APPENDIX E – ECOSYSTEM DIVERSITY REPORT

George Washington National Forest

April 2011

Updated February 2013

This page left intentionally blank

TABLE OF CONTENTS

1.0 INTRODUCTION

The ecological sustainability framework used to support Forest Plan revision for the George Washington National Forest (GWNF) is built on a foundation of ecosystem diversity. By restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems, the GWNF should be able to maintain and improve ecosystem diversity and also provide for the needs of diverse plant and animal species on the forest.

This Ecosystem Diversity Report describes the analysis process used to identify, evaluate, and develop guidance for sustaining ecological diversity. This report, and the Ecological Sustainability Evaluation database information from which it was derived, not only provide the overall framework for many of the plan components and the systems-based direction in the revised Forest Plan, but they are also expected to be an important source of data and guidance for sustaining native ecosystems and species when implementing the Plan.

The overall goal for ecological sustainability is to sustain native ecological systems and support diversity of native plant and animal species. Ecosystem diversity is defined as the variety and relative extent of ecosystem types including their composition, structure, and processes. The major characteristics of forest-wide ecosystem diversity and descriptions of the 24 ecological systems found across the GWNF are presented in this Ecosystem Diversity Report.

While most plant and animal species needs are expected to be met by sustaining ecosystem diversity, a corresponding species-specific analysis was also conducted to evaluate whether additional provisions were needed for federally listed species, sensitive species and locally rare species. This species-specific sustainability analysis is described in more detail in the companion document to this report entitled Species Diversity Report. These two reports focus on the terrestrial environment. The analysis of the aquatic systems is covered in the Aquatic Ecological Sustainability Analysis.

2.0 ECOLOGICAL SUSTAINABILITY EVALUATION PROCESS

The ecological sustainability framework for the GWNF was built around principles developed by The Nature Conservancy (TNC) in their Conservation Action Planning Workbook (TNC 2005). This basic structure was chosen because it is conceptually simple, flexible, and able to encompass guidance from the Planning Rule and Forest Service Manual and Handbook. It was also expected that its use would enhance opportunities for collaboration with TNC and other conservation partners in the future. Although built on the TNC structure, this document generally uses Forest Service terminology rather than TNC terms to refer to parts of the framework. Table 1 provides a crosswalk between relevant Forest Service and TNC terminology.

Table E-1. Crosswalk between conservation planning terms used in Forest Service Planning direction and The Nature Conservancy's Conservation Action Planning Workbook (2005)

Forest Service Terms	The Nature Conservancy Terms
Native ecological systems, Threatened and endangered species, Sensitive species, locally rare species and other species of management concern	Conservation Targets
Characteristics of ecosystem diversity (key attributes), Key ecological or habitat attributes for species or species groups	Key Ecological Attributes
Indicators	Indicators
Indicator Ratings	Indicator Ratings
Strategies (plan components)	Strategies

The Forest Service developed a relational database, the Ecological Sustainability Evaluation (ESE) tool, based on the structure of the TNC planning tool. The ESE tool served as the primary process record for ecological sustainability analysis. It included documentation of scientific and other sources consulted, uncertainties encountered, and strategic choices made during development of the database. In addition, the tool documented the many relationships among parts of the framework. For example, species were often related to one or more characteristics of ecosystems, and a given plan component frequently contributed to multiple ecological systems or species.

The following steps were used to build an ecological sustainability framework, with each step documented within the ESE tool. Although these steps are presented sequentially, the process required much iteration.

1. Identify and define ecological systems

To define terrestrial ecosystem diversity, all terrestrial ecological systems on the GWNF were identified using NatureServe's International Ecological Classification Standards (NatureServe 2004). Each system was defined in terms of existing Forest Service forest types and in terms of the LANDFIRE Vegetation Dynamic Models. Current acreage of each system was calculated using Forest Service GIS data. All identified terrestrial ecological systems were included in the ecological sustainability framework. These systems were also crosswalked with the Virginia Department of Conservation and Recreation Natural Heritage Program Vegetation Community types. The framework for diversity of aquatic ecological systems is described in the Aquatic Ecological Sustainability Analysis.

2. Identify species

To assess species diversity, a comprehensive list of plant and animal species was compiled by combining species lists from a variety of sources. These sources included federally-listed threatened and endangered (T&E) species obtained from the U.S. Fish and Wildlife Service; species that are tracked by the Virginia Department of Conservation and Recreation Natural Heritage Program and the West Virginia Division of Natural Resources; species identified in the Virginia and West Virginia State Comprehensive Wildlife Conservation Strategies as species of conservation concern; the Birds of Conservation Concern list compiled by the U.S. Fish and Wildlife Service; and the Regional Forester's list of sensitive species for the Southern Region. Species were then screened for inclusion in the framework. The criteria and process for identifying, screening and grouping species are detailed in the Species Diversity Report.

3. Identify and define characteristics of ecosystem diversity and related performance measures

To identify key characteristics and performance measures for terrestrial ecological systems, Forest Service biologists reviewed information in NatureServe, LANDFIRE, Virginia Department of Conservation and Recreation Natural Heritage Program community types, and other information.

4. Link species to the ecological systems and identify any additional needs of species

Species were then linked to terrestrial ecological systems. Where useful, species were grouped before linking them to systems. Where ecological conditions for these species were not covered by the ecosystem diversity framework, additional characteristics, performance measures, and rating criteria were added to the framework to cover these needs. All species have at least some of their needs covered by ecosystem diversity, but some species required additional plan components based on their major limiting factors. The ways in which individual species needs were addressed by ecosystem diversity components and additional plan provisions are described in the Species Diversity Report.

5. Assess current condition of performance measures

Current values and ratings of all performance measures were estimated using a variety of methods. Many current values were derived through analysis of existing GIS databases. Assumptions and methods for determining current values and ratings are recorded in the ESE tool.

6. Develop Forest Plan components

In this step, plan components were proposed that would be expected to provide for characteristics of ecosystem diversity and ecological conditions for species. This plan direction was then linked with characteristics and conditions within the ESE tool. In some cases, we identified where relevant provisions are made outside of the Forest Plan through other current requirements and processes. We ensured that all elements of the framework were addressed by appropriate management direction.

This report serves as a description of background, current status, and desired conditions for ecological systems on the GWNF. Current conditions for ecosystem characteristics reported here are based on a "snapshot in time." Conditions on the GWNF are constantly changing and new techniques improve how data can be used to measure progress. Ecosystem characteristics provide support for species diversity, and this report should be used in conjunction with the Species Diversity Report to obtain an accurate picture of ecological diversity on the GWNF.

3.0 ECOLOGICAL SYSTEMS

3.1 Background and Distribution of Ecosystems

The GWNF is interspersed with tracts of private and other publicly administered lands. National forest lands are significant from an ecological perspective in being relatively large parcels of vegetated and undeveloped lands with focused management goals. National forest lands contain a range of habitats and natural features that support a variety of locally rare species. These aspects plus the continued loss of forested land to developed uses on private lands is likely to make national forest lands even more important in the future for supporting ecological diversity.

Table E-2 lists the 24 ecological systems which were identified for the GWNF. Ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. These systems have similar potential and opportunities for management. Ecosystems are specifically defined as a group of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. The ecological systems for the GWNF represent both major and rare community types. Many of our rare communities are currently not completely mapped or inventoried; however, they are important components for sustaining ecological and species diversity.

These ecological systems are fully described at NatureServe Explorer at www.natureserve.org/explorer/. The descriptions of structure and disturbance regimes were derived from LANDFIRE (www.landfire.gov/). As discussed previously, these systems can also be related to the communities described by the Virginia Natural Heritage Program. Descriptions of the systems identified and described by the Virginia Department of Conservation and Recreation Natural Heritage Program (VADNH) are found in their online edition of The Natural Communities of Virginia Classification of Ecological Community Groups Second Approximation (Version 2.3) found at http://www.dcr.virginia.gov/natural_heritage/ncintro.shtml.

Table E-2. Distribution of ecological systems on the George Washington National Forest

Ecological System	Associated VA Natural Heritage Community Types				
Central and Southern Appalachian Spruce-Fir Forest	Spruce and Fir Forests				
Appalachian (Hemlock)-Northern Hardwood Forest (includes Southern Appalachian Northern Hardwood Forest)	Central Appalachian Northern Hardwood Forests				
Southern and Central Appalachian Cove Forest	Rich Cove and Slope Forests	Eastern Hemlock-Hardwood Forests	Acidic Cove Forests	High-Elevation Cove Forests	
Northeastern Interior Dry-Mesic Oak Forest (includes Southern Appalachian Oak Forest in part and Southern Ridge and Valley/Cumberland Dry Calcareous Forest)	Eastern White Pine-Hardwood Forests	Acidic Oak-Hickory Forests	Dry-Mesic Calcareous Forests	Basic Oak-Hickory Forests	Basic Mesic Forests
Northeastern Interior Dry-Mesic Oak Forest (includes Southern Appalachian Oak Forest in part and Southern Ridge and Valley/Cumberland Dry Calcareous Forest)	Montane Dry Calcareous Forests and Woodlands	Mountain/Piedmont Basic Woodlands			
Central and Southern Appalachian Montane Oak Forest(includes Southern Appalachian Oak Forest in part)	High-Elevation Boulderfield Forests and Woodlands	Northern Red Oak Forests	Montane Mixed Oak and Oak-Hickory Forests		
Central Appalachian Dry Oak-Pine Forest	Oak/Heath Forests				
Southern Appalachian Montane Pine Forest and Woodland (includes Southern Appalachian Low-Elevation Pine Forest)					
Central Appalachian Pine-Oak Rocky Woodland	Pine-Oak/Heath Woodlands	Montane/Piedmont Acidic Woodlands	Low-Elevation Boulderfield Forests		
Southern and Central Appalachian Mafic Glade and Barrens					
Central Appalachian Alkaline Glade and Woodland					

Ecological System	Associated VA Natural Heritage Community Types				
Appalachian Shale Barrens	Central Appalachian Shale Barrens				
North-Central Appalachian Circumneutral Cliff and Talus	Northern White-Cedar Slope Forests	Low-Elevation Basic Outcrop Barrens	Mountain/Piedmont Calcareous Cliffs		
North-Central Appalachian Acidic Cliff and Talus	High-Elevation Outcrop Barrens	Low-Elevation Acidic Outcrop Barrens	Mountain/Piedmont Acidic Cliffs	Lichen/Bryophyte Boulderfields	
Central Appalachian River Floodplain	Piedmont/Mountain Floodplain Forests	Piedmont/Mountain Alluvial Forests			
Central Appalachian Stream and Riparian	Sand/Gravel/Mud Bars and Shores	Rocky Bars and Shores	Semi-permanent Impoundments	Spray Cliffs	Montane Woodland Seeps
Central Interior Highlands and Appalachian Sinkhole and Depression Pond	Montane Depression Wetlands				
Southern and Central Appalachian Bog and Fen	Appalachian Bogs				
North-Central Appalachian Acidic Swamp	Montane/Piedmont Acid Seepage Swamps	High-Elevation Seepage Swamps	Piedmont/Mountain Swamp Forests		
North-Central Appalachian Seepage Fen	Montane/Piedmont Basic Seepage Swamps	Calcareous Fens and Seeps	Calcareous Spring Marshes and Muck Fens	Mafic Fen and Seeps	Wet Prairies and Prairie Fens
Caves and Karstlands					

As we developed the ecosystem diversity analysis, we identified that many of the ecological systems had similar key attributes, indicators, species associates and resulting forest plan components. For purposes of analysis we combined the systems into Ecological System Groups to use in the following ESE Tool:

Table E-3. Ecological Sustainability Evaluation Tool Ecological Systems

Ecological System Groups	Ecological System
Spruce Forest	Central and Southern Appalachian Spruce-Fir Forest
Northern Hardwood Forest	Appalachian (Hemlock)-Northern Hardwood Forest
	Southern Appalachian Northern Hardwood Forest
Cove Forest	Southern and Central Appalachian Cove Forest
Oak Forests and Woodlands	Northeastern Interior Dry-Mesic Oak Forest
	Central and Southern Appalachian Montane Oak Forest
	Central Appalachian Dry Oak-Pine Forest
	Southern Appalachian Oak Forest
	Southern Ridge and Valley/Cumberland Dry Calcareous Forest
Pine Forests and Woodlands	Southern Appalachian Montane Pine Forest and Woodland
	Central Appalachian Pine-Oak Rocky Woodland
	Southern Appalachian Low-Elevation Pine Forest
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Southern and Central Appalachian Mafic Glade and Barrens
	Central Appalachian Alkaline Glade and Woodland
Cliff, Talus and Shale Barrens	North-Central Appalachian Circumneutral Cliff and Talus
	North-Central Appalachian Acidic Cliff and Talus
	Appalachian Shale Barrens
Floodplains, Wetlands, and Riparian Areas	Central Appalachian River Floodplain
	Central Appalachian Stream and Riparian
	Central Interior Highlands and Appalachian Sinkhole and Depression Pond
	Southern and Central Appalachian Bog and Fen
	North-Central Appalachian Acidic Swamp
	North-Central Appalachian Seepage Fen
Caves and Karstlands	Caves and Karstlands

3.2 Descriptions of the Ecological Systems

The following information on descriptions of the ecological systems is derived largely from NatureServe.

3.2.1 Spruce Forest: Central and Southern Appalachian Spruce-Fir Forest

Background

Environment: This system occurs at elevations typically above 1300 m (4300 feet), up to the highest peaks. It occurs on most of the landforms that are present in this elevational range; most sites are strongly exposed and convex in shape. Elevation and orographic effects make the climate cool and wet, with heavy moisture input from fog as well as high rainfall. Strong winds, extreme cold, rime ice, and other extreme weather are

periodically important. Concentration of air pollutants has been implicated as an important anthropogenic stress in recent years. Soils are generally very rocky, with the matrix ranging from well-weathered parent material to organic deposits over boulders. Soils may be saturated for long periods from a combination of precipitation and seepage. Any kind of bedrock may be present, but most sites have erosion-resistant felsic igneous or metamorphic rocks. **Vegetation:** Vegetation consists primarily of forests dominated by *Picea rubens* or occasionally by *Sorbus americana*. *Betula alleghaniensis*, Tsuga canadensis, and Quercus rubra are the only other locally common canopy species. *Acer rubrum*, *Betula lenta*, *Magnolia acuminata*, and *Magnolia fraseri* may occur. Lower strata are most typically dominated by mosses, ferns or forbs, but a few associations have dense shrub layers of *Rhododendron catawbiense, Rhododendron maximum*, or *Vaccinium erythrocarpum*. **Dynamics:** This system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase generation on a fine scale. Despite the extreme climate, *Picea rubens* is long-lived (300-400 years). Both Picea and Abies seedlings are shade-tolerant, and advanced regeneration is important in stand dynamics. Natural disturbances include lightning fire, debris avalanches, wind events, and ice storms. Occasional extreme wind events disturb larger patches on the most exposed slopes. Fire is a very rare event under natural conditions, due to the wetness and limited flammability of the undergrowth, and return intervals have been estimated between 500-1000 years. If fires occur, they are likely to be catastrophic, because few of the species are at all fire-tolerant. Anthropogenic disturbances and stresses, beyond the effects of logging, have had major effects on dynamics in these systems in recent decades. Stress caused by concentrated air pollutants on the mountain tops has been suggested as a cause of observed growth declines in *Picea rubens*. Earlier, unnatural fires fueled by logging slash turned large expanses of this system into grass-shrub-hardwood scrub (e.g., Dolly Sods) that has not recovered to conifer dominance after 90 years but that in places has recovered to northern hardwoods forests. Climatic changes may affect this system severely. Climate change can be expected to raise the lower elevational limit and greatly reduce the land area available to this system.

Stresses and Threats

This system is very limited in extent on the Forest. It is currently only located in the Laurel Fork area. This system occupies about one-half of the area where it likely has the potential to exist. While the system is very limited on the GWNF, in adjacent West Virginia and on the Monongahela National Forest, it is more extensive. The greatest stresses and threats to this system include climate change and acid deposition.

3.2.2 Northern Hardwood Forest: Appalachian (Hemlock) - Northern Hardwood Forest

Background

Environment: This system occurs on somewhat protected low and midslopes and valley bottoms. In the central Appalachian center of its range, its ecological amplitude is somewhat broader, and it approaches matrix forest in some areas. It is considered a system of intermediate moisture regime. **Vegetation:** The canopy is characterized and often usually dominated by northern hardwoods (e.g., *Fagus grandifolia* and *Acer saccharum*), often with *Tsuga canadensis*, but may also contain large amounts of *Pinus strobus* and *Quercus* spp. The understory varies quite a bit, in some places dominated by evergreen shrubs and in others by herbs. **Dynamics:** This system is currently being devastated in large parts of its range by the hemlock woolly adelgid (*Adelges tsugae*). This sucking insect is continuing to cause close to 100% mortality as it spreads from the north into the southern United States. The insect will most likely cause canopy hemlocks to be replaced by other canopy trees. Historically, this system was probably only subject to occasional fires. Fires that did occur may have been catastrophic and may have led to even-aged stands of pine and hemlock. Fire suppression appears to have increased the extent of this system at the expense of oak-pine systems.

Stresses and Threats

The greatest stresses and threats to this system include climate change, acid deposition and invasive species (hemlock woolly adelgid).

3.2.3 Cove Forest: Southern and Central Appalachian Cove Forest

Background

Environment: This system occurs below 1525 m (5000 feet) elevation and generally below 1375 m (4500 feet) in low topographic positions such as valley bottoms and ravines. This cove type has two primary components, an acid cove of lower soil fertility that ranges from the lowest slope positions up the slope on north-facing protected slopes, and a rich, high-fertility cove forest that tends to occur only at the lowest slope positions. Both are sheltered from wind and may be shaded by topography, promoting moist conditions. Local slopes are usually concave. Bedrock may be of virtually any type. Acidic rocks, such as felsic igneous and metamorphic rocks, support rich cove forests in a more limited range of sites than do basic rocks, such as mafic metamorphic rocks or marble. Soils may be rocky or fine-textured, and may be residual, alluvial, or colluvial. In the southern Appalachians, the hemlock "phase" of this ("acidic cove forest") often occurs between "richer" examples of Southern and Central Appalachian Cove Forest (CES202.373) in the lowest areas and Southern Appalachian Oak Forest (CES202.886) on the midslopes. **Vegetation:** Vegetation consists of forests dominated by various combinations of mesophytic species, usually with many different species of primarily deciduous trees present. *Liriodendron tulipifera, Tilia americana, Tilia americana var. heterophylla, Fraxinus americana, Aesculus flava, Betula lenta, Magnolia acuminata, Magnolia fraseri, Halesia tetraptera, Prunus serotina*, and *Tsuga canadensis* are the most frequent dominant canopy species. Canopies are generally very diverse, with all species potentially occurring in one 20x50-meter plot in rich cove areas. A well-developed herb layer, often very dense and usually high in species richness, is present in all but the acid coves. Well-developed and fairly diverse subcanopy and shrub layers are often also present in all but the acid coves. Ulrey (1999) listed *Caulophyllum thalictroides, Actaea racemosa (=Cimicifuga racemosa), Laportea canadensis, Osmorhiza claytonii, Sanguinaria canadensis, Viola canadensis, Acer saccharum, Aesculus flava, Carya cordiformis,* and *Tilia americana var. heterophylla* as characteristic species. **Dynamics:** This system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase regeneration on a fine scale. Occasional extreme wind or ice events may disturb larger patches. Natural fire dynamics are not well-known and probably only occurred in years that were extremely dry. Fires may have occurred at moderate frequency but were probably usually low enough in intensity to have only limited effects. Most of the component species are among the less fire-tolerant in the region.

Stresses and Threats

The greatest stresses and threats to this system are invasive plants due to the moist, rich soil conditions of these sites. Wild pigs are also a threat.

