasive species and the presence of cattle. Invasives compete with native plants for the limited resources on site, such as soil, sunlight, and moisture. Quarrying is also a threat to this habitat and the plants they support. See Appendix D for a more complete description of Piedmont mafic barrens.

The county landscape includes several other habitats with drought tolerant plants like prickly pear cactus (*Opuntia humifusa*) and fameflower (*Phemeranthus teretifolius*).



FIGURE 11. PIEDMONT MAFIC BARREN SITES IN ALBEMARLE COUNTY. PICTURE ON RIGHT SHOWS THE FAMEFLOWER. PHOTOS: CENTER FOR URBAN HABITATS.

GOAL 12: Identify and protect xeric habitats.

RECOMMENDATIONS:

1. Identify areas with potential xeric habitats using GIS data analyses. [N,C,\$,P]
2. Review and update guidelines for Resource Extraction Areas. Limit new permits to areas that do not contain key habitats. [C]
3. Ensure that park trails avoid these xeric habitat areas except where measures like boardwalks and fences are provided to protect them, or where access is provided specifically for educational reasons. [C]
4. Protect steep bluffs along rivers through easements or other tools. [N,C,P]
5. Educate the public about these sensitive habitats and how to conserve them. [N]

RELICT PIEDMONT PRAIRIES, MEADOWS, AND GRASSLANDS

In recent centuries, forests have been the predominant native plant cover over most of Albemarle County. Nonetheless, prairie and savanna have existed in places in the county, at least temporarily. Existence of these systems may have been favored by presence of now absent large herbivores and fires set by Native Americans. Since European colonization, disturbances such as land clearing for agriculture, forestry, and power lines have created conditions favorable for conserving these important types of plant communities.

Although Albemarle prairies and savannas are now generally products of human disturbance, they provide habitat for many native species. Rare species they support include the regal fritillary butterfly (*Speyeria idalia*), rusty-patched bumble bee (*Bombus affinis*), and Appalachian grizzled skipper (*Pyrgus centaureae wyandot*). Prairies and savannas can also provide habitat for declining bobwhite quail (*Colinus virginianus*). Preddy Creek Trail Park includes an example of a biodiverse prairie grassland.

Maintenance of local prairies and savannas requires active management (e.g. burning, mowing, grazing, and occasional invasive species controls). Burning is labor intensive, requires specialized training, and may be viewed as a danger or nuisance by residents in many county locations. Control of some invasive species in grasslands may require spraying of chemical herbicides. Since locally native plant installations may be able to compete with invasive species only in certain soil types, controlling invasive species with herbicide treatment may be required in some instances.

Agricultural programs available through the federal Natural Resources Conservation Service (NRCS) include the Environmental Quality Incentives Program (EQIP), Conservation Reserve Program (CRP), and Conservation Reserve Enhancement Program (CREP). These programs provide support for maintenance of lands in grasslands and other habitats.



FIGURE 12. PRAIRIE AND GRASSLAND SITES IN ALBEMARLE COUNTY. LEFT, A NATIVE GRASS MEADOW AT IVY CREEK NATURAL AREA, PHOTO: SCOTT CLARK. RIGHT, GRASSLAND IN A POWERLINE RIGHT OF WAY, PHOTO: CENTER FOR URBAN HABITATS.

GOAL 13: Identify, restore, and protect prairie and savanna habitat.

RECOMMENDATIONS:

1. Identify existing biodiverse prairies and savannas. [N]
2. Promote grassland conservation programs such as those offered by NRCS and other organizations. [N C,P]
3. Advise landowners of herbicide no-spray zone programs offered by Virginia Department of Transportation (VDOT) and utility companies. [N,C]
4. Implement burning or mowing regimes aimed at promoting biodiversity for areas maintained as grasslands on County properties. [C,P]

RIVERS, STREAMS, AND RIPARIAN AREAS

Land disturbance and clearing often leads to the flow of sediment and other pollutants into rivers and streams. These flows reduce aquatic habitat and water quality in affected streams. Clearing land to the edges of rivers and streams also destroys riparian habitats important to amphibians and other species. According to the Albemarle County Biodiversity Work Group Report (2004, 23), much of the sedimentation associated with early agriculture and forestry likely remains in or adjacent to river and stream channels today.

