SECTION B - BIOLOGICAL ENVIRONMENT

B1 – ECOLOGICAL SYSTEMS DIVERSITY

AFFECTED ENVIRONMENT

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.

Twenty-four ecological systems, as defined by NatureServe's International Ecological Classification Standards, are identified for the analysis of biological resources. However, because many of these ecological systems have similar key attributes, indicators, species associates and resulting forest plan components, we combined the 24 ecological systems into 9 major communities. Additional information on ecological diversity can be found in EIS Appendix E – Ecosystem Diversity Report.

Spruce Forests

This system is dominated by red spruce (*Picea rubens*) and may contain a Balsam fir (*Abies balsamea*) component. Red spruce begins to occur in stands with northern hardwoods (yellow birch, *Betula lutea*; beech, *Fagus grandifolia;* maple spp. *Acer*; etc.) at elevations around 4,500 feet. It becomes more dominant with increasing elevation, and may be the dominant species between 5,000 and 5,500 feet. Common shrub associates of this ecological system include *Rhododendron catawbiense*, *Vaccinium erythrocarpum* and *V. constablaei, Rubus canadensis,* and *Viburnum alnifolium.* The herb layer commonly includes *Oxalis montana, Dryopteris campyloptera, Aster divaricatus, Clintonia borealis, Solidago glomerata, Carex pennsylvanica* and *Maianthemum canadense,* as well as a variety of other species. This community is characterized by relatively high moisture levels, short growing seasons, acidic soils with low levels of nutrients, and are often subject to strong winds and other extreme weather conditions.

Spruce-fir forests are low disturbance systems, with most of the area under forest canopy. Adverse effects caused by air pollution have caused significant mortality of overstory trees in many areas throughout its range, making quality examples of this community very rare and threatening the persistence of many associated species. The George Washington National Forest has not experienced significant mortality to date.

The forests provide key habitat for the Virginia northern flying squirrel, *Glaucomys sabrinus fuscus.* Isolated populations of several birds--the northern saw-whet owl *(Aegolius acadicus),* the black-capped chickadee *(Parus atricapillus)*, the red crossbill *(Loxia curvirostra)* and the olive-sided flycatcher (*Contopus borealis*)--occur at these high elevations and are uncommon or rare elsewhere in the southeast.

Within the Southern Appalachians, the southern extent of this habitat association coincides approximately with the state lines where Tennessee, North Carolina and Georgia come together. The northern extent of the association is roughly coincident with the northern boundary of the Monongahela National Forest. These forests are confined to the highest peaks of Virginia, Tennessee, and North Carolina. They provide a cool, moist habitat similar to the boreal forests found at more northern latitudes.

There are about 85,000 acres of spruce-fir forest in the region (SAMAB 1996:168-169). Of this total, 11,700 acres are on national forests. These stands occur on the George Washington, Jefferson, and Cherokee National Forests, and the National Forests in North Carolina. Of the remainder, 62,700 acres are in other public ownership (mostly National Park Service), and 10,600 acres are in private or corporate ownership. Most of the public land (including 39% of the NFS land) is in late successional stage (81 yrs. +) forests. At the time of the Southern Appalachian Assessment (1996), four percent of the National Forest acres were in the sapling/pole

(11-40 yrs.) stage and 57% were in the mid-successional (41-80 yrs.) stage. All of the private holdings are in either the sapling/pole stage or the mid-successional stage.

There are approximately 500 acres of spruce forest on the GWNF located in the Laurel Fork area of Highland County, VA. This area is currently identified as a Special Management Area to be managed to maintain or enhance the special biological features of the area, including the Central and Southern Appalachian Spruce-Fir Forest.

Northern Hardwood Forests

Hemlock and Northern Hardwood forests are broadly defined to include those forested communities that are either dominated or co-dominated by eastern hemlock (*Tsuga canadensis*) or sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and associates. For the purposes of this analysis, forests with a significant component of eastern hemlock are classified as hemlock forests, even where white pine may be dominant. This division puts priority on the presence of hemlock as a key habitat component. Northern Hardwood forests generally occur as the Sugar maple-beech-yellow birch forest type on the GWNF.

Eastern hemlock forests typically occur on acidic soils and often have a dense shrub layer composed of ericaceous species. These communities are typically low in herbaceous diversity, but may support rich bryophyte communities. The combination of a largely evergreen canopy and a dense midstory in naturally occurring hemlock provide for a variety of benefits, including shading and cooling of riparian systems, thermal cover for wildlife, and nesting and foraging habitat for several species of neotropical migrant birds dependent upon the layered canopy structure and understory thickets (Rhea and Watson 1994). There is some evidence that forests provide necessary habitat components for the long-term conservation of red crossbills (Dickson 2001). Eastern hemlock forests may also be important refugia for species typically adapted to higher elevations. Dickson (2001) states that red-breasted nuthatches, winter wrens, and golden-crowned kinglets are found in late successional hemlock forests down to elevations of 2,000 feet, and several species of rare bryophytes that are known to occur primarily within the spruce/fir zone are also found at lower elevations in humid gorges often under a canopy that includes eastern hemlock (Hicks 1992). Unfortunately, a vast majority of these forests have been severely impacted by the hemlock woolly adelgid resulting in severe or total mortality of hemlock. While it is not known what percentage of these older aged stands has succumbed to this non-native pest, we can assume that little or no hemlock forest remains unaffected or wholly intact.

A number of bird species, including the cerulean warbler (*Dendroica cerulea*) favor mature, northern hardwood forests with a diverse and well-developed canopy structure including canopy gaps and associated midstory and understory structural diversity (Hunter, et al. 2001; Rodewald and Smith, 1998). This structural diversity may be characteristic of the decadent, patchy conditions found in old growth forests, to which these species have presumably adapted. While a growing portion of the landscape in the Southern Appalachians consists of large hardwoods, most sites have very simple canopy structures (Runkle, 1985). This lack of structure is likely the result of previous even-aged timber management, resulting in forest stands of approximately equally-aged trees with low mortality and few canopy gaps. Most of these mid- and late successional forests have not yet begun to develop the canopy gaps characteristic of old growth forests. It may be many centuries before such structure develops through natural succession. For the Southern Appalachian Assessment area, the majority of the northern hardwood forests are currently in older age classes. Across all ownerships, approximately 75-80% of maple-beech-birch (northern hardwoods) is in mid- and late-successional stages. On the GWNF approximately 11,000 acres, or 1% of the forest, is found in northern hardwood forests. Approximately 98% of this forest type is in mid- and late-successional forest.

Cove Forests

This system is dominated by yellow poplar (*Liriodendron tulipifera*) and may contain white pine (*Pinus strobus*), various species of ash (*Fraxinus spp.*), and basswood (*Tilia Americana*) as associates. This community is characterized by relatively low levels of disturbance, and from a habitat perspective, their primary value is providing habitat for a variety of species dependent on mid- and late successional forest stages. It should be noted that the more mesic oak forest types are not addressed in this section, but are analyzed in the Oak and Oak Pine section.

The cove forests addressed in this section are relatively uncommon in the Southern Appalachian Assessment area, comprising just over 10% of the land area (SAMAB 1996:23). Cove forest communities such as mixed mesophytic and bottomland hardwood forests comprise 8.4%, and 1.2%, respectively, of the land area of the SAA area. While these forest communities occur throughout the entire forest, approximately 6% of the GWNF is comprised of cove forests.

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Oak Forests and Woodlands

The major species include chestnut oak (*Quercus montana*), northern red oak (*Q. rubra*), black oak (*Q. velutina*), white oak (*Q. alba*), and scarlet oak (*Q. coccinea*) (USDA Forest Service, 1997). The drier sites contain oak-pine forests which are oak-dominated forests containing a significant pine component. Predominant pine species include white pine (*Pinus strobus*), shortleaf pine (*P. echinata*), and Virginia pine (*P. virginiana)*

Complexes of woodlands, savannas, and grasslands were once a frequent occurrence across the southeastern landscape, maintained with frequent fire on xeric ridge-tops and south-facing slopes (DeSelm and Murdock 1993; Davis et al. 2002). Woodlands are open stands of trees, generally forming 25 to 60 percent canopy closure (Grossman et al. 1998:21) and may be of pine, hardwood (typically oak), or mixed composition. Savannas are usually defined as having lower tree densities than woodlands; grasslands are mostly devoid of trees. All of these conditions typically occurred in mixed mosaics within a fire maintained landscape. In all cases, a well-developed grassy or herbaceous understory is present.

Because existing woodland, savanna, and grassland complexes are rare, do not conform to existing definitions of community types, and are not consistently tracked, the current acreage in such condition is not well documented. This vegetative condition is not a community type in and of itself, but rather, could occupy some sites allocated to other formally defined community types. The woodlands, savannas, and grasslands are expected to occupy the most xeric sites of the dry and xeric oak forest, woodland, and savanna and the xeric pine and pine-oak forest and woodland community types. These community types are most likely to occupy sites that historically supported woodlands, savannas, and grasslands.

Existing remnants of this habitat and several associated rare species in both the Southern Appalachians and Piedmont are limited primarily to roadsides and powerline rights-of-way (Davis et al. 2002) due to reductions in fire frequency across most landscapes.

The abundance of these forests in the future will be primarily dependent on the management of existing oak stands to maintain oak dominance. However there also are opportunities to increase the availability of these forests, especially the mixed oak-pine types, through various regeneration techniques and supplemental planting of pine species.

Across the Southern United States, about 50% of the upland hardwood forests (predominantly oak-hickory) and 30% of the natural oak-pine forests are in mid- and late successional stages (41+ years of age) (USDA Forest Service 2001). However, only about 1% of the planted oak-pine forests are in mid- and late successional stages. For the Southern Appalachian Assessment Area, approximately 75% of oak-hickory forests are in mid- and late successional stages (SAMAB 1996: 165).

The age class distribution on the GWNF follows a pattern common to many other Southern Appalachian Forests. However, on the GWNF, this pattern is a little more extreme with over 90% of these community types in a mid-late successional stage.

The structural condition of these oak forests and woodlands is a key factor in the maintenance of these communities. Research indicates that these forest communities may not perpetuate themselves without some level of disturbance, especially on mesic sites (Loftis 1991). Treatments such as shelterwood harvest combined with prescribed burning (Brose et al. 1999) or basal area reduction from below using herbicides (Loftis 1990) have been shown to create conditions that promote adequate oak regeneration. Once established and grown to an average height of approximately 4.5 feet, oak advanced regeneration should be released and provided relatively full sunlight to encourage quick growth into the canopy of the regenerated stand. Oak dominance can be maintained with suitable tree densities and moderate fire return intervals.

Mid- and late successional oak forests and woodlands provide an important source of hard mast and dens. Acorns are a critical fall and winter food for numerous wildlife species (Martin et al. 1951). The availability of acorns has been shown to strongly influence population dynamics of species such as black bear (Pelton 1989), squirrels (Nixon et al. 1975), white-tailed deer (Wentworth et al. 1992) and white-footed mice (Wolff 1996). The large diameter hollow trees and snags found in older oak forests also are an important source of dens for black bears (Carlock et al. 1983). Hard mast production is an important habitat feature for a several wildlife species in demand for sport hunting. These include white-tailed deer, wild turkey, squirrels, and bear.

Pine Forests and Woodlands

These systems are often referred to as southern yellow pine forests and occur on a variety of landforms at a wide range of elevations. Historically, in the Blue Ridge Physiographic Province, these communities occupied areas that were subject to natural fire regimes and typically occurred on ridges and slopes with southern exposures (NatureServe 2002). However, due to a combination of previous land use, fire exclusion, and intensive forestry (plantations), many pine species that do not tolerate fire well have expanded beyond their normal sites and today, pine-dominated communities can be found on a variety of landforms and aspects. Meanwhile, pine species, such as table mountain pine, that benefit from, or depend upon fire, have been reduced in abundance.

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Existing remnants of this habitat and several associated rare species in both the Southern Appalachians and Piedmont are limited primarily to roadsides and powerline rights-of-way (Davis et al. 2002) due to reductions in fire frequency across most landscapes.

During the last 50 years across the southeastern United States, pine plantations have increased in importance in terms of a supply of wood products, expanding from 1% of the total pine forest acres to 48% of those acres (USDA Forest Service 2001: 1). It should be noted, however, that this expansion has occurred primarily in the

piedmont and coastal plains of the south; relatively few pine plantations have been established on the GWNF or in the mountains of Virginia. At the same time, the 20-year trend reported for the Southern Appalachian Assessment area (SAMAB 1996: 27) shows a downward trend of 16% for southern yellow pine forests. This trend is not, however, reflected in monitoring of this community type on the George Washington and Jefferson National Forests (GWJNF). The number of acres in this community type inventoried through FSVeg on the GWJNF has decreased less than 1% over the past decade (George Washington and Jefferson National Forest 2001). However, Forest Inventory and Analysis data indicate a substantial decrease in the acres of Virginia, pitch, and table mountain pines on the GWJNF since 1977 (George Washington and Jefferson National Forest 2001). So, while the decrease in the yellow pine community may not have been significant over the past decade, it has been dramatic over the past 30 years, indicating that much of the loss occurred prior to the past decade. A shift from more fire tolerant yellow pines to less fire tolerant pines may also be masked in this data. The GWNF currently contains approximately 160,000 acres in the xeric pine forest and woodland community type, representing about 15% of the GWNF.

Portions of the GWNF experienced a southern pine beetle epidemic in the mid 1990s. While the exact acreages of southern yellow pine forests that were severely impacted are not known, this insect pest certainly resulted in a recent significant impact in terms of the condition or quality of existing yellow pine stands. Many of the sites impacted were densely stocked stands of Virginia, table mountain, and/or pitch pine that had proliferated beyond their normal sites due to fire suppression and land management practices of the past 70 years. Historical data suggests that large areas that have become occupied by even-aged stands of yellow pine would have naturally supported mixed stands with varying levels of hardwoods. Some areas experiencing frequent fire would have contained open understories with grassy and/or herbaceous ground cover. These natural communities are maintained by low intensity fires originating on ridgetops and southern exposures (NatureServe 2002). Other areas with less frequent fire would contain a mix of pine and hardwood species. With large-scale mortality in these communities due to pine beetle effects, the opportunity now exists to restore the condition and/or quality of these sites to a more open pine woodlands or natural mixed pine hardwood community. On the GWNF, the pine forest and woodland community is well distributed throughout the ridge and valley province. However, this type is currently less abundant on the richer Blue Ridge Province soils of the Pedlar District.

The Southern Appalachian Assessment (SAMAB 1996) summarizes the age class distribution of southern yellow pine forests across the Southern Appalachian Assessment Area by a variety of land ownerships. Similar information is derived from queries of the GWNF FSVeg Database. This data indicates that this community type is very strongly skewed to the older age classes as compared to the Southern Appalachian Assessment area as a whole.

While public lands support the majority of late successional acres, the structure and composition of these forests has been altered due to years of fire suppression resulting in less than optimal habitat conditions. Fire intolerant species such as Virginia pine have proliferated while other pines (shortleaf, pitch, table mountain) have seen dramatic reductions (Nature Serve 2002, Martin et al. 1993). In the absence of fire, hardwoods, shrubs, and vines have replaced the open, grassy, herbaceous layer that is characteristic of frequently burned areas, and hardwoods have encroached into the midstory further affecting forest structure. This change in forest structure and resulting habitat condition has had a direct effect on species dependent upon these communities. Populations of several bird and reptile species associated with southern pine forests are in decline (Dickson 2001) as various habitat components are lost. In addition to declines in species dependent upon specific habitat attributes, entire pine communities are experiencing a reduction in abundance. Recent studies show that acreage of table mountain pine communities (considered a rare community in the southern Appalachians) has decreased due to fire suppression (Turrill and Buckner 1995) and that many remaining examples have substantial hardwood invasion. However, recent monitoring of the table mountain pine types on the GWJNF indicates the decline of table mountain pine has stabilized since 1977 (George Washington and Jefferson National Forest 2001).

Alkaline and Mafic Glades and Barrens

These systems are characterized by thin soils and exposed parent material that result in localized complexes of bare soils and rock, herbaceous and/or shrubby vegetation, and thin, often stunted woods. During wet periods

they may include scattered shallow pools or areas of seepage. Glades, barrens, and associated woodlands differ from rock outcrop communities by exhibiting soils and vegetative cover over the majority of the site, and differ from the more widespread woodland communities in that they occur on geologic substrates which are unique for the region, including limestone, dolomite, amphibolite, greenstone, mafic rock, serpentine, sandstone, or shale. Associated communities include Calcareous Woodlands and Glades, Mafic Woodlands and Glades, Serpentine Woodlands and Glades, and Shale Barrens as defined in the Southern Appalachian Assessment (SAMAB 1996). At minimum, this rare community complex includes rare associations within the following ecological groups as defined by NatureServe (2001a): 401-17 Appalachian Highlands Calcareous/Circumneutral Dry-Mesic Hardwood Forest.

Cliff, Talus and Shale Barrens

These systems are a variable group of sparse woodlands, shrublands, and open herbaceous rock outcrops occurring on Ridge and Valley shales and Blue Ridge metashales of the Central Appalachian Mountains. These small-patch communities range from western Virginia and eastern West Virginia to southern Pennsylvania. In Virginia, they occur at elevations from 850 to 3,040 feet. Although stunted trees of several species (*e.g*., *Quercus pinus*, *Pinus virginiana*, and *Caria glare*) are common, shale barrens are strongly characterized by their open physiognomy and by a suite of uncommon to rare plants found almost exclusively in these habitats. Endemic or near-endemic shale barren species include *Arabic serotonin*, *Clematis alb coma*, *Clematis viticaulis* (also endemic to Virginia), *Eriogonum allenii*, *Oenothera argillicola*, *Packera antennariifolia* (= *Senecio antennariifolius*) and *Trifolium virginicum*. Habitats generally occur on steep (~ 30 degree) slopes with south to west aspects. The steep, xeric slopes and friable nature of the shale create poorly vegetated hillsides of bare bedrock and loose channery visible from afar. Continual undercutting of thick but relatively weak shale strata by streams maintain shale barrens. Less common, densely graminoid-dominated variants occurring on steep spur ridge crests and mountain summits are sometimes referred to as “shale ridge balds.” Shale barrens are considered globally uncommon and host many locally rare species including the butterflies Appalachian grizzled skipper (*Pyrgus wyandot*) and Olympia marble (*Euchloe olympia*) and the federally listed plant *Arabis serotina*. The primary threat to these communities is probably invasion by non-native invasive species, but examples of these communities near roads are also threatened by quarrying.

