COMMONWEALTH of VIRGINIA

Management Plan for Bull Run Mountains Natural Area Preserve

Prepared by:
Virginia Department of Conservation and Recreation
Division of Natural Heritage

Natural Heritage Technical Report 04-09
April 2004

Virginia Outdoors Foundation

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

Management Plan for Bull Run Mountains Natural Area Preserve

2004

Natural Heritage Technical Report 04-09

Virginia Department Of Conservation And Recreation
Division Of Natural Heritage
217 Governor Street
Richmond, Virginia 23219
(804) 786-7951

This document may be cited as follows:
Leahy, M J. and S.Y. Erdle. 2004. Management Plan for Bull Run Mountains Natural Area Preserve. Natural Heritage Technical Report #04-09. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Richmond, Virginia. 71 pp. plus appendices.

PLAN APPROVALS

Recommended by:

Thomas L. Smith, Director Division of Natural Heritage	Date

Approved by:

Joseph H. Maroon, Director Department of Conservation and Recreation	Date
Leslie Grayson, Director Virginia Outdoors Foundation, Northern VA Office	Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

The authors thank Leslie Grayson, Director of the Virginia Outdoors Foundation – Northern Virginia office, for supporting biological research and management planning in the Bull Run Mountains. We recognize and thank Gary Fleming, Vegetation Ecologist for the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH) for his unfailing assistance and for his recent report "Ecological Communities of the Bull Run Mountains, Virginia" which compiles and summarizes years of research on the Bull Run Mountains.

This Management Plan for Bull Run Mountains Natural Area Preserve was compiled, developed, and completed with the combined expertise and reviews of many individuals from DCR-DNH, as well as individuals representing other state, federal, and private agencies, and private citizens. The authors especially thank Tanya Amrhein and Michael Kieffer – Bull Run Mountains Conservancy; Gary Fleming, Chris Hobson, Curtis Hutto, Rick Myers, and Tom Smith – DCR-DNH; and Mike Massey – Virginia Outdoors Foundation volunteer.

Management Plan for Bull Run Mountains Natural Area Preserve

PLAN SUMMARY

Bull Run Mountains Natural Area Preserve (BRMNAP) was dedicated as a state Natural Area Preserve in April 2002. BRMNAP is located in Fauquier and Prince William Counties, Virginia. The purpose of this management plan is to guide an adaptive resource management process that protects natural heritage resources on BRMNAP. This plan has a timeline of approximately five years (2004-2009). Natural heritage resources on BRMNAP include: Eleven element occurrences of eight natural community types as well as a population of a globally rare tiger beetle. In addition, populations of seven watch-listed odonates (dragonflies and damselflies), two watch-listed groundwater amphipods, and two watch-listed plant species occur on the preserve. Issues requiring management attention on BRMNAP include: Invasive exotic species; prescribed fire; off-road vehicle (ORV) trespass; woody plant encroachment; outdoor recreational uses of the preserve; and overbrowsing by white-tailed deer (*Odocoileus virginianus*). Management actions on BRMNAP will require cooperative management with the current landowner, other state and private agencies, and other interested landowners. The long-term management objective is to preserve rare species and ecological communities on BRMNAP for the perpetual benefit, education, and enjoyment of Virginia's citizens.

INTRODUCTION

Site Purpose

The primary purpose of BRMNAP is the preservation of outstanding natural heritage resources found at this site as well as the preservation of natural, historic, scientific, and recreational open-space resources. Management for enhancement and preservation of natural heritage resources shall take precedence over other purposes and management at this site. Secondary purposes of the preserve include scientific research, environmental education, and compatible outdoor recreational uses.

Virginia Outdoors Foundation

BRMNAP is owned by the Virginia Outdoors Foundation (VOF). VOF was created by the General Assembly in 1966 and is governed by a Board of Trustees appointed by the Governor. Virginia Code 10.1-1800 establishes the Foundation and declares that it is in the public interest for VOF to preserve areas of the Commonwealth having natural, scenic, historic, scientific, open-space, or recreational characteristics. VOF's purpose under law is to "…promote the preservation of open space lands and to encourage private gifts of money, securities, land, or other property to preserve the natural, scenic, historic, open-space, and recreational areas of the Commonwealth." The primary mechanism for accomplishing VOF's mission is through open space easements. VOF currently holds easements on over 229,000 acres in 76 local jurisdictions. These easements protect a wide variety of natural resources, including watershed areas, the setting for historic

homes, scenic views, lands adjacent to public parks, game preserves, and forestlands. Through gifts of property, VOF owns approximately 3,500 acres of unimproved land plus one historic site. The largest VOF landholdings are in the Bull Run Mountains – long recognized as an ecologically significant natural area (Stovall 1980).

Virginia Natural Area Preserves Act

The Virginia Natural Area Preserves Act (Code of Virginia, section 10.1-209-217; Appendix A): 1) establishes the responsibility of the Department of Conservation and Recreation (DCR) "to preserve the natural diversity of biological resources in the Commonwealth" through inventory, protection, and stewardship, 2) establishes the Division of Natural Heritage (DNH) to pursue this responsibility within DCR, 3) establishes the legal instrument for the dedication of natural area preserves (NAPs), 4) establishes the Virginia Natural Area Preserves System as a system of dedicated NAPs, 5) establishes the Natural Area Preservation Fund to financially support natural area protection, and 6) establishes the Virginia Registry of Natural Areas as a "state registry of voluntarily protected natural areas."

The mission of DNH—"Conserving Virginia's biodiversity through inventory, protection, and stewardship"—and the program's functional organization are derived directly from the Virginia Natural Area Preserves Act (Code of Virginia, section 10.1-209-217). The Inventory and Information Management sections "produce an inventory of the Commonwealth's natural heritage resources," "maintain a natural heritage data bank of inventory data and other relevant information for ecologically significant sites supporting natural heritage resources," and provide recommendations to support the Virginia Endangered Species Act and the Virginia Endangered Plant and Insect Species Act. The Protection section produces and implements the Natural Heritage Plan to guide the protection of dedicated NAPs and registered natural areas in the Virginia Natural Area Preserves System and Virginia Registry of Natural Areas, respectively. The Stewardship section plans and conducts biological and operational management on NAPs to benefit natural heritage resources. The Stewardship section also cooperates with other land managers and private landowners, as requested, to benefit natural heritage resources on those properties.

Natural Area Dedication

The authorization for DCR to dedicate NAPs and the legal instrument for such dedication is codified in the Virginia Natural Area Preserves Act (Appendix A). Natural area dedication protects natural areas with a legally binding instrument of dedication. The deed of dedication states the reason for dedicating the property, provides management guidelines for the property, restricts incompatible land uses, and places the site in Virginia's Natural Area Preserves System. The instrument of dedication is recorded with the deed of the property. Properties may be dedicated following fee simple purchase, purchase of an interest in the property by the Commonwealth of Virginia, or through voluntary transfer of fee simple title or other interest by a landowner. Dedication is perpetual; ownership of the property can be transferred, but the dedication will remain in effect. BRMNAP was dedicated as a state NAP in April 2002 (Appendix B).

The primary management objective for NAPs is to protect and benefit natural heritage resources (DCR-DNH 2000) (Appendix C). Where natural processes or habitat conditions are judged to vary from natural conditions, actions are taken that maintain, restore, or mimic natural ecological processes and result in a particular desired vegetative structure and composition. Restoring ecosystem processes capitalizes on the inherent resilience of the ecosystem to maintain or restore species' habitats and natural communities. Ideally, natural areas management attempts to restore or maintain functional sites. Functional sites "maintain focal ecosystems, species, and supporting ecological processes within their natural ranges of variability" (Poiani et al. 2000). In general, DCR-DNH extensively manages ecosystem processes on existing sites. However, intensive management practices such as prescribed burning, pesticide treatments, forest harvesting and nest box installation may be needed at times to restore ecosystem processes and/or required habitat conditions.

One secondary management objective is to manage NAPs to benefit general natural resources (other than natural heritage resources), scenic resources and historic resources (DCR-DNH 2000). Considerations for such management require that stewardship practices not conflict with protection of natural heritage resources. Planned management for natural heritage resources typically benefits other plants, animals, and natural communities, as well as scenic and historic resources.

Another secondary management objective is to provide public access for hiking, nature observation, nature photography, education and research (DCR-DNH 2000). These uses are normally appropriate activities and will be permitted to the extent possible, provided that they do not compromise natural heritage resource management. Picnicking, horseback riding, and hunting are conditionally appropriate uses that may be allowed under special conditions that permit or require (in the case of hunting) these activities. Incompatible and inappropriate uses include camping, bicycling, rock climbing, off-road vehicle use, unleashed pets, and unauthorized collection of plants, animals, minerals, and artifacts. Guard rails, signs, fences, gates, trail steps, and other devices or measures may be installed as necessary for site security and visitor safety. Potentially dangerous conditions such as dead trees, branches, abandoned wells or pits and similar hazards on trails or in authorized public use areas may be removed, cleared, filled in, or otherwise remedied.

Policy and Management Approach

BRMNAP is owned and managed by VOF and encompasses 2,486 acres in Fauquier and Prince William Counties, Virginia (Figures 1 and 2). Eight hundred acres of the southern portion of BRMNAP is currently leased (see Appendix D) to the Bull Run Mountains Conservancy, Inc. (BRMC). BRMC is a non-profit 501(c)(3) organization founded in 1995 to provide experiential learning through field trips, internships, and research opportunities for students, adults, and professionals that focus on the ecological, historical and cultural features of the Bull Run Mountains. BRMC works to manage the public use of the 800 ac lease area within the southern half of the BRMNAP through educational outreach efforts, trail maintenance, and interpretation of the area's natural and human history.

BRMNAP is owned, fee simple, by VOF; as such, VOF is the final management authority for the BRMNAP within the confines of the Natural Area Preserves Act. As the landowner, VOF has the lead role in terms of resource management and stewardship for BRMNAP. DCR-DNH has an advisory role in the management of BRMNAP and provides technical assistance. The role of the BRMC at BRMNAP is primarily one of environmental education and visitor management. Resource management at BRMNAP is directed by VOF and accomplished by VOF staff, VOF-coordinated volunteer stewardship committees, tenants of VOF houses, BRMC staff, DCR-DNH staff, and other volunteers and organizations as determined by VOF. Currently a volunteer stewardship committee is assisting VOF with operational management of the NAP as well as deer management activities on the north half of the NAP.

The north administrative unit of BRMNAP will continue to be managed as an area without open public access. This will ensure continued protection of the sensitive resources in this area and preclude the need to develop and maintain costly public access facilities (e.g., parking lots or trails). Public access to the north unit of the preserve will be by special arrangement with VOF for natural history outings, research, and environmental education.

The south unit of BRMNAP will continue to be managed for public access, but with restrictions to prevent degradation of natural heritage resources. VOF will likely continue its lease of 800 ac of the south unit to BRMC for environmental education purposes through the lease term (2010). BRMC will also continue its role in assisting with research and resource management projects, and with maintaining existing trails to prevent/minimize erosion.

BACKGROUND INFORMATION

Description and Location

For an in-depth discussion of the Bull Run Mountain's natural history, ecological communities, and rare plants and animals, see reports by Fleming et al. (1999) and Fleming (2002) that provide a detailed baseline of biological data on the area. The following descriptions of BRMNAP's natural history and ecological communities are condensed versions of those found in the reports cited above.

The Bull Run Mountains stand alone as a narrow, monadnock-like series of ridges, and comprise a prominent, isolated area of rugged highland terrain within the gentle, lower-lying Piedmont. The mountains, situated in the western part of the Piedmont consist of a complex of sharp ridges with narrow, intervening valleys. This highland complex extends north from New Baltimore (Fauquier County) for approximately 15 mi to Aldie (Loudoun County), varying from about 0.9 to 2.2 mi wide and rising conspicuously above the surrounding terrain. The Bull Run Mountains are located about 35 mi west of Washington, D.C. and currently (2004) lie just beyond the westernmost sprawl of the greater D.C. metropolitan region.

Climate

While detailed climatic data are not specifically available for BRMNAP, relatively complete data collected at Manassas, approximately 13 mi southeast of the Bull Run Mountains, indicates a mean annual minimum temperature of 44.0º F and a mean annual maximum temperature of 67.2º F.

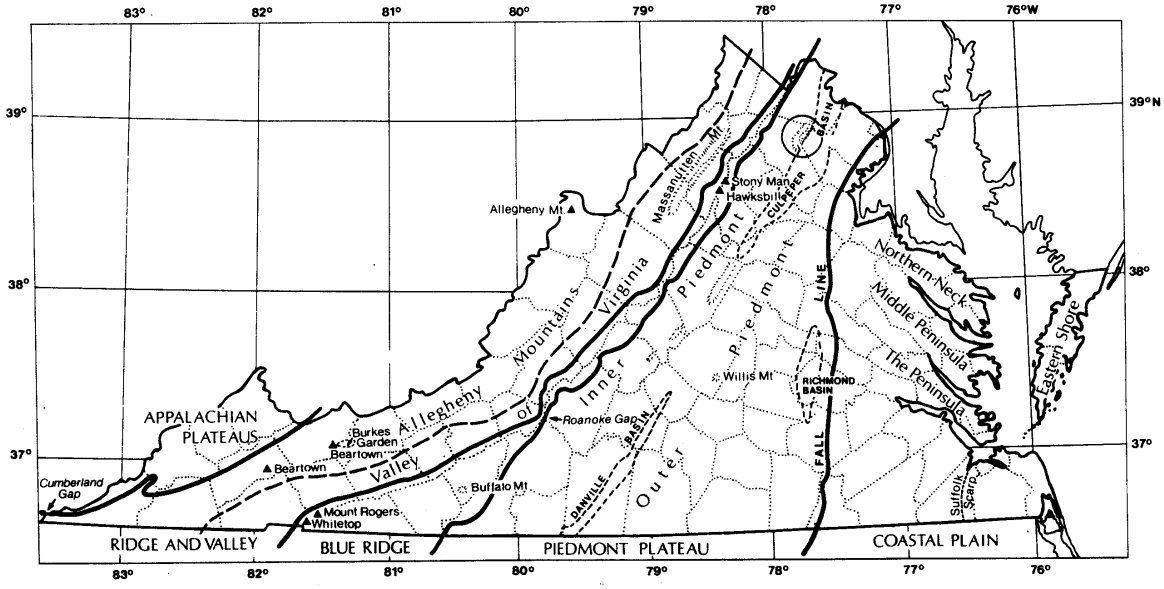

Figure 1. Location of the Bull Run Mountains (circled) in Virginia. Modified from Woodward and Hoffman (1991), and Fleming (2002), with permission.

Annual average precipitation is 35.59 in, with highest amounts falling in May and August. Annual snowfall averages 16.3 in. Data collected during the period 1954-2000 at The Plains, approximately 3 mi west of the study area, indicates annual average precipitation of 42.4 in (highest in May and August) and average annual snowfall of 27.1 in (Southeast Regional Climate Center 2002).

Geology

While occupying the physiographic Piedmont, the Bull Run Mountains form part of the eastern limb, or flank, of the Blue Ridge anticlinorium, a large linear fold that presumably resulted from Late Paleozoic Alleghanian orogeny (Espenshade 1970, Rader and Evans 1993). This great uplift extends in a southwest-to-northeast direction across Virginia and Maryland into southern Pennsylvania. The Bull Run Mountains are largely underlain by metasedimentary rocks of the Chilhowee Group. Massive, thick-bedded quartzite is highly resistant and well exposed along the upper west slope of High Point Mountain north of Thoroughfare Gap, at White Rock north of Hopewell Gap, and in numerous other localities. The strongly eastward-dipping quartzite strata are powerful ridge-forming features that have thoroughly shaped the local topography and relief. Substantial portions of the study area, especially on the eastern dip slopes of the ridges, are underlain by thin-bedded quartzite with local interbeds of muscovite schist and phyllite. Structurally, these mountains comprise a homoclinal ridge complex that is

faulted on the east along its contact with Triassic and Jurassic sandstone, siltstone, and diabase of the gently westward dipping Culpeper Basin. The Catoctin Formation underlies the lower to middle, western slope of the Bull Run Mountains, but is generally well covered by quartzite colluvium.

Landforms, Hydrologic Conditions, Soils

The Bull Run Mountains consist of a complex of sharp ridges with narrow, intervening valleys. The ridges are interrupted by three major gaps. From south to north, these are Thoroughfare Gap, where the mountain is breached by the passage of Broad Run; Hopewell Gap, which is cut by the headwaters of Little Bull Run; and Cold Spring Gap, which is cut by the headwaters of Bull Run. North of Hopewell Gap, the area reaches maximal width, with three parallel ridges. At the north end, the complex is again reduced to a series of low knobs, which terminate abruptly in a steep bluff along the Little River at Aldie. Maximum elevations of 1,200-1,369 ft are attained between Thoroughfare Gap and Cold Spring Gap on the highest ridges, which lie about 600-700 ft above irregularly rolling to hilly terrain on the west, and about 700-800 ft above the nearly flat Culpeper Basin to the east.

Broad Run, the largest stream in the area, originates in the Watery Mountains 7 mi to the southwest and generates floodplain and aquatic habitats not found elsewhere in the area. Interior valleys are drained by Catletts Branch, a tributary of Broad Run; Catharpin Creek (Jackson Hollow), a tributary of Little Bull Run; and the headwaters of Bartons Creek and Hungry Run, tributaries of the Little River. All waters originating in the Bull Run Mountains ultimately drain to the Potomac River, those flowing north via Goose Creek, and those flowing southeast via the Occoquan River. Interior drainages are characterized by cold, spring-fed brooks and braided stream channels with numerous lateral seeps and springs. The abundant and usually continuous outflow of groundwater seepage in the valleys is due in large part to favorable geotechnical properties of the area's bedrock and soils.

Prevalent soils of the area are described as dark to light yellowish-brown, very flaggy (i.e., with numerous flagstones and rock fragments), very strongly acidic loams with low natural fertility (Elder 1989). Variations in surface soil texture and chemistry, depth to bedrock, stoniness, and duff cover are much greater than soil unit descriptions indicate and have a much stronger correlation than soil map units with variations in vegetation composition across the landscape.