Buffers of relatively undisturbed vegetation are a widely recommended tool for limiting sediment and non-point pollutants in aquatic ecosystems. Vegetative buffers can range from grassy strips separating plowed fields from streams to native woods along waterways with fences that exclude livestock.

In addition to protecting water quality, wooded buffers provide riparian habitat used by a variety of wildlife species. They may also function as movement corridors for terrestrial species. A great deal of information exists about the positive ecological and biological effects of riparian buffers (e.g., Sweeney and Newbold 2014). Larger, wider buffer areas generally provide more habitat and benefits for biodiversity than smaller, narrower buffers. Crawford and Semlitsch (2007) recommend buffer widths of 92.6 meters (approx. 304 feet) to provide adequate habitat for stream-breeding salamanders of the southern Appalachian Mountains.

Albemarle County has been a leader in promoting river and stream buffers. Albemarle was the first locality west of the Tidewater region in Virginia to voluntarily enact buffer requirements that are enabled by the Chesapeake Bay Preservation Act.

Appendix H summarizes the Albemarle County Water Protection Ordinance and regulations currently in place related to stream and river buffers. At the time of this writing, Albemarle County is conducting an extensive review of stream buffer requirements.

Despite the simplicity of the vegetative buffer concept, there are many complexities to laws aimed at promoting buffers. Buffer requirements may vary for lands in different zoning or other legal categories. Lands in agricultural and forestal uses may be exempted from many requirements that apply elsewhere. Access to streams by livestock is generally not considered from a regulatory standpoint when determining if buffers are in place. While many farmers have used cost-share programs to voluntarily exclude or limit livestock access to streams, neither the state nor Albemarle County has the authority to require that livestock be excluded from water bodies.

Buffer cost share programs are available to landowners. Organizations offering these programs include the VA Department of Conservation and Recreation. Many cost-share programs apply to agricultural lands. The Virginia Conservation Assistance Program (VCAP) provides cost shares for implementing buffers on non-agricultural lands. The Thomas Jefferson Soil and Water Conservation District (TJSWCD) implements the VCAP in Albemarle County and acts as a clearing house for buffer cost-share programs. The TJSWCD is a good initial contact for landowners interested in implementing buffers on their properties.

River, stream, and riparian area ecosystems also can be affected by broadly acting threats (e.g. invasive species, climate change, and connectivity disruptions). Impacts of broad threats on these and other ecosystems are discussed elsewhere in this action plan.



FIGURE 13. RIVERS OF ALBEMARLE COUNTY. LEFT, RIVANNA RIVER AT DARDEN TOWE PARK, PHOTO: NATURAL HERITAGE COMMITTEE. RIGHT, DOYLES RIVER IN WESTERN ALBEMARLE, PHOTO: SCOTT CLARK.

GOAL 14: Improve county stream and river buffers to improve aquatic ecosystem health, water quality, and riparian habitat quality.

RECOMMENDATIONS:

1. Upon completing a review of current stream buffer rules, the county should strengthen stream buffer requirements. [N,C]
2. Inform and educate landowners about the county's buffer regulations. Ensure that landowners who convert land from agriculture or forestry to a different land use are informed. [N,C]
3. Educate the public on the value of stream buffers. Promote and support existing cost-share programs for buffers and livestock exclusion from streams. Promote locally native riparian plantings on non-agricultural lands through VCAP and other programs. [N,C,P]

WETLANDS

Wetlands are land areas permanently or seasonally saturated with water, resulting in anaerobic soil conditions and vegetation adapted to these conditions. The county does not have large wetlands of the kinds sometimes found in coastal areas. However, the Albemarle landscape is dotted with numerous small wetlands, many under an acre in size. These small wetlands usually exist next to streams, at the base of hills where springs surface, and as seasonal or vernal pools in low spots.