Floodplains, Wetlands and Riparian Areas

This system includes floodplains, streams, riparian areas, wetlands, bogs, fens, seeps, lakes, and ponds that may be found in both the Appalachian and Piedmont regions, and are characterized by: 1) soils that may be semi-permanently to permanently saturated as a result of groundwater seepage, perched water tables, rainfall, or beaver activity, and alluvial processes; and 2) presence of wetland-associated species such as sphagnum, ferns, and sedges. Dominant vegetation may be herbs, shrubs, trees, or some complex of the three. Ponds in this group include limesink, karst, and depression ponds, which may hold areas of shallow open water for significant portions of the year. Also included are all impoundments and associated wetlands resulting from beaver activity. Artificial impoundments are not included, unless they support significant populations or associations of species at risk. The primary management need is that of protection from activities that could disrupt wetland hydrology or other community structures and functions. Some sites may require periodic vegetation management to maintain desired herbaceous and/or shrubby composition. Rare mountain wetland communities include Mafic and Calcareous Fens, Sphagnum and Shrub Bogs, Swamp Forest-Bog Complex, Mountain Ponds, Seasonally Dry Sinkhole Ponds, and Beaver Pond and Wetland Complex as defined in the Southern Appalachian Assessment (SAMAB 1996).

Cave and Karstlands

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. 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.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Effects of the alternatives on the ecological systems of the GWNF are based on modeling of the extent of the ecological systems across the Forest. Objectives of timber harvest and prescribed burning were modeled through the next 50 years for each alternative. The current conditions of the systems are then compared to the modeled results. These results are compared to the biophysical settings identified through LANDFIRE for the systems on the GWNF.

LANDFIRE (also known as Landscape Fire and Resource Management Planning Tools) is interagency vegetation, fire, and fuel characteristics mapping program, sponsored by the United States Department of the Interior (DOI) and the United States Department of Agriculture, Forest Service. The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. It attempts to incorporate current scientific knowledge regarding the functioning of ecological processes – such as fire – in the centuries preceding non-indigenous human influence. Map units are based on NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). LANDFIRE's use of these classification units to describe biophysical settings differs from their intended use as units of existing vegetation. As used in LANDFIRE, map unit names represent the natural plant communities that may have been present during the reference period. Each BpS map unit is matched with a model of vegetation succession, and both serve as key inputs to the LANDSUM landscape succession model (Keane and others 2002). The LANDFIRE BpS concept is similar to the concept of potential natural vegetation groups used in mapping and modeling efforts related to fire regime condition class (Schmidt and others 2002; www.frcc.gov).

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, wildfires, 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.

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 35 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 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)
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.

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 35 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 rock cress, 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.

Species Composition

While changes in the extent of the ecological systems are not modeled, there are some changes in the species composition of the oak systems that could be expected over time. These changes would be most common in areas where timber harvest and prescribed burning are not used. They would therefore be more likely to be seen in Alternative C than in the other alternatives.

The variety of overstory and understory plants presently existing in stands of chestnut oak and scarlet oak could decline over time as forest succession follows its expected course. Chestnut oak could become more dominate as the single major overstory species. Several yellow pine species could decline significantly, except on the most severely dry and rocky sites already occupied only by table mountain pine. Bear oak barrens could disappear as tree species invade them and less frequent fires no longer initiate the regeneration process. On these dry sites, shrubs dominate the understory and the herbaceous layer is sparse. The understory vegetation which is dominated by plants of the heath family could change dramatically as disturbances (mainly fire) become less frequent. If a more closed canopy develops from the dominance of chestnut oak in the overstory and fires are less frequent, herbaceous plants may become more prevalent and shrubs less abundant Oaks could be replaced by red maple, black gum, black locust, sassafras and some yellow pines as a result of gypsy moth and oak decline impacts.

The variety of overstory trees presently existing in stands of white oak and black oak could decline over time as forest succession follows the course expected with little to no disturbances from timber harvests or prescribed burning. On most sites, succession will favor the eventual dominance of the white oaks. The small pine component (yellow and white pine) is likely to decline. Understory species would not vary much except where the pine overstory is replaced by oaks. Without planting or some disturbance to expose mineral soil, white pine would gradually decline as a species in this type-group except on poorer sites where it may become stable with chestnut oak. When conditions that provide for adequate regeneration of oak are eliminated, oak could be replaced in the overstory by blackgum, locust, red maple, white pine, and some yellow pine as a result of gypsy moth and oak decline impacts.

The variety of overstory and understory plants existing in stands of red oak and red maple could change over time as forest succession with less disturbance follows the course expected. However, the change may not be as great as in the preceding type-groups. While undisturbed stands tend to develop greater proportions of species other than northern red oak, historically red oak has generally retained its dominance in most stands. Red maple is usually second in importance in both the overstory and understory of stands containing red oak. White pine is found on either the more exposed drier sites or along stream corridors generally in association with hemlock. The varied understory, herbaceous plants and ferns, and tolerant tree species should continue to maintain their presence, although changes could be abrupt within small microsites, from even minor disturbances in the overstory. Fire is less likely to affect this type group and will generally only affect the

understory. Oaks could be replaced almost entirely by tolerant maples as a result of severe defoliation by gypsy moth.

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 (Anderson et al. 2012). 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.

The current conditions and expected conditions for each alternative are displayed in Tables 3B1-1 and 3B1-2. All of the alternatives protect the floodplain/riparian ecological system, but Alternatives B, C, E, F, G, H and I expand the width of the riparian corridor and so increase the area that will receive the riparian management objectives, desired conditions and objectives to protect, restore and maintain riparian resources. Alternatives B, C, D, E, F, G, H and I all prescribe direction for management of the caves and karstlands. Alternative C provides some level of increased protection of caves and karstlands due to the reduced level of ground disturbing activities. The spruce forests are protected in all alternatives, but the Laurel Fork wilderness recommendation in Alternatives C and F could impede restoration efforts aimed at actively expanding the spruce component of Laurel Fork.

None of the alternatives restore the other ecological systems to their LANDFIRE biophysical conditions. For example, LANDFIRE indicates that about 50 percent of area in the mid-late successional stage for oaks should have an open canopy structure, but the maximum that any alternative provides is about 12 percent after fifty years. However, the prescribed burning in Alternatives B, E, F, G, H and I move those systems closer to their appropriate structural conditions and vegetation composition by returning more acreage to its historic fire regime. Alternatives D and C also accomplish this, but at a slower pace. The timber harvest in Alternatives D moves the systems towards their LANDFIRE regeneration biophysical condition better than the other alternatives, with Alternatives A, B, E, G, H and I following behind. Alternative C relies solely on natural processes to achieve regeneration and open canopy conditions. The interspersed nature of GWNF lands with private lands, past and projected development on those lands, changes in the flora and fauna of the area, and past fire suppression efforts makes it extremely difficult for natural processes to perform at the scale they did before European settlement. Therefore, the ecological systems cannot be restored to their historical conditions without active management activities.

Tables 3B1-1 and 3B1-2 are based on prescribed fire levels of 3,000 acres in Alternative A, 7,400 acres in Alternative A[1], 12,000 acres and 5,000 acres in Alternative D, and 20,000 acres in Alternatives B, E, F, G, H

and I. Timber harvest levels are based on levels generated by the Spectrum model and are 2,400 acres in Alternative A, 700 acres in Alternative A[1], 3,000 acres in Alternative B, 0 acres in Alternative C, 4,258 acres in Alternative D, 1,800 acres in Alternative E, 1,000 acres in Alternative F, and 3,000 acres in Alternatives G, H and I.

Table 3B1-1. Ecological Systems – Indicators by Alternative at End of First Decade

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	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											
Acres Burned at Desired Frequency	7%	83%	23%	28%	34%	34%	18%	13%	34%	34%	34%	34%
Caves and Karstlands	119,000											
Total Occurrences at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cliff, Talus and Shale Barrens	13,637											
Acres of Open and Open Canopy	2%	100%	10%	12%	35%	35%	18%	8%	35%	35%	35%	35%
Cove Forest	61,022											
Acres in mid to late successional stages	98%	96%	98%	100%	95%	100%	95%	95%	98%	95%	94%	95%
Acres of Regenerating Forest	2%	4%	2%	0%	4%	0%	5%	5%	2%	4%	5%	4%
Acres of open canopy in mid to late successional stages	1%	9%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Northern Hardwood Forest	13,478											
Acres in mid to late successional stages	98%	95%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Acres of Regenerating Forest	2%	5%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Acres of open canopy in mid to late successional stages	2%	10%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Oak Forests and Woodlands	756,058											
Acres in mid to late successional stages	95%	92%	94%	97%	94%	97%	92%	92%	95%	96%	93%	93%
Acres of Regenerating Forest	3%	8%	5%	2%	5%	2%	7%	7%	4%	2%	5%	5%
Acres of open canopy in mid to late successional stages	2%	50%	6%	8%	12%	2%	9%	7%	12%	12%	12%	12%

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	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
Openings												
Acres of open grasslands or forbs	<1%	4%	0%	1%	1%	0%	1%	1%	1%	1%	1%	1%
Pine Forests and Woodlands	162,129											
Acres in mid to late successional stages	97%	91%	98%	98%	96%	98%	98%	98%	97%	96%	97%	97%
Acres of Regenerating Forest	3%	9%	2%	1%	3%	1%	2%	2%	2%	3%	2%	2%
Acres of open canopy in mid to late successional stages	3%	79%	5%	7%	12%	1%	8%	5%	12%	12%	12%	12%
Floodplains, Wetlands and Riparian Areas	51,430											
Compliance with Riparian Guidelines	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	582											
Total System Acres at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

Table 3B1-2. Ecological Systems – Indicators by Alternative at End of Fifth Decade

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	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											
Acres Burned at Desired Frequency	7%	83%	41%	73%	67%	67%	38%	28%	67%	67%	67%	67%
Caves and Karstlands	119,000											
Total Occurrences at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cliff, Talus and Shale Barrens	13,637											
Acres of Open and Open Canopy	2%	100%	18%	34%	71%	71%	40%	20%	71%	71%	71%	71%
Cove Forest	61,022											
Acres in mid to late successional stages	98%	96%	98%	100%	95%	100%	95%	95%	98%	95%	94%	95%
Acres of Regenerating Forest	2%	4%	2%	0%	4%	0%	5%	5%	2%	4%	5%	4%
Acres of open canopy in mid to late successional stages	1%	9%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Northern Hardwood Forest	13,478											
Acres in mid to late successional stages	98%	95%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Acres of Regenerating Forest	2%	5%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Acres of open canopy in mid to late successional stages	2%	10%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Oak Forests and Woodlands	756,058											
Acres in mid to late successional stages	95%	92%	94%	97%	94%	97%	92%	92%	95%	96%	93%	93%
Acres of Regenerating Forest	3%	8%	5%	2%	5%	2%	7%	7%	4%	2%	5%	5%
Acres of open canopy in mid to late successional stages	2%	50%	6%	10%	19%	2%	13%	9%	19%	19%	19%	19%

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	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
Openings												
Acres of open grasslands or forbs	<1%	4%	0%	1%	1%	0%	1%	1%	1%	1%	1%	1%
Pine Forests and Woodlands	162,129											
Acres in mid to late successional stages	97%	91%	98%	98%	96%	98%	98%	98%	97%	96%	97%	97%
Acres of Regenerating Forest	3%	9%	2%	1%	3%	1%	2%	2%	2%	3%	2%	2%
Acres of open canopy in mid to late successional stages	3%	79%	5%	13%	21%	1%	13%	9%	21%	21%	21%	21%
Floodplains, Wetlands and Riparian Areas	51,430											
Compliance with Riparian Guidelines	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	582											
Total System Acres at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

B2 – TERRESTRIAL SPECIES DIVERSITY

B2A - TERRESTRIAL VIABILITY EVALUATION

AFFECTED ENVIRONMENT

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in continued existence of the species well-distributed over time.

Because NFMA regulations require providing habitat for species viability within the planning area, focus of this evaluation is on habitat provided on national forest land. Surrounding private lands may contribute to, or hinder, maintenance of species viability on national forest land, but are not relied upon to meet regulation requirements.

Evaluation of migratory birds focused on breeding populations only, unless otherwise indicated. This focus does not mean that wintering and migrating populations were not considered during planning, but that viability evaluation makes most sense when viewed in terms of the relative stability of breeding populations.

Viability Evaluation Process

The ecological and species sustainability framework is built on the principle that by restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems and by identifying and managing for additional needs for key species, the GWNF will be able to maintain and improve ecosystem diversity, provide for the needs of diverse plant and animal species on the forest, and provide management direction to support viable populations of native and desirable plants, fish and wildlife.

The Ecosystem Diversity Report (EIS, Appendix E) describes the analysis process used to identify, evaluate, and develop guidance for sustaining ecological diversity. 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 forestwide 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 Species Diversity Report (EIS, Appendix F). This report and the Ecosystem Diversity Report focus on the terrestrial environment. The analysis of the aquatic systems is covered in the Aquatic Ecological Sustainability Analysis (EIS, Appendix G).

The following steps were used to build an ecological sustainability framework. Each step is documented within the Ecological Sustainability Evaluation (ESE) tool, a relational database developed by the Forest Service and based on the structure used by The Nature Conservancy in their Conservation Action Planning. 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 2005). 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 also relate to 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 (EIS, Appendix G).

2. Identify stresses and threats to the ecological systems

Major stresses and threats to the ecological systems were identified.

3. 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, Virginia Department of Conservation and Recreation Natural Heritage Program, Virginia and West Virginia State Comprehensive Wildlife Conservation Strategies, the Birds of Conservation Concern list compiled by the U.S. Fish and Wildlife Service, and the Forest Service's list of sensitive species. 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 (EIS, Appendix F).

4. Identify stresses and threats to the species

Major stresses and threats were identified for each species in regard to their populations on the GWNF.

5. 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.

6. 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 (EIS, Appendix F).

7. Assess current condition of the indicators for the ecological systems and species groups

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.

8. Develop plan components to address the stresses and threats and provide management direction to maintain habitat components

In this step, plan components were developed to provide desired conditions, objectives, standards and guidance for managing ecosystem diversity and ecological conditions for species. These plan components were then linked with characteristics and conditions within the ESE tool. We ensured that all elements of the framework were addressed by appropriate management direction.

Twenty-three native ecosystems were identified for the GWNF using NatureServe's International Ecological Classification Standards (NatureServe 2004a, 2004b). A system was added to cover caves and karstlands. Current acreage of each system was calculated using Forest Service GIS data.

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 the following Ecological System Groups:

Table 3B2-1. Ecological Systems

Ecological System	**Ecological System Group**
Central and Southern Appalachian Spruce-Fir Forest	Spruce Forests (approximately 600 acres)
Appalachian (Hemlock)-Northern Hardwood Forest	Northern Hardwood Forests (approximately 13,000 acres)
Southern Appalachian Northern Hardwood Forest	
Southern and Central Appalachian Cove Forest	Cove Forests (approximately 61,000 acres)
Northeastern Interior Dry-Mesic Oak Forest	Oak Forests and Woodlands (approximately 756,000 acres)
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	
Southern Appalachian Montane Pine Forest and Woodland	Pine Forests and Woodlands (approximately 162,000 acres)
Central Appalachian Pine-Oak Rocky Woodland	
Southern Appalachian Low-Elevation Pine Forest	
Southern and Central Appalachian Mafic Glade and Barrens*	Alkaline and Mafic Glades and Barrens (approximately 4,000 acres)
Central Appalachian Alkaline Glade and Woodland*	
North-Central Appalachian Circumneutral Cliff and Talus*	Cliff, Talus and Shale Barrens (approximately 14,000 acres)
North-Central Appalachian Acidic Cliff and Talus*	
Appalachian Shale Barrens*	

Central Appalachian River Floodplain	Floodplains, Wetlands and Riparian Areas (approximately 51,000 acres)
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 (approximately 119,000 acres)

The major stresses and threats to each of these systems were identified. Key attributes and indicators were identified for each of these systems to determine if the systems are performing to their desired conditions.

The GWNF started with statewide species lists compiled from a variety of sources including the Birds of Conservation Concern list, Virginia and West Virginia State Heritage Programs tracked plant and animal lists, Virginia and West Virginia State Comprehensive Wildlife Strategy species of greatest conservation need list, Regional Forester's Sensitive Species list, federally listed Threatened and Endangered Species, and demand species. The original list consisted of about 474 plant and animal species with ranges occurring throughout the states.

The EIS Appendix F lists the 97 species which were removed from the list because they did not occur or have potential to occur on NFS-administered land based upon suitable habitat, range, or expert taxonomic consensus. If these species are found to occur on the GWNF, they will be re-evaluated. Of the remaining species an additional 82 species were not analyzed further because: a) the species is unaffected by management; b) the Forest is of marginal importance to conservation of the species; c) knowledge of species' ecology is insufficient to support conservation strategy; d) species' taxonomy is too uncertain to develop conservation strategy; or d) species is common and demonstrably secure on the Forest.

The remaining 295 species are addressed in this analysis.

These species were placed in groups based on similar habitat needs or on similar management requirements. The major stresses and threats to each of these species were identified. Key attributes and indicators were identified for each of the species groups to evaluate alternatives and develop plan direction.

In addition to noting the Global and State ranks of each of the species, a unit rank, or rank of rarity on the GWNF was also assigned to each species. The U ranks are as follows:

Unit Rank	Unit Rank Description
U1	Critically Imperiled—Critically imperiled on the unit because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the unit.
U2	Imperiled—Imperiled on the unit because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the unit.
U3	Vulnerable—Vulnerable on the unit due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation on the unit.

U4	Apparently Secure–Uncommon but not rare; some cause for long-term concern due to declines or other factors.
U5	Secure–Common, widespread, and abundant on the unit.
UU	Unrankable–Species or system is known to occur on the unit, but is currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
UH	Possibly Extirpated (Historical)–Species or system occurred historically in unit, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or system could become UH without such
UX	Presumed Extirpated–Species or system is believed to be extirpated from the unit because it has not been located despite intensive searches of historical and other appropriate sites; there is virtually no likelihood that it will be rediscovered.
UP	Possibly Present--There are no known current or historical occurrences, but the unit is within the range of the species or system and there is some chance it may occur.
UNP	Not Present--Species or system is not known, and is not expected, to occur on the unit.
UNR	Not Ranked–A unit rank has not yet been assigned.
UNA	Not Applicable–A unit rank is not applicable because rarity or vulnerability is not the conservation issue for the species or system (e.g., cowbirds or invasive species).