Site History

Original inhabitants of the Bull Run Mountains were members of the Manahoac tribe of Sioux stock, who hunted extensively in the region between the Piedmont fall line and the Blue Ridge (Fauquier County Bicentennial Committee 1959). Little is known about the Stone Age culture of the Manahoacs, except that they practiced agriculture and gathered fruit, nuts, and other vegetable materials. The Manahoacs were also hunters and fishermen. Remaining artifacts include pottery, stone tools such as axes, grinders, scrapers, household goods such as stone mortars and tobacco pipes, and fish weirs (Egloff and Woodward 1992).

The Bull Run Mountains have played a key role in local history and factored in several Civil War skirmishes. Various accounts exist documenting local history, as well as various battles, sieges, and encampments (Stovall 1980; Johnston 1996).

Almost all forested areas of BRMNAP have been harvested at various times, but some areas have remained uncut since around 1900 (Fleming 2002). Hollows and the lower slopes of the Bull Run Mountains were homestead sites in the 18th and 19th centuries, and were extensively cleared and farmed. Most of these sites were abandoned by 1930 and have since undergone succession from nearly pure forests of Virginia pine (*Pinus virginiana*) or tulip poplar (*Liriodendron tulipifera*) to young mixed hardwoods. Most steep, rocky slopes have been continuously forested, with fires, cutting, and chestnut blight (*Cryphonectria parasitica*) as intermittent disturbances. During the late 19th and early 20th centuries "flaggy" quartzite was quarried by numerous small operators and many abandoned pits are scattered throughout the mountains. A number of small, locally-run rock quarries operated in the area up through the 1960s.

In the 1960's, the Natural Areas Council, Inc., with funding from America the Beautiful Fund and private contributions, began to buy land to protect the Bull Run Mountains. Various regional studies recognized the area as a unique natural and scenic site, a recreational resource, and the source of headwaters to Goose Creek and the Occoquan River, both vital to the Northern Virginia drinking water supply (National Park Service 1965). In 1965, the first Virginia Outdoors Plan identified the Bull Run Mountains as the highest priority for a State Park (Virginia Outdoor Recreation Study Commission 1965).

In 1979, the Virginia Outdoors Plan recommended the preservation of the Bull Run Mountains as a State Natural Area, recognizing limitations to developing the area for recreational use (Commission on Outdoor Recreation 1979). By the late 1970's, facing funding problems, the Natural Areas Council transferred its land holdings in the Bull Run Mountains to VOF, whose Trustees adopted a primary management objective "to preserve the Bull Run Mountains as a natural area" (Minutes, Oct. 1979 VOF Trustees meeting). Through the 1980's, VOF continued to acquire land for conservation with funds contributed by private individuals while also commissioning additional studies of potential uses (Stovall 1980).

In 1994, Friends of Bull Run (now the Bull Run Mountains Conservancy, BRMC) was founded as a non-profit, community organization and began leasing 800 ac of the Bull Run Mountains from VOF to provide educational and recreational opportunities to the public. As water quality became more of an issue in Northern Virginia, the Wetlands Science Institute included Broad Run at Thoroughfare Gap in a four-year study of fish diversity as an index of water quality (Teels and Danielson 2001). The Audubon Naturalist Society also began conducting a long-term study of several Northern Virginia streams, revealing that the Bull Run Mountains' Catletts Branch supports an exceptionally high diversity of macroinvertebrates for the region (Fleming 2002). During this period, the Virginia Department of Forestry provided VOF with recommendations for wildlife habitat enhancement and preservation of forest cover. A consultant study (Earth Design Associates 1997), as well as the 1996 Virginia Outdoors Plan (DCR 1996),

recommended a master plan for preservation of the mountain as a natural area and the development of a trail traversing the ridges from Aldie Mill on the north to Thoroughfare Gap on the south.

In 1998, DCR-DNH conducted a preliminary inventory of VOF land holdings in the Bull Run Mountains (Fleming et al. 1999). This study recommended Natural Area Dedication as the most appropriate tool for long-term, permanent conservation of VOF lands in this area due to the presence of natural heritage resources on these lands. VOF Trustees subsequently adopted a resolution accepting this recommendation, leading to formal dedication in the spring of 2002.

Surrounding Land Use

Although the Bull Run Mountains support a relatively sparse human population, construction of individual residences, vacation homes, and small developments has increased in recent years. The mountain ridges are crossed by Interstate 66 and US Route 55 in Thoroughfare Gap, and by County Route 601 in Hopewell Gap. One public road – County Route 629, and numerous private roads penetrate the area. Two large residential developments – Bull Run Mountain Estates and Thunder Oaks – occupy parts of the easternmost mountain slope. Immediately to the east, a large population influx of more than 50,000 people is underway along the US Route 15 corridor in Prince William County, bringing the western sprawl of the Washington, D.C., metropolitan area literally to the doorstep of the mountain. Remaining large tracts of land adjacent to and nearby BRMNAP are in a variety of agricultural/forestry uses including row crops, horse and cattle operations, and tree farms.

Associated Natural Resources

In Virginia, the Central Appalachian region is typified by the Ridge and Valley Province north of the New River and the Blue Ridge north of the Roanoke River. The Bull Run Mountains and other western Piedmont monadnocks are geological and biological outliers of the Central Appalachians, with vegetation patterns comparable to those of lower-elevation Blue Ridge sites. This is exemplified in the Bull Run Mountains by the great prevalence of the Chestnut Oak Forest community group and its dominant tree, *Quercus montana* (chestnut oak), along with the presence of the smaller-patch Pine-Oak/ Heath and Acidic Seepage Swamp communities, all of which are widespread and characteristic of acidic, montane landscapes in western Virginia (Fleming et al. 2001).

The Bull Run Mountains represent the largest exposures of metasedimentary rocks along the eastern flank of the Blue Ridge anticlinorium and contain a number of geological features that are significant at the state and regional levels. Large, nearly vertical cliffs such as those at High Point and White Rock, for instance, are exceptional features of the Piedmont region. Many of these rock outcrops offer spectacular vistas to the east and west.

NATURAL HERITAGE RESOURCES

Overview

Natural heritage resources are defined in the Virginia Natural Areas Preserves Act (Section 10.1-209 through 217, Code of Virginia), as "the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest benefiting the welfare of the citizens of the Commonwealth." Natural heritage resources are the most likely natural resources to be lost without conservation action in the near future. DCR-DNH compiles lists of the natural heritage resources of the state.

Chestnut oak is the most abundant tree species at BRMNAP, followed by tulip poplar and red maple (*Acer rubrum*) (Fleming 2002). Taken as a whole, the preserve consists predominantly of Chestnut Oak Forests (39%), while early-successional forests (21%), Basic Oak-Hickory Forests (12%), Mesic Mixed Hardwood Forests (9%), Acidic Oak-Hickory Forests (8%), and Pine-Oak / Heath Woodlands (7%) are also well-represented. Basic Oak-Hickory Forests have the highest species richness, followed by Acidic Seepage Swamps, Mesic Mixed Hardwood Forests and Basic Mesic Forests.

The most widespread and extensive natural community group in the Bull Run Mountains is the Chestnut Oak Forest. This dry oak- and ericad-dominated community forms large patches on all of the area's ridges and occurs on all topographic positions from lower slopes to crests, but is most characteristic of middle and upper slopes.

The Bull Run Mountains constitute one of the largest Piedmont areas with largely unfragmented forest cover. Recent inventories by DCR-DNH biologists have documented an impressive diversity of natural ecological communities. Much of this work was summarized in Fleming (2002), from which the following ecological community descriptions were excerpted.

Biodiversity Significance

A variety of rarity patterns exist based on the geographic range, habitat specificity and local abundance of species (Rabinowitz 1981). The Natural Heritage Network ranks plants, animals, and natural communities on two scales of rarity. The global rank (G-rank) and state rank (S-rank) are based on the number of occurrences of a species at a global scale and state scale, respectively (see Appendix E for rank specifications). G- and S-ranks help direct conservation actions to the rarest species and communities since these are usually the most vulnerable to extinction.

Areas that support a natural heritage element occurrence (EO), or multiple occurrences of one or more elements, are delineated in a conservation site. The ecological significance of conservation sites is represented with a biodiversity rank (B-rank). The B-rank summarizes the rarity, quality, condition, viability, defensibility and variety of natural heritage EOs on a site. The B-rank is intended to help prioritize and direct conservation attention to sites with the highest quality occurrences of plants, animals and natural communities tracked by DCR-DNH (see Appendix E). B-ranks range from B1 to B5,

with B1 assigned the most ecologically significant sites and B5 describing sites of lower ecological significance.

BRMNAP has been assigned a B-rank of B2. BRMNAP supports 11 outstanding element occurrences of eight natural community types as well as a globally rare tiger beetle. In addition, populations of seven watch-listed odonates (dragonflies and damselflies), two watch-listed groundwater amphipods (an order of small crustaceans), and two watch-listed plant species occur on the preserve. Additionally, BRMNAP is recognized for its (1) biogeographic significance as a meeting ground of disjunct species from both the mountains and the Coastal Plain, (2) high quality and diversity of natural communities including some that are uncommon or rare in the Piedmont, and (3) ecosystem-scale viability due to a large, unfragmented forest and excellent water quality within its stream reaches.

Natural Communities

The Bull Run Mountains support numerous ecological communities. A comprehensive treatment of the vegetation ecology of BRMNAP is provided in Fleming (2002), from which the community descriptions below are excerpted. Natural community maps (Figures 3 and 4) are based on extensive vegetation sampling at BRMNAP. However, these maps are intended as a coarse representation of the actual, intricate vegetation patterns on the ground. Still, they provide adequate information from which to develop management units for use in resource stewardship.

To better conceptualize the ecological communities at BRMNAP, two landscape profiles (Figures 5 and 6) and an ecological model (Figure 7) were developed. These are general representations of the hypothesized structure and function of the BRMNAP terrestrial ecosystem. Communities and the plant species that characterize them separate primarily along soil fertility and moisture gradients. Conceptual ecological models are inherently subjective and do not contain extensive quantification. The primary purpose of the model is to enhance understanding of the ecosystem with general predictive capabilities and thus help guide management actions toward conservation goals. Besides guiding management the model helps to identify key research and monitoring needs, is a good communication tool, and leaves future preserve managers with the means to quickly grasp essential biological information needed for management.

Ecological community groups (Fleming et al. 2001) are broad regional units of natural communities based on combinations of topographic, edaphic, physiognomic, and gross floristic similarities. Community groups are comparable to the level at which many natural community classifications define their basic units, e.g., Northern Red Oak Forests. Community groups are not defined at a single standard scale; and, because they differ in their extent on the landscape, some groups are broadly defined and have large geographic coverage while others are narrow in concept and distribution. *Community types* are the fundamental units of Virginia's vegetation classification system and are nested within ecological community groups. The community type level is equivalent to the "association" level of the U.S. National Vegetation Classification. Types within a given community group share definite environmental, structural, and floristic similarities.

The nomenclature of community types is similar to standards adopted for the U.S. National Vegetation Classification, which uses the scientific names of up to six characteristic species. Although they cannot serve as complete surrogates for detailed descriptions, the names of community types are constructed to facilitate both distinguishing among types and identifying them readily in the field. As a rule, species are listed in descending order of importance and structural position (i.e., canopy species are listed first, followed by understory species, then herbs and low shrubs). Nominal species in the same stratum are separated by a dash (–) while different strata are separated by a slash (/). The typical physiognomy (i.e., forest, woodland, shrubland, etc.) and hydrologic regime (for wetland communities) are included at the end of the formal community type name. Occasionally, community subtypes are employed to describe well-marked variation within community types.

Given below are brief descriptions of the main ecological community groups and their respective ecological community type(s) occurring at BRMNAP, described in descending order of their acreage on the preserve.

Chestnut Oak Forests: *Quercus montana* – (*Quercus coccinea, Quercus velutina*) / *Kalmia latifolia / Vaccinium pallidum* Forest community type. Forests overwhelmingly dominated by chestnut oak on subxeric to xeric, usually rocky, upland slopes. Because of bedrock stratigraphy and related patterns of soil development, this community type is probably more extensive on the western ridge flanks but also occupies sizeable areas on eastern slopes where conditions are favorable. Soils are mostly weathered in residuum from massive or flaggy quartzite, and typically have a dense, 1- to 4-in deep fibric, organic subsurface horizon of duff, humus, and shrub roots. Mineral soils beneath the organic mantle are light, yellowish, sandy loams, usually containing numerous small quartzite fragments.

The shrub-layer has moderate to dense cover, most of it contributed by *Kalmia latifolia* (mountain-laurel), *Gaylussacia baccata* (black huckleberry), and tree saplings. The herb layer consists mostly of low colonies of *Vaccinium pallidum* (early lowbush blueberry) and seedlings of chestnut oak. The rocky, infertile soils, dense root mats from colonial ericads, and dense shade of mountain laurel thickets combine to create difficult conditions for establishment of herbs. Many stands of this community type contain a high percentage of stump-sprouted trees, indicating a history of extensive logging. While the sites supporting chestnut oak forest were never suitable for agriculture, they have all been used for their timber resources and have been influenced by multiple disturbances such as chestnut blight, periodic fires, gypsy moth (*Lymantria dispar*) defoliation, damage to *Cornus florida* (flowering dogwood) from anthracnose (*Discula destructiva*), and herbivory by white-tailed deer.

Early-successional communities. Young forests occur on areas that were agricultural fields or pastures over 50 years ago. On dry sites these are dominated by Virginia pine, oaks (*Quercus* spp.), hickories (*Carya* spp.) and beech (*Fagus grandifolia*). Mesic sites are dominated by tulip poplar. Other trees succeeding on mesic sites include black cherry (*Prunus serotina*), black locust (*Robinia pseudoacacia*), black walnut (*Juglans nigra*),

hackberry (*Celtis occidentalis*), and sycamore (*Platanus occidentalis*). Except for spicebush (*Lindera benzoin*), the understory of most of these young mesic forests is dominated by exotic and invasive plant species: Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), stilt grass (*Microstegium vimineum*), garlic mustard (*Alliaria petiolata*), oriental bittersweet (*Celastrus orbiculatus*), and long-bristled smartweed (*Polygonum caespitosum* var. *longisetum*). Where powerlines, roadsides and clearings intersect seeps and headwater streams, highly variable assemblages of ruderal wetland plants occur. Powerline right-of-ways that cross the mountains support native grasses and sun-loving forbs such as yellow wild-indigo (*Baptisia tinctoria*). Specific ecological community types have not been assigned to these early-successional communites.

Basic Oak – Hickory Forests: ***Quercus Montana – Quercus rubra – Carya ovalis / Desmodium nudiflorum – Dichanthelium boscii*** **Forest community type**. This ecological community has a fairly extensive distribution in the Bull Run Mountains and forms large patches, particularly on the eastern dip slopes of the ridges. Smaller patches occur locally on the western slopes. Basic Oak-Hickory Forests appear to be strongly associated with the flaggy quartzite / muscovite schist / phyllite lithologic suite, which produces soils that are darker, deeper, and more fertile than those weathered from the massive, resistant quartzites. A few stands occur where Catoctin metabasalt may be shallowly covered by quartzite colluvium. Straight to convex slopes at middle to high topographic positions are optimal sites for this type. East to southeast aspects predominate, and site moisture potential was subjectively assessed as submesic or subxeric at all sampling sites. All sites have been logged at least once and some have probably recovered from agricultural uses during the 19th century.

This community type has a mixed overstory with variable co-dominance by chestnut oak, *Quercus rubra* var. *rubra* (northern red oak), *Carya ovalis* (red hickory), and tulip poplar. Red hickory and *Carya alba* (mockernut hickory) account for nearly 50% of the total density of trees, and dominate the understory tree layers. The shrub layer is typically composed of tree saplings (especially of hickories), flowering dogwood, and occasionally *Cercis canadensis* var. *canadensis* (eastern redbud).

The herb layer is patchy and contains a diverse mixture of mesophytic and xerophytic species. The adaptability of both moist-site and dry-site species to the relatively fertile, dry-mesic habitats enhances species richness values in stands of this community type. Typical patch-dominant herbs include *Ageratina altissima* var. *altissima* (white snakeroot), *Amphicarpaea bracteata* (hog-peanut), *Cimicifuga racemosa* (black bugbane), *Desmodium nudiflorum* (naked-flowered tick-trefoil), and *Dichanthelium boscii* (Bosc's panic grass).

The prominence of hickories in all strata of this community type is distinctive, as are the mixed overstory and patchy but species-rich herb layer containing both mesophytic and xerophytic species. Evidence of disturbance includes exotic plants, herbivory by white-tailed deer, mortality or die-back from dogwood anthracnose, blowdowns or crown damage from wind and ice storms, light gypsy moth defoliation, old chestnut wood debris

from the chestnut blight era, and charcoal or fire scars. *Symphoricarpos orbiculatus* (coralberry), a naturalized, drought-tolerant shrub from the midwestern U.S., is the most frequent invasive plant. Another exotic shrub, *Rubus phoenicolasius* (wineberry) is also potentially problematic, as is the exotic grass *Microstegium vimineum* (Japanese stilt grass) which has recently become established around tip-up mounds and along trails. Deer herbivory is moderate to severe.

Mesic Mixed Hardwood Forests: *Fagus grandifolia – Liriodendron tulipfera – Quercus rubra / Polystichum acrostichoides – Carex laxiculmis* Forest community type. This community type is associated with infertile ravines, lower slopes, and well-drained flats along streams. Stands are scattered irregularly in the Bull Run Mountains, most frequently in the interior valleys. Sideslope habitats are usually steep with a straight or concave shape, at least in one direction. Aspect is variable. Soils of most habitats appear to be the products of colluvial or alluvial deposition and are light- to dark-colored sandy loams, very strongly to extremely acidic, with low base status.

American beech is the most characteristic and prevalent woody species of this community type. Typical overstory associates that often co-dominate with beech are tulip poplar, northern red oak, and red maple. Frequent or locally important understory associates of beech include red maple, *Carpinus caroliniana* (American hornbeam), mockernut hickory, flowering dogwood, *Fraxinus americana* (white ash), *Hamamelis virginiana* (witch-hazel), mountain-laurel, spicebush, and *Nyssa sylvatica* (black gum).