Wetlands provide ecosystem services, support distinct plant communities, and are critically important to amphibian reproduction. The U.S. Fish and Wildlife Service maintains a National Wetlands Inventory (United States Fish and Wildlife Service 2017). Though extensive, this inventory of wetland locations and types does not include all wetlands. Covering the entire United States, the data are not always accurate, and are often used as a guide for the potential presence of wetlands.

Important county wetlands recognized in the Biodiversity Work Group Report Appendix (Albemarle County Biodiversity Work Group 2004, 2,3) include the Campbell, Preddy Creek, and Cove Garden wetlands.

In the past, many wetlands on agricultural lands have been drained. In some cases, runoff and other pollutants damage wetlands. Currently, the federal Clean Water Act (United States Environmental Protection Agency 2017) and Food Security Act (United States Environmental Protection Agency 2017) legally limit the allowed impacts to wetlands.

Federal regulations may permit destruction or impairment of specific wetlands if commitments are made to mitigate the losses by new wetland creation, by restoration of lost wetlands, or by functional enhancement of existing wetlands. Mitigation options are summarized in an EPA fact sheet (United States Environmental Protection Agency 2017).

The Comprehensive Plan (Chapter 4, Objective 6) calls for protection of wetlands. However, the plan notes that county wetland protections mainly are indirect, by promoting vegetated stream buffers.

The Thomas Jefferson Soil and Water Conservation District can educate landowners about programs that will share costs with landowners of livestock exclusions from wetlands. These programs include the Virginia Agricultural Best Management Practices Cost Share Tax Credit Program (Virginia Department of Conservation and Recreation 2017) and Virginia's Conservation Reserve Enhancement Program (CREP) (Virginia Department of Conservation and Recreation 2017).



FIGURE 14. WETLAND SITES IN ALBEMARLE COUNTY. LEFT, VERNAL POOL BESIDE RIO MILL ROAD, USED BY BREEDING AMPHIBIANS, PHOTO: NATURAL HERITAGE COMMITTEE. RIGHT, A SEEPAGE SWAMP IN THE BISCUIT RUN PROPERTY, PHOTO: GARY FLEMING, VA DEPT. OF CONSERVATION AND RECREATION.

GOAL 15: Identify, restore, and protect wetlands.

RECOMMENDATIONS:

1. Educate landowners regarding cost share programs to create wetland buffers and exclude livestock from them. [N,P]
2. Work with partner organizations to help landowners locate lost wetlands, encourage and facilitate their restoration, and understand ecological benefits of restoration. [N,P]
3. Investigate the county's authority and ability to protect wetlands, particularly those that are not contiguous to stream buffers. [N,P]

DEVELOPED AREAS

Urban areas provide opportunities for conservation and restoration of small but valuable habitat patches, as well as places for preservation of examples of rare native species. Moreover, contact with biodiversity adds to the quality of life for residents of developed areas. Indeed, if we wish to entice people to live in urban areas, we should offer them some natural amenities.

Developed areas in Albemarle County with biodiversity conservation value include neighborhoods with many large trees (e.g., many neighborhoods near the University of Virginia) and wetlands adjacent to streams (e.g., Fontaine Avenue and Sunset Avenue near Moores Creek). The crossing of spotted salamanders (*Ambystoma maculatum*) and other amphibians at Polo Grounds Road lies in a developed area. Significant effort has been expended to make crossing the road safe for the amphibians, and future additional efforts are planned. Rare species, including toadshade (*Trillium sessile*) and yellow pond-lily (*Nuphar advena*) occur in or near areas that have been developed.

The Rivanna River and nearby areas have long been recognized as a biodiversity conservation priority. Ecosystems adjacent to the river include vernal pools, oxbows, bluffs, and rich flood plains. Many developments already encroach on the edge of the river and the sensitive ecosystems that surround it. Because of the high property values and the strong need to preserve areas along the river, a Transfer of Development Rights program should be explored to see if it could be used to help meet comprehensive planning goals for river protection. See Stafford County Code Article XX Sec. 28-357 as an example (Stafford County 2015). As a sending area, the development rights could be transferred within developed areas to an adjoining property or to a property owned by the same person.