Viability outcomes can be expressed in terms of the abundance and distribution of species or their habitat. By definition, all of the species that are being addressed (except for the demand species) have limited distribution and limited abundance on the GWNF. The ESE tool generated a priority ranking for all of the species based on the global, state and unit ranks.

Different strategies were used in different alternatives to address habitat needs of the species. The way the alternative affected the indicators for the ecological systems and the species groups are displayed.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Many of the risks to viability of species on the GWNF are related to factors outside the management direction for the Forest. Many of the species are at the limits of their ranges, utilize habitat from an area much larger than the Forest itself, or are affected by large scale influences like climate change. In these cases, the best that can be done on the GWNF is to maintain and restore resiliency in habitat conditions so that species have the ability to utilize the habitat to the extent they can.

Table H.1 in Appendix H displays each of the species evaluated, the global and unit conservation rankings and the species groups to which each species are associated. Outcomes for the attributes and indicators for the ecological systems are summarized in Tables 3B1-1 and 3B1-2. Outcomes for the attributes and indicators for the species groups are summarized in Tables 3B2-2 and 3B2-3. They are displayed for the current condition and for 10 years and 50 years of plan implementation under each alternative.

Tables 3B2-2 and 3B2-3 are based on prescribed fire levels of 3,000 acres in Alternative A, 12,000 acres in Alternative D, and 20,000 acres in Alternatives B, E, F, G, H and I. Timber harvest levels are based on levels generated by the Spectrum model and are 2,400 acres in Alternative A, 3,000 acres in Alternative B, 0 acres in Alternative C, 4,258 acres in Alternative D, 1,800 acres in Alternative E, 1,000 acres in Alternative F and 3,000 acres in Alternatives G, H and I.

Table 3B2-2. Terrestrial Species Groups – Indicators by Alternative at End of First Decade

Species Group and 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
Alkaline Glades and Barrens	See Mafic and Alkaline Glades Ecological System										
Area Sensitive Grassland and Shrubland and Open Woodlands											
Total acres of area sensitive grasslands, shrublands or open woodlands	23,247	56,414	74,113	119,587	26,676	85,057	64,414	119,587	119,587	119,587	119,587
Shrublands > 40 acres	398	398	398	398	398	398	398	398	398	398	398
Area Sensitive Grasslands											
Area sensitive open Habitat grasslands greater than 100 ac	224	224	224	224	224	224	224	224	224	224	224
Area Sensitive Grasslands											
Area sensitive open habitat grasslands greater than 40 ac	389	389	389	389	389	389	389	389	389	389	389
Area Sensitive Shrubland and Open Woodlands											
Area sensitive open habitat shrubland and open woodland greater than 100 ac	22,569	55,736	73,435	118,909	25,998	84,379	63,736	118,909	118,909	118,909	118,909
Shrublands > 100 acres	109	109	109	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates											
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	898,162	890,272	912,998	884,844	913,891	871,957	871,957	896,272	904,925	885,149	884,849
Calciphiles											
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves	See Caves and Karstlands Ecological System										

Species Group and 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
Cavity Trees, Den Trees and Snags											
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and Large Rock Outcrops											
Compliance with cliff, talus and large rock outcrop guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests	See Cove Forests Ecological System										
Fire Dependent and Fire Enhanced											
Acres burned at desired frequency in all systems	26,144	35,855	53,555	99,028	6,118	64,498	43,855	99,028	99,028	99,028	99,028
Grasslands											
Existing grasslands in open conditions	2,773	2,773	2,773	2,773	1,387	2,773	2,773	2,773	2,773	2,773	2,773
Total grasslands acres	2,773	3,886	4,240	5,149	1,904	4,458	4,046	5,149	5,149	5,149	5,149
Hard and Soft Mast Dependent											
Total shrubland acres	31,967	42,447	19,347	48,447	18,447	61,447	61,447	36,447	28,447	48,447	48,447
Regenerating forest, pine + oak	29,232	39,742	17,622	44,242	16,742	56,947	56,947	33,742	24,162	43,442	44,228
Mature Oak	650,442	630,526	651,696	628,526	652,526	613,321	613,321	637,536	649,156	627,836	627,050
Open canopy pine + oak	19,275	50,309	67,648	109,653	16,742	78,058	59,002	109,653	109,653	109,653	109,653
High Elevation Coniferous, Deciduous and/or Mixed Forests											
Total acres of oak, cove or pine ecosystems in mid-late succession at elevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312

Species Group and 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
High Elevation Openings, Grassy or Shrubby or Open Woodlands											
Total High Elevation Grassland acres	411	411	411	411	411	411	411	411	411	411	411
Total high elevation shrubland acres	151	151	151	151	151	151	151	151	151	151	151
Regeneration at high elevation	5,599	7,526	3,278	8,630	3,113	11,021	11,021	6,423	4,952	8,630	8,630
Late Successional Hardwood Dominated Forest											
Mature and late successional oak, cove and northern hardwoods	689,162	679,772	701,548	676,844	702,391	661,457	661,457	686,782	697,425	675,659	675,359
Lepidopterans											
Compliance with lepidopteran guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks	See Mafic and Alkaline Glades Ecological System										
Occurrence Protection											
Compliance with Species Occurrence Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands											
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	22,460	55,627	73,326	118,800	25,889	84,270	63,627	118,800	118,800	118,800	118,800
Regenerating Forests											
Regenerating forest, pine, oak, cove, northern hardwood systems	30,444	40,924	17,824	46,924	16,924	59,924	59,924	34,924	26,924	46,924	46,924
Riparian	See Riparian Ecological System										
Ruderal											
Compliance with ruderal species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Species Group and 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
Sandstone Glades and Barrens											
Compliance with sandstone glades species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection											
Compliance with guidelines for over collection	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic											
Compliance with recreation traffic guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens	See Cliff, Talus and Shale Barrens Ecological System										
Shrublands											
Total shrubland acres	31,967	42,447	19,347	48,447	18,447	61,447	61,447	36,447	28,447	48,447	48,447
Total maintained Shrubland acres	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523
Species in a Special Biological Area											
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

Table 3B2-3. Terrestrial Species Groups – Indicators by Alternative at End of Fifth Decade

Species Group and 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
Alkaline Glades and Barrens	See Mafic and Alkaline Glades Ecological System										
Area Sensitive Grassland and Shrubland and Open Woodlands											
Total acres of area sensitive grasslands, shrublands or open woodlands	23,247	63,278	107,916	191,191	32,777	129,231	87,207	191,191	191,200	191,191	191,191
Shrublands > 40 acres	398	398	398	398	398	398	398	398	398	398	398
Area Sensitive Grasslands											
Area sensitive open Habitat grasslands greater than 100 ac	224	224	224	224	224	224	224	224	224	224	224
Area Sensitive Grasslands											
Area sensitive open habitat grasslands greater than 40 ac	389	389	389	389	389	389	389	389	389	389	389
Area Sensitive Shrubland and Open Woodlands											
Area sensitive open habitat shrubland and open woodland greater than 100 ac	22,569	62,600	107,238	190,513	32,099	128,553	86,529	190,513	190,522	190,513	190,513
Shrublands > 100 acres	109	109	109	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates											
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	898,162	882,514	993,786	863,259	998,078	788,388	788,388	916,563	965,265	857,706	857,280
Calciphiles											
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves	See Caves and Karstlands Ecological System										

Species Group and 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
Cavity Trees, Den Trees and Snags											
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and Large Rock Outcrops											
Compliance with cliff, talus and large rock outcrop guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests	See Cove Forests Ecological System										
Fire Dependent and Fire Enhanced											
Acres burned at desired frequency in all systems	26,144	42,720	87,358	170,641	12,219	108,681	66,657	170,641	170,641	170,641	170,641
Grasslands											
Existing grasslands in open conditions	2,773	2,773	2,773	2,773	1,387	2,773	2,773	2,773	2,773	2,773	2,773
Total grasslands acres	2,773	4,023	4,916	6,581	2,026	5,342	4,501	6,581	6,581	6,581	6,581
Hard and Soft Mast Dependent											
Total shrubland acres	31,967	42,400	19,300	48,392	18,400	61,392	61,392	36,392	28,400	48,392	48,392
Regenerating forest, pine + oak	29,232	39,742	17,622	44,242	16,742	56,947	56,947	33,742	24,162	43,442	44,228
Mature Oak	650,442	611,059	716,909	601,059	721,059	525,034	525,034	646,109	703,959	597,609	593,679
Open canopy pine + oak	19,275	55,389	96,730	175,165	16,742	118,485	79,539	175,165	175,165	175,165	175,165
High Elevation Coniferous, Deciduous and/or Mixed Forests											
Total acres of oak, cove or pine ecosystems in mid-late succession at elevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312

Species Group and 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
High Elevation Openings, Grassy or Shrubby or Open Woodlands											
Total High Elevation Grassland acres	411	411	411	411	411	411	411	411	411	411	411
Total high elevation shrubland acres	151	151	151	151	151	151	151	151	151	151	151
Regeneration at high elevation	5,599	7,518	3,269	8,620	3,104	11,010	11,010	6,413	4,943	8,620	8,620
Late Successional Hardwood Dominated Forest											
Mature and late successional oak, cove and northern hardwoods	689,162	672,015	782,337	654,418	786,579	577,047	577,047	706,232	757,766	647,375	646,949
Lepidopterans											
Compliance with lepidopteran guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks	See Mafic and Alkaline Glades Ecological System										
Occurrence Protection											
Compliance with Species Occurrence Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands											
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	22,460	62,491	107,129	190,404	31,990	128,444	86,420	190,404	190,413	190,404	190,404
Regenerating Forests											
Regenerating forest, pine, oak, cove, northern hardwood systems	30,444	40,877	17,777	46,869	16,877	59,869	59,869	34,869	26,877	46,869	46,869
Riparian	See Riparian Ecological System										
Ruderal											
Compliance with ruderal species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Species Group and 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
Sandstone Glades and Barrens											
Compliance with sandstone glades species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection											
Compliance with guidelines for over collection	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic											
Compliance with recreation traffic guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens	See Cliff, Talus and Shale Barrens Ecological System										
Shrublands											
Total shrubland acres	31,967	42,400	19,300	48,392	18,400	61,392	61,392	36,392	28,400	48,392	48,392
Total maintained Shrubland acres	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523
Species in a Special Biological Area											
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

The following descriptions of the alternatives in relation to species groups are based on comparisons to the current conditions, so they do not include Alternative A.

Alkaline Glades and Barrens species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this alternative. In addition, key glades are established as Special Biological Areas for all alternatives.

Area Sensitive Grassland and Shrubland and Open Woodlands species group is addressed through maintaining existing large maintained grassland and shrubland conditions and expanding habitat through the prescribed burning program. All of the alternatives maintain existing conditions, but Alternatives B, D, E, F, G, H and I all expand open woodlands through prescribed burning with Alternative D achieving less than the others. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland conditions in this alternative.

Area Sensitive Grasslands species group is addressed through maintaining existing large maintained grassland conditions. All of the alternatives are expected to maintain the existing occurrences of this habitat.

Area Sensitive Shrubland and Open Woodlands species group is addressed through maintaining existing large existing shrublands and achieving the desired the desired conditions and management objectives for the cliff/talus/shale barren, mafic/alkaline glades, oak, pine and cove ecological systems in regard to regenerating forests and creation of open woodlands. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest and prescribed burning, with Alternative D at a slower pace of burning. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland and shrubland conditions in this alternative.

Area Sensitive Late Successional Coniferous, Deciduous and/or Mixed Forests species group is addressed through achieving the desired the desired conditions and management objectives for the spruce, oak, pine, riparian and cove ecological systems in regard to mature forest conditions. All of the alternatives respond similarly with a large percentage of the forest in this habitat type.

Calciphiles species group is addressed through the cave and karstland standards and through the establishment of Special Biological Areas for the most representative calciphile sites. All of the alternatives provide protection and management of this group in the same way.

Caves species group is addressed through the establishment of cave and karstland standards that are part of all of the alternatives. These standards are designed to protect the physical (including the hydrology), chemical and biological characteristics of the caves and karstlands. In addition, in Alternatives E G, H and I caves (and defined areas around the caves) identified by the Virginia Natural Heritage Program are established as special geologic areas.

Cavity Trees, Den Trees and Snags species group is addressed through the establishment of standards to protect cavity and den trees and snags when management activities will remove trees. Given the mature and late successional stage of most of the forest, this habitat type is well represented throughout the forest. All of the alternatives provide protection and management of this group in the same way.

Cliff and Talus and Large Rock Outcrops species group is addressed through the establishment of a standard to assess the impacts of any activities proposed in this habitat type on the species identified as part of this group. All of the alternatives provide protection and management of this group in the same way.

Cove Forests species group is addressed through the desired conditions and management objectives for the cove forest ecological system, and so is dependent upon management actions to move this system to its desired condition. Alternatives B, D, E, F, G, H and I all do this through timber management, though

Alternatives E and A do so at a slower pace. The lack of a timber harvest program in Alternative C limits the development of the diverse age and structural conditions to meet the desired conditions.

Fire Dependent and Fire Enhanced species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades, cliff/talus/shale barren, pine, and oak ecological systems in regard to are burned at desired frequency, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the active restoration of this habitat in this alternative which relies on naturally ignited fire to achieve restoration of fire communities.

Grasslands species group is species group is addressed through maintaining existing grasslands. All of the alternatives, except Alternative C, are expected to maintain the existing occurrences of this habitat. In Alternative C, maintenance of existing grasslands is reduced below current levels.

Hard and Soft Mast Dependent species group is addressed through maintaining existing shrublands and achieving the desired the desired conditions and management objectives for the oak, pine and cove ecological systems in regard to regenerating forests and the oak systems for mature forest. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, G, H and I. The lack of a timber harvest program in Alternative C limits the development of the soft mast component and could reduce the hard mast through oak stands aged past their prime acorn bearing years and through the replacement of oak with shade tolerant trees.

High Elevation Coniferous, Deciduous and/or Mixed Forests species group is addressed through maintaining the acreage of these forest types. All of the alternatives are expected to maintain the existing occurrences of this habitat.

High Elevation Openings, Grassy or Shrubby or Open Woodlands species group is addressed through maintaining existing grasslands and achieving the desired the desired conditions and management objectives for the oak, pine, northern hardwood and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, G, H and I. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Late Successional Hardwood Dominated Forest species group is addressed through achieving the desired the desired conditions and management objectives for the oak, northern hardwood and cove ecological systems in regard to late successional forest conditions. All of the alternatives respond similarly with a large percentage of the forest in this habitat type.

Lepidopterans species group is addressed through the establishment of standards to protect against impacts from spraying for gypsy moth and from prescribed burning. All of the alternatives provide protection and management of this group in the same way.

Mafic Rocks species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this alternative. In addition, key mafic rock locations are established as Special Biological Areas.

Occurrence Protection species group is addressed through the establishment of standards to guide review and assessment of activities that could affect species in this group. All of the alternatives provide protection and management of this group in the same way. Due to the fewer ground disturbing activities allowed in Alternative C, it is likely to have fewer potential impacts on these species.

Open Woodlands species group is addressed through achieving the desired the desired conditions and management objectives for the cliff/talus/shale barren, mafic/alkaline glades, oak, and pine ecological systems in regard to creation of open woodlands. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, with Alternative D at a slower pace of burning. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland conditions in this alternative.

Regenerating Forests species group is addressed through achieving the desired the desired conditions and management objectives for the oak, pine, northern hardwood and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, G, H and I. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Riparian species group is addressed through the establishment of standards to guide management of activities in riparian areas. Alternatives B, C, E, F, G, H and I provide protection and management of this group in the same way by expanding the riparian areas to the same level as the Fish and Mussel Conservation Plan used in the Jefferson Forest Plan. Alternative D only expands the riparian areas in watersheds that support Threatened and Endangered aquatic species.

Ruderal species group is addressed through the establishment of standards to manage the old home sites, roadsides, and old fields where members of the ruderal species group are found in conditions that maintain their open character. All of the alternatives provide protection and management of this group in the same way.

Sandstone Glades and Barrens species group is addressed through the establishment of Special Biological Areas for high quality examples of this habitat. All of the alternatives provide protection and management of this group in the same way.

Sensitive to Over-Collection species group is addressed through the establishment of standards to limit collection of the species in this group. All of the alternatives provide protection and management of this group in the same way.

Sensitive to Recreation Traffic species group is addressed through the establishment of standards to reduce impacts of recreation activities on the species in this group. All of the alternatives provide protection and management of this group in the same way.

Shale Barrens species group is addressed through the desired conditions and management objectives for the cliff/talus/shale barren ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this alternative. In addition, key shale barren locations are established as Special Biological Areas.

Shrublands species group is addressed through maintaining existing maintained shrublands and achieving the desired the desired conditions and management objectives for the oak, pine and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, and G. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Species in a Special Biological Area group is addressed through the establishment of Special Biological Areas to protect rare communities. All of the alternatives generally provide protection and management of this group in the same way. However, recommended wilderness could affect Special Biological Areas. If an area were designated, the ability to provide management activity, if it were needed, could be prohibited, or made difficult to achieve.

The relative changes in habitat for each species are then displayed in Table H-2 in Appendix H based on the effects to the various species groups. The table shows species effects from the addition of standards to protect species and the effects from management actions proposed in the alternatives.

The table shows that almost all of the species benefit from each alternative, other than Alternative A, due to the additional species group protections that are common to all the other alternatives. About half of the species need management action to create the composition or structure of vegetation that they need. The needs of the other half are largely met through standards to protect their habitat. Many of the species that need the protection standards are riparian species. If the riparian species are not considered, then about three-quarters of the terrestrial species considered in the analysis, need some level of vegetation management. All of the alternatives provide a large portion of the forest in remote settings with little management activity. All of the alternatives except Alternative C provide for active vegetation management in the form of timber harvest and prescribed burning. The lack of this vegetation management in Alternative C makes it the only alternative that does not address the viability needs of all of the species on the Forest.

Despite similarities among Alternatives A, B, D, E, F, G, H and I, some differences in effects of alternatives are apparent. Since Alternative A continues current direction, it does not have the advantage of the additional protection and management guidance developed to support ecosystem and species diversity that is part of all of the other alternatives. Since Alternative D does not expand the riparian areas the same level as Alternatives B, C, E, F, G, H and I, it does not provide the same level of protection to the riparian species. Alternatives B, E, F, and G have similar levels of prescribed burning and Alternatives E, G, H and I have similar levels of timber harvest. Alternatives E, G, H and I provide the best mix of habitat management and habitat protection to create resilience and diversity of habitat to maintain viability of the species on the GWNF.