The herb layer of this forest is commonly patchy and contains many low-cover woody seedlings. *Polystichum acrostichoides* (Christmas fern), *Athyrium filix-femina* var. *asplenioides* (southern lady fern), *Aster divaricatus* (white wood aster), and *Carex laxiculmis* var. *laxiculmis* (spreading sedge) are the most constant and abundant herbs. Distinguishing characteristics of this community type include the prevalence of beech in all age classes along with patch-dominance of *Polystichum acrostichoides* in an open to sparse herb layer.

Herbivory by white-tailed deer appears to be a problem in this community type. Normally robust shrubs and herbs (*e.g.*, spicebush, and *Podophyllum peltatum*, mayapple) are dwarfed by repeated topping in many areas. The rather sparse herb cover in some areas may be the general result of overgrazing by deer over a period of years. The most serious potential threat to the compositional integrity of Mesic Mixed Hardwood Forest stands comes from the exotic grass *Microstegium vimineum*.

Acidic Oak – Hickory Forests: *Quercus montana – Quercus alba – Carya glabra / Cornus florida* Forest community type. Mixed hardwood forests of submesic to subxeric upland habitats over subacidic rocks. Hickories are less abundant than in the Basic Oak-Hickory Forests group but are nevertheless prominent, sometimes primarily as understory trees. Dominant oaks include white oak (*Quercus alba*), black oak (*Q. velutina*), scarlet oak (*Q. coccinea*) and chestnut oak. Deciduous ericads such as lowbush blueberry and deerberry (*Vaccinium stamineum*) are usually present, but patchy.

Although there is some recruitment of oaks, mainly chestnut oak, most understories in stands of this community type are dominated by red maple and beech. In the absence of periodic fire this community may succeed to the Mesic Mixed Hardwood Forest community. Similar successional trends have been documented in an old-growth white oak forest in Fairfax County, Virginia (Abrams and Copenheaver 1999). A wide-spread pattern of fire suppression has been documented for Virginia and is thought to be a major factor in the lack of oak recruitment in dry-mesic oak-dominated forests of the northern Virginia Piedmont (Orwig and Abrams 1994).

Table-Mountain Pine (*Pinus pungens*) and Pitch Pine (*Pinus rigida*) / Oak-Heath Woodlands: *Pinus pungens – Quercus Montana / Kalmia latifolia – Gaylussacia baccata* Woodland and *Pinus rigida – Quercus Montana – (Pinus virginiana) / (Quercus marilandica) / Kalmia latifolia* Woodland community types. These Pine-Oak / Heath communities can be considered pyrophytic, with the major species having evolved life histories that include production of highly flammable litter, stems, and foliage, as well as specific adaptations to ensure reproductive success in a frequently burned environment. Fire adaptations in table-mountain pine include serotinous, heat-responsive cones, while pitch pine exhibits both serotiny and the ability to sprout prolifically from fire-injured stems and branches. The dry-site oak forests that now prevail over much of the central Appalachian and mid-Atlantic regions developed under a regime of frequent burning, both natural and anthropogenic, that suppressed more tolerant competitors and created conditions necessary for successful oak regeneration (Abrams and Nowacki 1992). A dramatic reduction of fires that has marked the 20th century both in Virginia and region-wide is now leading to slow but certain changes in the structure and composition of these communities. Specific dynamics and manifestations of these changes are examined in detail in Fleming (2002) and are briefly summarized here.

The Table-Mountain Pine-Oak Heath Woodland community has a very restricted distribution at BRMNAP. It occurs in a long, narrow, interrupted band along the upper west slope and crest of High Point Mountain. It is not known from the east ridge, although not all potential habitats there have been investigated. Sites supporting this vegetation are the most xeric and edaphically stressful of the preserve. Habitats are situated on very rocky, steep, dramatically convex crests (including those of secondary spurs) and upper slope / crest transition zones at high elevations (> 1160 ft). Western aspects are most typical. At all sites, the community is associated with the tops of massive quartzite cliffs and adjacent, more weathered outcrop complexes. The ground is covered by exposed bedrock and boulders with many lichens and shallow, infertile soils.

Vegetation is a stunted, open woodland with incomplete canopy cover and little, if any, tree-layer stratification. Table-mountain pine is the most numerous tree. Chestnut oak is less abundant but essentially co-dominant despite barely exceeding shrub stature. Except where bare rock prevails, this community type has a dense shrub layer dominated by ericaceous species and contains considerable young recruitment of table-mountain pine and chestnut oak. The ericad component consists of a multi-tiered complex of mountain-laurel, black huckleberry, and early lowbush blueberry. Herbaceous plants are essentially

absent except on some of the open ledges at High Point cliffs, where *Danthonia spicata* (poverty oat grass) and a few xerophytic forbs occur.

Large quantities of charcoal are found in the duff and humus layers, along with fire scars on the trunks of chestnut oak, indicating severe or recurrent fires in the past. Snags of table-mountain pine most likely killed by southern pine beetle (*Dendroctonus frontalis*) within the past ~10 years are present, as are minor *Castanea dentata* (American chestnut) wood debris.

The Pitch Pine Woodlands are scattered on most major ridges of the Bull Run Mountains, forming small to occasionally large patches. This community type is strongly associated with dry, convex slopes with copious evidence of past fires. Subjectively, habitats appear scarcely less xeric than those of the Table-Mountain Pine – Oak / Heath Woodland. Sites include narrow to broad ridge crests, upper slopes and, less frequently, middle slopes. Westerly aspects prevail. Except on cliffs, soils commonly have a 3- to 4-in deep surface horizon of charcoal-rich duff, partly decomposed (sapric) soil materials, and shrub roots. Mineral soils beneath the organic mantle are light, yellowish sandy loams with relatively high undecomposed organic matter content and extremely low fertility.

Stand physiognomy varies from stunted, open woodland to nearly closed forest. Pitch pine and chestnut oak share overstory dominance. Most of the pitch pine populations consist of even-aged cohorts that probably regenerated following catastrophic fires. Most older chestnut oaks originated from basal sprouts. Stands usually have a well-developed but open understory tree layer that contains recruitment of the overstory species, as well as *Quercus marilandica* var. *marilandica* (blackjack oak), *Sassafras albidum* (sassafras), and black gum.

The shrub layer is dense with mountain-laurel and black huckleberry dominating, and numerous tree saplings usually present. The herb layer is dominated by patchy early lowbush blueberry and tree seedlings; herbaceous plants are nearly lacking.

Populations of pitch pine and table-mountain pine share a dependence on periodic fires to maintain themselves. In the absence of stand-opening fire or other disturbance, little or no recruitment of these shade-intolerant species is possible. Presumably because of dramatic reduction or exclusion of fires in the 20th century, many Pitch Pine Woodlands appear to be undergoing canopy closure and slow but certain encroachment by chestnut oak and other oaks. A good indicator of fire suppression in the Bull Run Mountains is the recent establishment of red maple and/or American beech saplings in the understory of Pitch Pine Woodland communities.

Mountain / Piedmont Acidic Seepage Swamps: ***Acer rubrum – Liriodendron tulipfera / Ilex verticillata – Vaccinium fuscatum / Osmunda cinnamomea – Symplocarpus foetidus*** **Forest community type.** This community type occurs in small, linear patches along sloping stream headwaters and ravine bottoms. Complex microtopography, braided streamlets, areas of coarse gravel and cobble deposition, muck-filled depressions, and abundant *Sphagnum* moss mats are typical microhabitat features.

Soils are moderately acidic, with medium base status. This community occurs on groundwater-saturated flats along the headwaters and small tributaries of Catletts Branch, Little Bull Run, Mill Run, Catharpin Creek (Jackson Hollow), Bartons Creek, Hungry Run, Bull Run, and other streams. Hydrologically, these habitats are classified as "groundwater slope wetlands," where seepage discharged at the ground surface is drained away as stream flow (Golet et al. 1993). Surface substrate is highly variable and may contain substantial cover of boulders, stones, cobbles, gravel, and/or wood debris. Soils are predominantly mineral, although local areas of organic muck sometimes accumulate in depressions or intermittent channels.

This community is dominated by red maple and tulip poplar. The shrub layer is variable in density and usually contains *Alnus serrulata* (smooth alder), *Ilex verticillata* (winterberry), *Vaccinium fuscatum* (hairy highbush blueberry), *Rhododendron periclymenoides* (wild azalea), spicebush, *Chionanthus virginicus* (fringetree), *Smilax rotundifolia* (common greenbriar) and *Vitis labrusca* (fox grape). The dense herb layer has a springtime patch-dominance of *Symplocarpus foetidus* (skunk cabbage) and at some sites *Veratrum viride* (false hellebore). Abundant ferns occur including *Osmunda cinnamomea* (cinnamon fern), *Thelypteris noveboracensis* (New York fern), and *Athyrium filix-femina* var. *asplenioides*. Other more or less constant, high-cover herbs include *Viola cucullata* (marsh violet), *Arisaema triphyllum* (jack-in-the-pulpit), *Osmunda regalis* var. *spectabilis* (royal fern), *Boehmeria cylindrica* (false nettle), and *Carex prasina* (a sedge).

Early historical homesteads in the Bull Run Mountains were entirely dependent on springs and streams for domestic water, as indicated by the remains of several springhouses and weirs. Similarly, these wetlands also provide a critical resource for the area's wildlife. Because of their special microhabitats, seepage swamps are likely to harbor a number of amphibians, odonata (dragonflies and damselflies), and other invertebrates that are restricted to or dependent upon wetlands.

This community is the most distinctive of all community types in the Bull Run Mountains and is easily recognized in the field. The most frequent disturbances are windthrows – perhaps encouraged by wet, thin, rocky soils, exotic plants – primarily *Microstegium vimineum*, and white-tailed deer herbivory.

This community is likely to harbor a number of animals that are more or less restricted to seepage wetland habitats. Included are amphibians such as the northern dusky salamander (*Desmognathus fuscus*) and northern red salamander (*Pseudotriton ruber ruber*); odonates (damselflies and dragonflies) such as the eastern red damsel (*Amphiagrion saucium*), aurora damsel (*Chromagrion conditum*), gray petaltail (*Tachopteryx thorei*), and *Cordulegaster* spp.; and amphipods that inhabit interstitial groundwater. Two uncommon species of the latter, *Gammarus pseudolimnaeus* and *Stygobromus tenuis*, were documented in a 1998 DCR-DNH inventory of VOF lands (Fleming *et al*. 1999).

Basic Mesic Forests: *Liriodendron tulipfera – Quercus rubra / Asimina triloba / Lindera benzoin / Amphicarpaea bracteata* – (*Adiantum pedatum*) Forest community type. This community type occupies fertile, well-drained soils of mesic lower slopes and ravines. Slopes vary from moderate to steep and are typically straight or concave. Soils are deep, dark loams or sandy loams of colluvial origin. Basic Mesic Forests are scattered in small to large patches throughout the preserve. Areas now supporting this community are some of the most productive in the Bull Run Mountains, and most were cleared or selectively harvested in the past. Sites that have recovered from agricultural uses were abandoned at least 100 years ago, and some may have been among the many Virginia fields abandoned for the last time during the Civil War.

The overstory of most stands is dominated by tall, straight tulip poplar. Northern red oak is present in most stands but is rarely co-dominant. Sub-canopy tree layers contain representatives of the overstory species and red maple, mockernut hickory, *Carya cordiformis* (bitternut hickory), black gum, chestnut oak, and *Ulmus rubra* (slippery elm). The lowest tree and shrub layers usually contain small to large colonies of *Asimina triloba* (paw-paw) and spicebush, along with eastern redbud and flowering dogwood. The typical stand structure of this community type consists of a tall, closed overstory, with very open understory tree layers, and a variably dense shrub layer. The herb layer is usually lush and dense, except where boulder fields prevail or deer grazing is severe. Patch-dominance of ferns and leafy forbs is characteristic. Species achieving local abundance in the type include *Adiantum pedatum* (maidenhair fern), *Amphicarpaea bracteata*, *Arisaema triphyllum*, *Asarum canadense* (wild ginger), *Cimicifuga racemosa*, *Deparia acrostichoides* (silvery spleenwort), *Phegopteris hexagonoptera* (broad beech fern), *Polystichum acrostichoides*, and *Uvularia perfoliata* (perfoliate bellwort).

Perhaps because of their moist, fertile soils, habitats of this community type are very favorable for shade-tolerant, invasive exotic plants, particularly following small-scale soil disturbances. Populations of the exotic/invasive Japanese stilt grass, wineberry, Japanese honeysuckle, and garlic-mustard have been documented in these communities. While each of these species is capable of displacing native vegetation and degrading natural environments, Japanese stilt grass may be the most problematic.

Mortality or partial die-back of flowering dogwood resulting from the dogwood anthracnose fungal pathogen was recorded, as was visible damage to herbaceous plants by grazing white-tailed deer in stands of this community type. It appears that long-term selective grazing in this community type has already resulted in the patch-dominance of unpalatable species that are normally avoided by deer.

Low-Elevation Boulderfield Forests / Woodlands: *Quercus montana – Quercus rubra / Vitis aestivalis* var. *bicolor – Parthenocissus quinquefolia / Aralia nudicaulis – Dryopteris marginalis* Forest community type. The most extensive sites for this community type are west- to north-facing upper slopes below outcrop escarpments of massive, eastward-dipping quartzite. Less extensive occurrences are situated on lower to middle slopes in gaps, where stream incision has exposed and eroded the underlying bedrock. The surface substrate is dominated by rock debris and often some weathered-in-

place bedrock. Lichen cover is often > 50% and usually includes *Umbilicaria mamulata* (smooth rock tripe), *Lasallia papulosa* (common toadskin), *Flavoparmelia baltimorensis* (rock greenshield lichen), and many crustose taxa. Site moisture ranges widely and is difficult to interpret because of variations in rock cover, interstitial soil, cold-air drainage, and subsurface water. Soils are very strongly to extremely acidic, with relatively high organic matter content and low base status. Cold-air drainage is pronounced in a few localities, especially at the base of the High Point Mountain cliffs. This community type is scattered locally throughout the study area, often in linear patches below cliffs and outcrops. Because of their extremely rugged character, boulderfields were never cleared or used for agriculture, and one or two were evidently never logged.

Overstory composition is limited, with chestnut oak usually the most abundant tree, followed by northern red oak and tulip poplar. On exceptionally mesic sites, northern red oak or tulip poplar may be the leading dominant. On most sites, overstory trees have a somewhat gnarled and spreading growth form indicative of older ages and crown damage from ice and wind disturbances. Typical stand structure is an open forest but may vary to woodland stature on the most exposed, xeric sites. Lower woody layers tend to be rather open and contain significant cover from climbing and scrambling woody vines of *Vitis aestivalis* var. *bicolor* (silverleaf grape), *Parthenocissus quinquefolia* (Virginia creeper), and *Toxicodendron radicans* (poison ivy). Chestnut oak, however, generally contributes the highest cover to every understory stratum.

Considerable variation in herb-layer cover and composition corresponds to variations in surface substrate, moisture, and site protection. Woody seedlings and vines are common herb-layer components, and species richness is somewhat limited by high rock cover, regardless of microhabitat conditions. *Dryopteris marginalis* (marginal wood fern) is one of the more characteristic herbaceous species, adaptable to both rock crevices and rocky interstitial soils. *Aralia nudicaulis* (wild sarsaparilla) is also characteristic and tends to form large clones on finer bouldery and stony colluvium with well-developed soils. Many other herbs occur inconstantly and with low cover. Localized areas on the lower, more protected parts of the boulderfields support surprisingly lush vegetation that may include colonies of paw-paw and robust patches of mesophytic herbs such as *Arisaema triphyllum*, *Cimicifuga racemosa*, *Circaea lutetiana* ssp. *canadensis* (enchanter's nightshade), and *Dryopteris carthusiana* (spinulose wood fern). Conditions that allow such lush patches to develop in what appear to be rather harsh environments are not clearly understood, but may include the enhancement of soil fertility and moisture-holding capacity by colluvial processes, reduced air temperature, and insulating rock cover. The near immunity of boulderfields to deer grazing may also be a contributing factor (Abrams et al. 1998).

Old wood debris and persistent root-collar sprouts in three plots indicate that American chestnut was once a component of this community, although perhaps not a particularly abundant one. Other evidence of disturbance include fire scars, very minor exotic plant populations, minor gypsy moth defoliation, and mortality from dogwood anthracnose. Because of rugged, inaccessible terrain and the poor growth form of trees, some of these

sites appear to have escaped logging. Sites supporting this community at BRMNAP often harbor hibernacula for timber rattlesnakes (*Crotalus horridus horridus*).

Piedmont / Mountain Acidic Cliffs. A large, high-quality occurrence of this natural community occupies the exposed, massive quartzite cliffs at the summit of High Point Mountain north of Thoroughfare Gap. As defined here, the community encompasses both the cliff faces proper and the surfaces of open, large-block talus lying immediately below. Crustose, foliose, and umbilicate lichens are the prevalent biota. *Lasallia pensylvanica* (blackened toadskin) is the dominant lichen, with common associates of *Xanthoparmelia conspersa* (peppered rock-shield), *Dimelaena oreina* (golden moonglow lichen), and *Umbilicaria muhlenergii* (plated rock tripe). The dominance of blackened toadskin, a lichen usually found at higher elevations in Virginia, is unusual. Habitats for rooted vascular plants are essentially limited to crevices and a few narrow ledges with mats of organic matter. Woody vines, especially common greenbrier, are locally common on shelves and in deeper-soiled crevices. Very stunted clumps of mountain laurel, *Populus grandidentata* (bigtooth aspen), chestnut oak, and table-mountain pine also occur. No specific ecological community type has been assigned to these sites.

Eastern Hemlock-Hardwood Forest: *Tsuga canadensis – Quercus montana / Hamamelis virginiana* Forest community type. A single, very small stand of this community occurs at BRMNAP in a sheltered, north-facing ravine. Soils are extremely acidic, infertile and with high organic matter. The overstory is dominated by a mix of chestnut oak, tulip poplar and *Pinus strobus* (white pine) with an understory of eastern hemlock (*Tsuga canadensis*), beech and *Rhododendron maximum* (great laurel). The herb layer is very sparse.

Element Occurrences

Element occurrences (EOs) are specific sites where a particular species or ecological community considered to be a natural heritage resource occurs. EOs are mapped and tracked by DCR-DNH in the natural heritage database (BIOTICS).

Rare / exemplary ecological communities. Eleven EOs of eight natural community types are found at BRMNAP (Table 1).