Urban streams present many habitat restoration opportunities. In many cases, urban streams have been covered completely or channelized, forced into narrow canyons bounded by steep retaining walls. Opening streams to sunlight and surrounding them with gradually graded, vegetated banks will restore some of their value as bird and pollinator habitats. Streams with graded, vegetated buffers will also better retain nitrogen and phosphorous run-off from surrounding areas. Beyond these ecological benefits, "daylighting" of streams provides much aesthetic value and contributes to a sense of place, improving the quality of life for many area residents.

Green Roof Colonized by Extremely Rare Plant

There is growing evidence that green roofs with native plants can provide critical habitat for biodiversity conservation. For example, a green roof in London was colonized by an extremely rare green-winged orchid, *Anacamptis morio* (T. Marshall 2016).

Runoff from extensive impervious surfaces in developed areas can lead to unnaturally high stream water flows, especially after storms (“flashing”). Better designs of parking lots and other hard surfaces could reduce flashing occurrences. The local guide “Before the Storm” (Southern Environmental Law Center, Rivanna Conservation Society and the University of Virginia, 2008) provides examples of ways that stormwater runoff can be mitigated to protect streams and rivers. Stormwater facilities often provide significant opportunities to provide desirable green space and habitat.

Natural or semi-natural amenities enjoyed by urban residents include locally produced food, greenspaces, trails, clean water, and recreation opportunities. The last Parks Needs Assessment showed that residents particularly value green spaces and walking trails.



FIGURE 15. IMPORTANT BIOLOGICAL RESOURCES IN DEVELOPED AREAS. LEFT, SPOTTED SALAMANDERS CROSSING POLO GROUNDS ROAD TO BREED IN VERNAL POOLS, PHOTO: CENTER FOR URBAN HABITATS. RIGHT, MOORES CREEK IN A COUNTY DEVELOPMENT AREA, VERY NEAR THE CITY OF CHARLOTTESVILLE, PHOTO: NATURAL HERITAGE COMMITTEE.

GOAL 16: Protect and restore urban streams.

RECOMMENDATIONS:

1. Establish protection standards for urban streams. [C,P]
 - a. Where appropriate, consider buffers less than 100 feet wide and relative to the size of the stream.
 - b. Consider waivers if the solution preserves a visible surface stream and improves water quality.

2. Develop density bonuses, tax credits, or other incentives for preserving and restoring streams. [C]
3. Develop design standards to encourage preserving and/or recreating gradual grading to the stream. [C,P]
4. Develop policies that encourage protection of existing natural streams and wetlands rather than the construction of stormwater facilities. [C,P]

GOAL 17: Protect the Rivanna River and adjacent ecosystems.

RECOMMENDATIONS:

1. Allow Nutrient Banks and Wetland Mitigation banks as by-right uses adjoining the Rivanna River. [C,P]
2. Investigate and identify other land uses for riverfront parcels that protect and enhance water quality. [N,C]
3. Investigate the possibility of a Transfer of Development Rights (TDR) program for areas near the Rivanna River. [N,C]

Urban areas often contain undesirable former industrial sites, gas stations with leaking underground storage tanks, and underperforming properties with large unused paved spaces. The Environmental Protection Agency has been supportive of approaches that help clean up contaminated sites while making them usable for redevelopment and wildlife habitat. Figure 9 provides a map of contaminated sites in Albemarle County.

Many other areas of the country have successfully converted such areas to wildlife habitat. The Midewin National Tallgrass Prairie (United States Department of Agriculture Forest Service 2017), only 60 miles from Chicago, was a contaminated ammunition plant that now includes roaming herds of bison. While bringing bison back to Albemarle is probably out of the question, we certainly can find ideal areas that can be used for habitat for butterflies, native bees, birds, and other beneficial wildlife. Bioremediation using native plants has also been shown in research to be an effective cleanup strategy for many sites.

GOAL 18: Clean up and reuse potentially contaminated sites with bioremediation and natural habitat restoration.