The data in Table H-2 can be summarized as descriptive viability outcome ratings. The data is summarized into the following categories.

Table 3B2-4. Categories of Outcome Ratings

Outcome Rating	Global and Unit Conservation Ranks Included in the Rating
Outcome A. Species is globally secure or apparently secure and it is reasonably distributed and relatively abundant on the Forest. Likelihood of maintaining viability is high.	G4 or G5 and U3 or U4
Outcome B. Species is globally secure or apparently secure. Species is potentially at risk on the Forest due to limited distribution. Therefore, likelihood of maintaining viability is moderate.	G4 or G5 and U1, U2, or UP/UH
Outcome C. Species is vulnerable globally, but is reasonably distributed on the Forest. Therefore, species viability on the Forest is moderate.	G3 and U3 or U4
Outcome D. Species is vulnerable globally and is potentially at risk on the Forest due to limited distribution. Therefore, species viability may be at risk.	G3 and U1, U2, or UP/UH
Outcome E. The species is imperiled or critically imperiled globally. Therefore, species viability may be at risk.	G1 or G2

The expected changes in viability ratings based on implementation of each alternative are displayed in Table 3B2-5.

Table 3B2-5. Number of Species Whose Viability Outcome Changes by Alternative

Viability Outcome Groups	Number of Species							
Indicator	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Outcome Group A								
Total in group		17	17	17	17	17	17	17
Benefit from direction for additional protection		12	12	12	12	12	12	12
Small improvements in habitat due to effects of management activities		2	0	8	2	4	2	2
Improvements in habitat due to effects of management activities		6	0	0	6	2	6	6
Reductions in habitat due to effects of management activities		0	8	0	0	0	0	0
Minimal change in habitat due to effects of management activities		3	3	3	3	5	3	3
Outcome Group B								
Total in group		188	188	188	188	188	188	188
Benefit from direction for additional protection		170	170	170	170	170	170	170
Small improvements in habitat due to effects of management activities		23	1	57	11	12	23	23
Improvements in habitat due to effects of management activities		36	0	2	36	34	36	36
Reductions in habitat due to effects of management activities		1	59	1	1	11	1	1
Minimal change in habitat due to effects of management activities		9	9	9	21	12	9	9
Outcome Group C								
Total in group		12	12	12	12	12	12	12
Benefit from direction for additional protection		12	12	12	12	12	12	12
Small improvements in habitat due to effects of management activities		2	1	4	1	2	2	2
Improvements in habitat due to effects of management activities		2	0	0	2	2	2	2
Reductions in habitat due to effects of management activities		1	4	1	1	1	1	1
Minimal change in habitat due to effects of management activities		0	0	0	1	0	0	0
Outcome Group D								
Total in group		44	44	44	44	44	44	44
Benefit from direction for additional protection		43	43	43	43	43	43	43
Small improvements in habitat due to effects of management activities		1	1	11	0	0	1	1
Improvements in habitat due to effects of management activities		10	0	0	10	10	10	10
Reductions in habitat due to effects of management activities		1	11	1	1	2	1	1
Minimal change in habitat due to effects of management activities		2	2	2	3	2	2	2
Outcome Group E								
Total in group		41	41	41	41	41	41	41
Benefit from direction for additional protection		41	41	41	41	41	41	41

Viability Outcome Groups	Number of Species							
Indicator	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Small improvements in habitat due to effects of management activities		2	0	7	1	1	2	2
Improvements in habitat due to effects of management activities		5	0	0	5	5	5	5
Reductions in habitat due to effects of management activities		0	8	0	0	1	0	0
Minimal change in habitat due to effects of management activities		2	1	2	3	2	2	2

Planning for, and evaluation of, species viability for forest plan revision has focused primarily on providing desired abundance and distributions of habitat elements, in compliance with NFMA regulations. Risks to species viability can be much reduced by additional provisions present in existing law and policy. These include specific consideration of effects to federally listed threatened and endangered species, those proposed for such listing, and Regional Forester's Sensitive Species; and in biological assessments and evaluations conducted as part of all national forest management decisions. These assessments and evaluations identify where additional protective measures are warranted to provide for continued existence of the species on national forest land. Projects that may affect federally listed or proposed species must be coordinated with the US Fish and Wildlife Service. In support of these requirements, these species are also often the focus of inventory and monitoring efforts.

Additional species-based provisions included in all Forest Plan alternatives supplement existing law and policy. All alternatives include general and species-specific provisions for federally listed species, developed through coordinated planning with the US Fish and Wildlife Service.

In conclusion, high-risk species/habitat relationships are primarily a result of historical influences that have reduced distribution and abundance of some habitat elements and species populations, and of future impacts from forest health threats. In general, effects of proposed management strategies are small relative to historical impacts and future external threats. In general, risks to species viability are minimized by forest plan revision alternatives that provide a balanced mix of low-disturbance and disturbance-dependent habitat elements. Some elements in this mix are best provided through passive management and protection, while others require active management for restoration and maintenance.

B2B – FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

Indiana Bat

AFFECTED ENVIRONMENT

The Indiana bat is a medium-sized, *Myotis* species. On March 11, 1967, the Indiana bat was listed as a federal endangered species under the Endangered Species Preservation Act (ESPA) of 1966. Species listed under ESPA carried over and became listed by the Endangered Species Act when it became law in 1973. A recovery plan for the species was completed on October 14, 1983. In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan," which incorporated changes from the 1996 Technical Draft, was released. Subsequently, an agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A final revision has never been completed. The range of the bat has been divided into recovery units. The GWNF falls within the Appalachian Mountains Recovery Unit.

Critical habitat was designated for the species on September 24, 1976 and includes 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and Hellhole Cave in Pendleton County, West Virginia. No critical habitat is on or near the Forest and Hellhole Cave is 12.6 miles west of the Forest. The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Bats are often readily found and easily counted at this time. Census of hibernating Indiana bats is the most reliable method of tracking population trends rangewide. As such, the winter distribution of the Indiana bat is well documented. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range. During summer months, maternity colonies of more than 100 adult females roost under sloughing bark of dead and partially dead trees of many species, often in forested settings (Callahan et al. 1997). Reproductive females may require multiple alternate roost trees to fulfill summer habitat needs. Adults forage on winged insects within three miles of the occupied maternity roost. Swarming of both males and females and subsequent mating activity occurs at cave entrances prior to hibernation (MacGregor et al. 1999). During this autumn swarming period, bats roost under sloughing bark and in cracks of dead, partially dead and live trees in proximity to the cave used for hibernation.

POPULATION

Based on winter surveys at Priority 1 and 2 hibernacula, plus data from Priority 3 and 4 hibernacula when available, the U.S. Fish and Wildlife Service reported in 2007 that the total population of Indiana bats was at a recent historic high of approximately 467,947 individuals (this total is still less than half the estimated population in 1960). The 2009 rangewide population estimate was 415,512 individuals, a decline of 52,435 from 2007. Reasons for the decline are unknown, but perhaps the decline was caused by White Nose Syndrome (WNS), which was causing severe bat mortality in some cave hibernating bats in the northeastern and eastern U.S. In January 2012, the January-February 2011 rangewide total was reported at 424,708, an increase of 9,196 bats, and a number comparable to the 2005 count of 425,372 individuals (USFWS 2012).

In 2011, there were 411 hibernacula considered extant, and 62 considered historic or uncertain (USFWS 2012). In 2007, Indiana bats were known to hibernate in approximately 281 hibernacula in 19 states (USFWS 2009). Based on 2011 survey data, Indiana had 52.5% of hibernating individuals, followed by Kentucky 16.6%, Illinois 13.2%, West Virginia 4.8%, New York 3.8%, Missouri 3.2%, Tennessee 3.0%, Ohio 2.3% and the remaining eight states with hibernacula (including Virginia) 0.6% (USFWS 2012). In 2011 the eighteen Priority 1A hibernacula contained 368,597 Indiana bats, or 87% of the total known population, and 36 of 53 hibernacula classified as Priority 2A&B contained 43,328 Indiana bats, or 10% of the total known population. The remaining 340 caves considered extant, Priority 3 or 4 hibernacula contained 12,783 bats, or 3% of the total population. The four hibernacula on or near the Forest – Starr Chapel, Mountain Grove, Clarks, and Hupman's Saltpetre Caves – are considered Priority 3 or 4 hibernacula.

Data on the Indiana bat has been collected in Virginia since the early 1960s, when the state's Indiana bat population was estimated at over 5,000. Dalton (1987) found 2,500 Indiana bats hibernating in eight caves during a 10-year survey of 170 caves in 22 counties. In 1997 the state's population was estimated to be 1,840 bats. Since 2001, the estimated number of bats in Virginia has remained relatively constant, at 700 – 1100 (Table 3B2-6). West Virginia, has seen a steady increase in bats during the past decade, from 10,000 to 20,000 bats.

Table 3B2-6. Estimated Indiana Bat Populations

State	2001	2003	2005	2007	2009	2011
Virginia	969	1,158	769	723	730	863
West Virginia	9,714	11,443	13,417	14,745	17,965	20,358

Population estimates of hibernating bats, provided by Rick Reynolds of the Virginia Department of Game and Inland Fisheries, suggest that bat populations in the four hibernacula on associated with the GWNF fluctuate

substantially. In general, however, caves with lower numbers of bats seem to maintain low numbers, while caves with higher numbers maintain relative higher numbers of bats (Table 3B2-7).

Four hibernacula are known to occur on, or within 2 miles, of the Forest. All four caves are gated to control human access. Bat numbers fluctuate from count-to-count, but caves with lower numbers of bats seem to maintain low numbers, while caves with higher numbers maintain relative higher numbers of bats (Table 3B2-7).

Table 3B2-7. Indiana Bats in Hibernacula on or Near the GWNF
(Caves with Primary and Secondary Cave Protection Areas on land managed by GWNF)
(Number of Bats Counted per Rick Reynolds - VDGIF)

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
1960	600			
1962	600			
1972	35			
1974	30			
1978	2			
1979	1			
1980	0			
1981		0		
1982	16	0		
1983	29			
1984				
1985	30			
1986		0	21	
1987	5		52	
1988			31	0
1989	36			
1990	37	5	22	26
1991	23			0
1992	38	23	0	220
1993	31	0		
1994	42	1	20	300
1995	60			
1996			0	225
1997	54			
1998		2		
1999	55		1	
2000				
2001		2		5
2002				

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
2003	67		47	4
2004				
2005	57		50	0
2006				
2007	68		49	
2008				
2009	61		48	
2010				
2011	74		64	3
2012	92		63	1

Blank cells = no survey done that winter.

Prior to 2003, there were no documented areas of Indiana bat maternity activity in West Virginia, although a juvenile male was captured during the maternity period in Nicholas County in 1999. This bat was not tracked so no additional information on the potential maternity usage in the area is available. In the summer of 2003, two post-lactating female Indiana bats were captured and tracked to roost trees in Boone County, West Virginia. These captures represented the first confirmed Indiana bat maternity activity in West Virginia. Surveys at this site during 2005 located two primary roost trees and resulted in a maximum emergence count of 73 bats. Maternity activity at this site has consistently been confirmed since then through annual surveys. In the summer of 2004, a second maternity colony of approximately 25 bats was confirmed through the capture and tracking of a lactating female Indiana bat. This colony was located adjacent to the Monongahela National Forest (MNF) in Tucker County and is located within 2 miles (3.2 km) of a known Indiana bat hibernaculum. The roost tree that the bats were eventually tracked to fell down the following summer. Subsequent surveys in the area have not been successful in capturing any reproductively-active females, although a number of male Indiana bats have been caught. The status of this maternity colony is unknown. A third maternity colony was documented as a result of surveys conducted in 2005 near Kanawha State Forest in Boone County. Emergence counts at the two identified primary roost trees documented a maximum count of 49 bats. In the spring of 2010, female bats tracked emerging from a hibernaculum in Pennsylvania were found to have established a roosting area just over the State border in Ohio County, West Virginia. A maximum of 58 bats were found to emerge from a roost tree in this area. In the summer of 2010, a pregnant female was captured in Wetzel County. Radio telemetry was not conducted on this bat, and follow-up surveys were not able to locate any additional Indiana bats, so no additional information on this maternity area is available. In July and August 2012, five female Indiana bats were captured in Brooke and Ohio Counties. Subsequent tracking and emergence counts documented a number of separate roost areas, and up to 26 bats flying out of an individual roost tree. These captures may represent a number of different maternity colonies within the northern panhandle of West Virginia.

In addition to these captures near potential or confirmed maternity colonies, individual male Indiana bats have been captured in numerous locations throughout the State in the following counties: Clay, Fayette, Nicholas, Pendleton, Preston, Pocahontas, Randolph, Raleigh, and Tucker. Three male Indiana bats were captured on another site on the MNF in Pendleton County in 2004. These bats were tracked to a roost tree and subsequent emergence counts on that tree revealed 23 bats. Surveys conducted since that time confirmed this area supports a bachelor male colony roost. In July 2012, a number of male Indiana bats were captured along the Kanawha/Fayette County line in the same area that the juvenile male was captured in 2010. These adult male bats were subsequently tracked to a number of roost trees, as well as to the underside of an Interstate Highway bridge that was later documented to have up to 89 Indiana bats roosting underneath. All the bats that were captured, tracked, or examined were found to be males, providing evidence of an extensive bachelor colony in the area. These captures of both male and female bats confirm that the Indiana bat uses forested

habitats throughout the State for summer foraging and roosting. The increase in captures after 2002 may not reflect an actual increase in densities of Indiana bats summering within the State; rather these results may reflect the fact that survey efforts in relation to project review and monitoring have increased in recent years.

MIGRATION

The timing of spring and autumn migration has been generally inferred as the time between when bats leave the hibernacula and when they are found in maternity areas (spring), and vice-versa (autumn). In most portions of the range, this is generally considered to be from 15 April to 15 May in spring, and 15 August to 15 November in autumn, although these dates are sometimes adjusted regionally to accommodate latitudinal differences in season. Essentially all acres within the Forest could serve as potential migratory Forest habitat for the Indiana bat.

Little is known about the habitat used by either sex during migration, although it is generally presumed to include a variety of wooded habitats. The following is an excerpt from the USDI Fish and Wildlife Service (1999) Revised Draft Indiana Bat Recovery Plan: "Although certain migration patterns may be inferred from limited band returns, they should be interpreted with caution. The sparse band recovery records, all of which are from the Midwest, indicate that females and some males migrate north in the spring upon emergence from hibernation (Hall 1962; Barbour and Davis 1969; LaVal and LaVal 1980), although there is also evidence that movements may occur in other directions. However, summer habitats in the eastern and southern United States have not been well investigated; it is possible that both sexes of Indiana bats occur throughout these regions. Very little is known about Indiana bat summer habitat use in the southern and eastern United States, or how many Indiana bats may migrate to form maternity colonies there. Most summer captures of reproductively active Indiana bats (pregnant or lactating females or juveniles) have been made between April 15 and August 15 in areas generally north of the major cave areas. While these observations suggest that many or most female Indiana bats in the Midwest migrate north in the spring and south in the fall, potentially significant numbers also migrate in other directions." When Indiana bats are captured in spring or autumn, especially when caught near a cave or mine, there is generally no way to determine why the bat was in the area. In West Virginia, a male juvenile caught on August 5, 1999 (Kiser et al. 1999) was likely migrating to a nearby hibernaculum. As noted above, Indiana bats hibernating in mountainous regions of West Virginia may travel to warmer areas in the western part of the state or states to the west to raise their young. Brack and others (2002) indicated that nursery colonies were less likely in higher elevations and areas of cooler temperatures. During a survey of coal mining operations in Wise County Virginia, a consulting firm documented use of an abandoned coal mine by a female Indiana bat on April 14, 2001 which may have been a migratory individual. During autumn swarming and spring staging, Indiana bats use the cave hibernacula and nearby wooded habitats. In autumn, use of woodlands decreases over time as bats enter hibernation. The converse is true in spring. Two recent telemetry studies documented use of a variety of habitats within 2 miles of two caves on the Jefferson National Forest. In late September 1999 four Indiana bats (3 males, 1 female) were trapped and fitted with radio transmitters at the entrance of Rocky Hollow Cave in Wise County. From September 23rd to October 13th (21 days) three roost trees were located (all on private land) that were used by two of the bats (one male and one female). The female used two different trees in open woodlands approximately 1.5 miles southwest of the cave near the Lonesome Pine Country Club. One was a shagbark hickory 19" DBH (diameter breast height) and the other was a yellow poplar with peeling bark that was next to a skid-road that had been damaged during a logging operation. The tree occupied by the male bat was used as a roost on multiple days and was a pignut hickory 27.9" DBH located 0.15 miles north of the cave. Other observations made during the course of the study included extensive foraging activity over hayfields and along edges of forests and fields.

McShea and Lessig (2005) conducted a study in April 2005 where thirteen female Indiana bats were fitted with radio transmitters while still in their winter hibernacula in Bath County, VA. They were released and followed closely with both ground and aerial telemetry in an attempt to track them to their unknown summer maternity roost sites. Radio tracking was conducted on a daily basis from the day of their release until their signal disappeared. All bats but one could be followed for up to three weeks and their flight paths were recorded mostly traveling north or south. Four roost trees were found along natural corridors of creeks and ridges and one was still occupied at the end of the study. Several of the bats were observed to travel large distances in a short amount of time. The major directions of travel were generally north and south, with only one bat flying east (into the Shenandoah Valley) and none flying west (over the higher mountain ridges into

West Virginia) following release from the winter caves. The bats were located mostly in line with ridges, suggesting that they use these corridors as flyways to follow for easy transportation routes. When they do decide to move the bats can cover large distances in a short amount of time. For example, one bat moved 50-miles south in four days and another moved 25-miles north in two days. The small size of the transmitters necessitated “direct line of sight” to locate the animals, so ground crews were only effective when near the animal or above the animal on a ridge. An aerial crew was a necessity in order to keep track of all individuals when they foraged at night and as the bats dispersed following release. The four roost trees found by McShea and Lessig had similar characteristics. All were large snags and three were along the forest edge (creek or road) where they received significant sunlight during April. All roost sites were within oak-dominated forest types. The three bats that ultimately left their roost trees only stayed in them a few days before moving elsewhere. The overall movement pattern suggests flying to a nearby roost tree, resting for a few days and then flying a long distance before resting again.