Rare plants and animals. One rare animal, a globally rare tiger beetle, is currently documented at BRMNAP (Table 2). In addition, populations of seven watchlist odonates (dragonflies and damselflies), two watchlist groundwater amphipods, and two watch-list plant species occur on the preserve. There are also numerous historical records of rare plants, and the preserve supports many disjunct mountain species, including such species as *Veratrum viride*, *Maianthemum canadense* (Canada mayflower), *Glyceria melicaria* (slender managrass), and *Fraxinus nigra* (black ash). The watchlist plant *Juglans cinerea* (butternut) occurs in the preserve's boulderfield habitats. Montane faunal species present include timber rattlesnake and raven (*Corvus corax*), along with odonates more typical of the Coastal Plain. One rare insect species, the barrens tiger beetle (*Cicindela patruela*), occurs in dry, open forests and woodlands of the crest of High Point Mountain. Six watchlist odonates (dragonflies and damselflies) occur in the seeps of Jackson Hollow

and the headwaters of Hungry Run: *Amphiagrion saucium* (eastern red damsel), *Argia bipunctulata* (seepage dancer), *Arigomphus villosipes* (unicorn clubtail), *Lanthus vernalis* (single-striped clubtail), *Libellula flavida* (yellow-sided skimmer) and *Tachopteryx thoreyi* (gray petaltail). One watchlist dragonfly occurs along Catletts Branch: *Cordulegaster erronea* (tiger spiketail). The watch-list groundwater amphipod, *Gammarus pseudolimnaeus* (northern spring amphipod), occurs in the seeps of the headwaters of Hungry Run and another watchlist groundwater amphipod, *Stygobromus tenuis*, occurs in the seeps of Jackson Hollow.

Table 1. Rare / exemplary ecological communities of Bull Run Mountains NAP.

Ecological Community Type	Global/State Rarity Rank	Element Occurrence Number (s)	EO Rank (s)
Basic Mesic Forests	G?/S4	29	AB
Basic Oak-Hickory Forests	G3G4/S3?	27, 26	B, BC
Chestnut Oak Forests	G5S5	26	AB
Low-Elevation Boulderfield Forests and Woodlands	G?/S?	10	A
Mesic Mixed Hardwood Forests	G?/S4	20, 19	B, BC
Mountain / Piedmont Acidic Seepage Swamps	G3G4/S3?	10, 11	AB, B
Piedmont / Mountain Acidic Cliffs	G?/S?	2	A
Pine-Oak / Heath Woodlands	*Pinus pungens* subtype (G4S4) *Pinus rigida* subtype (G4S3)	9	B

Notes: At this time, many communities are awaiting assignment of global or state rarity ranks. See Appendix E for Rarity Ranks and Status Explanation.

Table 2. Rare animals of Bull Run Mountains NAP.

Scientific Name	Common Name	Global / State Rarity Rank	Federal / State Status	EO Rank (EO #)
Cicindela patruela	Barrens tiger beetle	G3 / S2	--	E

Note: See Appendix E for Rarity Ranks and Status Explanation.

Potential Natural Heritage Resources

There are historical records of more than eight rare plant species (e.g., *Trillium cernuum*) and six watchlist plant species from BRMNAP. It is highly possible that management activities, coupled with monitoring and additional inventory work, could uncover new or regenerated occurrences of some of these species. It is also possible that additional inventory of rare ecological communities, such as the Mountain / Piedmont Acidic Seepage Swamps, will yield new invertebrate finds as well. Additional occurrences of the Mountain / Piedmont Acidic Seepage Swamp community may be delineated in the northern unit of the preserve.

RESOURCE STEWARDSHIP

Goals and Objectives

The primary objective of natural areas stewardship is to provide for the continued presence of natural heritage resources. The overriding goal at BRMNAP is a restored and functioning ecosystem with a matrix of communities native to the site. The philosophy and policy direction for the management of natural area preserves is outlined in the Natural Area Preserve Management Guidelines (2000) (see Appendix C). Preserve-level management and monitoring actions, as well as cooperative management initiatives and protection strategies are planned based on the best current information and available resources. VOF is the landowner and manager of BRMNAP with technical assistance provided by DCR-DNH. Environmental education and visitor management services will be provided by BRMC. A volunteer stewardship committee approved by VOF will continue to assist with preserve management.

Primary objectives for BRMNAP include:

- Maintain and restore the natural communities.
- Maintain and restore populations of rare plants and animals.
- Manage habitat to benefit other natural resources, scenic resources and historic resources.
- Evaluate effects of management on plants, animals, and natural communities.
- Ensure visitor safety and site-security.
- Provide for natural resources protection.

Secondary objectives for BRMNAP include:

- Increase public awareness of the preserve through appropriate public access and education.
- Foster research to accomplish conservation goals and contribute to the body of knowledge on the flora, fauna, and natural communities of Virginia.

Biological Management Issues

Biological resource management actions are taken to return human-altered land or vegetation to a condition that supports continued existence of rare species and/or natural communities by reinstating natural processes or abating threats. Major threats to biodiversity include: Habitat degradation/loss, exotic invasive species, pollution, overexploitation, and disease (Wilcove et al. 1998). The more destructive forms of habitat degradation are: Land conversion to development, water development (e.g., dams, drainage projects), agricultural practices, livestock grazing, outdoor recreation (includes off-road vehicles), pollutants, infrastructure development (includes roads), disruption of fire regimes, logging, and mining activities. After habitat loss, exotic invasive species are the greatest threat to terrestrial species. For aquatic species, water pollution is the most significant threat after habitat loss (Richter et al. 1997). Because of these threats to biodiversity, active management is often needed to restore and maintain natural heritage resources (Wilcove and Chen 1998).

Several biological issues currently threaten the natural heritage resources of BRMNAP. In addition, a number of public use issues either currently, or have the potential to, negatively impact natural heritage resources at BRMNAP and are described in detail in the Operations Management section of this plan. Biological issues of greatest concern and most likely to cause negative impacts to natural heritage resources at BRMNAP are: Invasive non-native insects and pathogens; invasive non-native plants; native animal populations lacking natural abundance controls; fire suppression; groundwater status; and development pressures outside the preserve. Before addressing these current issues, it is important to note that forests at BRMNAP have already been impacted by major logging and clearing efforts over the last two centuries, the chestnut blight at the end of the 19th century which eliminated a major canopy dominant (American chestnut), and long-term fire suppression. The current dominance of tulip poplar and oaks other than chestnut oak on certain sites is, in part, the result of this land-use history.

Invasive, non-native insects. Lacking natural predators, pathogens or parasites, introduced insect species populations can quickly alter ecosystems. Tree defoliators and sap-sucking insects can cause extensive tree mortality when trees are already stressed by factors such as drought, air pollution, and or disease pathogens.

Gypsy moth (*Lymantria dispar*). The gypsy moth is an invasive, exotic moth whose caterpillars can defoliate trees and lead to their untimely death, altering forest ecosystems (USDA 1995). Gypsy moth may be the greatest current threat to the forests at BRMNAP (Fleming 2002). Gypsy moth populations are cyclic and can go from "boom to bust" quickly. Typically, outbreaks range from 1-3 years with 2-5 years of low level moth populations between epidemic years. Damage to a forest stand from an infestation of gypsy moths depends on a large number of factors (Gottschalk 1993): Moth population density, stand composition, tree vigor, environmental conditions (e.g., drought), stand age and history, site factors (e.g., infertile soils), population density of gypsy moth predators, pathogens, and parasites, and secondary organisms that attack trees after gypsy moth defoliation (e.g., *Armillaria* spp. or shoestring root rot). In stands with widespread oak mortality from gypsy moths, species such as red maple, tulip poplar and black gum often replace oaks. Increased light, moisture, and nutrients available on the forest floor after defoliation may promote a flush of weedy species and create brushy conditions. On dry ridges, a thicket of heath species is sometimes left after a severe gypsy moth outbreak. Gypsy moth attacks can also alter fuel loadings and create wildfire hazards by creating unusually large numbers of snags and increased amounts of downed woody debris.

The first significant defoliation by gypsy moths in northern Virginia occurred in 1984. Since then, the moths have moved steadily south and westward following the Appalachian mountains. Significant Virginia outbreaks of gypsy moths have occurred in 1990-91, 1995, and 2000-02 (Ross 2002). These outbreaks have corresponded to drought years with dry and warm winters and springs. The gypsy moth fungus (*Entomophaga maimaiga*) has become naturalized in Virginia and is thought to have caused two major die-offs of gypsy moth in Virginia in 1992 and 1995 (Hajek et al. 1996). In 2001, another major gypsy moth population outbreak in Virginia was decimated by both the gypsy moth fungus and the gypsy moth nucleopolyhedrosis virus (Sellers 2001). The

gypsy moth virus seems to play a role in gypsy moth control only in very large gypsy moth populations. The gypsy moth fungus requires cool, wet conditions in April-June to effectively control a gypsy moth outbreak (Reardon and Hajek 1998).

In terms of gypsy moth larvae feeding preferences (USDA 1995), the following woody species at BRMNAP are preferred host foods: Oaks, hornbeam, serviceberries (*Amelanchier* spp.) and witch-hazel. The following woody species are typically resistant to gypsy moth larval feeding: Beech, blackgum, butternut, black cherry, hickories, maples, pines, ericads (*Vaccinium* and *Gaylussacia* spp.), paw-paw, and redbud. Species that are rarely fed upon include: Ashes (*Fraxinus* spp.), tulip poplar, dogwoods, grapes (*Vitis* spp.), greenbriars (*Smilax* spp.), mountain laurel, spicebush, most viburnums (*Viburnum* spp.), and most azaleas (*Rhododendron* spp.).

All oak-dominated forests at BRMNAP are susceptible to gypsy moth defoliation; however, dry and infertile forest communities (Chestnut Oak Forests, Pine-Oak / Heath Woodlands, Low-Elevation Boulderfield Forests, Acidic Oak-Hickory Forests) have the greatest potential for overstory tree mortality from gypsy moth infestations. Research has shown that when there are 1000 or more gypsy moth egg masses per acre, the risk of significant tree mortality the following spring is high (Liebhold et al. 1994).

Within areas generally infested with gypsy moths, such as BRMNAP, there are four general treatment options (USDA 1995): The biocide Bt (*Bacillus thuringiensis*), the insecticide Dimilin (diflubenzuron), the biocide Gypcheck (gypsy moth nucleopolyhedrosis virus), and lastly, doing nothing and hoping that the weather will create favorable conditions for the fungus. Mating disruptant pheromones are ineffective in generally infested areas and are used only at the leading edge of the gypsy moth infestation (USDA 1995). Dimilin is inappropriate for use in natural areas as it negatively impacts lepidopterans, orthopterans, parasitic wasps, benthic crustaceans, aquatic insects, and immature planktonic crustaceans (USDA 1995). Bt is only conditionally appropriate in natural areas as it negatively impacts all spring-feeding lepidopterans. Gypcheck is appropriate for use in natural areas as it is specific to gypsy moth (Reardon et al. 1996). However, Gypcheck is only available in limited quantities from the USDA Forest Service. Monitoring of the effectiveness of gypsy moth insecticides on the George Washington and Jefferson National Forests in Virginia indicates that one treatment of Bt is successful about 70% of the time, two applications of Gypcheck are successful about 70% of the time, two applications of Bt are successful about 90% of the time, and one application of Dimilin is successful 99.5% of the time (Ross 2002). The success of Bt and Gypcheck applications are dependent on weather and proper timing of the treatment. Data from the same report also indicates that Gypcheck often fails in suppressing gypsy moth populations with high egg mass densities.

In the late 1980's and early 1990's, the gypsy moth reached outbreak levels in the Bull Run Mountains (Fleming 2002). This infestation was partially controlled with widespread spraying of the biocide Bt and the insecticide Dimilin. The gypsy moth population then remained at a low level until 2000-2002 when the population built back to outbreak levels – again, paralleling a drought. In 2001, a potentially severe defoliation

was controlled by a collapse of the moth population due to the gypsy moth fungus. The year 2002 was marked by another burgeoning gypsy moth population at BRMNAP. In the fall of 2002, gypsy moth egg masses were systematically sampled at BRMNAP by staff from DCR-DNH, VOF, and BRMC using the methodology described in Liebhold et al. (1994). An average of 3000 egg masses per acre in the southern administrative unit of the preserve were found – well above the 1000 egg masses per acre threshold established by the USDA Forest Service for tree mortality. The northern administrative unit of the preserve had egg mass densities at around 100 egg masses per acre. In the throes of the second worst drought on record in Virginia, DCR-DNH and VOF jointly decided to pursue treatment of the gypsy moth population in the southern unit of BRMNAP during spring of 2003. Due to a severe state budget situation, funding for treatment was limited and outside funding sources were required. Because DCR-DNH and VOF could not afford to independently contract an aerial spraying treatment, an option was sought to obtain aerial treatment of gypsy moths at BRMNAP from the Virginia Cooperative Gypsy Moth Suppression Program through the Virginia Department of Agriculture and Consumer Services, the USDA Forest Service, and Prince William County. This necessitated the use of the biocide Bt. Fauquier County currently has no gypsy moth program and VOF funded and contracted for spraying of Bt on the Fauquier County portion of the preserve.

In early May of 2003, 916 ac of the most heavily infested acreage in the southern administrative area (824 ac in Prince William County, and 92 ac in Fauquier County) were sprayed with the biocide *Bacillus thuringiensis* var. *kurstaki* (Btk) at a dosage of 24 BIU (biological international units) from a fixed-wing aircraft. This was the lowest dosage available and was applied when the gypsy moth larvae were primarily in the second instar. In late October 2003, gypsy moth egg mass surveys were conducted again on the preserve. These surveys indicated a general population crash due (probably) to some combination of the Btk treatment of spring 2003, the gypsy moth fungus, and the gypsy moth virus. As in fall 2002, gypsy moth egg mass densities were very low and scattered in fall 2003 in the northern unit of BRMNAP. However, in the treated south unit, the fall 2003 surveys revealed a mean egg mass density of just 75 +/- 26 egg masses per acre with an 80% confidence interval. This is a reduction by two orders of magnitude from fall 2002. A combination of a wet winter and spring in 2003 created ideal conditions for the gypsy moth fungus and virus to attack gypsy moth caterpillars. These factors acted in combination with the spraying of Btk at BRMNAP and it is not possible to know what the outcome would have been had the drought not broken over the winter of 2003.

Gypsy moth populations will be sampled annually by egg mass counts. Whenever average egg mass counts exceed 1000 per acre in a management unit, control efforts will be recommended. Control will ideally be Gypcheck applied by a helicopter. Due to practical constraints, control may have to be Bt applied by a fixed-wing aircraft. Repeated applications of Bt should be avoided until a better understanding of its effects on native lepidopterans at the preserve is determined. Bt should only be used as a last resort when forest stands are stressed by severe drought or other compromising environmental conditions. The oldest oak stands on the most exposed and dry landscape

positions at BRMNAP are at highest risk from gypsy moths (Gottschalk 1993) and should be targeted during control efforts. Stands not dominated by older oaks and stands with more mesic microclimates may withstand limited gypsy moth outbreaks. An inventory of spring-feeding Lepidoptera is critically needed as future gypsy moth control efforts could cause unacceptable damage to native moths and butterflies. The presence of rare or uncommon Lepidoptera at BRMNAP would significantly improve the chances of obtaining Gypcheck from the USDA Forest Service.

Hemlock woolly adelgid (*Adelges tsugae*). A small population of eastern hemlock occurs at BRMNAP in the Eastern Hemlock-Hardwood / *Rhododendron maximum* Forest. This hemlock stand as well as others in the Bull Run Mountains are infested with the hemlock woolly adelgid. This Asiatic insect first appeared in Virginia in 1954 and since the 1980's has spread rampantly throughout all of Virginia east of the New River, leaving dead hemlock stands in its wake. The adelgid causes severe needle drop, bud mortality, branch die-back, and tree death (Morisawa 2003). Young twigs are the insect's preferred feeding sites and sap feeding causes needle discoloration and branch desiccation. Infestations of eastern hemlock and Carolina hemlock *(Tsuga caroliniana*) are generally fatal, and tree death occurs within four to six years of infestation. Because the adelgid defoliates all sizes of trees from seedlings to mature individuals, entire hemlock stands can be eliminated within a few years.

Although a biological control agent has been introduced to the eastern US and may ultimately have some impact, currently, there are no methods to control the adelgid in forest environments. In 1992, a predatory ladybeetle *(Pseudoscymnus tsuga*e) that feeds exclusively on hemlock woolly adelgid in Japan was discovered and evaluated as a potential biological control agent for use in the US. While releases of *P. tsugae* were made in Connecticut and Virginia during 1995-1997, its effectiveness has not yet been determined.

Invasive, non-native plants. Control of invasive non-native plants is expensive, resources are limited, and management efforts must be prioritized (Hiebert and Stubbendieck 1993). The goal of management is to prevent the worst invasive species from becoming established in high-quality natural communities. Eradication is not a practical option for many invasive species already well-established at BRMNAP. However, preventing new invasive species from getting established on the preserve is a viable objective. Control efforts will focus on reducing the abundance of the most problematic invasive plants in the highest quality natural communities by 50% (Table 3). Fleming (2002) considered Japanese stilt grass as the most problematic invasive at BRMNAP.

Table 3. Natural communities and threats from invasive plant species at BRMNAP (from Fleming 2002).

Community Type (in order of degree of threat)	Most threatening invasive plant species
Basic Mesic Forest	*Microstegium vimineum, Alliaria petiolata, Rubus phoenicolasius, Lonicera japonica*
Acidic Seepage Swamp	*M. vimineum, L. japonica*
Mesic Mixed Hardwood Forest	*M. vimineum, L. japonica*
Basic Oak-Hickory Forest	*R.s phoenicolasius, M. vimineum, Symphoricarpos orbiculatus*
Boulderfield Forest	*R. phoenicolasius*

Japanese stilt grass (*Microstegium vimineum*). A native of Asia, Japanese stilt grass is now widespread east of the Mississippi (Hunt and Zaremba 1992; Redman 1995; Ehrenfeld 1999). It first appeared in the Bull Run Mountains in 1986 and has spread rapidly since then (Fleming 2002). Japanese stilt grass is typically an annual grass, although a perennial form has apparently been discovered (Ehrenfeld 1999), that spreads into mesic forest habitats. It spreads rapidly into disturbed areas but can invade undisturbed upland areas by forming satellite populations brought in by animals or flooding. It is generally slow to invade undisturbed areas, but rapidly fills disturbed areas such as flood-scoured stream sides, tip-up mounds, and along roads and trails (Tu 2000). Japanese stilt grass is generally avoided by deer as a food resource.