3.2.4 Oak Forests and Woodlands

3.2.4.a. Northeastern Interior Dry-Mesic Oak Forest

Background

Environment: These oak-dominated forests are one of the matrix forest systems in the northeastern and north-central U.S. Occurring in dry-mesic settings. They are typically closed-canopy forests, though there may be areas of patchy-canopy woodlands. They cover large expanses at low to mid elevations, where the topography is flat to gently rolling, occasionally steep. The typical landscape position is midslope to toeslope, transitioning to more xeric systems on the upper slopes and ridges. Soils are acidic and relatively infertile but not strongly xeric. Vegetation: Mature stands are dominated by oak species characteristic of dry-mesic conditions (e.g., Quercus rubra, Quercus alba, Quercus velutina, and Quercus coccinea), along with various Carya spp. Quercus prinus may be present but is generally less important than the other oak species. Castanea dentata was a prominent tree before chestnut blight eradicated it as a canopy constituent. Acer rubrum and Betula lenta are frequently common associates. Local areas of calcareous bedrock may support forests typical of richer soils (e.g., with Acer saccharum and/or Quercus muehlenbergii). In addition, Pinus strobus may be prominent in some stands in the absence of fire.

3.2.4.b. Central and Southern Appalachian Montane Oak Forest

Background

Environment: The habitat for this system includes high ridgelines and exposed upper slopes, primarily on south- to west-facing aspects, mostly between 915 and 1372 m (3000-4500 feet) elevation, and less commonly ranging up to 1680 m (5500 feet). It generally occurs as a transition between Southern Appalachian Oak Forest (CES202.886) and more mesic Southern Appalachian Northern Hardwood Forest (CES202.029) that occurs on less-exposed ridgetops and cooler, moister upper slopes (e.g., north- and east-facing aspects). At high elevations (e.g., above 1372 m [4500 feet]), this system is generally less common than Southern Appalachian Northern Hardwood Forest (CES202.029) since the habitat on most slopes at this elevation tends to favor those species adapted to a more mesic environment. **Vegetation:** This system is dominated by *Quercus rubra* and, more rarely, *Quercus alba*. Often the trees are stunted or at least not as tall as they would be in other systems farther downslope. Species richness is low to moderate. Tree associates include *Prunus serotina, Betula lenta*, and *Betula alleghaniensis*. Typical small trees and shrubs include *Ilex montana, Hamamelis virginiana, Acer pensylvanicum, Menziesia pilosa, Rhododendron prinophyllum, Vaccinium pallidum, Corylus cornuta var. cornuta*, and sprouts of *Castanea dentata*. The understory is usually dominated by ericaceous shrubs, but some communities are dominated by graminoid species or ferns. *Dennstaedtia punctilobula, Carex pensylvanica*, and *Deschampsia flexuosa* are common. Only rarely are the communities dominated by other herbs. **Dynamics:** The communities of this system inhabit some of the most inhospitable parts of the Appalachians. Their occurrence on exposed high ridges means they are subject to frequent ice and wind storms in the summer and high winds throughout the year. This probably explains the forests' stunted appearance. In addition, lightning-caused fires may create ground fires that change the understory composition and inhibit some ericaceous shrub species in some areas. Presettlement forests are likely to have experienced lightning-caused fires every 40-60 years (Fleming et al. 2005). In some locations, fire exclusion and competing understory vegetation are a factor in poor oak regeneration, with replacement by more mesophytic species such as Acer saccharum (Fleming et al. 2005). Despite the high elevation, chestnut had been a fairly substantial component of this system and can still be seen as rotting stumps in the forest. In the northern Blue Ridge, gypsy moth infestations have caused widespread tree mortality and pose a threat to these systems (Fleming et al. 2005).

3.2.4.c Central Appalachian Dry Oak-Pine Forest

Background

Environment: These oak and oak-pine forests cover large areas in the low- to mid-elevation central Appalachians and middle Piedmont. The topography and landscape position range from rolling hills to steep slopes, with occasional occurrences on more level, ancient alluvial fans. The soils are coarse and infertile; they may be deep (on glacial deposits in the northern part of the system's range), or more commonly shallow, on rocky slopes of acidic rock (shale, sandstone, other acidic igneous or metamorphic rock). The well-drained soils and exposure create dry conditions. **Vegetation:** Stands of this forest system are mostly closed-canopied but can include more open woodlands. They are dominated by a variable mixture of dry-site oak and pine species, including *Quercus prinus, Pinus virginiana*, and *Pinus strobus*. The system may include areas of pine forest and mixed oak-pine forest. Heath shrubs such as *Vaccinium pallidum, Gaylussacia baccata*, and *Kalmia latifolia* are common in the understory. Within these forests, hillslope pockets with impeded drainage may support small isolated wetlands with *Acer rubrum* and *Nyssa sylvatica* characteristic. **Dynamics:** Disturbance agents include fire, windthrow, and ice damage.

Stresses and Threats

The greatest stresses and threats to this system are lack of disturbance to create regeneration and open woodland structure and non-native invasive species including the gypsy moth.

3.2.5 Pine Forests and Woodlands

3.2.5.a Southern Appalachian Montane Pine Forest and Woodland

Background

Environment: This system occurs on ridgetops, usually only on the sharpest and narrowest spur ridges, and adjacent convex upper slopes. These sites are the extreme of convex landforms. Rapid drainage of rainfall and exposure to wind, sun and lightning are probably the important characteristics. Bedrock may be of any acidic type, including felsic igneous and metamorphic rocks, sandstone and quartzite. Soils are shallow and rocky residual soils. Fire appears to be an important factor. **Vegetation:** Vegetation consists of open forests or woodlands dominated by *Pinus pungens*, often with *Pinus rigida* or less commonly *Tsuga caroliniana*, and sometimes with *Pinus virginiana* or rarely *Pinus echinata* codominant. In examples that have not had fire in a long time, *Quercus prinus, Quercus coccinea*, or other oaks are usually present and are sometimes abundant, as are *Nyssa sylvatica* and *Acer rubrum*. *Castanea dentata* may also have once been abundant. A dense heath shrub layer is almost always present. *Kalmia latifolia* is the most typical dominant, but species of *Rhododendron, Vaccinium*, or *Gaylussacia* may be dominant. Herbs are usually sparse but probably were more abundant and shrubs less dense when fires occurred more frequently. **Dynamics:** Fire is apparently a very important process in this system (Harrod and White 1999). Pines may be able to maintain dominance due to shallow soils and extreme exposure in some areas, but most sites appear eventually to succeed to oak dominance in the absence of fire. Fire is also presumably a strong influence on vegetation structure, producing a more open woodland canopy structure and more herbaceous ground cover. Occurrence in highly exposed sites may make this system more prone to ignition, but most fires probably spread from adjacent oak forests. Fires could be expected to show more extreme behavior in this system than in oaks forests under similar conditions, due to the flammability of the vegetation and the dry, windy and steep location. Both intense catastrophic fires and lower-intensity fires probably occurred naturally. Natural occurrences probably include both even-aged and uneven-aged canopies. Southern pine beetles are an important factor in this system, at least under present conditions. Beetle outbreaks can kill all the pines without creating the conditions for the pines to regenerate. If the pines are lost, the distinction between this system and Southern Appalachian Oak Forest (CES202.886) or Central Appalachian Pine-Oak Rocky Woodland (CES202.600) becomes blurred.

3.2.5.b Central Appalachian Pine-Oak Rocky Woodland

Background

Environment: This system encompasses open or sparsely wooded hilltops and outcrops or rocky slopes in the Central Appalachians, High Allegheny Plateau, and Lower New England / Northern Piedmont. It occurs mostly at lower elevations, but occasionally up to 1220 m (4000 feet) in West Virginia. **Vegetation:** The vegetation is patchy, with woodland as well as open portions. *Pinus rigida* and (within its range *Pinus virginiana* are diagnostic and often are mixed with xerophytic *Quercu*s spp. and sprouts of *Castanea dentata*. Some areas have a fairly well-developed heath shrub layer, others a graminoid layer. **Dynamics:** Conditions are dry and nutrient-poor, and at many, if not most, sites, a history of fire is evident. In the Central Appalachians ecoregion, this system is sometimes found on sandy soils rather than rock. The southern extent overlaps with Southern Appalachian Montane Pine Forest and Woodland (CES202.331), which is characterized by *Pinus pungens*. This type is differentiated from the similar Central Appalachian Dry Oak-Pine Forest CES202.591) by its mosaic nature of wooded and open patches, as opposed to being merely a "thin forest."

Stresses and Threats

The greatest stresses and threats to this system are lack of disturbance to create regeneration and open woodland structure and invasive species including the native pine bark beetle and climate change that could reduce rainfall and make insect outbreaks more common.

3.2.6 Mafic Glade and Barrens and Alkaline Glades and Woodlands

3.2.6.a Southern and Central Appalachian Mafic Glade and Barrens

Background

Environment: Occurs on upper to mid slopes, usually on gentle to moderate slopes but occasionally steeper. The ground is mostly shallow soil over bedrock, usually with significant areas of rock outcrop. The rock usually has few fractures but may have a pitted or irregular surface. This rock structure supports more extensive and deeper soil development than in Southern Appalachian Granitic Dome (CES202.297), but has few of the crevices and deeper rooting sites available in Southern Appalachian Rocky Summit (CES202.327). Micro-scale soil depth and presence of seepage are important factors in determining the vegetation patterns. Shallow soil, unable to support a closed tree canopy, separates this system from forest systems. Bedrock includes a variety of igneous and metamorphic rock types. Some examples are on mafic substrates such as amphibolite, some are on felsic rock such as granitic gneiss but have flora that suggests a basic influence, and a few occur on felsic rocks and are clearly acidic. Rock or soil chemistry appears to be the most important factor affecting different associations on sites that have the physical structure to belong to this system. Elevation may also be an important factor causing variation. **Vegetation:** Vegetation is a fine mosaic of different physiognomies, with open woodland and grassy herbaceous vegetation or short shrubs predominating. Some instances may have closed canopies of small trees or large shrubs, but no examples have large canopy trees with a closed canopy. Bare rock outcrops are usually present in a minority of the area. The canopy species are species tolerant of dry, shallow soils, most commonly *Quercus prinus, Pinus* spp., and *Juniperus virginiana*. Basic examples may also have *Carya glabra, Fraxinus americana*, and other species abundant. Shrubs may be dense, with species determined by soil chemistry. The herb layer is usually fairly dense and dominated by grasses, both in treeless areas and beneath open canopy. An abundant forb component is also usually present, especially in the more basic examples. The forbs include species characteristic of other rock outcrops and grassland species, with a smaller number of forest species present. **Dynamics:** The dynamics of this system are not well known. The occurrence of the system appears to be primarily determined by site physical properties, with physical and chemical properties determining vegetational variation. Fire may be an important influence on vegetation, and may in the long run be important for keeping the vegetation structure open, though the patchy distribution of vegetation might limit fire intensity. Periodic drought and wind storms may also be an important factor limiting canopy density and stature. The shallow soil would make these sites particularly prone to all three. These glades do not appear to be undergoing the kind of cyclic succession that has been described for granitic domes, but some balance of soil accumulation and destruction may be occurring on a longer term or coarser scale. It is possible that the slightly irregular curved surface of some examples represents a late stage in the weathering of old exfoliation surfaces that once supported granitic domes, but most known examples are not spatially associated with existing granitic domes.

3.2.6.b Central Appalachian Alkaline Glade and Woodland

Background

Environment: This system occupies mid-elevation rocky ridges, slopes, and outcrops with thin soils and calcareous bedrock. Large amounts of exposed mineral soils and/or gravel are characteristic. Soils are high in pH and rich in calcium and magnesium. Although these areas are subject to prolonged droughts, local areas of ephemeral vernal seepage occur in microtopographic concavities, and they may have distinctive vegetation (e.g., colonies of Dodecatheon meadia). A series of glades in western Virginia is somewhat distinctive because of the dolostone, which contains a high magnesium content. These glades are located on low dolomite knobs and foothills of Elbrook dolomite that occupy middle to upper slopes and crests of south- or southwest-facing spur ridges at relatively low elevations. **Vegetation:** In some cases, the woodlands grade into closed-canopy forests. *Juniperus virginiana* is a common tree, filling in in the absence of fire, and *Quercus muehlenbergii* is indicative of the limestone substrate. *Rhus aromatica, Cercis canadensis*, and *Ostrya virginiana* may occur. Prairie grasses are the dominant herbs (*Andropogon gerardii, Schizachyrium scoparium, Bouteloua* spp.); forb richness is often high. Characteristic forbs include *Asclepias verticillata*, *Monarda fistulosa*, *Salvia lyrata*, *Symphyotrichum oblongifolium*, and *Brickellia eupatorioides* (Braun 1950). **Dynamics:** Fire is an important natural disturbance vector.

Stresses and Threats

These systems are uncommon on the Forest so their limited distribution is a stress. Other important stresses and threats to these systems include the lack of fire, non-native invasive plants, and trampling from excessive recreation use.

3.2.7 Cliff, Talus and Shale Barrens

3.2.7.a North-Central Appalachian Circumneutral Cliff and Talus

Background

Environment: This cliff system occurs at low to mid elevations from central New England south to Virginia and West Virginia. It consists of vertical or near-vertical cliffs and steep talus slopes where weathering and/or bedrock lithology produce circumneutral to calcareous pH and enriched nutrient availability. Substrates include limestone, dolomite and other rocks. Vegetation: The vegetation varies from sparse to patches of small trees, in places forming woodland or even forest vegetation. *Fraxinus* spp., *Tilia americana*, and *Staphylea trifolia* are woody indicators of the enriched setting. *Thuja occidentalis* may occasionally be present but is more characteristic of the related Laurentian-Acadian system to the north. The herb layer is typically not extensive but includes at least some species that are indicators of enriched conditions, e.g., *Impatiens pallida, Pellaea atropurpurea, Asplenium platyneuron*, or *Woodsia obtusa*.

3.2.7.b North-Central Appalachian Acidic Cliff and Talus

Background

Environment: This system comprises sparsely vegetated to partially wooded cliffs and talus slopes in the Central Appalachians and adjacent ecoregions, occurring on rocks of acidic lithology and lacking any indicators of enriched conditions. This cliff system occurs at low to mid elevations from central New England south to Virginia, and up to 1500 m in West Virginia. It consists of vertical or near-vertical cliffs and the talus slopes below, formed on hills of granitic, sandstone, or otherwise acidic bedrock. In some cases, especially in periglacial areas, this system may take the form of upper-slope boulderfields without adjacent cliffs, where talus forms from freeze/thaw action cracking the bedrock. Most of the substrate is dry and exposed, but small (occasionally large) areas of seepage are often present. **Vegetation:** Vegetation in seepage areas tends to be more well-developed and floristically different from the surrounding dry cliffs. The vegetation is patchy and often sparse, punctuated with patches of small trees that may form woodlands in places. *Juniperus virginiana* is a characteristic tree species, *Toxicodendron radicans* a characteristic woody vine, and *Polypodium virginianum* a characteristic fern. Within its range, *Pinus virginiana* is often present.

3.2.7.c Appalachian Shale Barrens

Background

Environment: This system is found at low to mid elevations in the central and southern Appalachians. Most shale barrens occur between 305 and 610 m (1000-2000 feet) elevation and have a generally southern exposure. Slopes are steep and often undercut by a stream at the base. Soils are thin, with a layer weathered rock fragments covering the surface. The exposure and lack of soil create extreme conditions for plant growth. The chemistry and pH vary somewhat from site to site, and this variability may be reflected in the vegetation. The substrate includes areas of solid rock as well as unstable areas of shale scree, usually steeply sloped. **Vegetation:** Although stunted trees of several species such as Quercus prinus, Pinus virginiana, and *Carya glabra* are common, Central Appalachian Shale Barrens are strongly characterized by their open physiognomy and by a suite of uncommon and rare plants found almost exclusively in these habitats (Fleming et al. 2004). Endemic or near-endemic shale barren species include shale-barren rock-cress (*Arabis serotina*), white-haired leatherflower (*Clematis albicoma*), Millboro leatherflower (*Clematis viticaulis*; also endemic to Virginia), shale-barren wild buckwheat (*Eriogonum allenii*), shale-barren evening-primrose (*Oenothera argillicola*), shale-barren ragwort (*Packera antennariifolia*), and Kate's Mountain clover (*Trifolium virginicum*). Other more-or-less widespread and characteristic herbaceous species of Virginia shale barrens include Pennsylvania sedge (*Carex*

pensylvanica), little bluestem (*Schizachyrium scoparium*), poverty oatgrass (*Danthonia spicata*), wavy hairgrass (*Deschampsia flexuosa var. flexuosa*), moss phlox (*Phlox subulata*), mountain nailwort (*Paronychia montana*), rock spike-moss (*Selaginella rupestris*), shale-barren pussytoes (*Antennaria virginica*), Canada cinquefoil (*Potentilla canadensis*), smooth sunflower (*Helianthus laevigatus*), false boneset (*Brickellia eupatorioides* var. *eupatorioides*), hairy woodmint (*Blephilia ciliata*), and western wallflower (*Erysimum capitatum* var. *capitatum*; Bath and Alleghany counties). **Dynamics:** Aspect with increased exposure to drying and extremes in temperature plus dynamic downslope creep of shale fragments along with water erosion when undercut by a stream are the primary natural dynamics influencing this system. Fire may play a role in surrounding xeric to dry pine-oak woodlands by limiting encroachment of trees and shrubs onto barren.

Stresses and Threats

The major stresses and threats to these systems include the lack of fire, non-native invasive plants, problematic native species (deer browsing), trampling from excessive recreation use, and altering the normal disturbance regimes that maintain the character of the cliff, talus and barren features (rock slides, stream erosion).

3.2.8 Floodplains, Wetlands, and Riparian Areas

This group consists of a number of relatively small systems that can be difficult to map. All known locations of these systems are included in the group along with all lands within 100 feet of perennial streams, lakes, seeps and wetlands and all lands within 50 feet of intermittent streams.

3.2.8.a Central Appalachian Floodplain

Background

Environment: This system encompasses floodplains of medium to large rivers in Atlantic drainages from southern New England to Virginia. This system can include a complex of wetland and upland vegetation on deep alluvial deposits and scoured vegetation on depositional bars and on bedrock where rivers cut through resistant geology. **Vegetation:** This complex includes floodplain forests in which *Acer saccharinum*, Populus deltoides, and *Platanus occidentalis* are characteristic, as well as herbaceous sloughs, shrub wetlands, riverside prairies and woodlands. Most areas are underwater each spring; microtopography determines how long the various habitats are inundated. Depositional and erosional features may both be present depending on the particular floodplain.

3.2.8.b Central Appalachian Riparian

Background

Environment: This riparian system ranges from southern New England to Virginia and West Virginia and occurs over a wide range of elevations. It develops on floodplains and shores along river channels that lack a broad flat floodplain due to steeper sideslopes, higher gradient, or both. It may include communities influenced by flooding, erosion, or groundwater seepage. **Vegetation:** The vegetation is often a mosaic of forest, woodland, shrubland, and herbaceous communities. Common trees include *Betula nigra*, *Platanus occidentalis*, and *Acer negundo*. Open, flood-scoured rivershore prairies feature *Panicum virgatum* and *Andropogon gerardii*, and *Carex torta* is typical of wetter areas near the channel. **Classification Comments:** This is a high-gradient system, unlike the low-gradient system described in Central Appalachian River Floodplain (CES202.608). To the south in the Appalachians and interior, this system is replaced by South-Central Interior Small Stream and Riparian (CES202.706).

3.2.8.c Central Interior Highlands and Appalachian Sinkhole and Depression Pond

Background

Environment: Examples of this system occur in basins of sinkholes or other isolated depressions on uplands. Soils are very poorly drained, and surface water may be present for extended periods of time, rarely becoming

dry. Water depth may vary greatly on a seasonal basis, and may be a meter deep or more in the winter. Some examples become dry in the summer. Soils may be deep (100 cm or more), consisting of peat or muck, with parent material of peat, muck or alluvium. **Vegetation:** Ponds vary from open water to herb-, shrub-, or tree-dominated types. Tree-dominated examples typically contain *Quercus* species, *Platanus occidentalis, Fraxinus pennsylvanica, Acer saccharinum*, or *Nyssa* species, or a combination of these. In addition, *Liquidambar styraciflua* may be present in southern examples. *Cephalanthus occidentalis* is a typical shrub component. The herbaceous layer is widely variable depending on geography. **Dynamics:** Water depth may vary greatly on a seasonal basis, and may be a meter deep or more in the winter. Some examples become dry in the summer.