A study that started in the spring of 2012 tracked two female Indiana bats from their hibernacula on the Cumberland Plateau in Tennessee south to two locations. One location was on the Talladega National Forest in Alabama, and the other on a wildlife management area in Gilmer County, Georgia. Information is still being gathered, but the tracked bat on the Talladega National Forest is roosting with approximately 25 to 30 other Indiana bats in an old woodpecker cavity in a dead loblolly pine on the Shoal Creek Ranger District. Both bats and associated roost trees are in an area where recent management has occurred, including thinning and prescribed burning.

There is limited data in WV that can make an overall assessment of Indiana bat migration patterns. This is based on numerous returns from bats who were banded in the non-hibernation period (spring, summer, or fall) and then later recovered during hibernation in the same county where they were banded, indicating that many bats will stay in the vicinity of their hibernacula. The following band returns from bats that moved outside the vicinity of their hibernacula into another county for the summer. Some of the bats went north (movement to Greene Co., PA was frequent) both others went south.

Summer Capture Location	Winter Capture Cave/Location
Greene Co., PA	Cliff Cave, Pendleton Co., WV
Greene Co., PA	Big Springs Cave, Tucker Co., WV
Greene Co., PA	Izaak Walton Cave, Randolph Co., WV
Greene Co., PA	Hellhole, Pendleton Co., WV
Somerset Co., PA	Hellhole, Pendleton Co., WV
Nicholas Co., WV	Hellhole, Pendleton Co., WV
Tucker Co., WV	Hellhole, Pendleton Co., WV
Pocahontas Co., WV	Minor Rexrode Cave, Pendleton Co., WV

There are at least four abandoned mines in WV that are being used by Indiana bats in the late fall swarming period, indicating that they are likely being used as hibernacula.

MATERNITY COLONIES

During summer, reproductive females form maternity colonies in trees. Maternity colonies may form hundreds of miles from the hibernacula, and females from a maternity colony may come from more than one hibernaculum. In contrast, males often use wooded areas near the hibernaculum, occasionally visiting the hibernaculum throughout the summer. Males sometime migrate long distances to summer habitat, although they tend to be less migratory than females, and often, though not always, remain geographically close to the hibernacula. During this time, males often roost individually, and likely use trees similar in character to those used near hibernacula in autumn and spring. Wooded lands closer to hibernacula are more likely to support

males in summer than areas farther away, but essentially all of the Forest may provide suitable summer habitat.

The core summer range of the Indiana bat is southern Iowa, northern Missouri, northern Illinois, northern Indiana, southern Michigan, and western Ohio. West Virginia is within the eastern maternity range, but not within the core range. Maternity colonies are known to occur in some eastern states, such as Kentucky and North Carolina, but, to date, none have been found in Virginia or neighboring areas in other states.

During a previous study in the summer of 1995, six male Indiana bats were captured in Tucker County, West Virginia. These captures represented the first documented summer use in West Virginia by Indiana bats, and suggest that males in West Virginia use areas near the hibernacula during summer. Until 2004 the best evidence of maternity activity in West Virginia was the discovery of a juvenile male on August 5, 1999. This is outside the defined maternity period and likely represents a juvenile migrating to a nearby hibernaculum. Then during the summer of 2004 surveys found a maternity colony estimated at 25 Indiana bats in Tucker County, West Virginia within two-miles of a known hibernaculum (USFS 2009). That same summer three male Indiana bats were captured on the Monongahela National Forest in Pendleton County and tracked to a roost tree where 23 other bats were subsequently counted (USFS 2009). To date no maternity colonies or reproductive female Indiana bats have been captured in Virginia during the summer reproductive season. In summer 1993, Chris Hobson of the Virginia Division of Natural Heritage surveyed areas of Bath, Bland, Highland, Lee, Tazewell, and Wise counties in proximity to known hibernacula. No female Indiana bats were captured and seven males were captured at five sites. One of the males, captured on July 28, 1993 in Cumberland Gap National Historic Park, Lee County, was a juvenile, suggesting that a maternity colony may be located in the Cumberland Gap area of Virginia, Kentucky, or Tennessee. These captures are the only documented summer Indiana bat occurrences in Virginia and suggest that males, at the least, use areas near the hibernacula during summer in western Virginia (Hobson 1993). Brack and others (2002) analyzed summer netting efforts 1995 to 2000 to identify summer reproductive populations in Virginia, West Virginia, and portions of Pennsylvania considered within the summer range of the Indiana bat. Over 3,000 net nights of effort failed to produce evidence of any maternity colonies.

SUMMER FORAGING

Due to the variability of known roost sites and the lack of knowledge about landscape-scale habitat characteristics, it is difficult to quantify summer roosting habitat for Indiana bat at a range-wide, regional, or local level. Forest management practices that affect occupied roost trees may have local impacts on Indiana bat populations. Across the historic range of the Indiana bat vegetation disturbances are prevalent and the species depends on an ephemeral resource (standing snags; living, dead or dying trees with cavities and/or exfoliating bark). Anecdotal evidence suggests that Indiana bats may benefit from limited disturbance around potential roosting areas (Menzel et al. 2001). Limited disturbance can create potential roost trees and open the canopy around potential roost trees (Gardner et al. 1991; Kurta et al. 1993). Indiana bats may be resilient to minor perturbations on the landscape such as targeted forest management and prescribed fire. General standards that would help ensure adequate roost habitat include retention of snags and suitable roost trees whenever possible, prescribed burning to restore and maintain open midstory foraging conditions (using only cool season backing fires in karst areas), and ensuring a continuous supply of oaks, hickories, and yellow pines as well as other trees with exfoliating bark (Menzel et al. 2001).

FALL SWARMING

Indiana bats may use caves and mines during the non-maternity season (autumn through spring) for one of several reasons: 1) winter hibernation; 2) autumn swarming; 3) spring staging; and 4) vagrant or migratory use. Autumn swarming and spring staging typically occur in woodlands near the hibernacula, with use of the hibernacula increasing as autumn progresses towards winter, and decreasing as spring progresses towards summer. Hibernacula tend to have higher use in spring and autumn, and larger winter concentrations typically produce greater spring and autumn use.

During autumn, when Indiana bats swarm and mate at hibernacula, male bats roost in trees nearby during the day and fly to the cave or mine at night. Work in Missouri (Romme et al. 2002) and Kentucky (Kiser and Elliott

1996; Gumbert 1996) have found that Indiana bats range up to 5 miles from hibernacula during autumn and spring swarming activity periods. In Kentucky, Kiser and Elliott (1996) found male Indiana bats roosting primarily in dead trees on upper slopes and ridgetops, within 1.5 mi of their hibernaculum. In West Virginia, some male Indiana bats roosted within 3.5 mi of their cave, in trees near ridgetops, and often switched roost trees from day to day (C. Stihler, West Virginia Division of Natural Resources, pers. observ., October, 1996). One Indiana bat in Michigan roosted 1.4 mi away from the hibernaculum during fall swarming, and another chose trees at a distance of 2.1 mi (Kurta 2000). Gumbert (2001) found an average of 1.2 mi between roost trees and the hibernaculum for 20 radio-tagged Indiana bats. Brack found a range of 0.18 to 0.87 mi between roost trees and a hibernaculum in Virginia, although he did not follow bats if they left the "project area" and the range may actually be greater. Based on terrain and landscape characteristics of these areas (generally rolling without great vertical relief) when compared to the Ridge and Valley terrain of Virginia (mountainous with vertical relief 1,300 to 2,500 feet) it is likely Indiana bat activity in this portion of the Appalachians is confined to the valley in which the hibernaculum occurs and may extend into adjacent valleys via gaps in the surrounding ridges or mountains.

During September and October of 2000 an extensive survey was made of fall swarming activity near Newberry-Bane Cave in Bland County, Virginia as part of the proposed American Electric Power (AEP) 765 kV Wyoming (WV) to Jacksons Ferry (VA) powerline project. This work was conducted by Virgil Brack of Environmental Solutions and Innovations, Cincinnati, Ohio and is documented in the Appendix to the Biological Assessment for the EIS associated with that project. Of 27 Indiana bats captured (24 males and 3 females) at the mouth of Newberry-Bane Cave, 17 (14 males and 3 females) were fitted with transmitters. Radio-tagged bats were monitored between September 9th and October 21st within 2-miles of the cave entrance.

The Brack study found that Indiana bats most frequently foraged over agricultural land (44.7%), intermediate deciduous forests (22.6%), and open deciduous forests (19.0%) habitats types, comprising 86.3% of all habitat types used for foraging during the survey. The bats' activity areas included proportionally more agricultural lands and open forests than was available in the study area. Closed canopy woodlands were not used by foraging bats to the extent they were available. This study concluded that Indiana bats more frequently used rights-of-way, pasture edges, savannah-like woods, and other openings rather than large, continuous tracts of closed canopy forests. These findings are consistent with the interpretation of telemetry data in similar studies.

For roosting ecology the study by Brack found a total of 26 roost trees for 8 of 17 bats fitted with transmitters. Of the 26 roost trees, 39% were shagbark hickories (*Carya ovata*) and 12 % northern red oak (*Quercus rubra*), for a total of 51%. Other tree species used as roosts included white oak (*Quercus alba*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), American basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*). Five (19%) of the roost trees were dead snags. All roost trees were located in close proximity to the cave entrance ranging from 0.16 to 0.86 miles, with an average distance of 3,280 feet (0.6 miles). All roost trees were located near forest canopy openings such as open woodlands of pastures, scattered trees of recently logged areas, old logging roads, utility line corridors, and natural drainages. Five of the eight bats used the same roost tree for two to three consecutive days. Roosts were located in all types of deciduous forests, but exhibited a disproportionately small use of mixed evergreen and deciduous forests. Roost trees were very exposed with little or no canopy shading by other trees. It is likely that in doing so the bats were taking advantage of exposure to solar radiation in order to better regulate body temperature. Many open-canopy areas existed due to recent logging activity that left scattered trees within the harvested areas. Roosts in closed canopy deciduous forests were often in small openings near open corridor flyways.

While much of the activity observed during the study was close to the cave (within approximately 0.6 mile) bats also left the 2-mile study area all together. Males more so than females tended to range further from the cave. Perhaps they would leave to forage where there was less competition for prey (the caves in the area serve as hibernacula for over 8,000 individual bats of at least five different species) and return to the cave area periodically to mate. It's therefore likely roosting and foraging activity also occurred outside this 2-mile area but all documented roost trees and foraging behavior observed were within two miles of the Newberry-Bane cave.

HIBERNACULA

Indiana bats tend to hibernate in the same cave or mine at which they swarm (LaVal et al. 1976; C. Stihler, pers. observation, October 1996), although swarming has been observed at hibernacula other than those in which the bats hibernated (Cope and Humphrey 1977). It is generally accepted that Indiana bats, especially females, are philopatric, that is, they return annually to the same hibernaculum (LaVal and LaVal 1980). Most bats of both sexes enter hibernation by the end of November (mid-October in northern areas–Kurta et al. 1997). Indiana bats hibernate in large, dense clusters, ranging from 300 bats per square foot to 484 bats per square foot (Clawson et al. 1980; Hicks and Novak 2002).

Caves must possess certain characteristics to be suitable as Indiana bat hibernacula. Raesly and Gates (1986) compared microhabitat and microclimate variables between occupied and unoccupied caves and mines. They found that Indiana bat hibernacula tended to have larger openings, more cave passage length, and higher ceilings compared to unoccupied sites. In addition, occupied hibernacula have noticeable airflow (Henshaw 1965). Once Indiana bats enter hibernation, they require specific roost sites in caves or mines that reach appropriate temperatures (Tuttle and Taylor 1994). Indiana bats choose roosts with a low risk of freezing. Stable low temperatures allow the bats to maintain a low metabolic rate and conserve fat reserves until they are ready to emerge in spring; thus, Indiana bats select roosts within hibernacula that best meet their needs for cool temperatures. Indiana bat hibernacula usually host other species of bats. Indiana bats are occasionally observed clustered with or adjacent to other species, including gray bats (*M. grisecens*), Virginia big-eared bats (*Plecotus townsendii virginianus*), little brown bats and northern longeared Myotis (Myers 1964; LaVal and LaVal 1980; Kurta and Teramino 1994).

NEW THREATS

Additional recent threats include White Nose Syndrome (WNS) and commercial scale wind power development. WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009 with additional spread and caves now contaminated. To date well over 1-million bats have been killed by this fungus which irritates bats during hibernation causing them to wake and use precious fat reserves. The bats then starve and or freeze when they attempt to fly and leave the cave in search of food during the midst of winter conditions.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode. Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Effects to the federally endangered Indiana bat (*Myotis sodalis*) were considered because there are hibernacula on and near the Forest, plus it is assumed the entire Forest is potential roosting and foraging habitat for this species. Potential effects include direct effects on hibernacula and effects on foraging and roosting habitat. The main management tool used in the Forest Plan to protect and manage habitat for the Indiana bat is the continued use of a management prescription area with an emphasis on the Indiana bat. This management area is located around the four caves known to contain the Indiana bat. This prescription area is established to: 1) protect hibernacula (caves in which the bats spend the winter); 2) maintain and enhance upland and riparian swarming and foraging areas; and 3) identify and protect summer roosting and maternity site habitat.

Management activities can degrade Indiana bat habitat if implemented in an unrestricted manner, therefore all alternatives continues to employ standards that apply to vegetation management across the entire forest to protect roosting and foraging habitat. Alternatives B, C, D, E, F, G, H and I also expand the areas defined as

riparian corridors, providing additional protection to vegetation in the riparian corridors which have been reported to be important foraging areas.

EFFECTS ON HIBERNACULA

Steps have been taken by the Forest to protect and maintain these caves as suitable for the Indiana bat. Since 1995, bat gates have been installed on all caves known to be used by endangered bat species on the Forest. Starr Chapel Cave and Mountain Grove Cave on the Warm Springs Ranger District in Bath County are the only caves with entrances on Forest land that serve as hibernacula for Indiana bats. Clarks Cave and Hupman's Saltpeter Cave are on private land, but within 2-miles of National Forest land. The Indiana Bat Primary Cave Protection Area is defined by a radius of no less than one half mile around each hibernaculum, defined by national forest surface ownership and topography. This area is intended to protect the integrity of the cave and the immediate surrounding uplands where bats may swarm and forage in the fall. Commercial timber harvest, road construction, and creation of new wildlife openings are prohibited. Prescribed burning, tree cutting, and road maintenance are evaluated in terms of effects on the Indiana bat before approval. This area is unsuitable for wind energy development. Two Indiana bats were found to have WNS during an April 21, 2010 cave survey conducted by Rick Reynolds (VDGIF) and Wil Orndorff (VDCR) in Starr Chapel Cave. This represents the first time Indiana bats have been documented with WNS on the Forest. Indiana bats occur in other caves infested with WNS, and where other bat species have been found infected, but individual Indiana bats in those other caves have not shown signs of WNS infection. Caves with significant bat populations on Forest land will continue to be gated and locked year-round. Currently, a Regional Forester closure order is in effect that closes all caves and mines year-round on National Forest lands to human intrusion. If and when access is needed, WNS protocols will be followed that should eliminate contamination from other caves.

EFFECTS ON ROOSTING OR FORAGING HABITAT

The Indiana Bat Secondary Cave Protection Area is defined by a radius of approximately 1½ miles around each primary cave protection area, defined by easily recognizable features on the ground. This configuration of the two protection areas provides management direction to protect and enhance the two-mile area around the hibernacula that is most critical to fall swarming. This secondary area is designed to further maintain and enhance swarming, foraging, and roosting habitat. Timber harvest, prescribed burning, wildlife habitat improvement, road construction, trail construction, and special uses may occur following evaluation of the effects on Indiana bats. Vegetation management is allowed to enhance foraging conditions. Timber management activities are suspended during the fall swarming season. The area is unsuitable for wind energy development.

Potential roosting habitat (mature forests with trees having exfoliating bark) exists across the entire Forest and contains tree species of the size and type known to be used by the Indiana bat. The retention of some snags, shagbark hickory, and hollow trees (as available) will allow for potential Indiana bat roost sites. Decreasing canopy closure as occurs with timbering and prescribed fire activities will increase the degree of exposure of some potential maternity roost trees to solar radiation, providing improved thermal conditions for raising young during a wide range of weather conditions. Pond/waterhole construction will increase the number of upland water sources available for Indiana bats. Persistence of early successional habitats and forests with an open understory and patchy overstory would create favorable foraging areas and flight corridors leading to potential roost trees. Harvesting would produce a mosaic of regeneration areas intermixed with mature and late successional forests. Likewise, prescribed fire would also create a mosaic of forest successional stages from early to late resulting from varying fire intensities associated with topographic features, vegetative types, and fuel accumulations. This will indirectly provide feeding areas since bats are known to forage within the canopy openings of upland forests, over clearings with early successional vegetation, and even along the borders of croplands, or wooded strips (fencerows), and over ponds. In contrast, negative impacts to the Indiana bat will be: (a) the slight chance that individuals or small groups of roosting bats (including summer maternity colonies if present) could be unintentionally killed by the felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bats which would be incurred on regeneration cuts immediately after harvest. Although the likelihood is very low, tree cutting activities could result in the inadvertent loss of

individual Indiana bats or small groups of Indiana bats via removal of some large-diameter hardwood trees occupied by bats during the period from approximately April 1 to October 15. Occupied and potential roost trees could be directly affected by vegetation management, firewood and salvage sales, routine maintenance/permitting of small clearings including easements, rights-of-way and access to privately-owned lands, and road construction. Plan implementation will result in vegetation disturbance and possible impact to currently occupied and potentially occupied roost trees. There is potential for adverse effects to a maternity roost tree if one occurs on the Forest and in an area where trees are being felled. However, forestwide standards minimize, if not eliminate, the chance of adverse effects under all alternatives. Any Indiana bat roosts that are discovered would be protected until they were no longer suitable (unless treatments were needed for public or employee safety) under all alternatives.