An individual plant of Japanese stilt grass can produce up to 1000 seeds, which can remain viable in the soil for three to five years. Once established, Japanese stilt grass is able to crowd out native herbaceous vegetation in wetlands and forests within three to five years (Barden 1987; Hunt and Zaremba 1992). Manual/mechanical, environmental/cultural, and chemical methods have all been used with some success for control of Japanese stilt grass. Prescribed burns have not been successful in controlling this species so far, but fall burns may have the potential for partial control. If controlled during the early stages of invasion, the potential for successful management is high. The potential for large-scale restoration of wildlands where Japanese stilt grass has become established is probably moderate (Tu 2000). Grass-specific herbicides may need to be used to control Japanese stilt grass at the cost of sacrificing some native grass species populations. The best combination of control for Japanese stilt grass will likely involve mowing/cutting in late summer prior to seed set and spot treatments of herbicide in early summer, along with the use of pre-emergent herbicides in late winter.

Garlic mustard (*Alliaria petiolata*). Garlic mustard is a serious threat to mesic forest habitats throughout the eastern U.S. (Nuzzo 2000). This biennial species has high shade-tolerance and is extremely invasive. Cutting flowering plants at ground level or hand-pulling can provide control. However, hand-pulling disturbs the soil and can create an ideal seedbed for garlic mustard seed germination. Flowers of cut stems can still produce viable seed such that cut flowering stems must be removed from the site. Dormant season application of glyphosate to garlic mustard rosettes is a highly effective control method but can cause non-target plant impacts. Garlic mustard rosettes are actively

growing both in fall and in early spring – after and prior to, respectively, the growth period of many native plants – creating a window for herbicide control. Deer typically avoid browsing garlic mustard.

Japanese honeysuckle (*Lonicera japonica*). This semi-evergreen perennial vine rapidly invades open areas but can also persist in shade. Seeds are dispersed readily by birds (Nyboer 1992). In fire-adapted communities, periodic spring burning will control this species. Glyphosate herbicides applied in the fall when the surrounding vegetation has become dormant – but before a hard freeze (25 degrees Fahrenheit) – will allow for control of this species without negatively impacting non-target plants.

Wineberry (*Rubus phoenicolasius*). Little is known about the control of this perennial shrub. However, good control will likely be achieved by basal bark treatment with a herbicide such as triclopyr. DCR-DNH has had success in treating small diameter woody plants with triclopyr herbicides. These herbicides are labeled for control of blackberry (*Rubus allegheniensis*); thus, it is likely that they will be effective on wineberry as well. Repeated mowing, cutting, and dormant-season burning will usually stimulate resprouting of *Rubus* species.

In addition to the above species, Fleming (2002) indicated that the following invasive species could become a problem in the future at BRMNAP: Tree-of-heaven (*Ailanthus altissima*), Asiatic bittersweet (*Celastrus orbiculatus*), and mile-a-minute plant (*Polygonum perfoliatum*). Bittersweet can establish in shaded understories while tree-of-heaven and mile-a-minute are more likely to become established in areas with canopy gaps formed by blow downs or gypsy moth mortality. If populations of these plants are discovered on BRMNAP in high-quality natural communities, they should be controlled as soon as is feasible.

Forest tree diseases. A variety of pathogens, some native, some non-native, and others of unknown origin are known to stress the forests of the eastern U.S. To date none of these pathogens have been as virulent and destructive as the chestnut blight that decimated Appalachian forests over thousands of square miles of the eastern U.S. at the turn of the century. Most tree diseases are fungal but viral diseases also occur. Some diseases kill the tree directly while others act in concert with other tree stressors such as drought or insect attacks.

Dogwood anthracnose (*Discula destructiva*). Dogwood anthracnose is a disease of flowering dogwood. Large numbers of dogwoods have succumbed to this disease at BRMNAP in an infestation that likely started in the mid-1980's (Fleming 2002). A fungus has been identified as the causal agent of this dogwood disease. Infection of dogwoods is favored by cool, wet spring and fall weather, but can occur throughout the growing season. Drought and winter injury weaken trees and increase disease severity. Consecutive years of heavy infection have resulted in extensive mortality in both woodland and ornamental dogwoods of the eastern U.S. (Hibben and Daughtrey 1988). The origin of this disease is unknown. The fungus may have been introduced or a change in environment may have altered host/parasite relationships, enabling a previously

innocuous fungus to become a significant pathogen. Individual dogwood trees can be treated with fungicides or given more sun to control this disease; but, control of dogwood anthracnose at the forest scale is currently impractical (SAMAB 1996c).

Butternut canker (*Sirococcus clavigignenti-juglandacerum*). Fungus-caused butternut canker currently has no practical cure (SAMAB 1996c). However, genetic resistance in some trees appears to exist. If healthy butternuts are found growing in the vicinity of diseased trees the population should be mapped and monitored.

Beech bark disease. Beech bark disease causes significant mortality and injury in American beech trees. The disease results when bark, attacked and altered by the beech scale (*Cryptococcus fagisuga*) is invaded and killed by fungi, primarily *Nectria coccinea* var. *faginata*, and sometimes *N. galligena* (Houston and O'Brien 1983). Around 1890, the scale was accidentally brought to Nova Scotia. By 1932, the scale and an associated nectria fungus were killing trees throughout mature beech areas of the Maritime Provinces and in localized areas of eastern and southcentral Maine. In addition, isolated infestations of scale were occurring in southwestern Maine and eastern Massachusetts. The scale insect has continued to spread to the north into Quebec and to the west and south throughout New England, New York, New Jersey, and northern and eastern Pennsylvania, and West Virginia.

Beech bark disease is currently not known from the Bull Run Mountains, but does occur in the neighboring states of West Virginia and Pennsylvania. It is rampant in the Allegheny Mountains of Highland County, Virginia, but at present, is limited to high-elevation sites in the Mid-Atlantic region. It may be only a matter of time before this disease becomes an issue for the forests at BRMNAP. Consequently, the preserve's extensive beech stands should be monitored to detect any onset of beech bark disease.

Other insects and wood-rotting fungi quickly invade the wood beneath bark killed by beech bark disease. Species of *Hypoxylon* that decay sapwood are among the first to invade. Ambrosia beetles make holes that allow other fungi to enter. The shoestring root rot fungus, *Armillariella mellea*, sometimes invades weakened trees and hastens their death. Attacks by these organisms make it difficult to judge when trees will succumb to beech bark disease. Many trees that are partially girdled remain alive, in a weakened state, for years. A ladybird beetle (*Chilocorus stigma)* feeds on the scale and a fungus (*Nematogonum ferrugineum / Gonatorrhodiella highlei*) parasitizes the nectria fungi. Effects of these organisms on the disease agents and on the course of the disease have not been critically evaluated. Scales on high-value ornamental trees can be controlled with insecticides, but the disease in forest stands cannot be controlled at a reasonable cost. However, vigorous trees free of the disease are often found in heavily affected areas and recent trials with some of these trees have shown them to be resistant to the scale. This offers hope that methods can be developed to increase the levels of resistance in affected forests (Houston 1994).

Oak decline. Oak decline is a disease complex involving environmental stress (often drought), root disease (e.g., *Armillaria* root disease), insect pests of opportunity (e.g., 2-

lined chestnut borer, *Agrilus bilineatus*), and physiologically mature trees (SAMAB 1996c). The introduction of gypsy moth can exacerbate this decline. Species in the red oak group are most susceptible. Conditions of oak decline may impact oak forests at BRMNAP.

Native problem species. Due to overabundance, certain native species of animals have become problematic – from both ecological and economic perspectives. While these species are native to Virginia, their recent population increases have resulted in negative effects on habitat and to other aspects of human coexistence. Overabundance of some species is often incompatible with a broad array of resource management objectives. For ecological and or economic reasons, natural resource managers must often control burgeoning populations of native animals.

White-tailed deer (*Odocoileus virginianus*). A large body of research (Russell et al. 2001) presents evidence that dense populations of deer in many eastern U.S. ecosystems can negatively impact tree regeneration, recruitment and composition (Alverson and Waller 1997, Horsley et al. 2003), alter natural community composition (Rooney and Dress 1997), eliminate certain plant species from areas (Augustine and Frelich 1998), and disrupt bird populations (deCalesta 1994; McShea; Rappole 1997). Deer also avoid browsing on the invasive non-native plants, Japanese stilt grass (Tu 2000) and garlic mustard (Nuzzo 1991), further exacerbating the nefarious effects of these weeds on the native flora. Of particular concern for natural areas management are the negative effects of high deer densities on herbaceous plants (Anderson 1994; Balgooyen and Waller 1995; Augustine and Frelich 1998) and rare plants (Miller et al. 1992).

It is estimated that the presettlement deer density of the eastern U.S. was about 8 to 11 deer/mi^2 (McCabe and McCabe 1997). At the end of the 19th century, deer were over-hunted to the point of near extirpation from Virginia. Since then, the implementation of strict game laws, the elimination of natural predators, and the changing landscape of the state with more edge habitats has given rise to a burgeoning deer population that today, in most areas of the state, exceeds the estimated presettlement deer densities (Knox 1997).

A number of studies have demonstrated that deer densities >20 deer/mi^2 can have negative impacts on tree regeneration, recruitment and composition (Tilghman 1989; Healy 1997; Horsley et al. 2003). Forests with deer densities of 8-15 deer/mi^2 have well-stocked and diverse woody understories (Healy 1997) and abundant and flowering populations of such deer sensitive species as *Trillium grandiflorum* (Anderson 1994) and *Laportea canadensis* (Augustine et al. 1998). In 1988, Prince William and Fauquier Counties had an estimated 15-31 deer/mi^2 with the northern half of Fauquier County having >31 deer/mi^2 (Knox 1997). Today, the mixed forest / openland habitats of these counties support deer densities sometimes in excess of 100 deer/mi^2 (Dan Lovelace, DGIF wildlife biologist, personal communication). Strictly forested habitats generally support 40 – 60 deer/mi^2 in these counties today. It should be noted that effects of deer on forest ecosystems depends on the landscape context in which they occur (Horsley et al. 2003). Forest stands in landscapes with a significant amount of agricultural row-crop

land are less impacted by the same density of deer than a forest stand in a primarily forested landscape.

Abundant anecdotal evidence from plot sampling and field surveys at BRMNAP (Fleming 2002) points to deer overpopulation in the area. Deer herbivory impacts are greatest in Basic Oak-hickory Forest and Acidic Oak-hickory Forest natural communities. Little to no deer herbivory was documented in dry Chestnut Oak Forests and Pine-oak/Heath Woodlands. Moderate deer herbivory impacts were noted in Basic Mesic Forests and Mesic Mixed Hardwood Forests.

Results of the ecological community inventory of BRMNAP coupled with deer density data for Prince William and Fauquier Counties indicate that there are currently too many deer in the Bull Run Mountains if the goal of managing the preserve is to sustain and restore natural communities and rare plants. Detailed and replicated, labor-intensive exclosure studies are not practical for BRMNAP at this time. Deer are a problem and a deer management program via regulated hunting needs to be enacted to reduce the local herd to a density that does not negatively impact the ecological communities. Deer hunting is the most practical method of deer control currently available (DGIF 1999). Using deer birth control or trapping and removing individuals would be extremely costly and of uncertain efficacy. Since 1993, lands comprising the preserve north of Hopewell Gap have been hunted by a group of volunteer land stewards in exchange for boundary marking and other operations management work. This program should continue, but the control of deer at BRMNAP will need a specific plan. VOF, DCR-DNH, BRMC, and VOF volunteer land stewards need to work with wildlife biologists from the Virginia Department of Game and Inland Fisheries (DGIF) through the deer management assistance program (DMAP) to develop a deer management plan for the area. Increased harvest of female deer (does) will undoubtedly be a needed step towards reducing the herd and the entire preserve will likely need to be hunted in the future. It is also possible that hunting of does will need to occur on neighboring lands to impact the deer population using/affecting BRMNAP. The overall deer management goal will be to reduce impacts of deer on the abundance, flowering and composition of the diverse vegetative ground layers found in the basic and mesic ecological communities at BRMNAP. This will likely occur when the local deer herd has been reduced and stabilized at ≤ 20 deer/mi^2.

Deer population pressures can be measured in terms of deer densities and/or deer impacts (Horsley et al. 2003). Deer density can be assessed via a number of techniques including deer harvest data (DGIF 1999), counts at dusk (Storm et al. 1992), the drive method (deCalesta 1994), pellet counts (Neff 1968; White 1992; Alverson and Waller 1997), winter aerial surveys (Augustine and Frelich 1998) and line-transect sampling (Burnham et al. 1980; Healy and Welsh 1992). Population data on sensitive or "indicator" herbaceous plants have been used as a relatively crude but quick method of gauging the impact of deer populations on natural communities (Anderson 1994; Balgooyen and Waller 1995; Augustine and Frelich 1998; Augustine et al. 1998). It is recommended that a monitoring program to track deer population densities and deer impact be used to assess the success of a deer management (hunting) program. Monitoring trends of deer impacts with exclosure plots and measurements of sensitive herbaceous ground flora plants is also

recommended. Exclosure plots need not be large and part of a replicated experimental design. Tracking trends in vegetation types that reflect deer densities is a valid monitoring approach. It is recommended that small, 100 ft^2 exclosures be used that are easily constructed and monitored. Research studies have effectively used plots of this size (Alverson and Waller 1997; Healy 1997). These deer exclosure plots paired with a control plot will be located (nested) within permanently marked 400 m^2 (4,306 ft^2) vegetation plots established by Fleming (2002) and for which baseline data already exist.

Beaver (*Castor canadensis*). Although beavers are a native species and a component of Virginia's natural landscape, in certain situations large local populations of these animals can degrade and/or destroy natural heritage resources. Like white-tailed deer, beavers were over-harvested in the 19th century but have since rebounded in population size. They have continued to increase in population size due to declines in trapping pressure and a near absence of natural predators in Virginia (Linzey 1998). Beavers can destroy rare plant habitat and natural communities by creating dams on streams that eventually back up and inundate and or silt in the natural heritage sites (Hammerson 1994; Wilson 2001). In the northeast beavers have been implicated in the destruction of some sites for the federally endangered northeastern bulrush (*Scirpus ancistrochaetus*) (USFWS 1993). In Virginia, beavers have negatively impacted populations of the rare swamp-pink (*Helonias bullata*) and Kentucky lady's slipper orchid (*Cypripedium kentuckiense*).

Of course, beavers modified streams in the presettlement landscape. However, protected sites supporting high-quality, rare wetland communities such as Seepage Swamps (which occur at BRMNAP) must be protected in today's landscape context from destruction by the activities of an, arguably, artificially-high beaver population. Numerous streams and seeps abound in the landscape around BRMNAP that do not harbor natural heritage resources and provide habitats where beavers can (and do) create impoundments. In the presettlement era, there were more Seepage Swamps; timber wolves (*Canis lupis*) were a frequent predator of beavers (Wilson 2001), and invasive plant species were a minor issue. Hence, beavers and Seepage Swamps were once in better balance and the loss of a few Seepage Swamps would not have had a significant impact on the status of this natural community type. Today, the story is much different. We must conserve the few remaining Seepage Swamps that remain as part of DCR-DNH's mission to preserve biological diversity.

At BRMNAP, the strategy will be to monitor beaver activity and remove dams and populations that become established on streams linked to high-quality Mountain / Piedmont Acidic Seepage Swamp community occurrences. Water level control devices can be used to mitigate the effects of already established beaver dams by preventing further flooding (Wilson 2001) and may be considered a solution for already well-established beaver dams on the preserve. These devices and relocation of beavers are not effective at preventing the creation of new beaver dams. As necessary, trapping may be used to control the population of beavers at BRMNAP. In particular, trapping should be used to remove beavers that threaten high-quality Seepage Swamp communities. Trapping is the most practical method of controlling beavers (Wilson 2001). VOF should work with DGIF wildlife biologists in developing a strategy to effectively trap beavers.

Southern pine beetle (*Dendroctonus frontalis*). Southern pine beetle is a native insect species that attacks stressed or dying pine trees (including both pitch and Table Mountain pines), as well as pines infested previously by other native bark beetles (Coulson and Witter 1984). This species causes significant damage in cycles; and, when outbreaks occur, the beetles can attack, colonize, and kill even vigorous healthy trees. Pine stands that are very dense and/or drought stressed are most susceptible to southern pine beetle. An outbreak of the southern pine beetle in the mountains and western piedmont of Virginia in the early 1990s likely caused mortality in pine stands of BRMNAP.

Since dense stands of pine are most susceptible to southern pine beetle attack, thinning to promote more vigorous trees can reduce the risk of mortality (Swain and Remion 1981). The best quality stands of pitch and Table Mountain pine at BRMNAP should be periodically monitored for pine beetles. If an outbreak occurs, VOF should consider cutting and burning/removing infested trees. Prescribed fire is another tool that can be used to lessen the outbreak potential of southern pine beetles. For more on this subject, see the discussion of prescribed fire at BRMNAP in the Fire Management Issues sub-section.

Urban interface factors. BRMNAP lies in an area with increasing suburban-type development (Fleming 2002) and is only 35 miles from the Washington, D.C. metro area. Already, the eastern edge of the preserve is adjacent to two developments: Bull Run Estates and Thunder Oaks. The construction of nearby housing, roads and other infrastructure and the resulting increase in impervious surfaces all have impacts on the larger landscape and ecosystems that comprise the Bull Run Mountains. Even more distantly-located emissions from motor vehicles, power plants, industry, and other fossil-fuel producers have additional air and water quality impacts at the Bull Run Mountains.

Groundwater status. The health of the Mountain / Piedmont Acidic Seepage Swamps and the streams associated with them at BRMNAP are directly linked to the flow regime and water quality of the surrounding watershed and groundwater supplies. Protecting or restoring natural hydrologic regimes and water chemistry is basic to conserving aquatic, riparian, and wetland natural communities (Mitsch and Gosselink 1993).