3.2.8.d Southern and Central Appalachian Bog and Fen

Background

Environment: This system occurs in patches in flat valley bottoms, usually on the outer edges of stream floodplains at elevations below 1220 m (4000 feet). The soil is saturated most or all of the year, at least in the wettest parts, and may be very mucky. Although sites rarely flood, wetness results from a combination of groundwater input, rainfall, seepage from adjacent slopes, and impeded drainage. The groundwater is usually highly acidic and low in dissolved bases, but one or a few examples have somewhat calcareous water input because groundwater flows through mafic rock substrates. Overland flow and stream flooding are presumably only rare events. The geologic substrate is usually alluvium. Often, but not always, there is an adjacent slope with a seep at its base or some visible microtopographic feature, such as a stream levee or ridge, that impedes water drainage out of the area. Some occurrences have substantial microtopography of abandoned stream channels or ridge-and-swale systems that pond water in low areas. **Vegetation:** Vegetation is a complex of zones or patches with a mix of physiognomies. The wettest areas have herbaceous vegetation dominated by Carex spp., usually with abundant Sphagnum. Scattered trees and shrubs may be present in the herbaceous zones. Most examples also have a dense shrub zone around the edges. Some examples have forest zones as well, around the edges or as a matrix in which numerous small herbaceous openings are embedded. Characteristic tree species are *Tsuga canadensis, Acer rubrum, Nyssa sylvatica*, and *Pinus rigida*. Characteristic shrubs include *Rhododendron maximum, Alnus serrulata, Viburnum nudum var. cassinoides, Viburnum nudum var. nudum*, and *Toxicodendron vernix*. A number of plant species are shared with northern bogs, including some that are disjunct long distances and occur in the south only in bogs. Other species are narrow endemics, such as *Helonias bullata*. In the more southern examples, some species are shared with bog communities in the Coastal Plain. The very rare richer fen examples have very distinctive vegetation, sharing a number of species with northern rich fens. **Dynamics:** The natural dynamics of this system are not well known and are subject to debate. The factors that created and naturally maintain this system are unclear. Most examples show a strong tendency at present for shrubs and trees to increase in density in the open areas, threatening to eliminate the characteristic herb species. This suggests that an important process has been altered or lost. One hypothesis is that bogs are an ephemeral feature developing from abandoned beaver ponds. Another hypothesis is that they result from a narrow combination of moisture and nutrient conditions, which have been widely altered in an obscure way that has changed ecosystem stability. The cattle grazing that was nearly universal in examples of this system in the past appears to have delayed woody succession but may also have altered the natural characteristics. Fire is sometimes considered as a factor, but most examples do not appear flammable enough to burn. Besides woody encroachment, bogs may be altered by changes in adjacent drainage, such as entrenchment by streams.

3.2.8.e North-Central Appalachian Acidic Swamp

Background

Environment: These swamps are distributed from central New England through the Central Appalachians south to Virginia and west to Ohio. They are found at low to mid elevations (generally <700 m) in basins or on gently sloping seepage lowlands. The acidic substrate is mineral soil, often with a component of organic muck; if peat is present, it usually forms an organic epipedon over the mineral soil rather than a true peat substrate (although peat layers up to 1 m deep have been found in some of these swamps). **Vegetation:** *Tsuga canadensis* is usually present and may be dominant. It is often mixed with deciduous wetland trees such as *Acer rubrum* or *Nyssa sylvatica*. Sphagnum is an important component of the bryoid layer. Basin swamps tend to be more nutrient-poor and less species-rich than seepage swamps; in some settings, the two occur adjacent

to each other with the basin swamp vegetation surrounded by seepage swamp vegetation on its upland periphery.

3.2.8.f North-Central Appalachian Seepage Fen

Background

Environment: This system is found in scattered locations in the central Appalachians and eastern Great Lakes regions. Mostly non-forested, these open fens develop on shallow to deep peat over a sloping substrate, where seepage waters provide nutrients. Conditions are often circumneutral to alkaline. **Vegetation:** Sedges are the major dominants. *Packera aurea*, *Symplocarpus foetidus*, and *Lobelia kalmii* are among the characteristic forbs. **Dynamics:** Some of these areas are kept open by grazing, and succession to shrublands may occur in the absence of disturbance.

Stresses and Threats

The greatest threat or stress on the systems is alteration of the hydrology that supports the system. This includes the loss of beaver activity that is important to many of these systems. Other stresses and threats include recreation use (including off road vehicles), acid deposition, and climate change. Non-native invasive plants are another stress and riparian areas can provide important dispersal corridors for many species.

3.2.9 Caves and Karstlands

Background

This system includes the terrestrial and aquatic subterranean habitat. The landscapes are formed in limestone and dolostone bedrock and are generally found in valley bottoms but occasionally on ridges and mountains depending on bedrock geology, strata location and outcrops. Passages are formed by water flowing over many millennia and can provide habitat for a variety of species, some quite rare and specialized. It is not a separate ecological system from the others, since it has vegetation defined by the previously discussed systems. It is the underground environment and the features that sometimes manifest themselves at the surface, like sinkholes, caves and springs. The location is defined by broad scale geologic mapping, so the actual areas of caves and karst terrain occupy only a small portion of the entire area.

Stresses and Threats

The greatest threats or stresses on the system are alteration of the hydrology that supports the system and degradation of water quality. This includes changes to the groundwater and surface water flow and human caused impacts to water quality such as improper pesticide use or disposal of harmful materials in sinkholes.

A summary of the stresses and threats identified for each ecosystem are displayed in Appendix E-1.

4.0 SPECIAL BIOLOGICAL AREAS

Special Biological Areas

The 121 Special Biological Areas on the GWNF support ecosystem diversity at a fine scale by recognizing and managing for rare natural communities and assemblages of rare plant and animal species. Some of these areas represent the best representatives of ecological systems and other represent unique assemblages of vegetation, animals and the physical environment. These areas include rare habitats such as sinkhole ponds, seepage swamps, bogs, and fens, mafic and limestone outcrops, spruce forest, shale barrens, and, in limited situations, habitat for single species such as sweet pinesap, coal skink, sword-leaved phlox, and Bentley's coralroot. All known locations of T&E plant species on the Forest are included in Special Biological Areas. The following table summarizes the communities represented.

Table E-4. Community Types Represented in Special Biological Areas

Community Type	Acres
Stream	173
Riparian	27
Montane Depression Wetlands	19,414
Appalachian bog	45
Mountain/Piedmont Seepage Swamp	2,642
Montane Calcareous Seepage Swamp	304
Calcareous fen	672
Cave/karst	1,799
Dry calcareous forest, cave/karst	1,135
Montane Dry Calcareous Forest/Woodland	661
Dry/Mesic Calcareous Forest	24
Calcareous cliff	1,062
Cliff/Talus, calcareous	56
Dry - Mesic Calcareous Forests, Calcareous cliff, cave	838
Cliff/Talus	775
Outcrop	17
Outcrop barren	179
Central Appalachian Shale Barren, calcareous	769
Central Appalachian Shale Barren	10,681
High elevation	5,224
Juniper woodland	163
Mafic glade	366
Sandstone glade	141
Montane Mixed Oak/Oak - Hickory Forest,	380
Mountain/Piedmont Acidic Woodland	483
Pine - Oak/Heath Woodland	2,208
Spruce/Fir	6,694
Other	5,835
Shenandoah Mountain Crest	58,000

5.0 FORESTWIDE ECOSYSTEM DIVERSITY – ALTERNATIVES AND EFFECTS

5.1 Ecosystem Diversity Characteristics

Attributes and Indicators

The following key attributes were identified for each ecosystem along with the indicator to be used to measure the key attribute.

Table E-5. Key Attributes and Indicators for ESE Ecological Systems

Ecosystem	Key Attribute	Indicator
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Ecological System Abundance	Total Occurrences at Desired Condition
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Fire Regime	% Burned at Desired Frequency
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Invasive Species Abundance	Compliance with Invasive Species Guidelines
Mafic Glade and Barrens and Alkaline Glades and Woodlands	Vegetation Structure	% Open Canopy
Caves and Karstlands	Ecological System Abundance	Total Occurrences at Desired Condition
Caves and Karstlands	Physical Structure	Compliance with cave, karst physical settings including hydrologic, biologic and chemical setting
Cliff, Talus and Shale Barrens	Ecological System Abundance	Total Occurrences at Desired Condition
Cliff, Talus and Shale Barrens	Invasive Species Abundance	Compliance with Invasive Species Guidelines
Cliff, Talus and Shale Barrens	Vegetation Structure	% Open and Open Canopy
Cove Forest	Forest Age Diversity	% in mid to late successional stages
Cove Forest	Forest Age Diversity	% Late Successional
Cove Forest	Forest Age Diversity	% Regenerating Forest
Cove Forest	Vegetation Structure	% open canopy in mid to late successional stages
Northern Hardwood Forest	Forest Age Diversity	% in mid to late successional stages
Northern Hardwood Forest	Forest Age Diversity	% Late Successional
Northern Hardwood Forest	Forest Age Diversity	% Regenerating Forest
Northern Hardwood Forest	Vegetation Structure	% open canopy in mid to late successional stages

Ecosystem	Key Attribute	Indicator
Oak Forests and Woodlands	Fire Regime	% Burned at Desired Frequency
Oak Forests and Woodlands	Forest Age Diversity	% in mid to late successional stages
Oak Forests and Woodlands	Forest Age Diversity	% Mature Forest
Oak Forests and Woodlands	Forest Age Diversity	% Regenerating Forest
Oak Forests and Woodlands	Vegetation Structure	% open canopy in mid to late successional stages
Oak Forests and Woodlands	Vegetation Structure	% open grasslands or forbs
Pine Forests and Woodlands	Fire Regime	% Burned at Desired Frequency
Pine Forests and Woodlands	Forest Age Diversity	% in mid to late successional stages
Pine Forests and Woodlands	Forest Age Diversity	% Regenerating Forest
Pine Forests and Woodlands	Vegetation Structure	% open canopy in mid to late successional stages
Floodplains, Wetlands and Riparian Areas	Habitat Element Abundance	Compliance with Riparian Guidelines
Spruce Forest	Ecological System Abundance	Total System Acres at Desired Condition

Abundance and Distribution

Table E-6. Current abundance of ecological systems on the George Washington National Forest

Ecological System	Approximate Existing Acres
Spruce Forest	582
Northern Hardwood Forest	13,478
Cove Forest	61,022
Oak Forests and Woodlands	756,058
Pine Forests and Woodlands	162,129
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842
Cliff, Talus and Shale Barrens	13,637
Floodplains, Wetlands, and Riparian Areas	51,430
Water	3,284
Total Acres	1,065,462
Caves and Karstlands (included in above acres)	119,000

Structure and Tree Age Diversity

Structure and tree age diversity are both characteristics that are important to all forested ecological systems. Structure is also important to non-forested systems. Every forested community requires a balance of age-class conditions representing a diversity of vertical structure that allows for recruitment of young growth to replace losses due to storm events, pest infestations, wildland fires, and loss of over-mature trees. An appropriate balance of vertical structure within each community provides critical habitat for associated species that require either grass/forb-seedling/shrub (early seral), and/or trees (late seral).

Canopy structure reflects the general health and sustainability of the community by the amounts and arrangement of early seral and mature stands. Canopy closure, as a surrogate for horizontal structure, was measured as a combination of stem density, basal area and extent of canopy cover. This measure was used primarily to delineate forested (closed canopy) from open canopy and woodland conditions.

Table E-7. Definitions of Structural Classes

Open	Land with less than 10 percent canopy cover in permanent or long-term open condition (grasslands, barrens, etc.; not newly cut forest regeneration.)
Early Successional or Regenerating Forest	Stands developing after a major disturbance, generally less than 11 years in age in the most common systems, but can be up to 24 years.
Mid-Successional Open Canopy	Stands beyond regeneration that stay in a relatively open canopy (canopy closure of 25-60%)
Mid-Successional Closed Canopy	Stands beyond regeneration where the canopy closes (canopy closure of 61% or greater)
Late Successional Closed Canopy Forest	Stands reaching older ages of mature trees (50-100 years or greater) and more lasting structural conditions with a largely closed canopy (all layers) greater than 60 percent. Includes natural canopy gaps.
Late Successional Open Canopy Forest	Stands reaching older ages of mature trees (50-100 years or greater) and more lasting structural conditions with overall open canopy (canopy closure of 25-60 percent; typical of thinned forests)

Old Growth

Summary of Old Growth Guidance

In 1989 then-Chief Dale Robertson issued a national position statement on old growth. This included a national generic definition and description of old growth forests that is still applicable today:

> Old growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics that may include tree size, accumulation of large dead woody material, number of canopy layers, species composition, and ecosystem function.
>
> The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to forest type with climate, site conditions, and disturbance regime. For example, old growth in fire-dependent forest types may not differ greatly from younger forests in the number of canopy layers or accumulation of downed woody material.
>
> Old growth is typically distinguished from younger growth by the following structural attributes and characteristics:
>
> 1. Large trees for that species and site.
> 2. Uneven age structure with tree species in several size classes resulting in multiple canopy layers.

3. Accumulations of large-size dead standing and fallen trees that are high relative to earlier stages and in all stages of decay.
4. Broken or deformed tops or bole and root decay primarily resulting from weather phenomena such as ice or wind storms.
5. Single or multiple tree-fall gaps usually resulting from windthrow and resulting in understory patchiness and increased micro-topography relief.
6. Undisturbed soils and soil macropores usually with a well-developed surface organic layer (0 horizon).
7. On mesic sites a well-developed fungal component.

Beginning in 1990, the Southern and Eastern Regions of the Forest Service; the Forest Service Southern, Northeastern, and North Central research stations; and The Nature Conservancy began efforts to develop science-based old growth definitions for the east. The effort proved to be problematic in large part because so few representatives of old growth conditions exist and their history for their entire life so poorly known that quantifying the range of natural variability was imprecise. But after five years of effort, in December of 1995, the Southern Regional Forester chartered the Region 8 Old Growth Team to make the draft scientific old growth definitions 'operational and useful'. In June of 1997 the Team completed a report entitled *Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region*, hereafter called the 'old growth report' (Forest Service 1997). It is this report that continues to guide management of old growth on the Southern Region Forests.

The old growth report recognized old growth forests as a valuable natural resource worthy of protection, restoration, and management that provides a variety of ecological, social, and spiritual values. Old growth communities are rare or largely absent in the southeastern forests from Virginia south to Florida. Existing old growth areas (referred to as 'primary forests') may represent around 0.5% (approx. 482,000 acres) of the total forested acreage of 88,079,000 acres (Davis 1996). For these reasons the Southern Region's National Forests are making efforts to restore more of this portion of forest ecosystems.

The old growth report gave operational definitions for sixteen old growth community types that encompassed nearly all of the forest cover types in the Southeast. Factors used to define old growth forest type (OGFT) groups are those that most strongly influence the structural and functional characteristics of old growth forests. These include site factors that directly or indirectly affect productivity and spacing of trees, disturbance regimes, physiognomy, dominant tree species, and geography (in that geography is related to climate, which controls productivity, in part). A few forest cover types were not included such as those considered rare communities plus the tropical forests of the Caribbean.

For each old growth forest type, minimum ages were determined at which a stand will begin to develop attributes characteristic of old growth conditions. Several accepted definitions used to describe old growth state that a given old growth forest type will begin to develop old growth characteristics at an age approximately one-half the maximum longevity (lifespan) of the dominate tree(s) found in that type (Cogbill 1983; Leverett 1996; Loehle 1988). The nine old growth forest type groups that occur on the Forest have five different ages at which they begin to develop old growth characteristics ranging from 100 to 140 years. These groups not only reflect the longevity of dominate trees, but natural disturbance regimes (fire, ice storms, gap formation, etc.) and edaphic conditions (rainfall, slope, aspect, etc.) where they're found.

The operational definitions established four criteria which had to be met before a stand would be considered 'existing' old growth: (1) AGE - minimum age in the oldest age class; (2) PAST DISTURBANCE - no obvious human-caused disturbance that conflicts with old growth characteristics for that type; (3) BASAL AREA - minimum basal areas of stems 5" d.b.h. and larger; and (4) TREE SIZE - a minimum diameter at breast height (d.b.h.) of the largest trees. Except for number two, the values for these criteria vary by old growth type. The report also generally charged each Forest to provide: (1) a distribution of large (more than 2,500 acres), medium (100 thru 2,500 acres), and small (1 thru 99 acres) potential old growth patches; and (2) representation of all potential and applicable old growth forest types for each ecological section unit (e.g. physiographic region). An exception to the large block requirement was made for forests in the Northern and Southern Cumberland Plateau and the Appalachian Piedmont ecological sections because of land ownership patterns. The distribution guidance did not specify an amount, such as acres or percent of area, to be in each patch size. In addition, old growth patches were assumed to be occurring on National Forests in a matrix of

mid- to late successional forest conditions, providing connectivity without old growth allocations being physically contiguous. Representation was limited to ensuring that old growth community types were present, not a total amount nor an amount per each type. Amounts (i.e. acres) were to be based on public issues and ecological capabilities of the land.

The Biological Significance of Old Growth

To date no species of plant or animal had been identified in the Southeastern United States that is considered an old growth obligate; that is, requiring old growth for some portion or all of their life cycle. Therefore, the provision of existing or future old growth is not directly linked in a cause and effect relationship to the viability of any species.

However, old growth and associated late successional forests & woodlands are a condition that is particularly rich in habitat attributes for a variety of species and these attributes occur in close association (intra-stand) with one another as opposed to a landscape scale (inter-stand) distribution. A wider variety of habitat niches are available than in earlier life stages of the same community. The long development period is conducive to the formation of complex vertical structure that may include 'emergent' trees, dominant and co-dominant trees, suppressed trees, and a forest floor shrub layer and/or a herb/forb/grass layer. Canopy gaps of various sizes caused by: (a) the death in-place of a single tree; or (b) the deaths in-place of small groups of trees; or (c) the falling of a group of trees, in comparison with their immediate surroundings provide micro-sites with higher light regimes, higher stem counts, and an 'edge effect' both around the edge of the gap and back into the surrounding stand. Standing dead trees provide large and small diameter snags for foraging, perching, and cavity excavation. Down logs and limbs provide a substrate for wood decomposing fungi and insects; cover for small mammals, amphibians, and insects; and in later stages a 'nurse log' for the establishment of new tree seedlings. Large-diameter living trees, with a long-term exposure to natural damaging agents, have the potential through wood-rotting fungi activity for the formation of large cavities suitable for bear, raccoon, squirrel, bats, or other cavity users. The heavy limb structure that develops in some tree species as they age provides sturdy nest platforms for species such as bald or golden eagles.

The Social Significance of Old Growth

Whether biologically necessary to species or not, old growth is of value. There seems to be a general sense that it is intelligent to be sure to have this habitat condition on the landscape. In Aldo Leopold's words, '*The first rule of intelligent tinkering is to keep all the parts.'* As with Wilderness, there also appears to be a desire for places almost completely unmodified by humans whether or not those holding such a value ever visit them; that is, an 'existence' value. There can be, and often is, a historical, cultural or spiritual value associated with old growth whether it's a few acres, hundreds of acres, or even thousands of acres. There also is value in providing old growth of different types on a variety of landscapes that each person holding that value can readily relate to. That is, it is not enough to say something valued is being provided simply 'somewhere'.

In more pragmatic terms, old growth has other recognized social values. It is a desirable recreation setting, both for its biological variety and for the associated state of mind from knowing one is in an 'old growth' setting perhaps surrounded by an open forest of big trees. It serves as a 'biological time machine' in that it is a reference area for what ecologically-comparable areas may have been previously and can be restored to given a similar amount of time and disturbance history. They are a valuable part of showing a comprehensive whole of ecological dynamics in conservation education. They are also a source of scientific information for research such as dendrochronology (tree ring analysis) used in studies of disturbance regimes and climate fluctuations.