The National Forest fuelwood program allows the public to purchase and collect wood, often recently downed or standing/leaning dead trees, for personal use. The program is regulated by issuance of an area-specific permit and collection occurs primarily along roadsides and other specified sites with easy access. Vehicles must remain on open roads are not allowed to travel through the forest in order to facilitate finding, cutting, and loading firewood. This, therefore, restricts the distance at which most people are willing to cut and haul firewood and results in firewood being cut within 150 feet (about two tree lengths) of an open road, and is limited almost exclusively to level terrain or the uphill side. Volume of firewood cut on the Forest during 2008 was 4,488 CCF (hundred cubic feet) and during 2009 5,256 CCF, for an average of 4,872 CCF over the two-year period. A 14" DBH tree contains approximately 0.5 CCF of firewood; therefore approximately 9,744 dead trees were cut for firewood each year. The number of standing dead trees on the Forest can be calculated based on analysis of data collected during the 2002-2007 Forest Inventory and Analysis conducted by the Southern Forest Research Station, Asheville, NC and published in 2009. The number of dead standing trees at that time was 14.9 per acre for all trees larger than 5" DBH and 6.1 per acre for trees larger than 9" DBH. Given that the Forest is approximately 1.1 million acres, this equates to at least 6.5 million dead standing trees >9" DBH. All portions of the Forest continue to be infested with gypsy moths and infestations are forestwide with cycles of defoliation and mortality resulting from population fluctuations of gypsy moths. The result of these infestations is extensive areas of hardwood (especially oak) mortality in the overstory. Therefore, if 10,000 standing dead trees are cut each year for firewood, this equals 0.15% of the total available standing dead trees. Since most of these dead trees are not close to roads or are in Management Prescriptions where firewood cutting is not allowed, the possibility of harming an Indiana bat is extremely remote. In addition, most Indiana bats roost in live trees. Brack and Brown (2002) reported 81% of roost sites used by radio-tagged Indiana bats were live trees and 19% were snags. The odds of encountering a roosting bat are even further reduced since only dead trees are available for cutting as firewood and these dead trees represent perhaps 20% of the trees where they roost. Assuming this trend represented Indiana bat roost selection throughout the Forest, personal use firewood collection could affect 0.0003% of the potential Indiana bat roost trees. Firewood collecting is not allowed in the Primary and Secondary Indiana Bat Cave Protection Management Prescription Areas, ensuring that snags near hibernacula are retained. Although the risk of "take" resulting from firewood cutting cannot be completely eliminated, the risk of direct effects to roosts in the vicinity of hibernacula is further minimized since the collection of firewood in the Primary and Secondary Indiana Bat Cave Protection areas is not allowed by prescription standard. Some minimal risk of taking a bat roosting in a standing dead tree cut for firewood elsewhere on the Forest would continue to exist. However, given the relatively low number of Indiana bats on the Forest when compared to the number of acres, standing trees and snags, the use of any individual dead tree as a roost is likely to be brief, and the likelihood of take from firewood cutting is extremely small under all alternatives.

Most types of timber harvest (salvage, even-aged, uneven-aged, etc.) would require some snag and potential roost tree retention, plus specific retention of leave trees such as shagbark hickories. Forestwide standards in all alternatives require stand regeneration treatments greater than ten acres in size, retaining a minimum average basal area of 15 square feet per acre of live trees, and giving priority to retaining the largest available trees that exhibit characteristics favored by roosting Indiana bats (sloughing bark, cracks and crevices).

To maintain flight and foraging corridors in upland and riparian areas, a Conservation Recommendation in the 1997 Biological Opinion encouraged the Forest to increase its prescribed burning program on lands unsuitable for timber harvest. Over the past 15 years, the Forest has steadily increased its prescribed burn program. Alternative E would have the highest acres with 20,000 acres estimated to be prescribed burned each year.

Alternatives B, F, G, H and I have an objective to burn 12,000 to 20,000 acres per year. Prescribed fire is used for ecosystem restoration, wildlife and rare species management, site preparation and oak-pine regeneration. Most prescribed burns occur from March to mid-May, with a few during late May and June. Depending on weather and fuel conditions, a few may occur in late October and November. Control lines consist of existing roads, trails, and streams wherever possible. In areas where control lines need to be constructed, handtools and/or bulldozer will be used to dig a two to five foot wide strip to mineral soil. Some trees will need to be felled during line construction, but in most cases larger trees will be avoided with the line going around and between the largest trees. Some standing trees and snags near the line will be felled because they pose a hazard to personnel, or may burn and fall across the line, potentially spreading the fire into areas not scheduled for burning.

Some of the ridgetops on the GWNF have been identified as having potential for developing wind energy. The total area with a potential rated as fair to superb is about 117,000 acres. Plan Alternatives C and E do not allow for commercial wind power development. Alternatives B, D, F, G, H and I allow for consideration of wind power development. Alternatives B, F, G, H and I assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently, there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

Cumulatively, with implementation of any alternative, the Forest will maintain a supply of snags, live potential roost trees, upland water sources, and other habitat features across the landscape to allow for the maintenance, and promote the recovery, of Indiana bat populations. At the same time, activities can still continue to meet other multiple-use objectives. For example, timber harvesting can still occur to accomplish sufficient forest regeneration to provide diverse insect productions and provide for the continuation of diverse forest conditions across the Forest. Overall, there will be both potential benefits and potential impacts to the Indiana bat from management activities on the Forest. From a beneficial standpoint, the retention of most snags, all shagbark hickory, and hollow trees in sale areas would allow potential Indiana bat roost sites to be conserved; the reduction of canopy closure in sale areas and along unit margins would increase the degree of exposure of potential roost trees to solar radiation, providing improved thermal conditions for roosting and perhaps raising young; pond/waterhole construction would increase the number of upland water sources available for Indiana bats along with other bat species. Slightly positive benefits for Indiana bat would result as harvested units create insect-rich foraging areas and flight corridors leading to any tree roosts that might be present there. Positive benefits would result from prescribed burning by decreasing understory vegetation density and reducing canopy closure plus favoring oak, yellow pines, and hickory while reducing the in-growth of yellow poplar, red maple, and white pine. Positive benefits will also be realized from the application of prescriptions and associated standards focused on protecting caves and managing vegetation structure and conditions within 2-miles of hibernacula.

Contrastingly, negative impacts to the Indiana bat would be: (a) the slight chance that individuals or small groups of roosting bats (including possible summer maternity colonies) could be unintentionally killed by the intentional felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bats which would be incurred on regeneration cuts. Although these bats will use small forest openings and edges as foraging habitat, they would be unlikely to utilize the central portions of harvested units during the early years of regeneration unless the residual basal area was high enough. It is possible that the increased rate of insect production in the regeneration areas would make up for any loss of foraging habitat acreage, but such a determination would be difficult to make without extensive long-term research on the subject. The level of estimated timber harvest ranges from 1,000 to 5,000 acres depending on Alternative. Specific acreage by type of silvicultural system for each alternative is discussed in the Social/Economic Environment, Timber Management section of the EIS. See specifically Table 3C6-14.

Although the likelihood is very low, implementation of any alternative may result in the inadvertent loss of individual Indiana bats or small groups of Indiana bats, via removal of some large-diameter hardwood trees occupied by bats during the period April 1 through October 15. This risk would be greatest in those alternatives

with the highest acres of timber harvest. Alternative D has the highest acres estimated, followed by Alternatives A, B, E, G, H and I, and F in order. Alternative C has no timber harvest allowed.

Under all alternatives, Forestwide and management prescription standards will provide adequate protection for summering and transitory Indiana bats. These standards and prescriptions provide for maintenance of extensive forest areas that would remain undisturbed. These areas are characterized by disturbance events where net losses and gains of potential roost trees would be dependent on ecological processes including tree mortality due to aging, insect and disease, wildland fires, and weather events.

In addition, all alternatives allocate areas surrounding known Indiana bat hibernacula to Management Prescription 8E4a and 8E4b. In the future, any newly discovered hibernacula will be added to this prescription through the Forest Plan amendment process. In the 1997 Biological Opinion for the Forest, and the 2004 BO for the Jefferson NF, the USDI Fish and Wildlife Service determined that the level of anticipated take (4,500 acres not including prescribed burning on the Forest and 16,800 acres including prescribed burning on the JNF) is not likely to result in jeopardy to the Indiana bat or destruction or adverse modification of any critical habitat. Although the loss of a few individuals from time to time during timber harvest is remotely possible, the overall large amount of improvement of roosting and foraging habitat for the Indiana bat, coupled with management activities taking bat life requirements into account, plus an increasing number of upland drinking water sources, and gating of hibernacula, suggests that these potential losses would be offset by overall future net gains in the population.

Long-term effects of WNS are unknown at this time. It's likely that Indiana bats will be further affected by WNS and those cumulative effects may exceed any action Forest Plan implementation will cause.

Cumulative effects of wind power development will be addressed in project level analysis if and when the Forest receives a proposal for construction.

Virginia Big-Eared Bat

AFFECTED ENVIRONMENT

Formerly included in the genus *Plecotus*, the Virginia big-eared bat is a subspecies of the more common and widespread Western (or Townsend's) big-eared bat that occurs throughout the western U.S., southwest Canada, and most of Mexico. The subspecies, *virginianus*, occupies a very limited geographic range in the Central Appalachians that includes portions of four states: West Virginia, Virginia, Kentucky, and North Carolina (Bayless et al. 2011). The species was listed under provisions of the Endangered Species Act as "Endangered" in December 1979. The Recovery Plan was issued on May 8, 1984 and a draft revised recovery plan was submitted for review in 1996, but was never finalized. The first substantive 5-year review of the species was released by the USFWS, West Virginia Field Office, during the summer of 2008. On March 6, 2012, a request was made in the Federal Register by the USFWS for information to initiate a 5-year review of 9 listed species in the northeast, including the Virginia big-eared bat.

Population numbers have shown moderate to strong increases range-wide over the past 20 years. In the late 1970s, when the recovery plan was drafted, the known population of Virginia big-eared bats in maternity colonies was approximately 3,600, and the known hibernating population was approximately 2,585 (U.S. Fish and Wildlife Service 2008). In the late 1980s, the estimated, total population of the subspecies in West Virginia, Virginia, Kentucky, and North Carolina was approximately 10,000 bats (Dalton 1987). By 1997 the range-wide population of *C.t. virginianus* was estimated to have almost doubled to just under 20,000 individuals (Pupek 1997). In West Virginia some cave populations grew as much as 350% from 1983 to 1995 (Pupek 1997). Survey data from 2006-2007 indicate a population of 11,694 hibernating bats and 7,630 maternity colony bats (USFWS 2008). These surveys did not include bachelor colonies or several caves with significant bat use due to access or safety concerns. The 2012 surveys of the 10 summer colonies in West Virginia show that the Virginia big-eared bats continue to do well with the total being the highest count on record with 7,531 bats, up 0.9% from 2011 and up 18.2% since 2008, pre-WNS (WNS was found in WV in 2009). The 2012 count increased in 8 of the 10 caves compared to the 2011 count (Stihler 2012 per comm).

In Virginia, this bat is known from eight caves in six counties in two separate geographic areas. One area is in the upper headwaters of the James River (Cowpasture and Bullpasture Rivers) and the other is in the New River watershed. According to the Virginia Fish and Wildlife Information Service, the Virginia big-eared bat is known from three caves in Tazewell County and one in Highland County during the summer and five caves during the winter in Tazewell, Bland, and Highland Counties. Previous observations of single or a few (<5) individuals in caves found in Rockingham, Bath, and Pulaski Counties are likely transient males and are only seen occasionally in these locations.

In West Virginia, the Virginia big-eared bat is known from at least 30 caves in five counties, with most of the occurrences (20) in Pendleton County. The final rule that placed the Virginia big-eared bat on the endangered species list also designated five caves in West Virginia as Critical Habitat: one cave in Tucker County (Cave Hollow Cave) and four caves in Pendleton County (Cave Mountain Cave, Hellhole Cave, Hoffman School Cave, and Sinnit Cave).

The Virginia big-eared bat occupies caves year-round. These bats are not migratory and their longest recorded movement is approximately 64 kilometers (40 miles; Dalton & Handley 1991). Males and females hibernate singly or in mixed gender, single species clusters in a few caves, and move in the spring to other cave(s), with females forming smaller summer maternity/nursery colonies and males remaining solitary, or forming bachelor groups, during the summer.

Mating begins in late summer/early autumn and continues into early winter. Ovulation and fertilization are delayed until late winter/early spring. Maternity colonies form as early as March or as late as June depending on when the roost site reaches a suitably warm temperature. Gestation lasts 2-3.5 months. Solitary pups are born in late spring/early summer. Young can fly at about 2.5-3 weeks of age, are weaned by 6-8 weeks, and leave the cave to forage on their own by the end of July or August. Most individuals leave the nursery cave by mid to late September. Females are sexually mature their first summer. Males may not be sexually active until their second year. Nearly all adult females breed every year (NatureServe 2011).

The Virginia big-eared bat primarily feeds on moths. Morphological adaptations (long ears and wing shape that results in low wing loadings) facilitate foraging tactics which involve slow-maneuverable flight where prey can be captured in air or from the surface of objects. Foraging techniques consist both of aerial hawking and gleaning. Lacki and Dodd (2011) noted that Lepidopteran prey comprises >80% volume of the diet of all *Corynorhinus* species. Food habits of the maternity colony in Tazewell County, Virginia found that moths formed over 90% of the diet, with beetles a distant second, followed by lesser quantities of other flying insects. The bats typically leave the cave after sunset with the onset of full darkness to begin foraging. Level of flight activity in Virginia big-eared bats is negatively associated with moon phase and wind speed, and directly related to percent relative humidity (Adam et al. 1994). Foraging area averages approximately 280 acres (60–650 acres). Maximum flight distance of foraging from caves is 7.0 miles, with 80% of foraging occurring within 3.7 miles (Stihler 2010). Bats have been observed foraging over corn and alfalfa fields as well as mature upland forests, wherever moths occur in abundance (Dalton et al. 1986). An overriding pattern of habit usage in foraging is a preference for abrupt changes in vertical structure, such as along forested and riparian corridors and forest/edge interfaces. The vertical surfaces likely help in capturing stationary moth prey by gleaning. Because most of these same habitats are avoided by families of moths typically eaten by *Corynorhinus*, Lacki and Dodd suggest that foraging habitats are better predicted by structural configuration than by local abundance of preferred moth prey (Lacki and Dodd 2011).

Limiting factors for the Virginia big-eared bat include caves with suitable temperature regimes (cold in winter and warm in summer). Compared to other bats, Virginia big-eared bats tolerate lower cave temperatures during hibernation, and often occupy areas in caves that receive cold-air flow near entrances. Maternity caves are typically warmer than hibernation caves. Declines appear to be primarily related to human disturbance and loss of cave habitat quality. The Virginia big-eared bat is extremely intolerant of any human disturbance. Former declines in bat populations are likely attributable to human intrusion into caves, which depletes energy reserves of aroused bats and may lead to cave abandonment if disturbance is frequent (NatureServe 2011). The recovery plan (USDI Fish and Wildlife Service 1984) recommends recovery actions focused on cave acquisition and gating of entrances to control human access. The increased population of Virginia big-eared

bats over the past 30 years is likely attributable to gating and year-round closure of caves occupied by these bats.

On the Forest there are no caves regularly occupied by the Virginia big-eared bat at any time of the year. All occupied caves in Virginia, during both summer and winter, are on private land. Cave occurrences of the Virginia big-eared bat closest to the Forest are located in Highland County, Virginia, and Pendleton County, West Virginia, where the closest distance from an occupied cave to Forest managed land is approximately 2.5-miles (Arbegast Cave, Highland County). In Pendleton County the closest distance from caves designated as Critical Habitat to Forest land is: Hellhole Cave, 12.6 miles; Cave Mountain Cave, 10.25 miles; Sinnit Cave, 5.0 miles; and Hoffman School Cave, 3.6 miles. It's therefore possible, based on observed flight distances for foraging activity of 2.2–5.2 miles, that Virginia big-eared bats may forage over some portions of the North River Ranger District, from the Brandywine area of Pendleton County, WV south to the McDowell area of Highland County, VA.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The greatest threat currently known to Virginia big-eared bats is human disturbance in hibernacula, roosting, and maternity caves. None of these caves occur on the Forest. The Forest has assisted with building and maintaining cave gates, such as the purchase of materials and construction of the gate on Arbegast Cave in 2007. Currently, all the caves on or near the Forest utilized by the endangered Indiana bats are gated and locked year-round, plus a Closure Order, issued by the Regional Forester to lessen spread of WNS and prevent disturbance to bats, continues on all caves and mines.

Negative effects to Virginia big-eared bats from vegetation management are minimal because these bats utilize caves year-round for all roosting and hibernation. Vegetation management such as timber harvest, thinning, and prescribed burning will increase vertical structure in closed canopy forests creating a spatial mosaic of conditions and will therefore provide and enhance foraging habitat.

Under all alternatives, Forest Plan standards relevant to the Virginia big-eared bat and associated cave habitat would protect all caves now known on the Forest, as well as any cave discovered or purchased that may support Virginia big-eared bats. Although no hibernacula, summer roost, or maternity caves have been identified on the Forest, forestwide standards maintain vegetation, and require installation of gates or other protective structures, at entrances of all caves occupied by populations of any threatened or endangered bats. Until a newly discovered cave has been surveyed for bats, it is assumed that federally listed bats are present and the cave and surrounding habitat are maintained for them until surveyed. Potential foraging habitat will be maintained in a mosaic of vegetative conditions, and any changes will result from forest succession and management activities such as timber sales and prescribed burning.

Recent potential and known threats include White Nose Syndrome (WNS) and commercial-scale wind power development.

WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009. Since 2009, the fungus has continued to spread and contaminate caves in and near the Forest. To date, there have been no Virginia big-eared bats found with WNS (Stihler 2012 pers. comm.). WNS has been documented in caves occupied by Virginia big-eared bats, yet the bats do not show signs of infection, and no mortality attributable to WNS has been documented.

All caves with significant bat populations on Forest land will continue to be gated and locked. Currently, a Regional Forester closure order is in effect that closes all caves and mines on the National Forest to human intrusion. If and when access is needed to any cave, WNS protocols will be followed that are designed to reduce the potential for contamination from caving activity.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County.

Bats are often killed by wind towers when they fly into the lower pressure surrounding the trailing edge of spinning blades, and suffer extreme barotrauma because the decompression causes capillaries in their lungs to explode. Bats are most affected during periods of fall migration because they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

Alternatives C, and E do not allow for commercial wind power development. Alternatives B, D, F, G, H and I allow for consideration of wind power development. Alternatives B, F, G, H and I assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

There are expected to be no cumulative effects to the Virginia big-eared bat resulting from implementation of any alternative. As stated above, the caves where this species occurs are on private land near the Forest. Landowners of these caves are aware of the bats' presence and the caves are either gated or protected to limit human entrance and disturbance. Individual Virginia big-eared bats may forage or fly over National Forest land, but current conditions will be maintained, and habitat enhanced through active management for preferred foraging habitat in all alternatives except Alternative C. Active management will include timber harvest, thinning, and prescribed burning will designed to increase forest openings and decrease canopy closure.