The Mountain / Piedmont Acidic Seepage Swamp communities are wetlands characterized by a constant or near-constant supply of groundwater (Fleming 2002). The water is derived from infiltration of surface water into the ground. Groundwater often flows in complex patterns relating to topography and bedrock geology, sometimes traversing long distances before emerging at a lower point on the landscape. Groundwater seepage wetlands receive their primary water inputs through groundwater inflows. This occurs when the groundwater surface intersects with the land surface (Mitsch and Gosselink 1993). These wetlands often have organic soils due to long-term soil saturation. The volume and flow of groundwater is another important determinant of groundwater wetland systems. Generally, the size of the groundwater community is somewhat proportional to the volume of the discharge, although local topography also plays a major role.

Except for the Mountain / Piedmont Acidic Seepage Swamp west of County Route 629, all occurrences of this natural community at BRMNAP have their immediate surface watershed protected. The seepage wetlands in Jackson Hollow and along County Route 629 are undoubtedly impacted to some degree by the roads nearby (Forman and Alexander 1998), although little can be done about this impact.

It is not known whether the groundwater that feeds the seepage swamps is derived from a local water table or a more regional aquifer. An important question is whether the groundwater of the seepage swamps is affected by groundwater contamination or well pumping outside of the preserve. Currently, the quality and quantity of the water in the preserve's seeps and streams appears to be good (Fleming 2002). More baseline data on water resources of BRMNAP would be helpful in determining long-term viability of the seeps and streams.

Development pressures. New housing with associated roads, well and septic systems, landscaped yards, and domestic animals have direct and indirect impacts on a landscape. Invariably, they create more edge habitats which further fragments the landscape and disrupts ecosystem processes. In particular, the network of roads that comes with new development creates negative ecological impacts beyond just the effect of construction of new buildings (Forman and Alexander 1998). To mitigate these impacts VOF should continue to pursue conservation easements and land acquisition of key tracts surrounding the preserve.

Air pollution. Ozone damage to tree foliage has been documented in the Appalachians. In the Blue Ridge Mountains of northern Virginia ozone damage has caused some growth loss in trees (SAMAB 1996b). Ozone exposure stresses forest communities and can exacerbate the effects of drought and insect attacks.

Elevated levels of atmospheric deposition of sulfate and nitrate occurs at higher elevations in the Blue Ridge Mountains of northern Virginia (SAMAB 1996a). Heavy deposition of these materials has the potential to acidify soils at high elevations, reducing productivity and altering stream chemistry. Additionally, many lichen species are sensitive to airborne pollutants and may be extirpated from an area when certain exposure levels are reached.

Occasional or chronic acidification of streams by sulfur and nitrogen oxide pollutants in the atmosphere creates acid rain and leads to elevated levels of dissolved aluminum, which in turn can reduce survival and diversity of macroinvertebrates and fish populations in sensitive streams (SAMAB 1996a). The bedrock geology of BRMNAP consists of a mixture of rock types including acidic quartzite and phyllite, but also includes base-rich metabasalt. Thus, the buffering capacity of the area's geology is variable and has not been quantified.

The extent to which excessive ozone and/or deposition of sulfates and nitrates are affecting the Bull Run Mountains is unknown. Assessing these kinds of impacts is beyond the expertise of VOF and DCR-DNH, and outside assistance would be needed in

order to gauge these impacts at BRMNAP. The Virginia Department of Environmental Quality and the U.S. Environmental Protection Agency could be contacted to help determine if air pollutant levels are negatively impacting the forests of the preserve. If air pollution is a current threat to the biota of BRMNAP, options for mitigation are limited and are likely beyond the ability of natural area preserve stewards to effect management. Stream acidification can be mitigated to some degree by liming (SAMAB 1996a); however, reducing ozone and other air pollutants requires governmental policy changes at levels far beyond the boundaries of the preserve and not within the control or influence of the organizations involved in its stewardship.

Fire Management Issues

Fire management is an important facet of natural areas management in Virginia. Fire management includes all activities associated with the management of fire-prone land, including the use of prescribed fire to meet land management goals and objectives. Prescribed fire is a unique and distinct component of natural areas stewardship combining elements of both biological and operations management. Fire management activities include both prescribed fire implementation and wildfire management.

Fleming (2002) provides ample documentation of the historical role of fire in the natural communities at BRMNAP. Wildfire was historically a pervasive process in the Bull Run Mountains and was a key ecological factor up until the beginning of effective widespread fire suppression, beginning around the 1930s. This pattern was similar throughout the northern Piedmont of Virginia (Orwig and Abrams 1994). Fire likely maintained the dominance of oaks and pines in most communities of BRMNAP. Today, in the absence of periodic fires, fire-sensitive species such as red maple are aggressively invading oak forest understories throughout the preserve. In particular, Acidic Oak-Hickory Forests on lower slope positions appear to be undergoing successional replacement by beech on many sites. Although red maple and black gum dominate the understory, Chestnut Oak Forests appear to be more resistant to successional change (Fleming 2002) with ample chestnut oak recruitment – due to more harsh growing conditions on the upper slopes. Pine stands at BRMNAP, except for those growing on the very harsh sites at High Point cliffs, are not reproducing. The Pine-Oak / Heath Woodlands are succeeding to Mixed Oak / Heath Forests.

Thousands of acres of Pine-Oak / Heath Woodlands occur in extensive and more manageable stands on National Forests in Virginia's mountains and Table Mountain-pitch pine forests are increasingly being managed with fire by the Forest Service. Although the Pine-Oak / Heath Woodlands at BRMNAP are at the edge of their range, they do not support rare taxa and the community type itself is not globally rare. More extensive stands of Table Mountain pine occur at DCR's Poor Mountain NAP which support the largest known population of the globally rare plant, piratebush (*Buckleya distichophylla*). Currently, Poor Mountain NAP is a higher priority than BRMNAP as a focus for the DCR-DNH fire program's limited resources.

Although at present DCR-DNH cannot begin planning and implementation of prescribed fire management at BRMNAP, the issue will be revisited in five years (the next revision

of this management plan). At that time, a fire management plan may be developed for the preserve by DCR-DNH staff. In the meantime, VOF could investigate wildland fire training opportunities for its volunteer stewardship committee members and make contacts with local fire departments regarding resources (trained personnel and equipment) for possible assistance with wildland fire management at BRMNAP. By providing trained wildland fire fighters to DCR-DNH, VOF could favorably impact the cost/benefit ratio associated with the application of prescribed fire at BRMNAP. Trained wildland fire fighters need to complete training, attend field exercises, and meet physical fitness standards set by the National Wildfire Coordinating Group. The DCR-DNH Natural Areas Fire Manager can be contacted for more information on wildland fire training programs.

In addition, VOF could contact the local Virginia Department of Forestry (DOF) field office to discuss a wildfire management contingency plan for the area and alert the DOF to a potentially dangerous urban interface wildfire hazard along the eastern boundary of BRMNAP where housing developments currently adjoin extensive areas of Oak-Pine / Heath Forests containing heavy fuel loads.

Operations Management Issues

Operations management is a crucial aspect of natural areas stewardship, especially on lands where recreational uses by members of the public may conflict with the primary management objective of protecting natural heritage resources. Natural area managers must design and maintain infrastructure such as trails, signs and observation areas to provide high quality visitor experiences, while protecting natural heritage resources from adverse human effects. Routine operations management activities include boundary line and access road maintenance, site security, visitor safety, and law enforcement. Since BRMNAP is owned and managed by VOF, site operations will be different than on a preserve owned by the Commonwealth. DCR-DNH operations stewards may assist VOF and BRMC as needed to accomplish operational objectives, but the presence of DCR-DNH operations stewards at BRMNAP will be less frequent than at state-owned NAPs. However, the local presence of VOF staff (with the office at Aldie), the local volunteer stewardship committee, VOF residences and tenants, and the BRMC office on the south preserve boundary provides a continuous and visible staff presence.

Federal and state natural resource laws. Laws that may affect the management of BRMNAP are noted in Appendix F. The conservation emphasis of NAP management means that VOF and DCR-DNH will rarely engage in land or water modifications subject to regulation. However, small-scale construction to provide visitor access must comply with federal and state laws that require mitigation of environmental impacts (i.e., erosion and sediment control laws and wetland protection laws). Decisions to permit fishing or hunting must comply with federal and state game laws. At BRMNAP, VOF's and DCR-DNH's efforts to control invasive species, protect rare and endangered species, and protect existing historic resources fulfill the requirements of several natural resource laws. DCR-DNH will work with VOF to enforce existing state laws and natural area regulations and will coordinate with other state and local law enforcement personnel as needed. Special attention will be devoted to posting boundary signs to reduce the chance

of encroachment and to minimize illegal hunting and off-road vehicle use on the preserve.

Visitor management. As stated in the Policy and Management Approach sub-section, the north unit of the preserve will continue to be managed as an area without open public access. Access will be by permission of VOF for natural history field trips, research, and environmental education. The south unit of the preserve will continue to be managed for open public access, but with restrictions so as to prevent natural resource degradation.

Appropriate uses and hiking trails. Normally appropriate uses of the preserve include: birding, wildlife-watching, wildflower and native plant observation, photography, hiking, research, teaching, and interpretation. See the DCR Natural Area Preserve Management Guidelines (Appendix C) for more information on public use of NAPs. Public use of BRMNAP for general hiking and nature study will be restricted to developed trails in the south unit of the preserve. Hiking trails allow visitors to appreciate and enjoy the biota, natural history, and natural beauty of BRMNAP as well as affording good exercise. However, all trails – even well-designed and constructed foot trails – have some negative impacts on natural resources (Hammitt and Cole 1987). Trails invariably create some degree of soil alteration (compaction and erosion), create vectors for edge species that are sometimes invasive (Hickman 1990; Adkison and Jackson 1996) and can disrupt breeding bird populations (Miller et al. 1998). Hiking off the designated trail bed can negatively influence natural communities, as well. Off-trail hiking at BRMNAP should be limited to resource management activities, research and monitoring, and periodic interpretive walks.

Trails should funnel people away from sensitive features while at the same time highlight the area's natural history. Historically, the cliffs at High Point Mountain have been accessed by hikers. Visitors/hikers currently use this area despite the fact that it is not officially open to the public due to a boundary dispute. If VOF secures access to the land leading up to High Point Mountain, the public should be allowed access to this feature in a limited way. A well-marked trail could funnel people to two designated vista points at this site. Non-obtrusive signs should indicate the hazards of the cliffs and the prohibited and unauthorized nature of rock climbing and rappelling on the preserve. All other unofficial feeder trails leading to the cliffs at High Point Mountain will be closed off and allowed to re-vegetate.

The concept of a "Mill-to-Mill Trail " (the old mill site at Thoroughfare Gap to Aldie's Mill) has been described in multiple publications, most notably the Virginia Outdoors Plan. Such a trail would follow the crest of the Bull Run Mountains from Thoroughfare Gap to Aldie's Mill. If such a trail were developed that crossed the BRMNAP, it would need to be designed to minimize adverse natural resource impacts and overuse. This trail corridor would be designed to have limited access and provide for "through hikers" primarily. There would be two parking lots with trailheads: One at Thoroughfare Gap and the other at Aldie's Mill. An additional trailhead with public road access might be located approximately half-way along the trail. The trail would be designed to the most

recent Appalachian Trail Conference standards (e.g., a 4-ft wide by 8-ft tall clearance with a 2-ft wide natural surface tread).

Adjacent landowner liability issues. Landowners adjacent to the BRMNAP may want to enter into an easement or memorandum of understanding with VOF to allow public access to their land through VOF's land as part of the possible "Mill-to-Mill Trail" or to scenic overlooks at the cliffs on High Point Mountain. The Code of Virginia (Section 29.1-509) allows for private landowners to enter into an easement or memorandum of understanding with a locality or governmental entity that provides them protection from liability if they grant the public access to their land for outdoor recreational purposes. Under this section of the Code of Virginia, the landowner waives their liability and the liability falls back upon the locality or government entity.

Inappropriate uses. Deterring the following inappropriate uses will require some level of operational work, e.g., on-site staff/tenant/volunteer presence, public contact and outreach efforts, or law enforcement (enforcement will require marked NAP boundaries).

- *Rock climbing and rappelling* have negative impacts on cliff and rock outcrop plant and animal communities, particularly for sensitive bryophyte taxa (McMillan and Larson 2002) and for cliff-using bird and bat species. These activities need to be deterred/precluded at BRMNAP to prevent degradation of the outstanding cliff communities at High Point Cliffs that support an exceptional diversity of lichens (Fleming 2002).

- *Horseback riding* on trails creates more erosion, soil compaction, and introduction of non-native plant species does use by hiking alone (Whittaker 1978; Summer 1980; Hammitt and Cole 1987; Adkison and Jackson 1996). While hiking trails can also impact natural resources negatively, damage from horse trails is often greater and more pervasive. Horseback riding is considered an inappropriate activity on Virginia's NAPs (Natural Area Preserve Management Guidelines 2000). Horses should not be allowed on hiking trails at BRMNAP, but could be allowed on gravel roads that border and bisect parts of the preserve.

- *Off-road vehicles (ORVs)* such as all-terrain vehicles pose one of the fastest growing threats to wildlands. Off-road vehicles, with their growing popularity and technological advances, are splintering the landscape into a web of trails and roads. These vehicles are built to travel across rugged landscapes and can cause severe disruption to the soil, facilitate the spread of invasive plants, and disturb sensitive and endangered wildlife. Soil impacts from ORVs include erosion, compaction and rutting (Webb et al. 1978; Webb and Wilshire 1983; Kuss et al. 1990). ORVs are particularly hard on hydrologic regimes and wetlands (Defenders of Wildlife 2002). ORVs can easily degrade natural communities by crushing vegetation and rutting the soil. For these reasons, ORVs are a highly inappropriate use on NAPs. Resource management use of ORVs will be limited to driving on established trails, old roads, and fire lines.

- *Mountain biking,* like all recreational activities, affects land and resources. The number of mountain bike users has increased steadily, as have impacts. These impacts can be classified broadly into the following categories: Trampling, erosion, and wildlife disturbance. Research is not conclusive as to whether mountain bikes create greater soil and vegetation impact than hiking trails (Cessford 1995). However, the speed at which mountain bikes travel creates user conflicts with hikers and those studying nature from trails (Grost 1989; Watson et al. 1991; Chavez et al. 1993). Mountain biking is an inappropriate use of NAPs and disrupts/conflicts with appropriate uses such as birding/wildlife watching.

- *Unleashed dogs and feral cats* disrupt or prey on ground-nesting birds (Yalden and Yalden 1990; Mitchell and Beck 1992) and terrestrial fauna. Pets must be restrained by a leash on NAPs at all times. Feral cats, dogs, or livestock that become established at BRMNAP should be trapped and removed from the preserve.

- *Camping* causes long-term concentrated impacts on soils and vegetation from trampling and fire rings (Marion and Cole 1996), and is an inappropriate use of NAPs. Virginia State Parks and nearby National Parks offer a wide array of camping opportunities.

- *Collection of plants, animals, minerals or artifacts* has direct impacts on the natural resources of a NAP and can quickly decimate populations of rare plants or animals. For this reason, collection of these materials are prohibited except for the non-commercial, incidental gathering of common species (e.g. blackberries) for personal consumption. Collection of plants, animals, minerals or artifacts for research or educational purposes requires a permit approved by DCR-DNH.

Hunting and trapping. Hunting and trapping at BRMNAP will be permitted only to meet certain resource management objectives and not as a general recreational activity. VOF and DCR-DNH should work with DGIF in developing a set of guidelines for these activities at BRMNAP. A BRMNAP volunteer stewardship committee will continue to hunt deer on the preserve in exchange for continued volunteer operations assistance (e.g., boundary marking and invasive species control). The volunteer stewardship committee will work with DGIF in developing and implementing a deer management plan for the BRMNAP.

VOF-owned residences on the NAP. VOF owns three rental houses and one historic structure on BRMNAP. The rental houses are: The Robinson/Yellow House and the Jackson Hollow House on the north unit of the preserve, and Catlett's Branch House on the south unit. By renting these houses to responsible tenants, these houses provide an additional site presence on the preserve that likely dissuades illegal and/or inappropriate uses at BRMNAP. The Creel House (located on the north unit) is a historic structure and would require major renovations to be habitable.

Data Gaps and Research Needs

A variety of data gaps and research needs exist in regard to management issues at BRMNAP. Further research and inventory will be required to address these questions, which include:

- What is the appropriate density of deer at BRMNAP to support viable native plant populations?
- What are the quantitative impacts of deer herbivory on the vegetation of the preserve?
- Can chestnut oak forests sustain themselves in the absence of fire?
- Do mixed dry-mesic oak (*Quercus alba, rubra, velutina*) forests retain a diverse ground flora as they succeed to stands more dominated by shade tolerant trees (e.g. *Acer rubrum*, *Fagus grandifolia, Nyssa sylvatica*)?
- What are the recharge areas for the seepage wetlands? Are the seeps fed by a shallow and local aquifer or a more regional and deep aquifer? Are groundwater baseflows being maintained? What does the hydrograph of the seeps look like?
- What is the water chemistry of the seeps? Are the seeps becoming overly acidic in relation to acid rain or nitrate deposition?
- What new developments are there in the control of invasive, exotic species that threaten BRMNAP?
- What are the spring-feeding lepidoptera fauna that could be potentially impacted by gypsy moth control efforts?
- How will recent and future gypsy moth control treatments affect populations of non-target lepidopertans?
- What are the aquatic communities on the NAP? What is the aquatic invertebrate diversity like? Are there management concerns for these communities/species?
- Can Pine-oak/Heath Woodlands be restored on a small scale with repeated low-intensity burns and thinning?
- Do early-successional forests established on old-fields during the current era of rapid exotic plant invasions ever develop diverse, native-species ground floras?
- What bird, mammal, reptile, amphibian, and invertebrate species occur at BRMNAP?
- What is the historical/archaeological significance of artifacts on the preserve?
- Where do these artifacts occur and how should they be managed?