RECOMMENDATIONS:

1. Identify contaminated sites with restoration potential and invest in restoring them. [C,P]
2. Seek grant funding to assist with restoration and potential redevelopment of contaminated sites, and encourage inclusion of wildlife habitat as part of cleanup plans. [C,P]
3. When practical, encourage establishing native wildflower meadows as approved and encouraged practice while sites are waiting to be redeveloped. [C,P]

4. Explore redevelopment incentives which can include wildlife habitat as part of the design standard. [N,C,P]

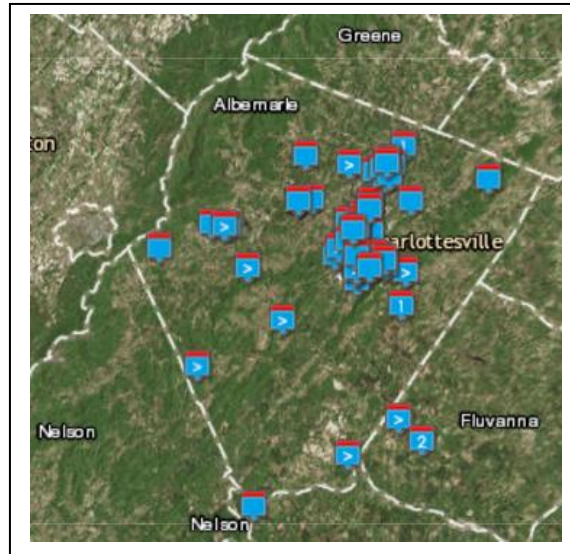


FIGURE 16. CONTAMINATED PROPERTIES, FROM THE EPA

Native plant communities, along with healthy soils, are the foundation of healthy ecosystems (Tallamy 2007). They also provide the visual context that creates a sense of place. By encouraging the use of locally native species to create native plant communities, particularly in our suburban and urban areas, we can help provide critical habitat and connect existing islands of biodiversity.

GOAL 19: Promote the use of locally native plants in developed areas.

RECOMMENDATIONS:

1. Review and/or develop list(s) of approved plants for the different types of projects that require county approval (e.g., site plans, stormwater management facilities, stream buffers). The lists should emphasize the use of locally native plants. [C]
2. Use a minimum of 80% locally native species (as discussed in the Comprehensive Plan, page 4.22, under Strategy 4e) in all county projects and projects reviewed by county staff. [C]
3. Recommend locally site-appropriate native species that occur together naturally and locally as approved plantings for all projects. Identify or develop the data source(s) to use. [N,C]
4. Provide assistance through the county's Office of Economic Development to help promote local nurseries and their marketing of locally native plants. [C]
5. Consider making native plant nurseries a by-right use of land in rural areas. [C]
6. Participate as a partner in the Virginia Native Plants Marketing Partnership through DEQ. [C]

EDUCATION

“In the end, we conserve only what we love.
We will love only what we understand.
We will understand only what we are taught.”
--Baba Dioum, Senegalese poet

Citizens value the beauty of our natural landscape, and the county has formalized this shared value in the Comprehensive Plan. We have a variety of diverse species and landscapes, and though most residents have a general appreciation of this nature, many lack the expertise to fully appreciate and protect it. A well-designed and comprehensive education program is needed to develop good citizen stewards and informed government leaders. There is a need for a public education program that contributes to both understanding and positive action in support of biodiversity.

There are several existing and successful education efforts that address biodiversity to varying degrees. However, there is no overall framework for biodiversity education. A local biodiversity education framework could place these program-by-program efforts in a context to help the county achieve its biodiversity goals (from Biodiversity Work Group Report 2004). Defining and discussing the importance of biodiversity should take place from a local perspective, focusing on native flora, fauna, and communities of the Piedmont region of central Virginia.

The Albemarle County Biodiversity Work Group Report (2004) recommended biodiversity education goals, topics, and audiences and tabulated existing biodiversity education efforts. Updates of these are presented in Appendix I.

GOAL 20: Educate the public on the importance of biodiversity and ways to protect it.