Implementation of Old Growth Guidance in Forest Plan

The GWNF has used the 1997 Regional Guidance to help address this component of biodiversity and in the delineation of old growth, both potential and existing. Small, medium, and large sized patches have been identified using stand ages contained in FSVeg and analyzed their spatial arrangement using GIS. Existing Wilderness, Recommended Wilderness study areas, Remote Backcountry, and other prescriptions with large acreages, such as Special Biological Areas and Shenandoah Mountain Crest, provide for the large blocks both now and in the future.

Successional Forests, Early Successional Habitat, Openings, Open Woodlands

Successional stages of forests are the determining factor for presence, distribution, and abundance of a wide variety of wildlife. Some species depend on early successional forests, some depend on late successional forests, and others depend on a mix of both occurring within the landscape (Franklin 1988; Harris 1984; Hunter et al. 2001; Hunter 1988; Litvaitis 2001). These habitat conditions are also important as wintering and stopover habitats for migrating species (Kilgo 1999; Suthers 2000; Hunter et al. 2001). Therefore, it is important that varying amounts of both types of habitat be provided within national forest landscapes.

For analysis purposes, forest succession is generally divided into three stages: early, mid, and late. Early successional forest is defined as regenerating forest of 0 to 24 years of age for depending upon the ecological system. It is characterized by dominance of woody growth of regenerating trees and shrubs, often with a significant grass/forb component, and relatively low density or absent overstory. This condition is distinguished from most permanent opening habitats by dominance of relatively dense woody vegetation, as opposed to dominance of grasses and forbs. Such conditions may be created by even-aged and two-aged regeneration cutting, and by natural disturbance events, such as windstorms, severe wildfire, and some insect or disease outbreaks. Ages defining the remaining successional stages vary by ecological system. Mid-successional forest often begins to develop with the sapling/pole forest characterized by canopy closure of dense tree regeneration, with tree diameters typically smaller than 10 inches. It then proceeds through stratification of over-, mid-, and understory layers. Late successional forests, from 50 to 100 years in age and older, include old growth conditions. This stage contains the largest trees and often has well-developed canopy layers and scattered openings caused by tree mortality. Of particular importance as habitat are forest conditions that exist at both extremes of the forest successional continuum-early successional and late successional forests.

Another important type of forest that combines elements of both early and mid – to late successional forest is open woodlands. Created and maintained largely by periodic fire disturbance regimes, open woodlands are characterized by an overstory of trees that are spaced far enough apart to allow sunlight to reach the forest floor. This structural condition allows the development of a grassy/shrubby/herbaceous/woody understory more typical of early successional forest and grassland/shrublands. Many high priority species depend on the juxtaposition of both overstory mature and a well-developed grassy/shrubby/herbaceous understory for their life cycle needs. Northern bobwhite quail, red-headed woodpecker, brown-headed nuthatch, northern flicker, Appalachian yellow-bellied sapsucker, eastern wood-pewee, golden-winged warbler, Indiana bat, pine snake, grizzled skipper, box huckleberry, shale-barren rockcress, small-spreading pogonia, sword-leaf phlox, variable sedge, and smooth coneflower are just a few high priority species dependent upon open woodland habitat.

Early successional forests are important because they are highly productive in terms of forage, diversity of food sources, insect production, nesting and escape cover, and soft mast. Early successional forests have the shortest lifespan (usually about 10 years) of any of the forest successional stages, and are typically in short supply and declining on national forests in the Southern Appalachians (SAMAB 1996:28), and in the eastern United States (Thompson 2001). Early successional forests are also not distributed regularly or randomly across the landscape (Lorimer 2001). These habitats are essential for some birds (ruffed grouse, chestnut-sided warbler, golden-winged warbler, prairie warbler, yellow-breasted chat, blue-winged warbler, Swainson's warbler); key to deer, turkey, and bear in the South; and sought by hunters, berry pickers, crafters, and herb gatherers for the wealth of opportunities they provide (Gobster 2001). Many species commonly associated with late successional forest conditions also use early successional forests periodically, or depend upon it during some portion of their life cycle (Hunter et al. 2001).

The need for seedling/sapling conditions to provide habitat for birds associated with early successional habitats is a current topic of concern. Old fields can provide conditions required by many early seral species, but this habitat type itself is very uncommon on the National Forest. The minimal area that is required by each species varies and is not fully understood. Kirpez and Stauffer (1994) documented local research findings that harvest groups of approximately 0.5 to 2 acres in size provide suitable habitat for such early seral dependent birds as the indigo bunting and rufous-sided towhee. In addition, local U.S. Forest Service bird monitoring efforts have identified the chestnut-sided warbler, an early seral species, inhabiting group harvest areas of less than 1 acre in size. In a discussion of management of early-successional habitats, Thompson and Dessecker (1997) identified group selection areas of less than 0.5 acres as inadequate for a variety of forest songbirds. Thus, there is a group of forest songbirds, such as the prairie and golden-winged warblers, which require

disturbance patches that are less than 10 years of age and greater than 2 acres is size. Thus, the early successional forest habitat that will be created in patches greater than 2 acres, will result from even-aged timber harvest.

In addition to structure and patch size, the elevation at which early seral habitats exist plays a role in providing habitat for some species. The chestnut-sided warbler typically occurs at higher elevations on the GWNF. Thus, provision of seedling/sapling habitat needs to be considered at both high and lower elevations.

Eastern hardwood stands begin to produce significant amounts of hard mast at about age 40. Hard mast is a very important component for many wildlife species such as bear, squirrel, and turkey. Therefore, the age at which hardwood stands begin to produce adequate amounts of hard mast, especially upland hardwood stands dominated by oak species, is an important stage in stand development. Hard mast production is highly variable between species as well as individuals of the same species. Hard mast production in any given year is dependent upon many factors including climate and weather, insects and disease, stand density, size of trees, stand composition, and stand age. Many of these factors are either beyond control (e.g. weather) or more appropriately considered at site specific levels (e.g. stand density). For the purposes of effects analysis and disclosure at the Forest Plan level, stand age and stand composition are excellent indicators of a stand's hard mast production capability.

The five major oak species (*Quercus alba, Q. prinus, Q. velutina, Q. rubra*, and *Q. coccinea*) all begin hard mast production at ages from 20 to 25 years old. Maximum acorn production is achieved at 40 to 50 years old. *Carya glabra, C. tomentosa*, and *Fagus grandifolia* produce hard mast in quantity at ages of 30 to 40 years. Finally, *Tilia americana* can begin producing adequate amounts of hard mast as early as 15 years old. (Burns and Honkala 1990.) Goodrum and others found that acorn yields tended to be largest in the classes from 40 to 49 years old up to 90 to 99 years old, but declined thereafter (Goodrum et al. 1971). Shaw arrived at a similar conclusion when he found that stands in his study area ranging from 40 to 80 years old comprised 50% of the management unit, but produced 90 percent of the acorn crop. (Shaw 1971.) Thus, the age of 40 years old as the beginning of significant hard mast production in eastern hardwood forests is widely accepted.

Like early successional forests, late successional forests provide habitats and food supplies for a suite of habitat specialists as well as habitat generalists. These habitats are important providers of high canopy nesting, roosting, and foraging habitat, suitable tree diameters for cavity development and excavation, and relatively large volumes of seed and hard mast. Although it takes many decades for late successional forest conditions to develop, these habitats are more common and contiguous across the national forest and are dominant features in the SAA area (SAMAB 1996:28).

At the time of the SAA, National Forest System lands had only 3% of forest habitats in the early successional stage, while 89% was in the mid- and late successional classes; 45% of this was late successional forest (SAMAB 1996:168). Other public lands were similar to the National Forest. Conversely, private industrial lands had 22% in early successional forest and only 4% in late successional forest; private non-industrial had 8% in early successional forest and 9% in late successional forest (SAMAB 1996:168-169). The 20-year trends (SAMAB 1996:28) show early successional forest on National Forests decreasing by 4%, with late successional forest increasing by 34%. Trends for private forests are mixed, with increases in both early- and late successional forest percentages. These results likely reflect the mixed objectives of private landowners, with some focusing on commodity production and others on amenity values. In general, on National Forest System lands forest conditions are weighted heavily toward total acres of older forests, while private forests are providing a more balanced distribution of forest successional conditions from young to old (Trani-Griep 1999).

Quality of forest successional habitats may also vary between private and national forest system lands. Objectives on national forests to provide for wildlife habitat needs, recreational activities, scenic integrity objectives, and water quality often result in greater vegetation structure retained in early successional forests than in similar habitats on private lands. On private lands, more intensive management may simplify structure and composition, reducing habitat quality. Similarly, effort to restore and maintain desired ecological conditions and processes in mid- and late successional forests also often enhances habitat quality over that found on private lands. For these reasons, conclusions regarding cumulative habitat availability from both private and national forest system lands must be made with caution.

Hurricanes (Foster 1992), lightning frequency (Delcourt 1998), fire frequency (Whitney 1986), and pre-settlement cultural activities (Delcourt 1987) were probably the major sources of disturbance events that created early successional forests prior to European occupation. Less drastic perturbations such as mortality events from tornadoes, insect or disease outbreaks, or defoliation (passenger pigeon roosts) were typically less extensive and cyclic but nonetheless provided a source of early successional forest conditions. Natural disturbances, however, are unpredictable, episodic, and heterogeneous (Lorimer 2001); influential at a landscape scale; and are neither uniform nor random in distribution. Anthropogenic disturbances occurred more frequently in floodplains along major rivers and in "hunting grounds." In a recent review paper by disturbance ecologist Craig Lorimer (Historical and ecological roles of disturbance in eastern North American forests: 9,000 years of change. Wildlife Society Bulletin 2001, 29(2):425-439), Lorimer states that predicting frequency of more severe natural disturbances (the kind that would create desired early-successional forest patches) is difficult because they are highly episodic and spatially heterogeneous. Lorimer goes on to state: "…the episodic nature of large natural disturbances creates a sort of 'feast or famine' environment that may subject early successional animal populations to erratic fluctuations…" Such feasts and famines may be especially extreme when looking at the smaller natural landscapes represented by national forests, surrounded by private lands that may be converted to nonforest. Successional forest objectives are designed to reduce the feast and famine swings for early-successional forest species, while providing ample habitat for mature forest species.

Overall, landscape patterns more consistently contain a component of early successional forests in places more "likely" to be susceptible to disturbances, i.e., south and west facing slopes, sandy or well drained soils, or in fire adapted plant communities. Fire suppression, intensive agriculture resulting in massive soil losses, land use changes, and urban sprawl have drastically altered the variables that would perpetuate a landscape with a significant component of early- successional forests. With many species associated with early successional forests in the southeast in decline (Hunter et al. 2001), it is imperative that management actions include some provision for perpetuating early successional forest conditions. At the same time, many of these same factors, especially land use conversion, have reduced the distribution and abundance of quality late successional forests across the larger landscape. Maintenance of these on public lands is equally imperative.

Permanent grass/forb and seedling/sapling/shrub habitats are important elements of early successional habitat. Permanent openings typically are maintained for wildlife habitat on an annual or semi-annual basis with the use of cultivation, mowing, or other vegetation management treatments. These openings may contain native grasses and forbs or may be planted to non-native agricultural species such as clover, orchard grass, wheat, or small grains. Old fields are sites that are no longer maintained, are maintained on a less frequent basis (5-10 year intervals, usually with burning and mowing) or are succeeding to forest. They are largely influenced by past cultural activities and may be dense sod or a rapidly changing field of annual and perennial herbs, grasses, woody shrubs and tree seedlings.

Permanent openings are used by a variety of wildlife, both game and non-game species. Parker and others (1992) reported use of agricultural openings by 54 species of birds and 14 species of mammals in a study on the Chattahoochee National Forest. Bird species observed included wild turkey, several species of raptors and woodpeckers, and numerous songbirds including a number of neotropical migrants such as pine warbler, ovenbird, and black-throated green warbler. The greatest number of avian species and highest bird species diversity was found within the edge zone of the openings. Mammals observed included species such as white-tailed deer, striped skunk, woodchuck, bobcat, black bear, red bat, eastern cottontail, opossum, and several other small mammals.

The benefits of permanent openings to white-tailed deer are well documented. Permanent openings, especially those containing grass-clover mixtures, are used most intensively in early spring, but also are an important source of nutritious forage in winter, especially when acorns are in short supply (Wentworth et al. 1990; Kammermeyer et al. 1993). Kammermeyer and Moser (1990) found a significant relationship between openings and deer harvest with only 0.13% of the land area in high quality openings. Forest openings also are a key habitat component for wild turkeys throughout the year (Thackston et al. 1991; Brenneman et al. 1991). Maintained openings provide nutritious green forage in the winter and early spring and seeds during late summer and fall. Because of the abundance of insects and herbaceous plants produced in these openings, they are especially important as brood rearing habitat for young turkeys (Nenno and Lindzey 1979; Healy and

Nenno 1983). Linear openings, especially those associated with young regenerating forests, provide optimal brood habitat conditions for ruffed grouse (Dimmick et al. 1996).

There also are numerous wildlife benefits from openings maintained in native species. Native warm season grasses provide nesting, brood-rearing, and roosting habitat for northern bobwhite and other grassland species of wildlife (Dimmick et al. 2001). Native species are well adapted to local environments and generally require less intensive maintenance following establishment.

Old fields provide food and cover for a variety of wildlife species. A number of disturbance-dependent birds, such as northern bobwhite, grasshopper sparrow, golden-winged warbler, and blue winged warbler, are associated with old field habitat (Hunter et al. 2001). Recently abandoned fields are important for rabbits and many small mammals (Livaitis 2001). Woodcock use old fields as courtship, feeding, and roosting sites (Straw et al. 1994; Krementz and Jackson 1999). Although managed less intensively than other types of permanent openings, some degree of periodic management is necessary to maintain these habitats.

Fire Regime

The presence of fire begins long before humans arrived in North America. Evidence of lightning fires exists as fusain in coal layers and as lightning scars on petrified trees (Pyne 1982). Even today, lightning and thunderstorms are abundant, and Pyne surmised, "A phenomenon of such magnitude and longevity has unquestionably kindled profound evolutionary consequences". This great and persistent selecting force has influenced ecosystem traits and characteristics since fuels and lightning first interacted. The result is a forest with diversity and flexibility that is well adapted to fire occurrence. Fire has no doubt been a major selection force in our forest ecosystems, both lightning and anthropogenic. Many communities and species require fire to sustain populations. Oak and southern yellow pine communities have been major components of these forests for thousands of years. These communities promote and require fire. Recurring fire has been a part of the ecosystem for thousands of years. Burning is the oldest sustained land management force on these forests. No other practice can be said to have such a track record with known results.

A clearer picture of change over time is gained when we focus on the period since the last ice age. Dramatic changes in plant and animal communities have occurred during this post-glacial period. Importantly, humans made their way onto the North American scene during this period. The ecosystems developed within the influences of both climatic and human forces. The question often debated is whether human ignition, for those thousands of years, should be considered when determining the “natural” state of ecosystems. Several points seem clear. The forests have been continually changing. The diversity and flexibility of these natural systems are necessary to react to change. Fire is an important mechanism to retain that diversity and flexibility.

Early human occupation of Virginia dates back to approximately 11,500 BP during the Paleoindian period (Barber, 1996). European contact was relatively early in the region of the George Washington and Jefferson National Forests, Barber (1996) notes European contact did not occur in the Ridge and Valley area until the 1670's, and the written historical record of fire is rich with accounts from travelers and explorers. The obvious conclusion, common to each account, was the extensive use of fire by Native Americans. The effect, likewise, was extensive. Early observations describe vast areas of grassy savannas, commonplace smoke and fire, clearings and fields and apparent utilization of fire-managed vegetation (Maxwell 1910; Day 1953; Pyne 1982; Hammett 1992; Brown 2000). Maxwell contains a great number of accounts, but his perspective certainly reflects the bias and prejudices of the opponents to light burning. From all accounts, regardless of their perspective, burning by the Native Americans was a commonplace practice, serving many needs.

Methods of constructing fire histories in the east for pre-European settlement times have relied largely on sediment records (Craig 1969; Watts 1979; Patterson and Backman 1988; Patterson and Sassaman 1988; Wilkins et al. 1991; Kneller and Peteet 1993; Patterson and Stevens 1995; Delcourt and Delcourt 1996). These studies typically extract a core of sediment from a pond or bog, and that core is then sampled for pollen, plant macrofossils, and/ or charcoal.

Though a scarcity of suitable sites has limited the number of such investigations, ponds and bogs have provided a number of valuable sites in the Central Appalachians. Sites within or near the Forests are: Potts Pond (Watts 1979) in Alleghany County; Hack (Spring) Pond and Quarles Pond (Craig 1969), in Augusta County;

Brown's Pond (Kneller and Peteet 1993) in Bath County; and another study that includes Brown's Pond and also Green Pond, in Augusta County, near Sherando Lake (Patterson and Stevens 1995).

Common to each study is the dynamic nature of the composition of plant communities. Climate is the determinant mechanism that propels this continuum of change along a geologic time scale (Patterson and Backman 1988). Fire acts within this continuum on a shorter scale, to provide an important catalyst that selects one plant over another. Watts (1979) agrees that this "migration of single species is an opportunistic response to changes in climate and environmental circumstances independent of other species". From 7,880 BP to the present, oak has been the dominant genus, comprising more than 50% of the pollen record. Pine is also present, increasing within this time period from 3% to 22%, with both white pine and yellow pines being represented. Chestnut stays below 1% until the upper, later half of the profile. The continued dominance of oak corresponds with relatively greater amounts of charcoal deposits. Blackgum was also found on Potts Mountain (Watts 1979) during this period. Watts had also noted an earlier rise in American chestnut at Potts Mountain.

Patterson and Stevens (1995) correlated charcoal surface area to pollen abundance, signifying the relative importance of fire for sampled time periods. Brown's Pond (Bath County) and Green Pond (Augusta County) were examined. Similar to other studies, they agree that the vegetation around Brown's Pond has changed little over the past 1,000 to as much as 4,000 years, with oak, hickory and chestnut representing important taxa. Also, ragweed was consistently present during this period, an indicator of agricultural activity.

Green Pond, on the other hand, showed a marked increase in total pine pollen, from <20% before the chestnut decline to over 40% more recently. Diploxylon pines (hard pines; i.e. pitch, table mountain, shortleaf, and Virginia) are more important than at Brown's Pond. Also of significance is the recent reduction in oak pollen since the chestnut decline, from > 40% to less than 30%, suggesting local vegetative changes.

They then looked at the amount of charcoal surface area found, relative to the pollen samples. At Green Pond, evidence suggests fire presence both before and after European settlement. They determined that fire had a significant impact on vegetation around the time of European settlement. Those high charcoal values are followed by a sharp increase in pine pollen. This charcoal peak was between the increase in agricultural pollen and before the chestnut decline. The data suggests that fire in early post-European settlement resulted in a dramatic change in vegetation.

At Brown's Pond, high charcoal to pollen ratios appear at 650 years BP, ~2,000 BP, and 4,210 years BP. The average ratio prior to European settlement is slightly higher than post-settlement, with two fires clearly evident since Euro-settlement. The higher pre-euro-settlement values indicate the long historical role fire has played in the hardwoods. The authors suggest that long interval fire regimes have been important in maintaining the vegetative composition typical of the central Appalachians.

Patterson and Sassaman (1988) compared amounts of sedimentary charcoal to archaeological sites and found that fires were common near larger Native American populations and where their land-use practices were greatest. Charcoal records prior to European settlement and post-settlement show little difference, except during the slash fires associated with the logging boom at the turn of the century.

These records clearly suggest that fires have been important in that area for the past 4,000 years, during a period of low lightning incidence. Human use of fire has been important in determining plant community composition (see also Sutherland et al. 1993).