There have been concerns about the effect gypsy moth (*Lymantria dispar*) defoliation and suppression efforts may have on Virginia big-eared bats. Gypsy moths are well established across the Forest. Defoliation, and the subsequent short-term loss of forest cover, may suppress insect populations and thus food sources for the bats. Likewise, pesticides suppress or eliminate insect populations to varying degrees, depending on the type of insecticide used (USDA 1996). Suppression of gypsy moth outbreaks have not been done on the Forest since Spring of 2003 when 1,311 acres in six areas were treated with Btk and none of those areas were within 50-miles of known Virginia big-eared bat occurrences. If necessary in the future decisions on gypsy moth management will be made at that time and further analysis handled at the project level including consultation with the US Fish and Wildlife Service.

Effects of WNS are unknown at this time. If infection occurs in Virginia big-eared bats and they are negatively affected by WNS there is little if anything the Forest can do other than assist with surveys and monitoring, plus keep caves gated and closed on a year-round basis.

Direct and cumulative effects of wind power development will be addressed in project level analysis, including consultation, if and when the Forest receives a proposal for construction.

Virginia Northern Flying Squirrel

AFFECTED ENVIRONMENT

Overview and Biology

The Virginia northern flying squirrel (*Glaucomys sabrinus fuscus*; hereafter abbreviated VNFS) is a nocturnal small mammal endemic to the Alleghany Highlands of West Virginia and Virginia. The species was federally listed as Endangered in 1985, along with another subspecies, the Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*), and is also state listed as endangered under the Virginia Endangered Species Act (Fies and Pagels 1991). VNFS is a relatively short-lived species primarily inhabiting mature spruce forest, as well as the ecotone between spruce and northern hardwood forests (Ford et al. 2004; Ford and Rodrigue 2007; Loeb et al. 2000; Menzel et al. 2004, 2006a; Reynolds et al. 1999; Schuler et al. 2002; Smith 2007; USFWS 1990, 2001, 2006, 2008; Weigl et al. 1999). VNFS will eat a range of seeds, buds, fruits, and insects, but, in the Appalachians, the squirrels rely heavily on hypogeal fungi (truffles) and lichens associated with the root systems of red spruce (Ford et al. 2004; Ford and Rodrigue 2007; Loeb et al. 2000, Maser et al. 1978, 1986, Maser and Maser 1988; Mitchell et al. 2001). While nesting mainly in tree cavities in live hardwoods and snags (yellow birch and American beech are preferred), the VNFS will also utilize leaf or 'drey' nests in conifers such as red spruce and eastern hemlock, and have been observed using multiple den/nest sites in one season

(Hackett and Pagels 2003; Menzel 2003; Menzel et al. 2000, 2004; Weigl et al. 1999). Den sites have often been found in trees and snags larger and taller than surrounding tress, and near trails, old logging roads, or railroad grades (Hackett and Pagels 2004; Menzel et al. 2004). VNFS will occupy artificial nest boxes (Reynolds et al. 1999). Individual home range sizes are variable, ranging from 5 to > 100 ha in West Virginia (Urban 1988; Menzel et al. 2006b). Home range size varies by habitat structure quality and seasonal food abundance, with males tending to have larger home ranges than females (Weigl et al. 1999). Optimal habitat is red spruce forest exhibiting mature to old-growth characteristics on north and east-facing slopes, with large trees, numerous snags, high volumes of coarse wood debris, and abundant lichens and hypogeal fungi providing year-round lifecycle needs (Carey 1989, 1991, 1995; Ford et al. 2004; Hackett and Pagels 2003; Odom et al. 2001; Payne et al. 1989; Rosenburg 1990; Shuler et al. 2002; Weigl et al. 1999). However, VNFS can persist in and around remnant patches of red spruce and mixed spruce-northern hardwood forest (Ford et al. 2004; Menzel 2003; Menzel et al. 2004, 2006a, b; Smith 2007).

Habitat Availability

In a 2006 5-year review and 2008 final rule, the USFWS estimated a range of 242,000 to 600,000 acres of potential suitable habitat for VNFS, generally following the spine of the high Allegheny Plateau in a northeast to southwest alignment (Menzel et al. 2006b; USFWS 2006 and 2008). No critical habitat has been designated for this species. Based on the Menzel habitat suitability model, the majority of ‘optimal’ (80%) and ‘likely’ (65%) habitat is found on the Monongahela National Forest in West Virginia (Menzel et al. 2006b; USFWS 2006 and 2008). Approximately 6,268 acres of mixed spruce and northern hardwood habitat occurs in the Laurel Fork area on the Forest, in Highland County, Virginia. This represents approximately 3% of the total estimated habitat for the VNFS rangewide and 25% of an estimated 25,250 acres of ‘likely’ habitat in Highland County, Virginia, as determined by the Menzel habitat suitability model (Menzel et al. 2006a; USFWS 2006 and 2008). At Laurel Fork, mature red spruce is found mixed within northern hardwood forest types, primarily associated with riparian areas along Buck, Slabcamp, Bearwallow, and Newman Runs, all on the upper east flank of Alleghany Mountain (Fleming and Moorhead 1996). Current estimates of mature red spruce is 219 acres, with an additional 154 acres of mature red spruce in plantations on the upper slopes of Allegheny Mountain, in the vicinity of Buck Knob and Locust Spring Run (Fleming and Moorhead 1996; USFS 2011). In addition, 116 acres of mature red pine plantation is present in the same area. Most of the spruce and red pine is estimated to be 90 years or older. Adjacent to the spruce and pine plantations and intermixed along the tributaries to Laurel Fork and Laurel Fork itself are an estimated 158 acres of open beaver meadow/wetland glades, and herbaceous and shrubby old field habitat (Fleming and Moorhead 1996). In total, 373 acres of mature red spruce and an additional 116 acres of mature red pine are components of the 6,268 acre mixed spruce/northern hardwood forest complex in Laurel Fork. Abundant red spruce regeneration is present throughout the area, both in the understory of spruce/northern hardwood forests and in adjacent old beaver meadows and wetland glades, making the total acreage of the spruce forest component estimated at around 600 acres (Fleming and Moorhead 1996; USFS 2011).

Population Trends

At the time of federal listing in 1985, VNFS was known to occur in four geographic areas, three in West Virginia (Cranberry Glades, Cheat Bridge/Cheat Mountain, Stuart Knob) and one in Virginia (Laurel Fork). The USFWS has documented 109 known sites with VNFS, 107 in West Virginia, and two in Virginia (USFWS 2006 and 2008). The Virginia population is known only from Highland County, Virginia and is considered part of the Spruce Knob/Laurel Fork population cluster (Pocahontas, Randolph, Pendleton Counties, West Virginia, and Highland County, Virginia) (USFWS 2006 and 2008). A population of uncertain genetic status is also located in southwestern Virginia at Mt. Rogers National Recreation Area and adjacent Grayson Highlands State Park (USFWS 2006 and 2008). Several studies have attempted to determine whether this population is the Virginia or Carolina northern flying squirrel subspecies, or an intergrade between the two, with the most recent research indicating a likely genetically distinct population (Arbogast and Schumacher 2010; Fies and Pagels 1991; Reynolds et al. 1999; Sparks 2005). Until the genetic uncertainties are officially resolved, the USFWS recovery plan for Carolina flying squirrel includes this population for conservation and management purposes, and is addressed in the Jefferson National Forest Revised Land Management Plan (USFS 2004; USFWS 2006). Since 1985, the Laurel Fork area has been monitored for VNFS using a combination of presence/absence surveys with nest box checks and live capture/recapture methods (J. Pagels unpublished data; Reynolds et al.

1999). At the time the first Forest Plan Revision was signed (1993), monitoring efforts estimated fewer than 20 individuals in the Laurel Fork Area (USFS 2011). Despite repeated monitoring efforts for over twenty years, very few VNFS have been captured. During a 10 year mark/recapture study on two sites in Laurel Fork (1986-1996), only one squirrel was captured in 10 years on site one, and 3-6 captured in four of 10 years on site two (Reynolds et al. 1999). Despite a low capture rate throughout the years, VNFS have been shown to persist in the Laurel Fork area with the most recent capture in 2004 (J. Pagels unpublished data). Three sites in Laurel Fork on the Forest have now been documented to have VNFS, as well as two sites on private land in Highland County, one adjacent to Forest land in Laurel Fork (Rick Reynolds, VDGIF and Marek Smith, TNC, pers. comm., 2012). The USFWS acknowledges known inadequacies in current monitoring techniques for VNFS to prove or disprove presence of the VNFS (USFWS 2001, 2006, 2008). The current Recovery Plan for VNFS, as amended, encourages the assumption of presence in suitable habitat, because the squirrels are less likely to use nest boxes or enter traps in good quality habitat due to the abundance of natural den sites and preferred foods in these areas (USFWS 2001).

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

A number of natural and human-related threats have been documented for the VNFS in the USFWS recovery plan, USFWS 5-year review, USFWS Final 2008 Rule, and published research.

Loss of suitable habitat and connectivity. Historically, the Allegheny Highlands contained over 500,000 acres of old growth spruce-dominated forest in the Allegheny Highlands (USFWS 2006 and 2008). Much of this was lost through historical logging and associated wildfires, which led to the replacement forest being more dominated by northern hardwood types, with a reduced spruce/conifer component (Adams and Stephenson 1989; Schuler et al. 2002). This habitat change and resulting fragmentation of suitable habitat had a serious negative impact on the size and distribution of VNFS populations throughout their range (Ford and Rodrigue 2007; USFWS 2006 and 2008). Currently, an estimated 242,000–600,000 acres of varying suitability exists for VNFS, based on the consolidation of several habitat suitability models (USFWS 2006 and 2008). In the Laurel Fork area on the Forest, 373 acres of mature red spruce, an additional 116 acres of mature red pine, and an estimated 300 acres of red spruce regeneration are intermixed within 6,268 acres of mixed spruce/northern hardwood forest ecological system. The current Forest Plan Revision (1993) identifies this area as the Laurel Fork Special Management Area and the Laurel Fork Roadless Area (USFS 1993), and management of the area has been in compliance with the guidelines of the VNFS Recovery Plan, as amended.
Alternatives A, B, D, E, G, H and I identify the Laurel Fork Area as a Special Biological Area and as Remote Backcountry. The Laurel Fork Area is also a Potential Wilderness Area. VNFS Recovery Plan Guidelines will continue to be followed in habitat with known populations or the potential to have populations of VNFS. Objectives for the Spruce Forest and Northern Hardwood Ecological Systems are to maintain current acreage. In Alternatives B, D, E, G, H and I there is also an objective to re-establish about 1,300 acres of regenerating spruce across the planning period. Where non-native red pines were planted, red spruce should be restored. Forestwide standards for the Spruce Forest Ecological System are to maintain or restore the forest type. Current spruce and northern hardwood systems in the Laurel Fork area are mature and will continue to age through the life of the proposed plan revision. Spruce regeneration is also present and will continue through mostly natural means throughout the proposed planning period, although active restoration may also occur. Habitat suitable for VNFS will continue to be available through the foreseeable future.

In Alternatives C and F the Laurel Fork area is recommended for wilderness study. Natural processes would continue in the area, but active restoration activities would not occur.

Disease. Several disease threats to the habitat of the VNFS have been documented at Laurel Fork. The hemlock woolly adelgid (*Adelges tsugae*) has caused serious death and decline of Eastern hemlock forests across the Forest (USFS 2011). Eastern hemlock was identified as a component of the spruce/northern hardwood system in Laurel Fork (Fleming and Moorhead 1996), but not a dominant overstory type in the area of Laurel Fork known to have VNFS populations. Because a predominately montane conifer component is still present, it is not anticipated that hemlock woolly adelgid would pose a serious threat to the habitat quality for VNFS, given the limited role of hemlock in flying squirrel survival (USFWS 2006 and 2008). Beech bark disease results from attack by the beech scale insect, *Cryptococcus fagisuga*; subsequent fungal infestations can either cause serious decline or mortality to mature trees (Cammermeyer 1993). Evidence of beech bark

disease is present in Laurel Fork (Fleming and Moorhead 1996), resulting in scattered mortality of mature trees, but the beech component is still present in the spruce/northern hardwood community. Scattered mortality provides potential suitable cavities for VNFS (USFWS 2006 and 2008). Due to the limited amount of beech present in Laurel Fork, beech bark disease is not considered to be a serious threat to the quality of habitat for VNFS in the life of proposed Forest Plan Revision.

Impacts from southern flying squirrel. The FWS Recovery Plan states VNFS can be threatened by competition for available den sites with the southern flying squirrel (*Glaucomys volans*) and by spread of a parasitic nematode (*Strongyloides*) from the southern to northern flying squirrel (USFWS 2001). Recently, however, the USFWS has documented that while co-occurrence of both species in areas of the VNFS range has been documented, available evidence indicates occurrence and potential severity of impacts due to sympatric existence appears limited (USFWS 2006 and 2008). One possible explanation could be the decline of available beech nuts by the spread of beech bark disease, an important food source for southern flying squirrels. With regards to parasitic infestations, research has hypothesized that the parasitic nematode (*Strongyloides*) is limited by below-freezing temperatures, such as occurs throughout the range of VNFS (Wetzel and Weigel 1994). Twenty years of capture data documenting VNFS with no signs of debilitating effects due to parasitic infestation appear to bolster this hypothesis (USFWS 2006 and 2008). Therefore, the USFWS has concluded the risk of competition with the southern flying squirrel does not threaten the continued existence of the VNFS (USFWS 2006 and 2008).

Acid precipitation and climate change. Since federal listing of VNFS, acid precipitation and climate change have been cited as factors in the decline of the spruce-fir ecosystem throughout the Appalachians. The negative effects of acid deposition on fir species have been well documented, though long-term effects to red spruce have not been as conclusive (USFWS 2006 and 2008). The long-term impacts of a rise of average high temperatures due to climate change could negatively affect the extent and quality of northern hardwood and spruce ecosystems, further reducing available habitat throughout the range of VNFS (Delcourt and Delcourt 1984).

Alternatives B, D, E, G, H and I have strategies to help mitigate, as much as possible, potential effects of habitat quality and reduction of the spruce and northern hardwood ecosystem. Objectives for the Spruce Forest and Northern Hardwood Ecological Systems are to maintain current acreage and re-establish about 1,300 acres of regenerating spruce across the planning period. Where non-native red pines were planted, red spruce should be restored. Forestwide standards for the Spruce Forest Ecological System are to maintain or restore the forest type. Current spruce and northern hardwood systems in the Laurel Fork area are mature and will continue to age through the life of the proposed planning period. Spruce regeneration is also present and will continue and be encouraged through mostly natural means throughout the proposed planning period. Habitat suitable for VNFS will continue to be available through the foreseeable future.

Alternatives C and F will rely on natural processes to dictate responses of the spruce and hardwood systems to changes in acid deposition and climate change.

Across the range of the VNFS, the Monongahela National Forest in West Virginia contains the majority of the estimated suitable 242,000 acres of suitable habitat (Menzel 2003; USFWS 2006 and 2008). The Laurel Fork area in the Forest, with an estimated 6,268 acres of suitable habitat, and representing approximately 3% of the available suitable habitat range-wide, borders the Monongahela National Forest, with two Monongahela NF Management Prescription 4.1 (Spruce and Spruce-hardwood Restoration) areas within 3 and 10 miles respectively of the Forest (USFS 2006). The Laurel Fork area is considered part of the larger Spruce Knob/Laurel Fork VNFS Recovery population cluster (Pocahontas, Randolph, Pendleton Counties, West Virginia, and Highland County, Virginia) and affords the best opportunity for connectivity of habitat and long-term population gene flow for VNFS (USFWS 2006 and 2008). In Virginia, smaller areas of spruce/northern hardwood on private land adjacent to and in the vicinity of Laurel Fork, and have known VNFS populations, are under Conservation Easement through the Virginia Nature Conservancy (Marek Smith, TNC, pers. comm. 2012). The current Forest Plan Revision (1993) identifies the Laurel Fork area as the Laurel Fork Special Management Area and the Laurel Fork Roadless Area (USFS 1993). Vegetation desired conditions and management have been performed in compliance with the guidelines of the VNFS Recovery Plan, as amended,

(USFS 1993). Current spruce and northern hardwood systems in the Laurel Fork area are mature and will continue to age through the life of the proposed plan revision.

Several studies have attempted to determine whether this population is the Virginia or Carolina northern flying squirrel subspecies, or an intergrade between the two, with the most recent research indicating a likely genetically distinct population (Arbogast and Schumacher 2010; Fies and Pagels 1991; Reynolds et al. 1999; Sparks 2005). Until the genetic uncertainties are officially resolved, the USFWS recovery plan for Carolina flying squirrel includes this population for conservation and management purposes. The Whitetop and Mount Rogers areas containing northern flying squirrel habitat (approximately 6,000 acres) have been allocated to special areas in the Jefferson National Forest Land Management Plan Revision (management prescriptions 4.K.3. and 4.K.4.) (USFS 2004). Both of these special areas are classified as unsuitable for timber management and management is primarily focused on protecting and restoring the high elevation rare communities and species that inhabit this area (including the spruce-fir and northern hardwood forest and northern flying squirrel), managing forest visitor use, maintaining the outstanding vistas and natural scenery that led to designation of this area as a National Recreation Area. Key spruce-fir and northern hardwoods restoration areas have been identified in the Jefferson NF Revised Forest Plan to provide linkages to connect suitable habitat types for northern flying squirrels.

Habitat on the Forest currently occupied by the northern flying squirrel is protected and habitat and gene flow linkages are being restored through management prescriptions on the adjacent Monongahela National Forest, as well as Conservation Easements on adjacent and nearby private land. The northern flying squirrel population of uncertain genetic status at Mount Rogers is also being protected through provisions in the Jefferson National Forest Revised Land Management Plan. These actions will provide suitable habitat, connectivity, and opportunities for gene flow over the life of the proposed planning period and into the future. Therefore the cumulative effects of the proposed George Washington Revised Forest Plan will be beneficial to the VNFS.

Shale Barren Rock Cress

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2012).

Shale barren rockcress was listed as endangered under the Endangered Species Act on August 8, 1989.