RECOMMENDATIONS:

1. Review and update existing education materials found on the Natural Heritage web page of the county's website. [N]
2. Create and assemble documents from other sources and develop mechanisms for the dispersal of information on biodiversity education topics such as: [N,P]
 - a. Values of biodiversity
 - b. Conservation concepts
 - c. Important local biological resources
 - d. Emerging threats (invasive species, climate change, etc.)
 - e. Land management for biodiversity
 - f. Landscaping with locally native plants
3. Sponsor workshops on land management practices that promote biodiversity. [N,P]

4. Create and distribute an informational flyer, to be mailed with tax bills, that provides simple landowner tips that promote biodiversity, best stewardship practices, and includes a link to the county's Natural Heritage web page. [N,C]
5. Create signage, use QR codes, and/or make brochures available at county parks to educate about the importance of biodiversity and to instill a greater appreciation for our native forests and the natural world. [N,C]
6. Create and disperse a welcome package for new landowners with information about best practices for enhancing biodiversity on their property and opportunities for placing property in a conservation easement. [N,C]
7. Create signage on county land where locally native plants have been used in landscaping as a way to educate the public. [N,C]
8. Create videos on landscaping techniques that preserve and enhance biodiversity and on conservation easement opportunities. [N,C,\$,P]
9. Create more demonstration landscapes using locally native plants on county land. [N,C, \$,P]
10. Create partnerships with local plant nurseries to disperse educational materials about invasive plant species, locally native species, and the creation of meadow landscapes. [N,C,P]
11. Create informational materials and provide workshops for developers on practices that preserve and protect biodiversity. [N,C,\$,P]
12. Sponsor a Conservation Cafe with the goal of promoting conversations and collaboration between county staff, elected officials, and conservation groups. [N,C,\$,P]
13. Designate an official plant and/or animal on a yearly basis to raise awareness about local habitats and the biodiversity found within them. [N,C]

INDICATORS OF THE STATE OF COUNTY BIODIVERSITY

The state of biodiversity in Albemarle County is continually evolving. Indicators of change are important in monitoring and assessing the current state, for tracking changes through time, and are critical for effective conservation planning.

GOAL 21: Develop indicators and monitor data that reflect the state of biodiversity in Albemarle County.

RECOMMENDATIONS:

1. Develop landscape protection indicators based on: [N,C]
 - a. Open space areas under long term protection.
 - i. Public lands with conservation value (e.g., county parks).
 - ii. Permanent conservation easements, including the level of biodiversity protection the easements provide.
 - b. Percentage of large forest blocks, Important Sites, and other significant conservation areas under conservation easements.
 - c. Ag/forestal district and open space agreement areas, including changes over time.
 - d. Percentage of stream lengths with forested buffers (Increase in vegetated stream buffers is Item 8 under Indicators of Progress for Natural Resources in the Comprehensive Plan, page 13.12).
2. Develop indicators of threats to biodiversity from development based on: [N,C,P]
 - a. Population growth, focusing on the proportion in developed areas compared to rural areas.
 - b. Demand for open space recreational opportunities.
 - c. Construction of new roads.
 - d. Construction of utility corridors.
3. Monitor data and develop indicators of conditions that reflect the state of biodiversity, either directly or indirectly. [N,C,P]
 - a. Develop indices or measurements of habitat fragmentation for the county.
 - b. Monitor and quantify changes in land use/land cover over time (Strategy 4b in Comp Plan, page 4.21).
 - c. Develop methods to quantify the ecosystem services generated by the county's landscape, with a focus on water quality and air quality. This should include monitoring the number of impaired waterways and total number of impairments on waterways in Albemarle County (Items 1 and 2 under Indicators of Progress for Natural Resources in the Comprehensive Plan, page 13.12).
 - d. Develop methods to quantify and describe the presence of invasive species, and track changes over time.
 - e. Monitor the number of highway underpasses created or improved in order to facilitate wildlife movement, and the number road-stream crossings that are upgraded or improved to facilitate movement of aquatic species.

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