Delcourt and Delcourt conclude by stating, "If management goals of the U.S. Forest Service include maintaining populations of fire-adapted pines and certain oak species that are currently declining because of active fire suppression, then future management tools clearly must include prescribed burning. The lesson from the Horse Cove example of prehistoric human use of fire is that fires of limited extent, focused on particular portions of the landscape, and excluded from others, can promote a heterogeneous mosaic of different vegetation types, some of which include clearly fire-adapted species, and others of which include fire-intolerant species. In order to maintain both old growth mesic hardwoods and fire-adapted pines within the same forest district, an optimal management plan would be based upon an understanding of the effects of different frequencies and intensities of fire applied to varying portions of the topographic-edaphic gradient and different areal extents of impact. Work of vegetation ecologists such as Runkle (1982, 1985) and Barden (1980, 1981)

indicates that equilibrium, old growth mixed mesophytic forests will regenerate only under a disturbance regime that includes infrequent windthrow to open canopy gaps but which explicitly excludes fire (see also Clark and Royall 1996). Promotion of Appalachian oak forests, including relatively widely spaced oak groves or "oak orchards" with sparse understory of grass and bracken fern (Stephenson et al. 1993), on the other hand requires use of frequent ground fires such as may have been used by prehistoric Native Americans to maintain their hunting and gathering grounds. Furthermore, periodic crown fires along exposed ridge crests may be necessary for regeneration of fire-adapted endemic pine species".

The George Washington National Forest was established in 1918 and the national direction regarding fire was quite clear in the early days of the Forest Service (Pyne 1982)..."Forest fires have no place in any forest but as a result of ignorance, carelessness, and indifference (Anonymous 1936)". The practitioners of "controlled burning" battled against an enormous campaign set at the national level to stop all fire. With that new direction of suppressing all fires, that major force of selection that had been present since the ice age was suddenly altered. The consequences of that well-intentioned but misguided policy would not be obvious for several decades. The selection process that influenced plant and animal communities now changed with the absence of fire.

Perhaps, though, in defense of the dedicated firefighters during these times, this is the way it had to happen. The use of fire-fighting equipment, intelligence, weather forecasts, budgets and fire behavior prediction have only recently enabled prescribed burning on a substantial level. Recent scientific literature regarding plant and animal reactions and effects are now better known. We have better data on pre-Euro-American settlement conditions. And now we are beginning to understand some of the more dramatic long-term impacts of fire exclusion, as plant and animal populations and conditions of forest ecosystems are altered.

Several other studies have approached the issue of fire occurrence, what it has been in the past and the implications of fire exclusion. Dendropyrochronology studies provide valuable information such as the season of fire occurrence since trees lay down early season and late season wood in each tree ring per year; the number of fire scars on an individual tree provides data on fire frequency; and, by cross dating fire scars on different trees that occurred in the same year one is able to approximate the spatial extent of a fire.

Sutherland and others 1993, sought to “reconstruct the historical relationship between fire and community structure using both the age and species composition approach in combination with tree-ring fire history analysis”. Their study was one of the first in the Central Appalachians to use fire scars on pines to examine fire history. The study site on Brush Mountain in southwest Virginia west of Blacksburg, noted the loss of table mountain pine (*Pinus pungens*) recruitment since fire suppression in the late 1930s. Major recruitment of P. pungens occurred twice during the 1800’s, probably due to exceptionally hot fires. The fire scar chronology indicated that fire occurred frequently (every 9-11 years) throughout the 19th century and early 20th century. Most of those fires occurred during the dormant season, most likely in early spring. The hot recruitment fires may have been during the growing season. They stated, “Fire suppression is most likely the cause of a dramatic change in the composition of the Brush Mountain communities during the last 60 years (Williams and Johnson 1990). In the past, fire clearly promoted integrity of the Pinus pungens community on Brush Mountain”.

Subsequent fire history studies using dendrochronology at multiple sites and a larger sample size of scarred trees on both the GWNF and Jefferson National Forest found that the fire interval from the early 1700s to the 1930s ranged from 2 to 9 years (Aldrich et al. 2010; DeWeese 2007; Lafon and Grissino-Mayer 2005). Additional unpublished work by Aldrich has pushed this timeframe back to the mid-1600’s which pre-dates European settlement in western Virginia. Work by Lafon in the southern Blue Ridge has found similar intervals for the same timeframe.

To examine fire history further back in time recent studies have examined and dated charcoal found in soil layers. A study on southwestern North Carolina found that fires burned regularly across the studied landscape for at least the past 4,000 years. These fires were not confined to the dry oak-pine dominated ridges but extended downslope into areas that are today dominated by mesic hardwood forests (Fesenmyer and Christensen 2010).

Habitat Fragmentation

Habitat fragmentation is a key issue for viability of local populations of breeding birds and other species like salamanders in some mature mesic deciduous forest settings. Birds in this group avoid forest edges during nesting and are adapted to forest interior conditions. Most are neotropical migrants that primarily nest and raise young in the temperate Americas. These species are grouped for effects analysis due to their sensitivity to forest fragmentation and edge effects (Hamel 1992).

Studies conducted in the mid-western U.S. have documented that forest interior species may not successfully breed in small patches of otherwise suitable habitat. Quality of their forest interior habitat is measured in part by proportion of edge, an artifact of juxtaposing forested and non-forested habitats. Edges fragment forest interior habitats and are associated with increased predation and brood parasitism by the brown-headed cowbird in agricultural settings (Primack 1993; Yahner 1998). However, characteristics of the surrounding landscape, such as percent forest cover, determine the magnitude of local edge effects. Findings of Robinson and others (1995) indicate that large landscapes with at least 70-80% forest cover offer high potential as quality habitat for forest interior species, where adverse effects of edge are reduced to levels compatible with productive populations.

Donovan and others (1997) found that abundance of the brown-headed cowbird in a midwestern U.S. setting was significantly greater in highly fragmented landscapes (< 15% forested) than in moderately fragmented (45-55% forested) or unfragmented (>90% forested) landscapes, but abundance in moderate and unfragmented landscapes did not differ. Landscape-scale habitat patterns significantly influenced overall nest predation patterns and cowbird abundance. However, local effects of livestock grazing and horse corrals caused high variation between landscape units with similar percent forest characteristics. The specific types of non-forested habitats present may be important.

As a general rule, parasitism levels of 25% or less and daily nest predation rates of 4% or less should give most forest interior species "at least a chance" (Robinson 1995) of having self-sustaining local populations (also May and Robinson 1985; Donovan et al. 1995). Based on the work of Robinson and others (1995), these parasitism rates are associated with a minimum of 70-80% forest cover at a landscape (75,000 acre) scale for a midwestern U.S. setting.

Duguay and others (2001) found that in a forested setting in West Virginia (Monongahela National Forest, >88% forest cover), “fifteen years after harvest, cuts placed within otherwise extensively forested areas do not result in the type of edge effects (population sinks) observed in areas fragmented by agriculture in the midwestern U.S.” They also concluded that implementing relatively small cuts that create edge on a small proportion of the landscape may not result in increased nest failure, provided that other factors such as proximity to cowbird feeding sites are not prominent. The study involved tracking 556 nests of 46 species over a four-year period and calculation of daily nest survival rates.

Other habitat factors are known to influence productivity of this species group. Presence of young forest patches within a forested landscape is likely to have positive benefits for immature birds. Vega Rivera (1998) and Anders and others (1998) found that after fledging, juvenile wood thrushes disperse from mature forest habitats and enter early successional forests where they fed on invertebrates and fruit. Use of these habitats was very high relative to their availability. Later in the season, they shifted back into mature forest habitats. Fledglings preferred areas with dense understory and ground cover with species such as blackberry, sumac, and grape. Such areas may be provided by relatively small even-aged regeneration areas or by smaller dispersed canopy gaps. Scattered canopy gaps and associated dense understories likely were characteristic of old growth mesic deciduous forests. Open habitats such as pastures, old fields, and managed wildlife openings were rarely used.

The significance of National Forest System lands to this species group was analyzed at both regional and forest scales in the Southern Appalachian Assessment (SAMAB 1996b: 69-73). This analysis of forest interior habitat focused primarily on patterns of land use (forested vs. non-forested) and measures of edge effects at a landscape scale. Based on this analysis, there are approximately 9 to 10.5 million acres of suitable habitat in the Southern Appalachian Assessment (SAA) Area with about 4.7 to 5.4 million acres (52%) located within tracts greater than 5,000 acres.

Approximately 70% of suitable habitat and 51% of the largest tracts are privately owned, while 23% of suitable habitat and 39% of the largest tracts are on national forest land. A notable difference is found within the Blue Ridge Mountains, where approximately 40% of suitable habitat and half of the largest tracts occur on national forest land. Within the SAA area, the majority of forest interior habitat occurs within the Blue Ridge Mountains, followed by the Northern Ridge and Valley/Cumberland Mountains. The Southern Ridge and Valley and Southern Cumberland Plateau have the smallest relative amount (SAMAB 1996b:73).

To determine the landscape context of the GWNF, a shifting window analysis was conducted using 1990 National Land Cover Data (U.S. EPA 2002). Percent forest cover within a surrounding landscape of 75,000 acres (per Donovan et al. 1997) was calculated for each 90-meter grid cell located on the national forest and nearby private land. For this analysis, Deciduous, Evergreen, and Mixed Forest, and Woody Wetlands were classified as forested lands. All other land cover types, including recent clearcuts (transitional cover type), were classed as non-forest cover. This analysis indicates the great majority of the GWNF occurs within a landscape that is more than 70 to 90% forested. A similar analysis was recently completed by the Nature Conservancy for the Central Appalachians. Termed landscape integrity analysis, TNC incorporated publicly available spatial data to analyze distance of forested habitat with known landscape disturbing features such as roads, residential and urban development, transportation corridors, and mining and other industries (Dougerty and Byers 2008). This analysis for the GWNF showed similar forested landscape patterns to the shifting window analysis.

There are several areas within the GWNF that have settings that are less than 70% forested, where edge effects could adversely affect productivity of forest interior birds and other species. In all cases, either urban and/or agricultural influences create a landscape that is less than 70% forested. The major river valleys of the Potomac and Shenandoah are largely privately owned and dominated by either residential and urban development, or agricultural activities.

Non-native Invasive Species (NNIS)

Non-native invasive plant and animal species can have severe detrimental effects on native species and natural communities, and are problematic across the GWNF. They currently occur on every district. NNIS degrade biological diversity by displacing native species, altering natural community structure and processes, and changing food webs. The desired condition for non-native invasive plants (NNIP) is to reduce or eliminate percent coverage across the GWNF. Because of their contribution to biological diversity, threatened, endangered, and sensitive (TES) species habitat and rare communities, including Special Biological Areas, are a high priority for NNIP control efforts. This key characteristic is addressed in the revised Forest Plan by forest-wide desired conditions, objectives for eradication and treatment of NNIP, and standards to help control NNIP at the project level. Although we do not have a complete inventory of all occurrences of NNIP, preliminary data indicate that they are widespread on all units. Based upon current and projected program levels NNIP will be treated more aggressively under the revised Forest Plan. Some NNIP will be more easily controlled than others. While we may have good results in some cases, NNIP will remain a difficult challenge and it is likely that species new to the Forest will appear during the life of the Forest Plan.
Non-native invasive insects such as hemlock woolly adelgid and gypsy moth are also a significant deterrent to ecological sustainability on the GWNF.

5.2 Ecosystem Diversity Indicators by Alternative

The following tables display the current condition of each indicator identified for each ecological system. It also displays the estimated condition of the indicator after 10 years (Table E-8), or 50 years (Table E-9), of implementation of each alternative. Please note that some of the indicators overlap each other (acres of late successional are included in the acres of mid to late successional stages and acres of open canopy are included in the acres of mid to late successional stages). Table E-10 identifies a description (poor, fair, or good) for the indicator based on the indicator values.

Table E-8. Condition of Indicators of Ecosystem Characteristics after Ten Years of Implementation

Ecosystem Indicator	Current Condition	Condition of Indicator at end of 10 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842
Acres Burned at Desired Frequency	277	880	1,060	1,296	1,296	674	504	1,296	1,296	1,296	1,296
Compliance with Invasive Species Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open Canopy	50	880	1,060	1,296	1,296	674	504	1,296	1,296	1,296	1,296
Caves and Karstlands	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000	119,000
Total Occurrences at Desired Condition	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Compliance with cave, karst guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff, Talus and Shale Barrens	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637
Compliance with Invasive Species Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open and Open Canopy	241	1,408	1,590	4,822	4,822	2,509	1,092	4,822	4,822	4,822	4,822

Ecosystem / Indicator	Current Condition	Condition of Indicator at end of 10 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Cove Forest	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022
Acres in mid to late successional stages	59,777	59,745	60,725	58,245	60,745	57,950	57,950	59,745	58,165	57,445	58,231
Acres of Late Successional	26,307	36,627	37,233	35,699	37,246	35,517	35,517	36,627	35,650	35,204	35,690
Acres of Regenerating Forest	968	1,000	20	2,500	0	2,795	2,795	1,000	2,580	3,300	2,514
Acres of open canopy in mid to late successional stages	712	712	712	712	712	712	712	712	712	712	712
Northern Hardwood Forest	13,478	13,478	13,478	13,478	13,478	13,478	13,478	13,478	13,478	13,478	13,478
Acres in mid to late successional stages	13,233	13,295	13,295	13,295	13,295	13,295	13,295	13,295	13,295	13,295	13,295
Acres of Late Successional	12,413	12,619	12,619	12,619	12,619	12,619	12,619	12,619	12,619	12,619	12,619
Acres of Regenerating Forest	244	182	182	182	182	182	182	182	182	182	182
Acres of open canopy in mid to late successional stages	251	386	386	386	386	386	386	386	386	386	386

Ecosystem / Indicator	Current Condition	Condition of Indicator at end of 10 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Oak Forests and Woodlands	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058
Acres Burned at Desired Frequency	21,457	27,874	41,672	74,583	0	49,894	34,966	74,583	74,583	74,583	74,583
Acres in mid to late successional stages	721,059	709,049	730,219	707,049	731,049	691,844	691,844	716,059	727,629	706,359	705,573
Acres of Mature Forest	650,442	630,526	651,696	628,526	652,526	613,321	613,321	637,536	649,156	627,836	627,050
Acres of Regenerating Forest	25,111	37,121	15,951	39,121	15,121	54,326	54,326	30,111	18,541	39,811	40,597
Acres of open canopy in mid to late successional stages	15,220	42,995	56,793	89,704	15,121	65,015	50,087	89,704	89,704	89,704	89,704
Acres of open grasslands or forbs	2,773	3,609	4,023	5,010	2,773	4,270	3,822	5,010	5,010	5,010	5,010

Ecosystem Indicator	Current Condition	Condition of Indicator at end of 10 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Pine Forests and Woodlands	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129
Acres Burned at Desired Frequency	4,169	5,693	9,233	18,328	0	11,422	7,293	18,328	18,328	18,328	18,328
Acres in mid to late successional stages	156,988	158,488	159,438	155,988	159,488	158,488	158,488	157,478	155,488	157,478	157,478
Acres of Regenerating Forest	4,121	2,621	1,671	5,121	1,621	2,621	2,621	3,631	5,621	3,631	3,631
Acres of open canopy in mid to late successional stages	4,055	7,315	10,855	19,949	1,621	13,043	8,915	19,949	19,949	19,949	19,949
Floodplains, Wetlands and Riparian Areas	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430
Compliance with Riparian Guidelines	Yes	Yes - 1993	Yes - 1994	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	582	582	582	582	582	582	582	582	582	582	582
Total System Acres at Desired Condition	582	582	582	582	582	582	582	582	582	582	582

*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

Alt A[1] represents the effects of the level of activities accomplished during the past three years (2009 through 2011) under the 1993 Forest Plan.

Table E-9. Condition of Indicators of Ecosystem Characteristics after Fifty Years of Implementation

Ecosystem / Indicator	Current Condition	Condition of Indicator at end of 50 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D*	Alt D	Alt E	Alt F	Alt G	Alts H and I
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842	3,842
Acres Burned at Desired Frequency	277	1,567	2,800	2,588	2,588	1,469	1,093	2,588	2,588	2,588	2,588
Compliance with Invasive Species Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open Canopy	50	1,567	2,800	2,588	2,588	1,469	1,093	2,588	2,588	2,588	2,588
Caves and Karstlands	119,000										
Total Occurrences at Desired Condition	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Compliance with cave, karst guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff, Talus and Shale Barrens	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637	13,637
Compliance with Invasive Species Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Acres of Open and Open Canopy	241	2,507	4,570	9,631	9,631	5,469	2,767	9,631	9,631	9,631	9,631

Ecosystem Indicator	Current Condition	Condition of Indicator at end of 50 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D*	Alt D	Alt E	Alt F	Alt G	Alts H and I
Cove Forest	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022	61,022
Acres in mid to late successional stages	59,777	59,745	60,725	58,245	60,745	57,950	57,950	59,745	58,165	57,445	58,231
Acres of Late Successional	26,307	47,723	52,195	40,959	52,287	39,613	39,613	47,723	40,574	37,366	40,870
Acres of Regenerating Forest	968	1,000	20	2,500	0	2,795	2,795	1,000	2,580	3,300	2,514
Acres of open canopy in mid to late successional stages	712	712	712	712	712	712	712	712	712	712	712
Northern Hardwood Forest	13,478	13,478	13,478	12,637	13,478	12,637	12,637	12,637	13,478	12,637	12,637
Acres in mid to late successional stages	13,233	13,342	13,342	12,511	13,342	12,511	12,511	12,511	13,342	12,511	12,511
Acres of Late Successional	12,413	13,233	13,233	12,401	13,233	12,401	12,401	12,401	13,233	12,401	12,401
Acres of Regenerating Forest	244	135	135	126	135	126	126	126	135	126	126
Acres of open canopy in mid to late successional stages	251	386	386	377	386	377	377	377	386	377	377

Ecosystem Indicator	Current Condition	Condition of Indicator at end of 50 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D*	Alt D	Alt E	Alt F	Alt G	Alts H and I
Oak Forests and Woodlands	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058	756,058
Acres Burned at Desired Frequency	21,457	31,581	61,314	125,739	0	81,484	50,304	125,739	125,739	125,739	125,739
Acres in mid to late successional stages	721,059	709,049	730,219	707,049	731,049	691,844	691,844	716,059	727,629	706,359	705,573
Acres of Mature Forest	650,442	611,059	716,909	601,059	721,059	525,034	525,034	646,109	703,959	597,609	593,679
Acres of Regenerating Forest	25,111	37,121	15,951	39,121	15,121	54,326	54,326	30,111	18,541	39,811	40,597
Acres of open canopy in mid to late successional stages	15,220	46,702	76,435	140,860	15,121	96,605	65,425	140,860	140,860	140,860	140,860
Acres of open grasslands or forbs	2,773	3,720	4,612	6,545	2,773	5,218	4,282	6,545	6,545	6,545	6,545

Ecosystem / Indicator	Current Condition	Condition of Indicator at end of 50 years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D*	Alt D	Alt E	Alt F	Alt G	Alts H and I
Pine Forests and Woodlands	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129	162,129
Acres Burned at Desired Frequency	4,169	7,066	18,674	32,684	0	20,258	12,493	32,684	32,684	32,684	32,684
Acres in mid to late successional stages	156,988	158,488	159,438	155,988	159,488	158,488	158,488	157,478	155,488	157,478	157,478
Acres of Regenerating Forest	4,121	2,621	1,671	5,121	1,621	2,621	2,621	3,631	5,621	3,631	3,631
Acres of open canopy in mid to late successional stages	4,055	8,687	20,295	34,305	1,621	21,880	14,114	34,305	34,305	34,305	34,305
Floodplains, Wetlands and Riparian Areas	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430	51,430
Compliance with Riparian Guidelines	Yes	Yes-1993	Yes-1994	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	582	582	582	1,423	582	1,423	1,423	1,423	582	1,423	1,423
Total System Acres at Desired Condition	582	582	582	1,423	582	1,423	1,423	1,423	582	1,423	1,423

*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

Alt A[1] represents the effects of the level of activities accomplished during the past three years (2009 through 2011) under the 1993 Forest Plan.