Monitoring. A wide variety of monitoring techniques are used to assess change in natural community composition and rare species population status. Monitoring can determine if natural processes essential to natural heritage resources health are occurring and whether or not management actions have been effective. Monitoring is also needed to document effects of human visitation and public use patterns on natural heritage resources and other natural features protected within natural areas. The term "monitoring" describes several different types of data collection related to resource management and includes inventory, natural history study, research, implementation monitoring, trend measurement, baseline measurement, and long-term ecological studies (Elzinga et al. 1998). Monitoring in a strict sense is "the collection and analysis of repeated observation or measurements to evaluate changes in condition and progress

towards meeting a management objective" (Elzinga et al. 1998). This strictly defined mode of monitoring is the mode immediately relevant for rigorously measuring change.

Research. Research to improve understanding of natural history, biology, and population dynamics of rare species and ecosystem functions is needed for sound and defensible management planning. Scientific studies are conducted by DCR-DNH or sponsored through funding support in order to inform stewardship decisions and actions. Studies to be conducted on BRMNAP will require prior submission of a Research and Collecting permit application, review and approval by DCR-DNH and VOF staff, and issuance of a written permit. At BRMNAP, 48 400 m^2 (4,306 ft^2) vegetation plots (with comprehensive environmental, structural and floristic data) have been permanently marked to facilitate future monitoring and research efforts (Fleming 2002). Future terrestrial biological studies will use these plots in most cases.

Management Units

In order to more efficiently conserve natural heritage resources and to expedite site operations management, natural areas are subdivided into administrative and management units. In particular, when property ownership patterns involve separate and noncontiguous tracts of land (as with BRMNAP), it is appropriate to describe, map, conduct planning, and manage tracts individually. For purposes of this management plan for BRMNAP, the preserve has been divided into two *administrative units* (North Unit, 1,365 acres; South Unit, 1,121 acres) (Figure 2). *Management units* were then delineated within each of the two administrative units. Management units are smaller areas of land that in many ways are analogous to the concept of compartments in forest management. Management units are subjectively based upon a combination of geographic, ecological and operational factors; e.g., landforms, land ownership, roads, streams, watersheds, wetlands, ecological communities, rare plant or animal populations, soil types and bedrock geology. Management units provide managers a method to conveniently map and organize information about a preserve and facilitate application of management treatments.

At BRMNAP, 11 management units have been delineated and described (Figures 8-11; Table 4). Not all management units have the same need or priority for management actions. Need depends on (1) the abundance, type, and quality of natural heritage resources contained within a unit, (2) the degree of threats to those resources, and (3) the practicality and likely effectiveness of applying a treatment to abate identified threats. At BRMNAP, the following general unit priorities apply:

Units 6, 8 and 9 – High Priority
Units 1, 3 and 4 – Moderate Priority
Units 2, 5, 7, 10 and 11 – Low priority

Table 4. Rarity, size, and distribution of ecological communities by management unit.

Ecological Community Type	Global/State Rank	Acreage (% of NAP)	Management Units (in order of predominance)
Acidic Oak-Hickory Forests	G?/S?	206 (8%)	8, 9, 6, 3, 7, 11
Basic Mesic Forests	G?/S4	28 (1%)	8, 9, 3, 6
Basic Oak-Hickory Forests	G3G4/S3?	301 (12%)	4, 9, 8, 1
Chestnut Oak Forests	G5S5	952 (39%)	3, 9, 5, 10, 8, 7, 1, 6
Early-Successional / Disturbed Forests; Old Home Sites; Other Disturbed Upland Sites	N/A	525 (21%)	11, 2, 4, 6, 10
Early-Successional / Disturbed Wetlands	N/A	23 (0.8%)	6, 11
Eastern Hemlock-Hardwood/ *Rhododendron maximum* Forest	G?/S2	2 (0.1%)	7
Low-Elevation Boulderfield Forests and Woodlands	G?/S?	15 (0.6%)	8, 6
Mesic Mixed Hardwood Forests	G?/S4	219 (9%)	9, 1, 3, 6, 11, 7
Mountain / Piedmont Acidic Seepage Swamps	G3G4/S3?	37 (1.5%)	6, 3, 2, 7
Piedmont / Mountain Acidic Cliffs	G?/S?	N/A	8
Pine-Oak / Heath Woodlands	*Pinus pungens* subtype (G4S4) *Pinus rigida* subtype (G4S3)	179 (7%)	5, 7, 8, 10

The North Administrative Unit of BRMNAP lies north of Hopewell Gap and County Route 601, comprising 1,365 acres subdivided into six management units (Units 1-6) (Figures 8-9). Unlike the South Administrative Unit, the North Unit is closed to general public use. Public use of the North Unit will be by permission from VOF only and limited mostly to educational and scientific uses.

The South Administrative Unit extends from Thoroughfare Gap and the I-66 corridor north to Hopewell Gap, comprising 1,121 acres subdivided into five management units (Units 7-11) (Figures 10-11). BRMC currently leases 800 acres from VOF in the southern portion of the South Unit for environmental education purposes (Figure 2) (Appendix D). A network of official, established (marked) hiking trails (Figure 12) extends for 7 miles through this area in addition to some existing old roads and unofficial hiking trails. That portion of the preserve currently leased to BRMC is designated as a public use concentration area for BRMNAP and appropriate parking and trail facilities exist to support this designation.

Unit 1. (See Figure 8). 106 acres. This unit is composed of Chestnut Oak Forests (60%; EO #26), Mesic Mixed Hardwood Forests (20%; EO #19) and Basic Oak-Hickory Forests (20%).

Management issues
- Deer overpopulation
- Gypsy moth outbreaks
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*)

Management actions (Medium priority unit)
- Control deer through regulated hunting
- Control gypsy moth through an integrated pest management approach
- Target specific, treatable populations of invasive, exotic plant species that invade higher quality stands of native vegetation in mesic and basic habitats
- Control invasive plants using herbicides, mowing/cutting, hand pulling, girdling, or prescribed fire depending on the species and infestation

Unit 2. (See Figure 8). 155 acres. This unit is composed of early-successional / disturbed forest (90%) and Mountain / Piedmont Acidic Seepage Swamps (10%). No natural heritage EOs are presently recorded. Seepage swamps will likely be EOs once they are surveyed. This unit is a high priority for additional inventory efforts.

Management issues
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*)
- Hydrology of seepage wetlands
- Beaver impacts on seepage wetlands
- Residence owned by VOF: Robinson/Yellow House
- The historic Creel House structure

Management actions (Low priority unit)
- Defer actions until issues are resolved in high and medium priority units
- Monitor beaver activity

Unit 3. (See Figure 8). 392 acres. This unit is composed of Chestnut Oak Forests (70%; EO #26), Acidic Oak-Hickory Forests (10%), Mesic Mixed Hardwood Forests (10%), Mountain / Piedmont Acidic Seepage Swamps (5%; EO #11) and Basic Mesic Forests (5%). The ridgeline forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*)
- Hydrology of seepage wetlands
- Beaver impacts on seepage wetlands
- Deer overpopulation

- Gypsy moth outbreaks
- Dogwood anthracnose

Management actions (Medium priority unit)
- Target specific, treatable populations of invasive, exotic plant species that invade higher quality stands of native vegetation in mesic and basic habitats
- Control invasive plants using herbicides, mowing/cutting, hand-pulling, girdling, or prescribed fire depending on the species and infestation
- Maintain/restore watershed and recharge area for seepage wetlands
- If beavers begin constructing dams that impact seepage wetlands, initiate trapping to eliminate the beavers following DGIF recommendations and regulations for beaver trapping
- Control deer population through regulated hunting
- Control gypsy moth through an integrated pest management approach

Unit 4. (See Figure 9). 229 acres. This unit is composed of Basic Oak-Hickory Forests (70%; EO #26) and early-successional/disturbed forests (30%). The upper slope forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues
- Deer overpopulation
- Gypsy moth outbreaks
- Dogwood anthracnose
- Invasive, exotic plant species (primarily *Symphoricarpos orbiculatus* and *Rubus phoenicolasius*)

Management actions (Medium priority unit)
- Control deer through regulated hunting
- Control gypsy moth through an integrated pest management approach
- Target specific, treatable populations of invasive, exotic plant species that invade higher quality stands of native vegetation in mesic and basic habitats
- Control invasives using herbicides, mowing/cutting, hand-pulling, girdling or prescribed fire depending on the species and infestation

Unit 5. (See Figure 9). 326 acres. This unit is composed of Chestnut Oak Forests (70%; EO #26) and Pine-Oak / Heath Woodlands (30%; EO #9).

Management issues
- Gypsy moth outbreaks
- Fire suppression
- Dogwood anthracnose
- Residence owned by VOF (Jackson Hollow House)

Management actions (Low priority unit)
Defer actions until issues are resolved in high and medium priority *units unless major gypsy moth outbreak occurs*. If outbreaks occur, control gypsy moth through an integrated pest management approach.

Unit 6. (See Figure 9). 159 acres. This unit is composed of Mesic Mixed Hardwood Forests (30%), early-successional / disturbed forests and early-successional / disturbed wetlands (30%); Acidic Oak-Hickory Forests (30%), Mountain / Piedmont Acidic Seepage Swamps (5%; EO #10), Chestnut Oak Forests (2.5%; EO #26) and Basic Mesic Forests (2.5%).

Management issues
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*)
- Hydrology of seepage wetlands
- Beaver impacts on seepage wetlands
- Road and trail use impacts on seepage wetlands
- Deer overpopulation

Management actions (High priority unit)
- Target specific, treatable populations of invasive, exotic plant species that invade higher quality stands of native vegetation in mesic and basic habitats
- Control invasive plants using herbicides, mowing/cutting, hand-pulling, girdling or prescribed fire depending on the species and infestation
- Maintain/restore watershed and recharge area for seepage wetlands
- If beavers begin constructing dams that impact seepage wetlands, initiate trapping to eliminate the beavers following DGIF recommendations and regulations on beaver trapping
- Control deer population through regulated hunting

Unit 7. (See Figure 10). 115 acres. This unit is composed of Chestnut Oak Forests (55%; EO #26), Pine-Oak / Heath Woodlands (20%; EO #9), Acidic Oak-Hickory Forests (15%), Mountain / Piedmont Acidic Seepage Swamps and early-successional / disturbed forests (5%); and Mesic Mixed Hardwood Forests (5%). The east facing upper slope forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues
- Fire suppression
- Gypsy moth outbreaks
- Residence owned by VOF: Catlett's Branch House

Management actions (Low priority unit)

- Defer actions until issues are resolved in high and medium priority units *unless major gypsy moth outbreak occurs*. If outbreaks occur, control gypsy moth through an integrated pest management approach.

Unit 8. (See Figure 10). 198 acres. This unit is composed of Acidic Oak-Hickory Forests (30%), Basic Oak-Hickory Forests (20%; EO #27), Chestnut Oak Forests (20%; EO #26), Pine-Oak / Heath Woodlands (15%; EO #9), Piedmont / Mountain Acidic Cliffs and Low-Elevation Boulderfield Forests (10%; EOs #2 and #10) and Basic Mesic Forests (5%; EO #29). The ridgeline forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues

- Gypsy moth outbreaks
- Fire suppression
- Deer overpopulation
- Dogwood anthracnose
- Rock climbing
- Hiking trails (official and unofficial)
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*)

Management actions (High priority unit)

- Control gypsy moth through an integrated pest management approach
- Control deer through regulated hunting
- Develop trail signs to deter hikers from accessing High Point Mountain until boundary disputes are resolved and such time as access is legitimate. A turn around point could be created at the lowest point of the High Point cliffs that is currently owned by VOF that would serve as a destination for hikers. (See Operations Management Issues section for discussion)
- Maintain hiking trails to prevent degradation to natural communities
- Discourage rock climbing through signs. If rock climbing on the cliffs becomes more constant or severe use enforcement efforts (e.g., foot patrols, citations)
- Target specific, treatable populations of invasive, exotic plant species that invade higher quality stands of native vegetation in mesic and basic habitats
- Control invasive plants using herbicides, mowing/cutting, hand-pulling, girdling, or prescribed fire depending on the species and infestation

Unit 9. (See Figure 11). 326 acres. This unit is composed of Chestnut Oak Forests (35%; EO #26), Mesic Mixed Hardwood Forests (25%; EO #20), Basic Oak-Hickory Forests (25%; EO #27), Acidic Oak-Hickory Forests (8%), Basic Mesic Forests (5%; EO #29) and early-successional / disturbed forests (2%). The east facing upper slope forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues
- Deer overpopulation
- Gypsy moth outbreaks
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*)
- Dogwood anthracnose
- Hiking trails (official and unofficial)

Management actions (High priority unit)
- Control deer through regulated hunting
- Control gypsy moth through integrated pest management
- Target specific, treatable populations of invasive, exotic plant species that invade higher quality stands of native vegetation in mesic and basic habitats
- Control invasive plants by using herbicides, mowing/cutting, hand-pulling, girdling or prescribed fire depending on the species and infestation
- Maintain hiking trails to prevent degradation to natural communities

Unit 10. (See Figure 11). 138 acres. This unit is composed of Chestnut Oak Forests (80%; EO #26); Acidic Oak-Hickory Forests and Mesic Mixed Hardwood Forests (10%); Pine-Oak / Heath Woodlands (5%; EO #9) and early-successional / disturbed forests (5%). The east facing upper slope forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues
- Gypsy moth outbreaks
- Fire suppression

Management actions (Low priority unit)
Defer actions until issues are resolved in high and medium priority units, *unless major gypsy moth outbreak occurs*. If severe outbreak occurs, control gypsy moth through an integrated pest management approach.

Unit 11. (See Figure 11). 342 acres. This unit is composed of early-successional / disturbed forests (70%), Mesic Mixed Hardwood Forests (10%), Acidic Oak-Hickory Forests (10%), Chestnut Oak Forests (5%) and early-successional / disturbed wetlands (5%). No natural heritage EOs. The east facing upper slope forests received some scattered wind throw damage from Hurricane Isabel in September 2003.

Management issues
- Invasive, exotic plant species (primarily *Microstegium vimineum*, but also *Alliaria petiolata*, *Rubus phoenicolasius*, and *Lonicera japonica*).
- Deer overpopulation.
- Hiking trails (official and unofficial).
- ORV trespass and entry points.

Management actions (Low priority unit, except for ORV trespass issue)

- Control ORV trespass through signs, barricades, and enforcement (e.g. patrols, citations) as necessary

LAND ACQUISITION AND PROTECTION NEEDS

To adequately protect and conserve the larger landscape ecosystem of the Bull Run Mountains will require further land acquisitions and/or conservation easements around the current BRMNAP. Ideally, all lands that encompass the conservation site of Bull Run Mountains (Figure 13) would be under some form of land protection. Habitat fragmentation will increasingly threaten the viability of the preserve in the future. To help protect critical lands supporting natural heritage resources, critical linkages and buffer lands, priorities must be placed on further acquisition/easement efforts. Land acquisition/conservation easement targets for inclusion in BRMNAP or to serve as important buffer lands are prioritized below and illustrated in Figures 14 and 15.

High Priority

1. High Point Mountain summit (Figure 14): includes element occurrences (partial or whole) of the following ecological communities: Chestnut Oak Forest (EO #026), Basic Mesic Forest (EO #029), Basic Oak-Hickory Forest (EO #027), Pine-Oak / Heath Woodland (EO #009) and Piedmont / Mountain Acidic Cliff (EO #002). Also includes part of the state significant geologic feature of the exposed quartzite cliffs at High Point. As of September 2003, the Smith Tract (55 ac) has been purchased. This tract protects the south ¼ of this protection priority area (Figure 14).
2. West Slope of High Point Mountain (Figure 14): includes element occurrences (partial or whole) of the following ecological communities: Mountain / Piedmont Acidic Seepage Swamp (EO #015), Basic Mesic Forest (EO #29), Chestnut Oak Forest (EO #026) and Basic Oak-Hickory Forest (EO #27).
3. West Slope of High Acre Ridge (Figure 15): includes element occurrences (partial or whole) of the following ecological communities: Mountain / Piedmont Acidic Seepage Swamp (EO #012) and Chestnut Oak Forest (EO #026) and a state rare plant, nodding trillium (*Trillium cernuum* – EO #007).
4. Catharpin Creek Headwaters (Figure 15): includes element occurrences (partial or whole) of the following ecological communities: Mountain / Piedmont Acidic Seepage Swamp (EO #010) and Chestnut Oak Forest (EO #026) and a state rare plant, nodding trillium (*Trillium cernuum* – EO #001). Also includes the riparian buffer area surrounding Catharpin Creek flowing into Jackson Hollow and White Rock Spring.

Medium Priority

1. Bartons Creek Headwaters (Figure 15): includes element occurrence of a Mountain / Piedmont Acidic Seepage Swamp (EO #013) and associated riparian buffer.

2. Little Bull Run Headwaters (Figure 15): includes element occurrence of a Mountain / Piedmont Acidic Seepage Swamp (EO #014) and associated riparian buffer and a stand of Pine-Oak / Heath Woodland (EO #009) that borders an established road and could be more easily managed with prescribed fire than other stands of this ecological community.
3. Signal Mountain (Figure 15): includes element occurrences (partial or whole) of the following ecological community groups: Chestnut Oak Forest (EO #026) and Pine-Oak / Heath Woodland (EO #009). The presence of a decent road to the top of Signal Mountain would allow for the possibility of managing a stand of pine-oak / heath woodland with prescribed fire.

Low Priority

Any other parcels within the conservation site boundaries (Figure 13) that would create a contiguous block of protected forestland with the BRMNAP at the core of this landscape.

CONCLUSION

Management to protect and maintain biological diversity at BRMNAP will require ongoing learning and assessment to ensure that natural heritage resources are conserved. The complexity of ecosystems and a shortfall of stewardship resources (staff time and money) will usually preclude a full understanding of the effects of ongoing biological change and management actions used to direct that change. Since the human-dominated landscape of Virginia today is far different than that of the "natural" landscape of pre-industrial/pre-urban expansion America 500 years ago, "doing nothing" as a management strategy will often not conserve natural heritage resources. By taking an active and adaptive ecosystem management approach at BRMNAP (Walters and Holling 1990), by using the existing strong baseline of inventory data, and by monitoring trends in natural communities following management actions (e.g., assess the effectiveness of controlling an invasive species on plant species composition in a high quality stand of a natural community) it is likely that successful stewardship of natural heritage resources will be attained.

FIGURES 2-15

REFERENCES

Abrams, M.D. and C.A. Copenheaver. 1999. Temporal variation in species recruitment and dendroecology of an old-growth white oak forest in the Virginia Piedmont, USA. Forest Ecology & Management 124:275-284.