Table E-10. Description of Indicator Condition

Ecosystem Indicator	Current Condition	Poor	Fair	Good
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842			
Acres Burned at Desired Frequency	277	<33% (<1,268 acres)	33-80%	> 80% (>3,074 acres)
Compliance with Invasive Species Guidelines	No	No		Yes
Acres of Open Canopy	50	<33% (<1,268 acres)	33-80%	> 80% (>3,074 acres)
Caves and Karstlands	119,000			
Total Occurrences at Desired Condition	100%	<70%	70-90%	>90%
Compliance with cave, karst guidelines	No	No		Yes
Cliff, Talus and Shale Barrens	13,637			
Compliance with Invasive Species Guidelines	No	No		Yes
Acres of Open and Open Canopy	241	<33% (<4,500 acres)	33-80%	> 80% (>10,910 acres)
Cove Forest	61,022			
Acres in mid to late successional stages	59,777	0-60% (<36,613 acres)or >99% (60,412 acres)	61-91 % (36,613 - 55,530 acres) or 97-99% (59,191 - 60,411 acres)	92-96% (55,530 - 59,191 acres)
Acres of Late Successional	26,307	<40% (24,409 acres) or greater than 80% (48,818 acres)	40-54% (24,409 - 32,952 acres) or 60-80% (36,613 - 48,818 acres)	55-59% (32,952 - 36,613 acres)
Acres of Regenerating Forest	968	0-1% (610 acres) or > 20% (12,204 acres)	1-3% (610 - 1,831 acres) or 9-20% (5,492- 12,204 acres)	4-8% (1,831 - 5,492 acres)
Acres of open canopy in mid to late successional stages	712	0-2 % (1,220 acres) or >25% (15,256 acres)	3 -5 % (1,220 - 3,051 acres) or 13-24 % (7,933 - 15,256 acres)	6 - 12 % (3,051 - 7,933 acres)
Northern Hardwood Forest	13,478			
Acres in mid to late successional stages	13,233	99-100 % (8,087 acres) or <60% (13,343 acres)	61 - 93 % (8,087 - 12,534 acres) or 97 to 98 % (13,073 - 13,343 acres)	94 - 96% (12,534 - 13,073 acres)
Acres of Late Successional	12,413	<40% (5,391 acres) or >90% (12,130 acres)	40-69% (5,391 - 9,300 acres) or 75-90% (10,108 - 12,130 acres)	70-74% (9,300 - 10,108 acres)
Acres of Regenerating Forest	244	0-1 %(135 acres) or >13% (1,752 acres)	2-4% (135 - 539 acres) or 7-12% (943 - 1,752 acres)	4-6% (539 - 943 acres)
Acres of open canopy in mid to late successional stages	251	0-3 % (404 acres) or >25% (3,370 acres)	4-7% (404 - 944 acres) or 13-24% (1,752 - 3,370 acres)	8-12% (944 - 1,752 acres)

Ecosystem Indicator	Current Condition	Poor	Fair	Good
Oak Forests and Woodlands	756,058			
Acres Burned at Desired Frequency	21,457	<33% (249,499 acres)	33-80%	>80% (604,846 acres)
Acres in mid to late successional stages	721,059	>96% (725,815 acres) or <50 % (378,029 acres)	94-95% (710.694-725,815 acres) or 51-90% (378,029 – 680,452 acres)	91-93% (680,452-710,694 acres)
Acres of Mature Forest	650,442	<30% (226,817 acres) or >89% (672,891 acres)	30-39% (226,817 – 294,862 acres) or 61-89% (461,195 – 672,891 acres)	40-60% (294,862 – 461,195 acres)
Acres of Regenerating Forest	25,111	0-3% (22,681 acres) or >30% (226,817 acres)	4-6% (22,681 - 45,363 acres) or 9 - 29% (68,045 – 226,817 acres)	7-9% (45,363 - 68,045 acres)
Acres of open canopy in mid to late successional stages	15,220	0-20 % (151,211 acres) or >80% (604,846 acres)	21-54% (151,211 – 408,271 acres) or 66-80% (498,998 – 604,846 acres)	55-65% (408,271 – 498,998 acres)
Acres of open grasslands or forbs	2,773	0-1% (10,654 acres)	1 - 3 %	3-5% (31,963 – 53,273 acres)
Pine Forests and Woodlands	162,129			
Acres Burned at Desired Frequency	4,169	<33% (53,503 acres)	33-80%	>80% (129,703 acres)
Acres in mid to late successional stages	156,988	>96% (155,644 acres) or <60% (97,277 acres)	60-88% (97,277 - 142,673 acres) or 94-95% (152,401 - 155,644 acres)	89-93% (142,673 - 152,401 acres)
Acres of Regenerating Forest	4,121	0-4% (6,485 acres) or >35% (56,745 acres)	5-7% (6,485 - 11,349 acres) or 12-35% (19,455 - 56,745 acres)	7-11% (11,349 - 19,455 acres)
Acres of open canopy in mid to late successional stages	4,055	<30 % (48,639 acres) or >90% (145,916 acres)	81-90% (48,639 - 111,869 acres) or 31 to 69% (131,324 - 145,916 acres)	70-80 % (111,869 - 131,324 acres)
Floodplains, Wetlands and Riparian Areas	51,430			
Compliance with Riparian Guidelines	Yes	No		Yes
Spruce Forest	582			
Total System Acres at Desired Condition	582	<90% (473 acres) of current acres	90-99% of current acres	current (582 acres)

6.0 FOREST PLAN DESIRED ECOLOGICAL CONDITIONS

6.1 Plan Components Needed for Ecosystem Diversity

Plan components that would provide for ecosystem diversity include desired conditions, objectives, and standards. Desired conditions and objectives for ecosystem diversity would be addressed not only under Ecosystem Diversity but also in plan components for species diversity, healthy watersheds, and healthy forests. The following sections describe recommendations for desired conditions, objectives and standards to address ecological diversity needs.

6.2 Extent of Ecological Systems

Table E-11. Current and desired ecological systems by unit on the George Washington National Forest

Ecological System	Approximate Existing Acres	Desired Acres
Spruce Forest	582	1,423
Northern Hardwood Forest	13,478	12,637
Cove Forest	61,022	61,022
Oak Forests and Woodlands	756,058	756,058
Pine Forests and Woodlands	162,129	162,129
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842	3,842
Cliff, Talus and Shale Barrens	13,637	13,637
Floodplains, Wetlands, and Riparian Areas	51,430	51,430
Water	3,284	3,284
Total Acres	1,065,462	1,065,462
Caves and Karstlands (included in above acres)	119,000	119,000

Changes in desired conditions reflect spruce restoration (changes from northern hardwoods to spruce) and restoration of pine plantations (changes from pine forests to oak forests).

6.3 Forestwide Desired Conditions

Forestwide desired conditions should be found in the following sections and include the following concepts:

Ecosystem diversity
Native ecological systems occupy appropriate sites and sustain strong, resilient populations of associated terrestrial and aquatic species.

There is a mix of closed canopy forest, intermittent canopy, and open canopy conditions. Forest and woodland ecological systems support a diversity of tree ages, from regeneration to old growth, providing a relatively stable mix of ecological conditions across the landscape over time. Ecological systems are intact and as resilient as possible to absorb negative effects associated with various natural and human-caused stresses.

Species Diversity
Natural ecological communities exist in amounts, arrangements, and conditions capable of supporting native and desired non-native species within the planning area.

Natural disturbances, such as fire, wind, insects and diseases, ice storms, and floods, modify the landscape, providing habitat for disturbance dependent species.
Threatened and endangered species are recovered or moving towards recovery. Risks and threats are reduced or eliminated, especially during critical life stages such as nesting or raising offspring. The potential for sensitive species to become listed as threatened or endangered is reduced.

Watersheds
Watersheds within the Forest are resilient, have intact hydrologic function, and support the quality and quantity of water necessary for channel maintenance, aquatic habitats, riparian habitats and beneficial water uses, including public water supplies.

Soils
Forest soils have adequate physical, biological, and chemical properties to maintain or improve vegetative growth, hydrologic function, nutrient cycling and slope stability.

Geology
Groundwater is protected. Management activities in karst areas are not adversely affecting groundwater. Groundwater-dependent ecosystems are protected and sustained. Caves, sinkholes and other karst features function to maintain groundwater quality and provide habitat for species that depend on these features.

Fire
Fire regimes across the GWNF are within historical ranges (Fire Condition Class 1). Low-intensity fires periodically burn through forests removing surface fuels and maintaining an open understory. Native vegetation patterns, species composition, and structure are intact and functioning within natural limits. The risk of losing key ecosystems is low. Fire is allowed to operate in its historic ecological role as close as possible.

6.4 Standards

Standards convey information and guidance that supplements agency policies and are applied to projects or activities aimed at achieving desired conditions. Many of the forestwide and Management Prescription Area standards are designed to assure projects are completed to best restore and maintain ecological systems.

6.5 Forestwide Management Strategies

Program emphasis for managing for ecosystem and species diversity should be placed on restoring composition, structure, and relative abundance of all native ecological systems. Restoration efforts should be implemented utilizing the vegetation management program practices to achieve desired conditions. Forest Plan strategies for wildlife and vegetation management programs should emphasize the need for using an integrated fire management program to restore and maintain all fire-dependent ecological systems. Future project work should examine needs for rare and wetland community restoration, T&E species sustainability, and restoring relative abundance of appropriate sites across the landscape. Program and project work should incorporate key ecological characteristics and work toward achieving desired conditions to support associated species. Based on current budgetary constraints, ecological restoration progress is expected to occur at a slow pace; therefore project work should explore alternative means such as stewardship projects and partnerships to restore ecological systems on the GWNF.

6.6 Ecological System Specific Direction

The following information is derived from the ESE database and describes the 24 ecological systems identified for the GWNF. Each description includes recommended desired ecological conditions, management strategies

and objectives. The ages of the various structural condition classes may need to be adjusted in the Forest Plan to better correlate with ten-year age classes traditionally used for management descriptions.

6.6.1 Spruce Forest

Desired Ecological Condition

Found only in the higher elevations near West Virginia this system is a predominately mature or old-growth forest with a diversity of vertical and age structure on sites to which this species is appropriate and of historical occurrence. Overstories are typically dominated by red spruce, but this system grades into northern hardwoods. Often other tree species found with red spruce include American beech, yellow birch, and sugar maple. The herbaceous layer is most typically dominated by mosses, ferns, sedges, and forbs, The Spruce Forest system supports populations of associated rare species, including the West Virginia northern flying squirrel. Regenerating forests (0-35 years old) comprise less than 18% percent of system acreage and is generally in small canopy gaps. Mature forest (66 years old or older) comprise approximately 57 percent of system acreage. Fire is rare in this system and the canopy is predominantly closed.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Mid-Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	18	14	11	57
Age	0-35	36-65	36-65	66+

Management Strategy

The Spruce Forest system is currently limited to the Laurel Fork area. Strategies for restoring and maintaining the Spruce Forest system should emphasize restoring spruce to those sites where Norway spruce and red pine have been planted and maintaining conditions favorable to continued growth of existing stands. The Laurel Fork area should continue to be managed to restore and maintain the Spruce Forest including active planting of red spruce seedlings and releasing red spruce seedlings that are suppressed by hardwoods.

Objectives

Objectives should focus on the extent of this system and on restoration needs.

6.6.2 Northern Hardwood Forest

Desired Ecological Condition

Usually found in the highest elevations on the Forest this forest is dominated by overstories that include American beech, sugar maple and yellow birch with some eastern hemlock. Midstories and understories are usually well developed. The understory varies quite a bit, in some places dominated by evergreen shrubs and in others by herbs. Regenerating forests occupy around 10% of the area. Late successional forests make up around 72 percent of the area. Since these sites are predominantly at high elevation and are mesic, fire is not a major disturbance mechanism. Weather events such as high wind, ice, heavy wet snow, and the combinations of these account for most disturbances where open canopies exist in about 10 percent of the area.

Structural conditions are patterned after the Southern Appalachian Northern Hardwood Forest System since it has a greater emphasis on closed canopy conditions which are more like the situation on the GWNF. They are as follows:

Structure	Early Successional	Mid-Successional Closed Canopy	Late Successional Closed Canopy	Late Successional Open Canopy
% of ecological system	10	18	62	10
Age	0-20	21-74	75+	75+

Management Strategy

Forest strategies for restoring, maintaining, and enhancing the Northern Hardwood Forest ecological system should emphasize maintaining this system on the lands where it occurs. Some regeneration management activities could take place, but it would not be a high priority.

Objectives

Objectives should focus on the extent of this system on the landscape.

6.6.3 Cove Forest

Desired Ecological Condition

These closed-canopy forests are found on concave landforms and often associated with riparian areas. Overstories are typically dominated by yellow poplar, hemlock, birch, magnolia, basswood, and red maple. Midstories are well developed and fairly diverse in acidic coves rhododendron is often abundant. Understories have a well-developed herb layer, often very dense and usually high in species richness, and it is present in all but the acid coves. Well-developed and fairly diverse subcanopy and shrub layers are often also present in all but the acid coves.

This system supports populations of associated rare species, such as ginseng. Regenerating forests (0-10 years old) comprise around 4 percent of system acreage. Late successional forests (100 years old or older) comprise around 57 percent of system acreage. Fire is not a major disturbance in this system and typically occurs only in driest of conditions. Open canopy structure is present on only about 9 percent of the area. On the Forest this type is interspersed with the oak dominated systems. Cove Forest often occupies land along riparian areas and adjacent to upland areas in concave landforms at upper ends of watersheds.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Late Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	4	39	9	48
Age	0-10	11-99	100+	100+

Management Strategy

The management strategy for the Cove Forest is to utilize timber harvest to approach the early successional habitat objective since fire is not a common disturbance in this system except in the driest of conditions.

Objectives

Objectives should focus on the structural conditions for early and late successional stages.

6.6.4 Oak Forests and Woodlands

Desired Ecological Condition

This is the most common ecological system on the Forest and can be viewed as the matrix forest in which all other vegetation types occur. Oak forests range from those found on moist (or mesic) sites to dry sites that then grade into yellow pine. Overstory trees on mesic sites are typically dominated by red oak, white oak, and hickory with chestnut oak, black oak and scarlet oak on drier sites. Heath shrubs such as blueberry, huckleberry and mountain laurel are common in the understory, especially on drier sites and often form a dense shrub layer along with grasses and sedges. Fewer heath shrubs are found on mesic sites and the understory often consists of various perennial herbaceous plants. Regenerating forests (0-15 years old) comprise around 12 percent of system acreage. Fire is a very important component of this system and results in open canopy structure on about 65 percent of the area. In many of the woodland areas native grasses are common.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Mid-Successional Open Canopy	Late Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	12	7	10	57	14
Age	0-15	16-69	16-69	70+	70+

The mid and late successional open canopy represents most of the system where frequent low intensity fire and other disturbances such as ice and wind maintains open canopy conditions. The late successional closed canopy condition occurs where fire is excluded due to topographic and moist fuel conditions resulting in more mesophytic species composition that then makes opportunities for fire even more uncommon.

Open areas (including permanent and semi-permanent grasslands, shrublands and old fields) occupy around 4% of the GWNF. While often within the oak forests and woodlands, they may occupy any of the ecological system groups.

Management Strategy

Forest strategies for maintaining, and enhancing the oak systems rely heavily on utilizing fire to restore and maintain the open canopy conditions and the openings. Openings will also be maintained through direct creation and maintenance activities. Timber harvest will be another frequent technique of creating regenerating forests and creating desired open canopy conditions. Given its importance as a food source for many wildlife species, maintaining a high percentage of oak in ages that produce mast is also important.

Objectives

Objectives should focus on structural conditions for early succession and mature forest with open canopy conditions through restoration of the fire regime. Objectives also include the need for open conditions and widespread restoration of American chestnut.

6.6.5 Pine Forests and Woodlands

Desired Ecological Condition

Next to Oak Forest and Woodlands this ecological system is the most common on the Forest and occupies the upper slopes and south to west exposures. Overstories are typically dominated by table mountain pine, pitch pine, and some Virginia pine along with dry site oaks such as chestnut oak, scarlet oak, and bear oak. A dense heath shrub layer is almost always present. Mountain laurel is the most typical and dominant, but species of blueberry and huckleberry along with fetterbush may also be dominant. Native grasses and sedges are

common along with dry site herbs and forbs. Their density varies depending on shrub cover. Regenerating forests (0-15 years old) comprise about 13 percent of system acreage. Mid to late successional forests comprise approximately 87 percent of system acreage. Frequent fire occurring about every 3-9 years is a very important component of this system and result in open canopy structure on about 80 percent of the area.

Structural conditions are as follows:

Structure	Early	Mid-Successional Closed Canopy	Mid-Successional Open Canopy	Late Successional Open Canopy	Late Successional Closed Canopy
% of ecological system	13	3	25	54	5
Age	0-15	16-70	16-70	71+	71+

Management Strategy

Fire will be the prime strategy for maintaining and enhancing the pine forests and woodlands. Timber harvest will also be used to a lesser extent for regeneration.

Objectives

Objectives should focus on structural conditions, particularly the need for open canopy conditions and restoration of the fire regime.

6.6.6 Mafic Glade and Barrens and Alkaline Glades and Woodlands

Desired Ecological Condition

The alkaline systems consist of woodlands and open glades on thin soils over limestone, dolostone or similar calcareous rock. In some cases, the woodlands grade into closed-canopy forests. Eastern red cedar is often a common tree, and along with chinkapin oak is indicative of the limestone substrate. Warm season grasses such as big and little bluestem are often the dominant herbs; forb richness is often high. The mafic systems found in the Blue Ridge consist of vegetation associated with shallow soils over predominantly mafic bedrock (which is rich in iron and magnesium), usually with significant areas of rock outcrops. These areas support a patchy mosaic of open woodland and grassy herbaceous vegetation sometimes with a predominant woody short-shrub community present. The canopy species are species tolerant of dry, shallow soils, most commonly chestnut oak, pines and eastern red cedar. Shrubs may be dense, with species determined by soil chemistry and often include redbud and fragrant sumac. The herb layer is usually fairly dense and dominated by grasses, both in treeless areas and beneath open canopy. The forbs include species characteristic of other rock outcrops and grassland species, with a smaller number of forest species present.

Edaphic features largely control these areas, but the open nature of the glades, woodlands and barrens continue to be maintained through fire which is operating in its natural regime. Non-native invasive plants are not significant influence on vegetation in these areas. Recreation use is managed so that it does not adversely affect the native vegetation. This system supports populations of associated rare species, including the marsh muhly, stiff goldenrod, drooping bluegrass, tall cinquefoil, and Rand's goldenrod.

Management Strategy

Forest strategies for maintaining, and enhancing this system include prescribed fire and managing wildfire, control of non-native invasive plants and monitoring and managing recreation use in the areas.

Objectives

Objectives should focus on the extent of the ecological system and the need for retaining open canopy conditions.

6.6.7 Cliff, Talus and Shale Barrens

Desired Ecological Condition

Vegetation on and near shale barrens is mostly classified as woodland, overall, but may include large open areas of sparse vegetation. Dominant trees are primarily chestnut oak, pitch pine, table mountain pine and Virginia pine, although on higher-pH substrates the common trees include eastern red cedar and white ash. Shale barren endemic plants are diagnostic in the herb layer. The substrate includes areas of solid rock as well as unstable areas of shale scree, usually steeply sloped.

The cliff and talus systems comprise sparsely vegetated to partially wooded cliffs and talus slopes. It consists of vertical or near-vertical cliffs and the talus slopes below. In some cases, this system may take the form of upper-slope boulderfields without adjacent cliffs, where talus forms from freeze/thaw action cracking the bedrock. Most of the substrate is dry and exposed, but areas of seepage are often present. The vegetation is patchy and often sparse, punctuated with patches of small trees that may form woodlands in places.

Edaphic conditions and landform features largely control the disturbance regime of these areas, but the open nature of the talus and edges of shale barrens continue to be maintained through fire which is occurring in adjacent forests and woodlands. Non-native invasive plants are not a significant influence on vegetation in these areas. Deer browsing is not impacting native vegetation. Recreation use is managed so that it does not adversely affect the native vegetation. This system supports populations of associated rare species, including the shale barren rockcress, Millboro leatherflower, shale -barren blazing star, shale-barren evening primrose, Appalachian grizzled skipper, bristly sarsaparilla, chestnut lipfern, mountain sandwort, and three-toothed cinquefoil.

Management Strategy

Strategies for maintaining, and enhancing these systems include prescribed fire and managing wildfire, control of non-native invasive plants, managing deer browsing, and monitoring and managing recreation use in the areas.

Objectives

Objectives should focus on the extent of the ecological system and the need for retaining open canopy conditions.

6.6.8 Floodplains, Wetlands, and Riparian Areas

Desired Ecological Condition

Overstories are typically dominated by the same trees occupying the oak and cove forest types. Midstories and Understories are often well developed and diverse. This system supports populations of many associated rare species. Regenerating forests (0-10 years old) are uncommon, though small openings are present and are important for key species. Open wetlands and open beaver meadows and ponds, including flooded forests, provide much of the open habitat conditions. Late successional forest is common and makes up most of the canopy. Fire is rare.

Riparian corridors reflect the physical structure, biological components, and ecological processes that sustain aquatic, riparian, and associated upland functions and values. The preferred management for riparian corridors is one that maintains, or moves toward, the restoration of processes that regulate the environmental and ecological components of riparian areas. However, due to the high value that these areas have for many uses, evidence of human activity (developed recreation areas, roads and trails, dams and reservoirs, and pastoral areas) may be present.

Riparian corridors are managed to emphasize the maintenance, restoration, and enhancement of habitat for species that depend on riparian resources for at least a part of their life-cycle. Management may also occur to maintain, restore, or enhance habitat for other species that benefit from riparian resources as long as the needs of species that depend on riparian resources for at least a part of their life-cycle are met.

The soils of riparian corridors have an organic layer (including litter, duff, and/or humus) of sufficient depth and composition to maintain the natural infiltration capacity, moisture regime, and productivity of the soil (recognizing that floods may periodically sweep some areas within the floodplain of soil and vegetation). Exposed mineral soil and soil compaction from human activity may be present but are dispersed and do not impair the productivity and fertility of the soil. Any human-caused disturbances or modifications that cause environmental degradation through concentrated runoff, soil erosion, or sediment transport to the channel or water body are promptly rehabilitated or mitigated to reduce or eliminate impacts.

Trees within the corridors are managed to provide sufficient amounts and sizes of woody debris to maintain habitat complexity and diversity for aquatic and riparian wildlife species. Recruitment of woody debris typically occurs naturally; however, woody debris may be purposefully introduced to enhance aquatic and terrestrial habitat. Both in-stream and terrestrial woody debris are regarded as essential and generally left undisturbed.

The riparian corridor functions as a travel-way for aquatic and terrestrial organisms. The corridor serves as a connector of habitats and populations allowing gene flow to occur, thus keeping populations genetically viable. Stream structures -- such as bridges, culverts, and aquatic habitat improvement structures -- may be evident in some streams and water bodies. With the exception of some dams, most structures do not decrease in-stream connectivity.

Suitable habitat is provided in the riparian corridor for riparian flora and fauna; especially threatened, endangered, sensitive (TES) and locally rare species. Vegetation (dead and alive) reflects the potential natural diversity of plant communities with appropriate horizontal and vertical structure needed to provide the shade, food, shelter, and microclimate characteristics for aquatic and terrestrial species. Rehabilitation of past and future impacts (both natural and human-caused) may be necessary to protect resource values and facilitate recovery of riparian structure and functions.

Vegetative communities within the riparian corridor are diverse and productive, providing for a rich variety of organisms and habitat types. The vegetative community within the riparian corridor is predominately forested; however, some native non-forested communities such as wet meadows and grass or shrub dominated plant communities may occur. The desired vegetative condition of non-forested communities is determined by site-specific analysis.

The forest contains multiple canopy layers, which provide diverse habitat structure, and thermal and protective cover for wildlife. Snags used by birds, bats, and other small animals are abundant. Dying and down trees are common, often in naturally occurring patches. Wet meadows, non-forest communities, and open forest canopies, created by flooding, wind damage, wildland fire, insect infestations, disease, restoration, and vegetation management may be seen.

Streams are in dynamic equilibrium; that is, stream systems normally function within natural ranges of flow, sediment movement, temperature, and other variables. The geomorphic condition of some channels may reflect the process of long-term adjustment from historic watershed disturbances (e.g., past intensive farming or logging practices). The combination of geomorphic and hydrologic processes creates a diverse physical environment, which, in turn, fosters biological diversity. The physical integrity of aquatic systems, stream banks and substrate, including shorelines and other components of habitat is intact and stable. Where channel shape is modified (e.g., road crossings), the modification preserves channel stability and function.

The range of in-stream flows is maintained to support channel function, aquatic biota and wildlife habitat, floodplain function, and aesthetic values. Water uses and other modifications of flow regimes are evaluated in accordance with the national Forest Service in-stream flow strategy and site-specific analysis.

Water quality remains within a range that ensures survival, growth, reproduction, and migration of aquatic and riparian wildlife species; and contributes to the biological, physical, and chemical integrity of aquatic ecosystems. Water quality meets or exceeds State and Federal standards. Water quality (e.g. water temperature, sediment level, dissolved oxygen, and pH) will be improved where necessary to benefit aquatic communities.

Floodplains properly function as detention/retention storage areas for floodwaters, sources of organic matter to the water column, and habitat for aquatic and riparian species. Modification of the floodplain is infrequent but may be undertaken to protect human life and property or to meet other appropriate management goals (e.g., restoration). There may be evidence of some roads, trails, and recreation developments. Some wetland habitats may show signs of restoration.

The biological integrity of aquatic communities is maintained, restored, or enhanced. Aquatic species distributions are maintained or are expanded into previously occupied habitat. The amount, distribution, and characteristics of aquatic habitats for all life stages are present to maintain populations of indigenous and desired non-native species. Habitat conditions contribute to the recovery of species under the Endangered Species Act. Species composition, distribution, and relative abundance of organisms in managed habitats is comparable to reference streams of the same region. Some streams and lakes, however, may be stocked with non-native fish by the respective State natural resource agency.

Beavers are recognized as a keystone species that increase landscape heterogeneity and species diversity. Beaver ponds beneficially modify water flow rates, enhance groundwater recharge rates, raise water tables, sequester sediment, increase aquatic productivity, and modify water chemistry. Over time, beavers create a mosaic of habitats that are utilized by numerous plants, amphibians, fish, insects, birds, and mammals that would not otherwise occur.

Management Strategy

Forest strategies for maintaining, and enhancing these systems rely on implementation of the standards originally developed to protect threatened and endangered fish and mussels on the Jefferson National Forest. Beaver populations are encouraged and allowed to provide a variety of benefits.

Objectives

Objectives should focus on retaining the extent and the character of the areas.

Standards

Standards for the riparian corridor are established in the guidance for the Riparian Management Prescription Area. These should be the same as the standards developed for the Federally Listed Mussel and Fish Conservation Plan that were incorporated into the Jefferson Forest Plan.

6.6.9 Caves and Karstlands

Desired Ecological Condition

This important ecological system is found to a limited degree on the Forest where it is associated with carbonate bedrock (limestone and dolostone) and often characterized by internal drainage. This bedrock type is typically found in valleys where it is dissolved by groundwater creating surface depressions (sinkholes) and underground caves and tunnels. These features are protected both from recreational damage and from polluted water, which, in turn, protects the species that depend on them.

Standards

Compliance with Cave and Karstland Guidelines should be met through use of forest-wide standards like:

- FW: A minimum of 200 foot buffers are maintained around cave entrances, sinkholes, and cave collapse areas known to open into a cave's drainage system. There are no soil-disturbing activities or harvest of trees within this buffer. Wider buffers are identified through site-specific analysis when necessary to protect caves from potential subterranean and surface impacts. Perennial, intermittent, channeled ephemeral stream standards will apply beyond the first 200 feet.
- FW: The use of caves for disposal sites or the alteration of cave entrances is prohibited except for the construction of cave gates or similar structures to ensure closure.
- FW: Management activities within any area draining into a cave are limited if they may affect the cave ecosystem through sedimentation, soil sterilization, the addition of nutrients or other chemicals (including pesticides and fertilizers), or if they change the cave's natural hydrology or micro-climate.
- FW: Post and enforce seasonal closure orders around entrances of caves and abandoned mines occupied by significant populations of bats, to reduce the frequency and degree of human intrusion. Prohibit camping and campfires at the entrance to caves, mines, and rock shelters used by bats.
- FW: If such closure orders are found to be ineffective, construct and maintain gates or other structures that allow for entrance and egress by bats. If necessary to further discourage human disturbance to

caves occupied by significant populations of bats, close non-essential public access routes controlled by the Forest Service within ¼ mile of cave entrances during periods of use by bats.

- FW: Human access to caves for educational and recreation use may be allowed during periods when bats are not present. If damage to a cave occurs as a result of such use, close the cave. Allow human access (i.e. scientific study) on a case-by-case basis when bats are present.
- FW: The specific location of a Significant cave cannot be made available to the public unless it is determined that disclosure of this information would not create a substantial risk of harm, theft, or destruction of the cave. Significant and potentially significant caves on the Forest are managed in accordance with the Cave Resources Protection Act of 1988 (16 U.S.C. 4301-4309) to protect them through regulating their use, requiring permits for removal of their resources, and prohibiting destructive acts.
- FW: Identify, using the appropriate type and scale of geologic mapping, the geologic components (processes, structures, materials, and landforms), such as groundwater and karst, relevant to proposed projects, and integrate the components into: 1) siting and design of the project; 2) restoration; 3) ecological sustainability; and 4) environmental analysis.
- FW: Locate and design projects to minimize potential adverse effects on groundwater and groundwater dependent ecosystems. In karst areas, integrate geologic assessment in project design and monitoring.
- FW: Identify caves or abandoned mines that contain significant populations of bats as smoke-sensitive targets. Avoid smoke entering these caves or mines when bats are hibernating (generally this is Nov 1 to April 1).
- Indiana bat Standards

Management Strategy

Forest strategies for maintaining and enhancing caves and karstlands include management to maintain the hydrology and not affect water quality in area draining into cave systems or in karst terrain. Monitoring of cave use and gating caves when needed to protect cave features and the biota are also components.

6.6.10 Special Biologic Areas

Desired Ecological Condition

Botanical-Zoological areas are managed for the following: (1) protection of threatened, endangered, sensitive, or locally rare species from human taking or human-caused detrimental habitat changes; (2) stable or increasing populations of threatened, endangered, sensitive, or locally rare species; and (3) functioning ecosystems.

Specific management activities necessary to maintain, restore, or enhance threatened, endangered, sensitive, and locally rare species for each special biological area are described in the Virginia Department of Conservation and Recreation, Division of Natural Heritage, Reports of Special Biological Areas (1991, 2000) and other pertinent biological reference material.

These management activities will result in a forest successional stage appropriate for maintaining the threatened, endangered, sensitive, and locally rare species. All areas are protected from human-caused detrimental habitat change, the taking of threatened or endangered species, and the collection of living plants or animals unless such collections are used for achieving the stated management goals. Access to these areas may be limited.

Management Strategy

The 121 Special Biological Areas on the GWNF all support ecosystem diversity and rare natural communities and assemblages of rare plant and animal species are represented there. These conditions of these communities are maintained or enhanced from their current condition. Management strategies are developed for each the Special Biological Areas that include needed management actions and monitoring needs.

6.6.11 Additional Guidance

Indicators for two of the ecological systems include compliance with Non-Native Invasive Species (NNIS) Guidelines. These NNIS guidelines include the following management strategies and standards:

Management Approach

- Management of non-native invasive species will focus on four components: 1) prevention of new infestations; 2) elimination of new infestations before they become established; 3) containment or reduction of established infestations; and 4) reclamation of native habitats and ecosystems.
- Post and maintain signs at trailheads and use other opportunities to inform OHV and ATV users to thoroughly wash their OHVs and ATVs to remove all soil, seeds, and other attached material prior to coming on the Forest.
- Utilize public notification such as posting signs in campgrounds to control the movement of firewood into Forest campgrounds and other dispersed campsites.
- NNIP parts capable of starting new plants (seeds, rhizomes, etc.) need proper disposal. Options include piling and burning on site, or bagging-and moving off site. Bagged plants should either be incinerated or should receive standard garbage disposal. For large woody bushed that are difficult to move, treatments should be scheduled prior to seed set, as practical.
- Use of mowing as a NNIP control method should be timed to avoid spreading seeds (e.g., before seed set).
- Retain native vegetation and limit soil disturbance as much as possible.
- Following NNIP treatments, exposed soils will be promptly revegetated to avoid recolonization by NNIP or potential soil erosion. Only approved seed mixtures and weed seed-free mulch should be used.

Forestwide Standards

- FW: The use of Category 1 Species is prohibited.
- FW: The establishment or encouragement of Category 2 Species is prohibited in areas where ecological conditions would favor invasiveness and is discouraged elsewhere. Projects that use Category 2 Species should document why no other (non-invasive) species will serve the purpose and need.
- FW: Favor use of native grasses and wildflowers beneficial as wildlife foods when seeding temporary roads, skid roads, log landings and other temporary openings when slopes are less than 5%. On slopes greater than 5%, favor use of vegetation that best controls erosion.
- FW: Planning for management activities includes consideration of existing and potential non-native invasive plant (NNIP) threats. Site-specific plans should include control/eradication treatments and follow up monitoring of those treatments for effectiveness. Examples include inventory and treatment of log landing and haul road sites for timber sales, control lines (particularly those with soil disturbance) and areas near existing seed sources for prescribed burns, and trail corridors for trail construction.
- FW: A contractor's sources of fill, soil, shale, and related materials will be pre-approved. Contractors will submit a description of the source. The project inspector or a qualified designee will inspect the supply source. Use of the source will be prohibited if contaminated by transferable agents of invasive species.
- FW: Forest sources of fill, borrow or road surfacing material will be examined for NNIP and treated as necessary to prevent transfer of invasive plants to other parts of the Forest.
- FW: Mechanical equipment, such as that used for logging, mowing, firefighting and earth moving (including road graders), should be free of soil, seeds, and other attached material prior to coming on the Forest or being moved from areas on the Forest with NNIP infestations to areas free from noticeable infestations. Such equipment should be examined by qualified Forest Service personnel before allowed on the Forest.
- FW: Personnel treating NNIP infestation will take appropriate measures to prevent transporting seeds or other propagules to other sites. Such measures may include cleaning equipment at the treatment site after treatment, bagging the equipment until such time that it can be cleaned (e.g. hand sprayers), removing and bagging outer garments after treatment, brushing clothing and boots thoroughly before departing the treatment site.

- FW: Fueling of oiling of mechanical equipment will occur away from aquatic habitat.
- FW: When work is conducted in areas containing TESLR plant species, those plants will be flagged, marked or identified for applicators to avoid spraying. A physical barrier will be used to protect non-target species when they occur immediately adjacent to the treatment area.

Management Area Prescription Standards

- Rx 1A: Forest insect and disease outbreaks are controlled only if necessary to prevent unacceptable damage to resources on adjacent land, prevent an unacceptable loss to the wilderness resource due to non-native pests, or protect threatened, endangered, and sensitive species.
- Rx 1A: Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied chemicals, with Regional Forester approval, when necessary.
- Rx 2C2: Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied chemicals, with Forest Supervisor approval, when necessary.
- Rx 2C3: Aggressively control insect and disease outbreaks when threatening the outstandingly remarkable values of the river corridor or when needed for safety or legal reasons. Consider eradication of recently established non-native pests. Favor the most effective control method.
- Rx 4B: Native forest insect and disease outbreaks are controlled only to protect threatened, endangered, and sensitive species or to prevent unacceptable damage to resources on adjacent land. Non-native invasive insects and diseases may be eradicated or suppressed. Favor biological control methods.
- Rx 4B: Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied pesticides, with Forest Supervisor approval, when necessary.
- Rx 4C1: Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, and sensitive species. Non-native invasive insects and diseases may be eradicated or suppressed. Favor biological control methods.
- Rx 4C1: Eradicate non-native invasive vegetation when the infestations are isolated. Use hand-applied pesticides, with Forest Supervisor approval, when necessary
- Rx 4D: Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, sensitive, or locally rare species. Non-native, invasive insects and diseases may be eradicated or suppressed to prevent a loss of the special biological community. Favor biological control methods.
- Rx 4D: Eradicate non-native invasive plants when the infestations are isolated. Use hand-applied pesticides, with Forest Supervisor approval, when necessary.
- Rx 4D: Control non-native invasive species (plants, animals, insects, and diseases) where they are causing negative effects to rare communities. Do not introduce non-native species in or near rare communities, unless it is a natural enemy of an non-native pest.
- Rx 4E: Control insect and disease outbreaks when necessary to protect the cultural/historic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- Rx 5A: Aggressively control forest insects, diseases, and non-native invasive plants using the most effective control method. Salvage is allowed.
- Rx 5B: Aggressively control non-native, invasive plant species within these areas.
- Rx 5C: Aggressively control non-native, invasive plant species within these corridors.
- Rx 7A1: Control insect and disease outbreaks, when necessary, to protect the scenic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- Rx 7B: Control insect and disease outbreaks, when necessary, to protect the scenic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- Rx 7C: The forest health strategy is to diminish the occurrence of pest problems by managing host-type conditions at low hazard. Use appropriate and practical suppression of pests, both non-native and native, with all available tools as the normal practice.
- Rx 7D: The forest health strategy is to prevent the occurrence of pest problems by managing host-type conditions at low hazard. Aggressive suppression of pests, both non-native and native, with all

available integrated pest management tools is normal practice. Favor the most effective control method. Salvage, cut and leave, and pruning are rapid and complete to protect the health and safety of visitors and facilities.

- Rx 7E: Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, and sensitive species. Non-native, invasive insects and diseases may be eradicated or suppressed to prevent a loss of the old growth community. Favor biological control methods.
- Rx 7E: Eradicate non-native invasive plants when the infestations are isolated. Use approved hand-applied pesticides, when necessary.
- Rx 7F: Control insect and disease outbreaks, when necessary, to protect the scenic values, to reduce hazards to visitors, or for safety or legal reasons. Eradicate recently established non-native pests when possible. Favor the most effective control method.
- Rx 7G: Eradicate non-native invasive plants.
- Rx 8E7: Native forest insect and disease outbreaks are controlled only to prevent unacceptable damage to resources on adjacent land or to protect threatened, endangered, sensitive, or locally rare species. Non-native, invasive insects and diseases may be eradicated or suppressed to prevent a loss of the special biological community. Favor biological control methods.
- Rx 8E7: Control or eradicate non-native invasive plants using hand-applied herbicides, with Forest Supervisor approval, when necessary.
- Rx 8E7: Control non-native invasive animals, insects, and diseases where they are causing negative effects to rare communities. Do not introduce non-native species in or near rare communities, unless it is a natural enemy of a non-native pest.
- Rx 12D: Suppression and eradication of non-native pests are allowed.
- Rx 13: The forest health strategy is to minimize the occurrence of pest problems by managing host-type conditions. Suppression of pests, both non-native and native, is accomplished with all available integrated pest management tools.
- Rx 13: Proactively manage species composition and tree vigor in stands at a level that reduces susceptibility to damage from insect and disease infestations and other forest health problems like oak decline. Suppress native and non-native insects and diseases using an integrated pest management approach.

6.7 Forest Plan Strategies for Addressing Ecological Stresses and Threats

Appendix E-1 contains a summary of some of the strategies considered in alternatives to address the identified stresses and threats to the ecological systems.