Abrams, M.D. and G.J. Nowacki. 1992. Historical variation in fire, oak recruitment, and post-logging accelerated succession in central Pennsylvania. Bulletin of the Torrey Botanical Club 119:19-28.

Abrams, M.D., C.M. Ruffner, and T.T. DeMeo. 1998. Dendroecology and species co-existence in an old-growth *Quercus-Acer-Tilia* talus slope forest in the central Appalachians, USA. Forest Ecology and Management 106:9-18.

Adkison, G.P. and M.T. Jackson. 1996. Changes in ground-layer vegetation near trails in Midwestern U.S. forests. Natural Areas Journal 16:14-23.

Alverson, W.S. and D.M. Waller. 1997. Deer populations and the widespread failure of hemlock regeneration in northern forests. Pp. 280-297 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.). The science of overabundance: deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

Anderson, R.C. 1994. Height of white-flowered trillium (*Trillium grandiflorum*) as an index of deer browsing intensity. Ecological Applications 4:104-109.

Augustine, D.J. and L.E. Frelich. 1998. Effects of white-tailed deer on populations of an understory forb in fragmented deciduous forests. Conservation Biology 12:995-1004.

Augustine, D.J., L.E. Frelich and P.A. Jordan. 1998. Evidence for two alternate stable states in an ungulate grazing system. Ecological Applications 8:1260-1269.

Balgooyen, C.P. and D.M. Waller. 1995. The use of Clintonia borealis and other indicators to gauge impacts of white-tailed deer on plant communities in northern Wisconsin. Natural Areas Journal 15:308-318.

Barden, L.S. 1987. Invasion of *Microstegium vimineum* (Poaceae), an exotic, annual, shade-tolerant, C4 grass, into a North Carolina floodplain. American Midland Naturalist 118: 40-45.

Burnham, K.P., D.R. Anderson and J.L. Laake. 1980. Estimation of density from line transect sampling: estimating abundance of biological populations. Wildlife Monographs 72, The Wildlife Society, Bethesda, MD.

Cessford, G.R. 1995. Off-road mountain biking: a profile of riders and their recreation settings and experience preferences. Science & Research Series No. 93. New Zealand Department of Conservation. Wellington, New Zealand.

Chavez, D.J., P.L. Winter, and J.M. Baas. 1993. Recreational mountain biking: A management perspective. Journal of Parks and Recreation Administration 11(3):29-36.

Commission on Outdoor Recreation of the Commonwealth of Virginia. 1979. Virginia Outdoor Plan. Unpublished report.

Coulson, R.N. and J.A. Witter. 1984. Forest entomology. John Wiley & Sons, New York.

DCR-DNH. 2000. Natural Area Preserve Management Guidelines. Natural Heritage Technical Guidelines. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. Unpublished report. 11 pp.

deCalesta, D.S. 1994. Impact of white-tailed deer on songbirds within managed forests in Pennsylvania. Journal of Wildlife Management 58:711-718.

Defenders of Wildlife. 2002. Out of control: The impacts of off-road vehicles and roads on wildlife and habitat in Florida's national forests. Washington, D.C.

DGIF. 1999. Virginia's deer management plan. Wildlife Information Publication No. 99-1. Virginia Department of Game and Inland Fisheries. Richmond, Virginia.

Earth Design Associates, Inc. 1997. Thoroughfare Gap to Aldie – the Bull Run Mountain Preserve: Past, present and future. Unpublished report submitted to the Virginia Outdoors Foundation. 73 pp.

Egloff, K. and D. Woodward. 1992. First people: The early Indians of Virginia. University Press of Virginia.

Ehrenfeld, J.G. 1999. A rhizomatous, perennial form of *Microstegium vimineum* (Trin.) A. Camus in New Jersey. Journal of the Torrey Botanical Society 126(4): 352-358.

Elder, J.H. 1989. Soil survey of Prince William County, Virginia. USDA Soil Conservation Service in cooperation with Virginia Polytechnic Institute and State University. U.S. Government Printing Office, Washington, D.C.

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and monitoring plant populations. Bureau of Land Management, Denver, Colorado

Espenshade, G.H. 1970. Geology of the northern part of the Blue Ridge anticlinorium. Pp. 199-211 *in* G.W. Fisher et al. (eds.). Appalachian geology. Interscience Publishers, New York.

Fauquier County Bicentennial Committee. 1959. Faquier County, Virginia: 1759-1959. Virginia Publishing. Warrenton, Virginia.

Fleming, G.P. 2002. Ecological communities of the Bull Run Mountains, Virginia: Baseline vegetation and floristic data for conservation planning and natural area stewardship. Natural Heritage Technical Report 02-12. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. Unpublished report. 276 pp + appendices.

Fleming, G.P., A.C. Chazal, K.M. McCoy and C.S. Hobson. 1999. A Natural Heritage inventory of Virginia Outdoors Foundation properties on Bull Run Mountain, Virginia. Natural Heritage Technical Report 99-05. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. 32 pp. + appendix.

Fleming, G.P., P.P. Coulling, D.P. Walton, K.M. McCoy, M.R. Parrish. 2001. The natural communities of Virginia: Classification of ecological community groups. First Approximation. Natural Heritage Technical Report #01-1. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. Unpublished report. January 2001. 76 pp.

Forman, R.T.T., and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29:207-231.

Golet, F.C., A.J.K. Calhoun, W.R. DeRagon, D.J. Lowry and A.J. Gold. 1993. Ecology of red maple swamps in the glaciated northeast: A community profile. Biological Report 12, USDI Fish and Wildlife Service. Washington, D.C.

Gottschalk, K.W. 1993. Silvicultural guidelines for forest stands threatened by gypsy moth. General Technical Report NE-171. USDA Forest Service, Northeastern Forest Experiment Station. Radnor, Pennsylvania.

Grost, R. 1989. Managing the mountain bike. American Forests 95: 50-53, 75-77.

Hajek, A.E., J.S. Elkinton, and J.J. Witcosky. 1996. Introduction and spread of the fungal pathogen *Entomophaga maimaiga* along the leading edge of gypsy moth spread. Biological Control 25:1235-1247.

Hammerson, G.A. 1994. Beaver (*Castor canadensis*) ecosystem alterations, management, and monitoring. Natural Areas Journal 14 (1).

Hammitt, W.E. and D.N. Cole. 1987. Wildland recreation: Ecology and management. John Wiley and Sons, New York.

Healy, W.M. 1997. Influence of deer on the structure and composition of oak forests in central Massachusetts. Pp. 249-266 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.). The science of overabundance: Deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

Healy, W.M. and C.J.E. Welsh. 1992. Evaluating line transects to monitor gray squirrel populations. Wildlife Society Bulletin 20:83-90.

Hibben, C.R. and M.L. Daughtrey. 1988. Dogwood anthracnose in the northeastern United States. Plant Disease 72:199-203.

Hickman, S. 1990. Evidence of edge species' attraction to nature trails within deciduous forests. Natural Areas Journal 10:3-5.

Hiebert, R. and J. Stubbendieck. 1993. Handbook for ranking exotic plants for management control. USDI National Park Service, Midwest Regional Office, Omaha.

Horsley, S.B., S.L. Stout and D.S. DeCalesta. 2003. White-tailed deer impact on the vegetation dynamics of a northern hardwood forest. Ecological Applications 13:98-118.

Houston, D.R. 1994. Major new tree disease epidemics: Beech bark disease. Annual Review of Phytopathology 32: 75-87.

Houston, D.R. and J.T. O'Brien. 1983. Beech bark disease. Forest insect and disease leaflet No. 75. USDA Forest Service.

Hunt, D.M. and R.E. Zaremba. 1992. The northeastward spread of *Microstegium vimineum* (Poaceae) into New York and adjacent states. Rhodora 94(878):167-170.

Johnston, R.M. 1996. Bull Run: It's Strategy and Tactics. John Kallman Publishers. 293 pp.

Knox, W.M. 1997. Historical changes in the abundance and distribution of deer in Virginia. Pp. 27-36 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.). The science of overabundance: Deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

Kuss, F.R., A.R. Graefe, and J.J. Vaske. 1990. Visitor impact management: A review of research. Vol. I. National Parks and Conservation Association, Washington, D.C.

Liebhold, A., K. Thorpe, J. Ghent, and D.B. Lyons. 1994. Gypsy moth egg mass sampling for decision-making: A users' guide. USDA Forest Service. Forest Health Protection Publication NA-TP-04-94. Morgantown, WV.

Linzey, D.W. 1998. The mammals of Virginia. The McDonald & Woodward Publishing Co. Blacksburg, Virginia.

Marion, J.L. and D.N. Cole. 1996. Spatial and temporal variation in soil and vegetation impacts on campsites. Ecological Applications 6(2):520-530.

McCabe, R.E. and T.R. McCabe. 1997. Recounting whitetails past. Pp. 11-26 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.). The science of overabundance: Deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

McMillan, M.A. and D.W. Larson. 2002. Effects of rock climbing on the vegetation of the Niagara Escarpment in southern Ontario, Canada. Conservation Biology 16:389-398.

McShea, W.J. and J.H. Rappole. 1997. Herbivores and the ecology of understory birds. Pp. 298-309 *in* W.J. McShea, H.B. Underwood and J.H. Rappole (eds.). The science of overabundance: Deer ecology and population management. Smithsonian Institution Press, Washington, D.C.

Miller, S.G., S.P. Bratton, and J. Hadidian. 1992. Impacts of white-tailed deer on endangered and threatened vascular plants. Natural Areas Journal 12:67-74.

Miller, S.G., R.L. Knight, and C.K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Mitchell, J.C. and R.A. Beck. 1992. Free-ranging domestic cat predation on native vertebrates in rural and urban Virginia. Virginia Journal of Science 43:197-207.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. 2nd edition. John Wiley and Sons, Inc., New York.

Morisawa, T. 2003. *Adelges tsugae* (hemlock woolly adelgid). Element Stewardship Abstract. The Nature Conservancy.

National Park Service. 1965. Outdoor recreation in the National Capital Region. National Capital Open Space Program Technical Report No. 3. Prepared by USDI National Park Service, National Capital Region, Washington, D.C.

Neff, D.J. 1968. The pellet-count technique for big game trend, census, and distribution: A review. Journal of Wildlife Management 32:597-614.

Nuzzo, V.A. 1991. Experimental control of garlic mustard (*Alliaria petiolata* [Bieb.] Cavara & Grande) in northern llinois using fire, herbicide, and cutting. Natural Areas Journal 11:158-167.

Nuzzo, V.A. 2000. *Alliaria petiolata* (garlic mustard). Element Stewardship Abstract. The Nature Conservancy.

Nyboer, R. 1992. Vegetation management guideline: Japanese honeysuckle (*Lonicera japonica* Thumb.). Natural Areas Journal 12:217-218.

Orwig, D.A. and Abrams, M.D. 1994. Land-use history (1720-1992), composition, and dynamics of oak-pine forests within the Piedmont and Coastal Plain of northern Virginia. Canadian Journal of Forest Research. 24:1216-1225.

Poiani, K.A., B.D. Richter, M.G. Anderson, and H.E. Richter. 2000. Biodiversity conservation at multiple scales: Functional sites, landscapes, and networks. BioScience 50:133-146.

Rabinowitz, D. 1981. Seven forms of rarity. Pp. 205-218 *in* H. Synge (ed.). The biological aspects of rare plant conservation. Wiley and Sons, New York.

Rader, E.K. and H.H. Evans (eds.). 1993. Geologic map of Virginia – expanded explanation. Virginia Department of Mines, Minerals, and Energy, Division of Mineral Resources.

Reardon, R.C., J. Podgwaite and R. Zerillo. 1996. Gypcheck – the gypsy moth nucleopolyhedrosis virus product. Forest Health Technology Enterprise Team 96-16. USDA Forest Service, Morgantown, West Virginia.

Reardon, R.C. and A.E. Hajek. 1998. The gypsy moth fungus *Entomophaga maimaiga* in North America. Forest Health Technology Enterprise Team 97-11. USDA Forest Service, Morgantown, West Virginia.

Redman, D.E. 1995. Distribution and habitat types for Nepal Microstegium [*Microstegium vimineum* (Trin.) Camus] in Maryland and the District of Columbia. Castanea 60(3):270-275.

Richter, B.D., D.P. Braun, M.A. Mendelson, and L.L. Master. 1997. Threats to imperiled freshwater fauna. Conservation Biology 11:1081-1093.

Rooney, T.P. and W.J. Dress. 1997. Species loss over sixty-six years in the ground-layer vegetation of Heart's Content, an old-growth forest in Pennsylvania, USA. Natural Areas Journal 17:297-305.

Ross, N. 2002. Environmental assessment. Gypsy moth suppression. George Washington & Jefferson National Forests. Fiscal Year 2002. USDA Forest Service. February 1, 2002.

Russell, F.L., D.B. Zippin, and N.L. Fowler. 2001. Effects of white-tailed deer (*Odocoileus virginianus*) on plants, plant populations and communities: A review. American Midland Naturalist 146:1-26.

SAMAB. 1996a. Southern Appalachian Man and the Biosphere: The southern Appalachian assessment aquatics technical report. Report 2 of 5. USDA Forest Service, Southern Region, Atlanta.

SAMAB. 1996b. Southern Appalachian Man and the Biosphere: The southern Appalachian assessment atmospheric technical report. Report 3 of 5. USDA Forest Service, Southern Region, Atlanta.

SAMAB. 1996c. Southern Appalachian Man and the Biosphere: The southern Appalachian assessment terrestrial technical report. Report 5 of 5. USDA Forest Service, Southern Region, Atlanta.

Sellers, P.A. 2001. Forest health protection evaluation of the gypsy moth on the Deerfield, Dry River, Glenwood-Pedlar, James River, Lee, and Warm Springs ranger districts of the George Washington and Jefferson National Forests, Fiscal Year 2002. Forest Health Protection. Asheville Field Office. Report #01-01-15. USDA Forest Service. November 2001.

Southeast Regional Climate Center. 2002. Climatic summaries for Virginia stations. Available at Website: http://www.dnr.state.sc.us/climate/sercc/services.html.

Storm, G.L., R.H. Yahner, and J.D. Nichols. 1992. A comparison of two techniques for estimating deer density. Wildlife Society Bulletin 20:197-203.

Stovall, A.D. 1980. Bull Run Mountains Natural Area: A feasibility study. Unpublished report submitted to the Virginia Outdoors Foundation. 60 pp.

Summer, R.M. 1980. Impact of horse traffic in Rocky Mountain National Park. Journal of Soil and Water Conservation 35:85-87.

Swain, K.M. and M.C. Remion. 1981. Direct control methods for the southern pine beetle. USDA Forest Service. Handbook 575.

Teels, B.M. and T.J. Danielson. 2001. Using a regional index of biotic integrity (IBI) to characterize the condition of northern Virginia streams, with emphasis on the Occoquan watershed. WLI Case Study. USDA Natural Resources Conservation Service, Wetland Science Institute, Laurel, Maryland. 92 pp.

Tilghman, N.G. 1989. Impacts of white-tailed deer on forest regeneration in northwestern Pennsylvania. Journal of Wildlife Management 53:524-532.

Tu, M. 2000. Element Stewardship Abstract for *Microstegium vimineum*, stilt grass. The Nature Conservancy's Wildland Invasive Species Program.

USDA. 1995. Final environmental impact statement: Gypsy moth management in the US – a cooperative approach. USDA Forest Service. Washington, D.C. 5 volumes.

USFWS. 1993. Northeastern bulrush (*Scirpus ancistrohaetus*) recovery plan. USDI Fish and Wildlife Service. Hadley, Massachusetts.

Virginia Department of Conservation and Recreation. 1996. The 1996 Virginia outdoors plan. Unpublished report, Virginia Department of Conservation and Recreation, Division of Planning and Recreation Resources, Richmond, Virginia. 360 pp.

Virginia Outdoor Recreation Study Commission. 1965. Virginia's common wealth: A study of Virginia's outdoor recreational resources and the Virginia outdoors plan for conserving and developing them for lasting public benefit. Unpublished report.

Walters, C.J. and C.S. Holling. 1990. Large scale management experiments and learning by doing. Ecology 71:2060-2068.

Watson, A.E., D.R. Williams, and J.J. Daigle. 1991. Sources of conflict between hikers and mountain bike riders in the Rattlesnake National Recreation Area. Journal of Parks and Recreation Administration 9(3): 59-71.

Webb, R.H., H.C. Ragland, W.H. Godwin, and D. Jenkins. 1978. Environmental effects of soil property changes with off-road vehicle use. Environmental Management 2:219-233.

Webb, R.H., and H.G. Wilshire (eds.). 1983. Environmental effects of off-road vehicles: Impact and management in arid regions. Springer-Verlag, New York.

White, G.C. 1992. Do pellet counts index white-tailed deer numbers and population change? Journal of Wildlife Management 56:611-612.

Whittaker, P.L. 1978. Comparisons of surface impact by hiking and horseback riding in the Great Smoky Mountains National Park. USDI National Park Service, Southeast Region, Research/Resource Management Report No. 24.

Wilcove, D.S. and L.Y. Chen. 1998. Management costs for endangered species. Conservation Biology 12:1405-1407.

Wilcove, D.S., D Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience 48:607-615.

Wilson, J.M. 2001. Beavers in Connecticut: Their natural history and management. Connecticut Department of Environmental Protection, Wildlife Division. Hartford, Connecticut.

Woodward, S.L. and R.L. Hoffman. 1991. The nature of Virginia. Pp. 23-50 *in* J.N. McDonald and T. Skware (eds.). Virginia's endangered species: Proceedings of a symposium. The McDonald and Woodward Publishing Co., Blacksburg, Virginia.

Yalden, P.E. and D. Yalden. 1990. Recreational disturbance of breeding golden plovers, *Pluvialis apricarius*. Biological Conservation 51:243-262.

APPENDICES

A. Virginia Natural Area Preserves Act

B. Deed of Dedication for Bull Run Mountains Natural Area Preserve

C. DCR Natural Area Preserve Management Guidelines

D. Lease Agreement Between the Virginia Outdoors Foundation and Bull Run Mountains Conservancy (FOBR)

E. Natural Heritage Rarity Ranks and Status Explanation

F. Federal and State Natural Resource Laws

G. Glossary of Technical Terms and Abbreviations