APPENDIX E1 - ECOLOGICAL SYSTEMS STRESSES, THREATS AND STRATEGIES

Target Name	Stress	Threat	Strategy
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	6.1 Recreational activities	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	6.1 Recreational activities	Objective to maintain or increase acres of spruce forest
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilize timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Mafic Glade and Barrens and Alkaline Glades and Woodlands	1.3.1 Limited existing distribution of system/habitat	0 None or Unknown	Establish desired condition Alkaline Glade and Woodlands and Mafic Glades and Barrens
Caves and Karstlands	1 Terrestrial System/Habitat Stresses	6 Human intrusions and disturbance	Establish guidelines for caves and karstlands
Caves and Karstlands	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Establish guidelines for caves and karstlands
Caves and Karstlands	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Cliff, Talus and Shale Barrens	1 Terrestrial System/Habitat Stresses	6.1 Recreational activities	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.1 Conversion and fragmentation	A.4 Roads and rights-of-way	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.1 Conversion and fragmentation	A.4 Roads and rights-of-way	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.1 Conversion and fragmentation	A.4 Roads and rights-of-way	Protect and maintain occurrences of rare communities in SBAs in addition to those in 1993 Plan
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish desired condition for shale barrens

Target Name	Stress	Threat	Strategy
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	7.1 Fire and fire suppression	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	8.2 Problematic native species	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.2 Modification of vegetation	8.2 Problematic native species	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Cliff, Talus and Shale Barrens	1.2.1 Modification of vegetation structure	7.33 Lack of disturbance; succession	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish guidelines for cliff and talus and shale barren areas
Cliff, Talus and Shale Barrens	1.2.2 Modification of vegetation composition	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Cliff, Talus and Shale Barrens	1.3 Limited distribution of the system/habitat	0.1 None	Establish desired condition for shale barrens
Cliff, Talus and Shale Barrens	1.3 Limited distribution of the system/habitat	0.1 None	Establish guidelines for cliff and talus and shale barren areas
Cove Forest	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish desired condition for cove forests
Cove Forest	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish Invasive Species Control Guidelines
Northern Hardwood Forest	1 Terrestrial System/Habitat Stresses	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition
Northern Hardwood Forest	1 Terrestrial System/Habitat Stresses	9.5.1 Acid deposition	Establish management strategy for climate change incl land allocation, obj and desired conditions
Northern Hardwood Forest	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish Invasive Species Control Guidelines
Northern Hardwood Forest	1.3 Limited distribution of the system/habitat	11.1 Geographic shifts in climate	Establish management strategy for climate change incl land allocation, obj and desired conditions
Oak Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year

Target Name	Stress	Threat	Strategy
Oak Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilize timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Oak Forests and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Oak Forests and Woodlands	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pine Forests and Woodlands	1.2 Modification of vegetation	11.3 Temperature extremes	Establish objective for mature pine forests
Pine Forests and Woodlands	1.2 Modification of vegetation	11.3 Temperature extremes	Establish objective for pine open woodlands
Pine Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Establish fire objective of 12,000 to 20,000 acres per year
Pine Forests and Woodlands	1.2 Modification of vegetation	7.33 Lack of disturbance; succession	Utilize timber harvest to create early successional habitat, annual harvest of 1,800 - 3,000 acres
Pine Forests and Woodlands	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Pine Forests and Woodlands	1.2.1 Modification of vegetation structure	7.1 Fire and fire suppression	Establish fire objective of 12,000 to 20,000 acres per year
Pine Forests and Woodlands	1.2.2 Modification of vegetation composition	8 Invasive & problematic species	Establish desired conditions for Pine Forests and Woodlands
Floodplains, Wetlands and Riparian Areas	1.1 Conversion and fragmentation	7.32 Off Road Vehicles	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.2 Modification of vegetation	8.1 Non-native invasive species	Establish Invasive Species Control Guidelines
Floodplains, Wetlands and Riparian Areas	1.2 Modification of vegetation	8.1 Non-native invasive species	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.3 Limited distribution of the system/habitat	0.1 None	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.3.1 Limited existing distribution of system/habitat	7.33 Lack of disturbance; succession	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	1.3.2 Limited potential distribution of system/habitat	7.34 Loss of beaver activity	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditions
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	11 Climate Change and Weather	Utilize Jefferson riparian standards

Target Name	Stress	Threat	Strategy
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	6 Human intrusions and disturbance	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2 Aquatic System/Habitat Stresses	7 Modification of natural systems	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.1 Stream flow modification	7 Modification of natural systems	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.1 Stream flow modification	7.2 Dams and water management	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.4 Water chemistry modification	9.5.1 Acid deposition	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.5 Aquatic/Riparian system modification	11.2 Droughts	Utilize Jefferson riparian standards
Floodplains, Wetlands and Riparian Areas	2.5 Aquatic/Riparian system modification	8 Invasive & problematic species	Utilize Jefferson riparian standards
Spruce Forest	1 Terrestrial System/Habitat Stresses	11 Climate Change and Weather	Establish management strategy for climate change incl land allocation, obj and desired conditions
Spruce Forest	1 Terrestrial System/Habitat Stresses	11 Climate Change and Weather	Objective to maintain or increase acres of spruce forest
Spruce Forest	1.2 Modification of vegetation	9.5.1 Acid deposition	Continue air resource management activities to reduce impacts of acid deposition

LITERATURE CITED

Aldrich, Serena R. et al. 2010. Three Centuries of Fire in Montane Pine-Oak Stands on a Temperate Landscape. Applied Vegetation Science 13: 36-46

Anders, A., Faaborg, J. and Thompson, F. 1998. Postfledgling dispersal, habitat use, and home-range size of juvenile wood thrushes. The Auk 115(2):349-358.

Barber, M.B. 1996. A summary report: FY 95 Heritage resource management for the George Washington and Jefferson National Forests, Virginia. George Washington and Jefferson National Forests, Roanoke.

Barden, L.S. 1980. Tree replacement in a cove hardwood forest of the southern Appalachians. Oikos. 35: 16-19.

Brenneman, R., J. E. Kennamer, and M. Kennamer. 1991. Managing openings for wild turkeys and other wildlife – a planting guide. National Wild Turkey Federation, Edgefield, SC. 39pp.

Brown, H. 2000. Wildland burning by American Indians in Virginia. Fire Management Today 60(3):29-39.

Burns, R.M. and B.H. Honkala. 1990. Silvics of North America. Two volumes: Volume 1; Conifers and Volume 2; Hardwoods. USDA Forest Service. Agriculture Handbook 654. 1552 pp. USGPO, Washington, D.C.

Clark, J.S. and D. Royal. 1996. Local and regional sediment charcoal evidence for fire regimes in presettlement north-eastern North America. Journal of Ecology 84,1-000, pp.1-18.

Cogbill,C. 1983. Natural old-growth forest stands in Maine. Maine Critical Areas Program, Maine State Planning Office Planning Report No. 79. [Number of pages unknown].

Craig, A.J. 1969. Vegetational history of the Shenandoah Valley, Virginia. Geological Society of America Special Paper, 123: pp.283-296.

Davis, Mary B., editor. 1996. Eastern Old-Growth Forests – Prospects for Rediscovery and Recovery. Washington, D.C.: Island Press. 383 pp.

Day, G.M. 1953. The Indian as an ecological factor in the northeastern forest. Ecology, Vol.34, #2. pp.329-345.

Delcourt, H.R. 1987. The impact of prehistoric agriculture and land occupation on natural vegetation. Trends in Ecology and Evolution 2:39-44.

Delcourt, H.R.; Delcourt, P.A. 1998. The influence of prehistoric human-set fires on oak-chestnut forests in the Southern Appalachians. Castanea, Vol. 64, 337-345.

Delcourt, P.A. and H.R. Delcourt. 1996. Holocene vegetation history of the northern Chattooga Basin, North Carolina. In report: Tennessee Valley Authority, Chatooga River project.

DeWeese, Georgina. 2007. Past Fire Regimes of Table Mountain Pine (*Pinus pungens* Lamb.) Stands in the Central Appalachian Mountains, Virginia, U.S.A. PhD Dissertation, The University of Tennessee, Knoxville, TN. 308pgs

Dimmick, R. W., J. D. Sole, W. G. Minser, and P. E. Hale. 1996. Response of ruffed grouse to forest management in the Southern Appalachian Mountains. Proc. 7th International Grouse Symp. Fort Collins, CO.

Dimmick, R. W., M. J. Gudlin, and D. F. McKenzie. Coordinators/Editors. 2001. The northern Bobwhite Conservation Initiative. A report on the status of the northern bobwhite and a plan for recovery of the species. Southeast Quail Study Group Tech Comm. Report to Sate Wildlife Agency Directors of the Southeastern Assoc. of Fish and Wildl. Agencies. Draft.

Donovan, T. Jones, P., Annand, E. and Thompson, F. 1997. Variation in local-scale edge effects: mechanisms and landscape context. Ecology 78(7):2064-2075.

Duguay, J., P. Wood, and J. Nichols. Songbird Abundance and Avian Nest Survival Rates in Forests Fragmented by Different Silvicultural Techniques. Cons. Biol. 15 (5):1405-1415.

Fesenmyer, K.A. and N.L. Christensen. 2010. Reconstructing Holocene Fire History in a Southern Appalachian Forest Using Soil Charcoal. Ecology, 91(3). 662-670.

Franklin, Jerry F. 1988. Structural and Functional Diversity in Temperate Forests. Pp. 166-175, in Biodiversity, E. O. Wilson editor, National Academy Press.

Gobster, P.H. 2001. Human dimensions of early successional landscapes in the eastern United States. Wildlife Society Bulletin 29(2):474-482.

Goodrum, P.D., V.H. Reid, and C.E. Boyd. 1971. Acorn Yields, Characteristics, and Management Criteria of Oaks for Wildlife. Journal of Wildlife Management 35 (3): 52-53.

Hamel, P. 1992. The Land Manager's Guide to Birds of the South. The Nature Conservancy and the Southern Region, US Forest Service. U.S. Forest Service General Technical Report SE-22. 437pp.

Hammett, J.A. 1992. The shapes of adaptation: historical ecology of anthropogenic landscapes in the southeastern United States. Landscape Ecology, Vol.7 (2), pp.121-135.

Harris, Larry D. 1984. The Fragmented Forest: Island biogeography theory and the preservation of biotic diversity. The University of Chicago Press 211 Foster, D.R., and E.R. Boose. 1992. Patterns of forest damage resulting from catastrophic wind in central New England, USA. Journal of Ecology 80:79-98

Healy, W. M., and E. S. Nenno. 1983. Minimum maintenance versus intensive management of clearings for wild turkeys. Wildl. Soc. Bull. 11:113-120.

Hunter, C., M. Rowe, F. Alsop, S. Andrew, T. Milling, N. Murdock, D. Lee, C. McGrath, and M. Johns Cryptic bird conservation issues of the Southern Blue Ridge: High-elevation (spruce-fir/ northern hardwood) forests. The High Peaks Bird Summit. Appalachian State University, Boone, NC. August 27-28, 1998. Unpublished report.

Hunter, W.C., J.D. Dickson, D.N. Pashley, and P.B. Hamel. 2001. Bird communities of southern forests. pp. 322-348 in J.G. Dickson, ed. Wildlife of Southern Forests: Habitat and Management. Hancock House Publishers, Blaine, WA.

Kammermeyer, K. E., W. M. Lentz, E. A. Padgett, and R. L. Marchinton. 1993. Comparison of three ladino clovers used for food plots in northeast Georgia. Proc. Annu Conf. Southeast. Assoc. Fish and Wildl. Agencies 47:44-52.

Kilgo, John C., Karl V. Miller, Winston P. Smith. 1999. Effects of Group-Selection Timber Harvest in Bottomland Hardwoods on Fall Migrant Birds. J. Field Ornithology, 70(3):404-413

Kneller, M. and D. Peteet. 1993. Late-quaternary climate in the Ridge and Valley of Virginia, U.S.A.; Changes in vegetation and depositional environment. Quaternary Science Reviews, Vol.12. pp.613-628.

Krementz, D.G. and J.J. Jackson. 1999. Woodcock in the Southeast: natural history and management for landowners. The University of Georgia College of Agriculture and Environmental Science/ Cooperative Extension Service. USDI Fish and Wildlife Service. Available online at: <http://www.ces.uga.edu/pubcd/b1183.htm>

Lafon, C.W. and Henri Grissino-Mayer. 2005. Fire Regimes and Successional Dynamics in Yellow Pine (Pinus) Stands in the Central Appalachian Mountains. Final Report to Joint Fire Science Program, Project # 01C-3-3-09. Boise, ID. 24pgs.

Leverett, R. 1996. Definitions and history. In: Davis, M.B. Eastern old-growth forests: Prospects for rediscovery and recovery. Washington, D.C.: Island Press: 3-17.

Litvaitis, J.A. 2001. Importance of early-successional habitats to mammals in eastern forests. Wildlife Society Bulletin 29(2):466-473.

Loehle, C. 1988. Tree life histories: the roles of defenses. Canadian Journal of Forest Research. 18: 209-222.

Lorimer, C.G. 2001. Historical and ecological roles of disturbance in eastern North American forests: 9,000 years of change. Wildlife Society Bulletin 29(2):425-439.

Maxwell, H. 1910. The use and abuse of forests by the Virginia Indians. William and Mary College Quarterly Historical Magazine, Vol.19, #2. pp.73-103.

May, R. and Robinson, S. 1985. Population dynamics of avian brood parasitism. Am. Nat. 126:475-494.

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.5. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.

Nenno, E. S., and J. S. Lindzey. 1979. Wild turkey poults feeding activity in old field, agricultural clearings, and forest communities. Trans. Northeastern Sect. Wildl. Soc. 36:97–109.

Parker, J.R., K. E. Kammermeyer, and R. L. Marchinton. 1992. Wildlife usage of cloverplots in the Chestatee Wildlife Management Area. GA J. Sci. 50:160-169.

Patterson III, William A. and Andrea Stevens. 1995. The History of Fire and Vegetation in the Appalachian Mountain Region of Virginia: A Piece of the Puzzle We Call Ecosystem Management. Report Submitted to the George Washington National Forest. Harrisonburg, Virginia. September, 1995. University of Massachusetts, Amherst, MA. 40pp.

Patterson, W.A. III and A.E. Backman. 1988. Fire and disease history of forests. in: Handbook of Vegetation Science, Vol.7- Vegetation History, B. Huntley and T. Webb III (eds). pp.603-632. Kluwer Academic Publishers.

Patterson, W.A. III and K.E. Sassaman. 1988. Indian fires in the pre-history of New England, in: Holocene human ecology in northeastern North America, edited by George P. Nicholas, Plenum Publishing Corporation.

Primack, R. 1993. Essentials of Conservation Biology. Sinauer Associates Inc., Sunderland, MA.

Pyne, S.J. 1982. Fire in America, a cultural history of wildland and rural fire. Princeton University Press, Princeton.

Robinson, S. 1995. Threats to breeding neotropical migratory birds in the midwest IN Management of Midwestern Landscapes for the Conservation of Neotropical Migratory Birds, F. Thompson, Ed. USDA Forest Service GTR NC-187.

Robinson, S., Thompson, F., Donovan, T., Whitehead, D. and Faaborg, J. 1995. Regional Forest Fragmentation and the Nesting Success of Migratory Birds. Science 267:31.

Runkle, J.R. 1982. Patterns of disturbance in some old-growth mesic forests in eastern North America. Ecology 63:1533-1546.

Runkle, J.R. 1985. Disturbance regimes in temperate forests. In: The ecology of natural disturbance and patch dynamics. pp. 17-33. Edited by S.T.A. Pickett and P.S. White. Academic Press, New York.

SAMAB. 1996a. The Southern Appalachian Assessment (SAA) Summary Report. Report 1 of 5. USDA Forest Service, Southern Region, Atlanta, GA.

SAMAB. 1996e. The Southern Appalachian Assessment (SAA) Terrestrial Technical Report. Report 5 of 5. USDA Forest Service, Southern Region, Atlanta, GA.

Shaw, Samuel P. 1971. Wildlife and Oak Management. In: Oak Symposium Proceedings. USDA Forest Service, Northeastern Forest Experiment Station, Upper Darby, PA.

Smith, L. R. 1991. Biological Diversity Protection on the George Washington National Forest. Natural Heritage Technical Report 91-1. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report submitted to the USDA Forest Service. 151pp. plus maps.

Stephenson, Steven L. 1993. Upland Forests of West Virginia. McClain Printing Co., Parsons, West Virginia. 295pp.

Straw, J.A., D.G. Krementz, M. W. Olinde, and G.F. Sepik. 1994. American Woodcock. Pages 97-114 IN T.C. Tacha and C.E. Braun, editors. Migratory Shore and Upland Game Bird Management in North America. International Association of Fish and Wildlife Agencies, Washington, D.C.

Sutherland, E.K., H. Grissino-Mayer, C.A. Woodhouse, W.W. Covington, S. Horn, L. Huckaby, R. Kerr, J. Kush, M. Moore, T. Plumb. 1993. Two centuries of fire in a southwestern Virginia *Pinus pungens* community. Paper presented at the IUFRO Conference on Inventory and Management in the Context of Catastrophic Events, University Park, PA, on June 21-24, 1993. 12 pp.

Suthers, H.B., J.M. Bickal, P.G. Rodewald. 2000. Use of successional habitat and fruit resources by songbirds during autumn migration in central New Jersey. Wilson Bulletin 112:249-260.

Thackston, R, T Holbrook, W. Abler, J. Bearden, D. Carlock, D. Forster, N. Nicholson, and R. Simpson. 1991. The wild turkey in Georgia- history, biology, and management. GA Dept. Nat. Resour. 32pp.

Thompson, F. R., III, and D. R. Dessecker. 1997. Management of early- successional communities in central hardwood forests: with special emphasis on the ecology and management of oaks, ruffed grouse, and forest songbirds. USDA For. Serv. Gen. Tech. Rep. NC-195. 33pp.

Thompson, F.R., III, R.M. DeGraff. Conservation approaches for woody, early successional communities in the eastern United States. Wildlife Society Bulletin 29(2):483-494

TNC. 2005. Conservation Action Planning Workbook User Manual, Version 4.b, August 2005.

Trani-Griep, M.K. 1999. Early Successional Habitat and Open Lands Assessment for the Eastern and Southern Regions. Report I. August 1999. USDA Forest Service, Atlanta, Ga.

US Environmental Protection Agency. 2002. Multi-Resolution Land Characteristics Consortium. http://www.epa.gov/mrlc/nlcd.html. (July 25, 2002).

USDA Forest Service, 1997. Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southeast. Report of the Region 8 Old-Growth Team. Forestry Report R8-FR 62.

Vega Rivera, J.H., W.J. McShea, J.H. Rappole, and C.A. Haas. 1998. Wood Thrush postfledging movements and habitat use in northern Virginia. Condor 100:69-78.

Virginia Department of Conservation and Recreation. 1996. Natural Heritage resources on the George Washington and Jefferson National Forests. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report submitted to U.S. Department of Agriculture, Forest Service. June 1996.

Watts, W.A. 1979. Late quaternary vegetation of central Appalachia and the New Jersey coastal plain. Ecological Monographs, 49(4). pp.427-469.

Wentworth, J. M., A. S. Johnson, and P. E. Hale. 1990a. Influence of acorn use on nutritional status and reproduction of deer in the Southern Appalachians. Proc. Annu Conf. Southeast. Assoc. Fish and Wildl. Agencies 44:142-154.

Whitney. G.G. 1986. Relation of Michigan's presettlement pine forests to substrate and disturbance history. Ecology 67: 1548-1559

Wilkins, G.R. and P.A. Delcourt, H.R. Delcourt, F.W. Harrison, and M.R. Turner. 1991. Paleoecology of central Kentucky since the last glacial maximum. Quaternary Research 36, pp. 224-239.

Williams, C.E. and W.C. Johnson. 1990. Age structure and the maintenance of *Pinus pungens* in pine-oak forests of southwestern Virginia. Amer. Midl. Naturalist 124:130-141.

Wilson, I.T. 2000. Biological Diversity Protection on the George Washington National Forest, First Supplement. Natural Heritage Technical Report 00-10. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. Unpublished report submitted to the USDA Forest Service. 89 pp. plus maps.

Yahner, R. 1988. Changes in wildlife communities near edges. Conservation Biology 2:333-339.