It is an endemic of shale deposits, occurring only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations generally ranging from 1300 to 2600 feet. Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. All extant occurrences are on shales of Devonian age (Ludwig pers. comm.); a single occurrence was known from the Martinsburg shale of Ordovician age, but it is no longer extant. This narrow endemic is known only from shale barren regions of Virginia and West Virginia and is one of the most restricted shale barren endemics. According to NatureServe, approximately 56 occurrences are believed extant, 34 in Virginia and 22 in West Virginia, of these, most are made up of fewer than 50 individuals; there are perhaps fewer than 4,000 plants altogether. Most occurrences are on public lands, predominantly national forests.

Recovery tasks for the Forest identified in the shale barren rockcress Recovery Plan include: Implement and evaluate the monitoring program.

The following is from the Forest’s Monitoring and Evaluation Report 2004:

“In 1993 there were 17 known occurrences of shale barren rockcress on the Forest. The Forest’s focus since this species was listed has been to attempt to locate additional populations and further define its range on the Forest. From 1994 to 1998 agency personnel worked cooperatively with the Virginia Division of Natural Heritage and the USFWS to inventory shale barrens on the Forest (Belden, Ludwig, and Van Alstine 1999). The Virginia Division of Natural Heritage identified 809 potential shale barrens from aerial photographs. Of these,

188 were examined for rare species. The inventory resulted in 27 new occurrences of shale barren rockcress, bringing the total known sites on the Forest (in Virginia) to 42. This number does not include two sites where shale barren rockcress was known to occur recently, but could not be found in 1994. In 2004 the West Virginia Department of Natural Resources discovered a new population of shale barren rockcress at the Little Fork North Shale Barren."

Currently on the Forest there are 26 Special Biological Areas (SBAs) in Virginia and 8 SBAs in West Virginia that support shale barren rockcress. These SBAs contain all of the known shale barren rockcress populations on the Forest. Within those sites the plants may be in more than one location. Depending on how one counts populations or subpopulations, there are about 75 occurrences of this species on the Forest. The *Arabis serotina* Recovery Task Force and the Shale Barren Protection Strategy Group devised a monitoring plan for shale barren rockcress in 1993. The plan calls for monitoring this species at several sites across its range by the WVDNR between 15 August and 5 September each year, and all other sites every five years. This protocol was followed from 1993 through 2001 in WV. In 2001, it was decided that, to limit the impact of repeatedly crossing the barrens, monitoring would be conducted biennially at the Little Fork and Brandywine shale barrens in Pendleton County, as opposed to every year. In 2011 the VDNH and the USFWS entered into an agreement to resurvey all sites on U.S. Forest Service (USFS) lands in Virginia to determine their persistence and to provide information needed to enable permanent protection measures to be taken by the USFS in cooperation with the Service.

Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Recovery tasks for the Forest identified in the shale barren rock cress Recovery Plan include: implement and evaluate the monitoring program.

Threats include:

- Construction of roads, railroads, and hiking trails has impacted occurrences in the past; several occurrences are now located adjacent to these corridors where they may be impacted by erosion or maintenance activities.
- Flood control measures are a potential threat at some locations (e.g. South Fork Valley of West Virginia) (Bartgis in litt.); one barren has already been destroyed by a stream dam (Dix 1990).
- Most extant occurrences are moderately to severely browsed by deer, which is considered by some to be a prime threat to the species (USFWS 1989); quantifying the impact of deer browsing is an area of active research (Ludwig pers. comm.).
- Moderately xeric sites may be subject to encroachment of exotic plant species such as *Centauria biebersteinii* and numerous grasses (Dix 1990). Such encroachment is a particular concern for *Arabis serotina* since it does not tolerate competition well; it is generally restricted to the more open portions shale barren communities.
- A significant threat to the insect pollinators of *A. serotina* is presented by the spraying of Dimilin and BT insecticides for gypsy moth control. Because of the open habitat, shale barren insects are maximally exposed to pesticides (Dix 1990). Dimilin is a broad-spectrum biocide that persists until leaf fall and up to a few years in the duff and would have a long-term impact of shale-barren slopes. All insect occurrences on shale barrens sprayed with Dimilin should be considered extirpated (Schweitzer in litt). BT is lepidopteran-specific and only persists for roughly one week (Dix 1990). Application during larval development may have devastating impacts on the fauna.
- Finally, the very small number of individuals within many occurrences suggests that the long-term persistence of these occurrences is uncertain, especially considering that populations tend to fluctuate dramatically.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (Dix 1990). These barrens support sparse, scrubby growth; frequently-observed species include *Quercus ilicifolia, Q. prinus, Q. rubra, Pinus virginiana, Juniperus virginiana, Prunus alleghaniensis, Rhus aromatica, Celtis tenuifolia, Kalmia latifolia, Bouteloua curtipendula, Andropogon scoparius, Phlox subulata var. brittonii, Silene caroliniana ssp. pensylvanica, Sedum telephoides, Antennaria spp., Aster spp*., and *Solidago spp.* (Dix 1990). Local variations in associated flora may be considerable (Braunschweig et al. 1999; Jarrett et al. 1996; Keener 1970; Keener 1983; Wieboldt 1987).

Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Because of the highly stressful nature of shale barren environments, this species is not believed to be capable of tolerating much additional disturbance. Specific threats (NatureServe 2012) include:

1) Construction of roads, railroads, and hiking trails has impacted occurrences in the past; several occurrences are now located adjacent to these corridors where they may be impacted by erosion or maintenance activities.
2) Flood control measures are a potential threat at some locations (e.g. South Fork Valley of West Virginia) (Bartgis in litt.); one barren has already been destroyed by a stream dam (Dix 1990).
3) Most extant occurrences are moderately to severely browsed by deer, which is considered by some to be a prime threat to the species (USFWS 1989); quantifying the impact of deer browsing is an area of active research (Ludwig pers. comm. and WVDNR 2011).
4) Moderately xeric sites may be subject to encroachment of exotic plant species such as *Centauria maculata* and numerous grasses (Dix 1990). Such encroachment is a particular concern for *Arabis serotina* since it does not tolerate competition well; it is generally restricted to the more open portions shale barren communities.
5) A significant threat to the insect pollinators of *A. serotina* is presented by the spraying of Dimilin and BT insecticides for gypsy moth control. Because of the open habitat, shale barren insects are maximally exposed to pesticides (Dix 1990). Dimilin is a broad-spectrum biocide that persists until leaf fall and up to a few years in the duff and would have a long-term impact of shale-barren slopes. All insect occurrences on shale-barrens sprayed with Dimilin should be considered extirpated (Schweitzer in litt). BT is lepidopteran-specific and only persists for roughly one week (Dix 1990). Application during larval development may have devastating impacts on the lepidopteran fauna.
6) The very small number of individuals within many occurrences suggests that the long-term persistence of these occurrences is uncertain, especially considering that populations tend to fluctuate dramatically.
7) Fire suppression is a potential threat. In his draft report on the classification of West Virginia shale barrens, Vanderhorst (in Norris and Sullivan 2002) states:

   "A potential threat to shale barrens is succession, or woody encroachment. Although shale barrens are usually thought to be edaphicly [sic] maintained, it is possible that disturbance such as fire may have some role in maintaining the open physiognomy necessary for survival of shale barren endemics. Fire may be a factor in some shale barren community types and not in others. It is possible that the high cover by deciduous woody species in plots of this community type is due to fire suppression and that the quality of these barrens is declining. Fire is thought to have played a historical role in maintenance of white pine-mixed oak communities near shale barrens on the Greenbrier District of the Monongahela National Forest and in the absence of fire these communities appear to be succeeding towards dominance by more mesophytic species (Abrams et al. 1995). Research into the historical role of fire in maintaining shale barrens is needed to determine appropriate management of this rare community."

FIRE

The specific role of fire in relation to shale barren rockcress is uncertain. No in-depth studies have been conducted about the direct or indirect effects of fire on this species; however, an increasing number of studies are showing the historical importance of fire in the Central Appalachians in shaping vegetation communities. Shale barren rockcress habitat is on extremely xeric south to southwest facing slopes in oak forests that are prone to wildfire. It would seem logical that fire would periodically burn through forest communities containing shale barren habitat and there is an increasing body of research that shows, until the early 1900s when fire suppression became universal, that fires occurred regularly on the Central Appalachian landscape. Abrams and others (1995) studied a forest that is transitional between the Ridge and Valley and Appalachian Plateau in Greenbrier County, WV. They concluded that without active management, including the use of prescribed fire, the present white pine-oak forest would transition to a more mesic maple-beech-hemlock forest. Lafon (2010) discusses the role of fire in table mountain pine-pitch pine stands. These pine types are found on dry ridgetops and south to west facing slopes often similar to areas supporting shale barrens. Dendroecological work shows these stands burned frequently in the past, with a regime of frequent surface fires at intervals of 2 to 10 years, and more severe burns at 50 to 100 years intervals. The surface fires maintained open understories needed by shade intolerant herbs and small shrubs. The more severe burns exposed mineral soil and created large canopy gaps enabling shade intolerant pine seedlings to become established. Lafon goes on to discuss the 'fire-oak' hypothesis which posits that many oak forests developed during many centuries of frequent burning. Fire benefits oaks by inhibiting fire sensitive tree species, which do not have oaks' protective bark, ability to compartmentalize fire damaged wood to prevent decay spread, extensive root systems, and strong sprouting ability. Aldrich and others (2010) studied fire chronology from 1704 to 2003 of trees on Mill Mountain in Bath County, VA on the Forest in an area where at least 10 *Arabis serotina* populations occur within 3.5 miles. They found a local fire return interval of about 5 years from the early 1700's until 1930 when fire suppression began. They also found that area-wide fires affecting multiple pine stands were common, recurring approximately every 16 years. The fires were frequent surface fires with occasional severe ones. In the Rough Mountain Wilderness, on the National Forest near the Mill Mountain study site, there were two lightning caused wildfires in 1999 alone (S. Croy pers. comm.). Aldrich and others (2010) conclude that "The greatest impact of industrial society is fire exclusion, which permitted hardwood establishment." There has been a trend since the initiation of widespread fire suppression of pine stands being overtaken by hardwoods in general, and of oak species being replaced by fire intolerant species such as red maple, white pine, tulip poplar, beech, and black gum (Groninger et al. 2005; Harrod and White 1999; Lafon and Grissino-Mayer 2005; Schuler and McLain 2003). It is possible that prescribed burning can halt and perhaps reverse this "mesophication" (Nowacki and Abrams 2008) of the forest.

Most shale barrens have little to no fuel loading so fire intensity, if any, would be expected to be low on the barren itself. Platt (1951) states fires are not a causal agent in shale barren formation. He goes on to say that "Fires in this region are quite rare and localized. Since shale barrens surfaces are bare and tree cover sparse, they usually escape even those fires which completely surround them. Careful examination of tree trunks gave no indication of fire scars." It could well be that Platt's observations are the result of the vigorous program of fire suppression. His comments about the fate of shale barrens in the event of fire are important. The lack of fuel loading would make fire spread nearly impossible in the shale barren environment. However, periodic fire might open and maintain habitat adjacent to the shale barren allowing shale barren rockcress populations to persist or expand. The LANDFIRE Biophysical Setting Model for Appalachian Shale Barrens states that "The absence or sparseness of fuel makes fire relatively unimportant on the barrens themselves, but is likely important in maintaining the adjacent pine and pine-oak dominated woodlands and limiting their encroachment along the barren-woodland edge. Likewise the "shale ridge bald" is maintained by edaphic conditions, but fire is likely important in limiting tree and shrub encroachment" (Croy and Smith 2009). Jarrett and others (1996) conducted an ecological study of shale barren rockcress on property managed by the U.S. Navy in West Virginia. In comparing their vegetation data with data collected ten years earlier they note that "(tree) canopies have closed somewhat at various West Virginia shale barrens, and that some shale barren endemics are no longer there." They go on to suggest that controlled burning or periodic thinning of the canopy may be necessary to set back plant succession (see discussion of mesophication above). This view is echoed by the West Virginia Department of Natural Resources factsheet on shale barren rockcress (accessed online in 2012), "Some observations suggests [sic] that some shale barrens may not always remain barren and dry. Over time, it is possible for conditions there to change, and more trees may eventually grow on them. If more

trees grow there, shale barren rockcress may not be able to survive." Several prescribed burns on the Forest in the past included shale barren rockcress habitat and plants.

Fire that burns immediately adjacent to shale barren rockcress plants might have a negative effect depending on the fire's intensity and duration. The higher the intensity and the longer the duration of fire exposure, the greater the effect and an individual plant may be killed. Fire may also have a beneficial effect as noted above. In the past, fire was considered to not be an important factor on shale barrens, especially if they are larger (larger buffer of the interior from fire) and/or steeper (less fuel build up on steep slopes). Since shale barren rockcress plants are usually more abundant in the more open parts of shale barrens, plants growing on smaller shale barrens would be more susceptible to encroachment by woody plants in the absence of fire, although all barrens could be affected to some extent. In addition to potentially enhancing seed germination, plant growth, and flowering and fruiting, fire could open the canopy on the periphery of shale barrens benefitting shale barren rockcress plants. Frequent low intensity fires would have a protective effect by lessening fuel loading in the vicinity of shale barrens and reducing fire intensity and duration. Observations have also shown that deer browse is lessened on rockcress plants when the areas around shale barrens have been burned. This is likely due to increased browse available as the result of coppice growth from top-killed trees and shrubs. This effect lasts for several years as coppicing continues and berry and nut production increases.

There are possible threats to shale barren communities from invasive native and exotic species, deer browsing, and mesophication.

All known locations of shale barren rock cress on the Forest in WV and VA are on land allocated to management prescription 4D, Special Biological Area. Habitat for this species is stable on the Forest. There are possible threats to shale barren communities from invasive native and exotic species. Populations appear stable, but since they naturally tend to fluctuate greatly from year to year, this is uncertain. Potential habitat is being inventoried and continues to reveal new populations that will be protected. Management activities are having no effect on the habitat that contains the shale barren rock cress and thus are having no effect on the rock cress.

Overall, viability is being maintained through identification and protection of occurrences, however, viability is still of concern due to the naturally limited distribution of this species. Shale barren rock cress populations are expected to remain relatively stable in the near future.

The Forest encompasses several populations of the endemic shale barren rock cress that are in the core of its limited distribution in the Northern Ridge and Valley Section of the mid-Appalachians. This species is inherently rare and not well distributed across the Forest. Current management provides for ecological conditions capable to maintain the shale barren rock cress populations considering its limited distribution and abundance. Overall, ecological conditions are sufficient on the Forest to maintain viability (persistence over time) of populations on national forest land.

Smooth Cone Flower

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Smooth coneflower was listed as endangered under the Endangered Species Act on September 8, 1992. This species is known from about 100 occurrences, a majority of which are of fair to poor viability in several southeastern states. Most historically known populations were destroyed by development and habitat alteration, especially the suppression of fire, and a number of remaining populations are primarily in marginal locations, where they are vulnerable to urbanization, the use of herbicides, repeated mowing, and potentially, collection for the medicinal trade. Small remote populations may suffer from loss of habitat due to succession.

The Recovery Plan for smooth coneflower does not have any recovery tasks specific to the Forest.

Formerly a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires as well as large herbivores (such as bison), it now primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. It is usually found in areas with magnesium and calcium-rich soils and requires full or partial sun. Associated species include: *Juniperus virginiana* and *Eryngium yuccifolium*. Fire or some other suitable form of disturbance, such as well-timed mowing or the careful clearing of trees, is essential to maintaining the glade remnants upon which this species depends. Without such periodic disturbance, the habitat is overtaken by shrubs and trees [Endangered Spp. Tech. Bull. 17(1-2): 9-10].

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Habitat loss and degradation due to habitat alteration affected 19 of 21 populations known in 1992 (USFWS 1992). Conversion of habitat to agriculture and/or silviculture, residential and industrial development, and highway maintenance (e.g., herbicides) has threatened this species in the past and may continue. Habitat loss and degradation as a result of prolonged fire suppression is also considered a major threat to the species' habitat. Commercial digging was not thought to be a problem as this practice is generally confined to Echinacea populations west of the Mississippi River. However, the Southern Appalachian Species Viability Project (2002) reported that this showy species with medicinal uses is occasionally harvested. Remaining populations appear to be small in numbers which may result in low genetic diversity.

All known locations of smooth coneflower on the Forest are on lands allocated to management prescription 4D, Special Biological Area. There are currently two known populations of this species on the Forest. Both are in Alleghany County. One is a roadside occurrence that continues to be difficult to manage due to the steepness of the site and encroaching woody vegetation. This population is very small and may not be viable over the long-term. The second population is more robust and occurs in an open woodland area. The site needs prescribed fire to maintain the open conditions this species requires.

Virginia Sneezeweed

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Virginia sneezeweed was listed as threatened under the Endangered Species Act on November 3, 1998.

A limited amount of habitat in two Virginia counties and six Missouri counties make up this species' entire global range. There are currently 61 documented occurrences, although 4 or fewer may not be extant, with the majority in Missouri as of 2006. The Virginia occurrences were located during extensive survey work from 1985 to 1995 in over 100 limestone sinkhole ponds along the western edge of the Blue Ridge Mountains, in the Shenandoah Valley of Virginia (USFWS 1998). The Virginia occurrences are restricted to small, discrete areas around sinkholes, and occupying, in total, less than 20 acres (8 ha). Missouri occurrences occupy ca. 11 acres within both discrete and less discrete wetland habitat. Seven Virginia occurrences are currently protected by being on National Forest land. Only 9 Missouri occurrences have some protection although it is not complete. Sites in both states are threatened by drainage and residential development.

The number of Virginia documented occurrences has been revised downward to 17 by using a 1 km separation distance between occurrences (J. Townsend, VA Dept. of Conservation and Recreation 2006 pers. comm.) These 17 occurrences had previously been recognized as 30 occurrences, with an occurrence at that time being equal to the plants within a discrete pond or wet meadow. It is expected that additional survey work will find more occurrences; some of these may be within the more disturbed farm pond type of habitat. In fact, a new, small population was found on the Forest in 2009 by VDNH cooperators (C. Ludwig pers. comm.). Based on what was known at the time the draft Recovery Plan was written in 2000 there were 4 sites where plants had not been seen over several years of surveys (U.S. Fish and Wildlife Service 2000).

The Draft Recovery Plan includes the Forest in the following recovery tasks:

- Seek permanent protection for known populations.
- Identify essential habitat.
- Identify sinkhole habitat adjacent to the National Forest lands, but within the proclamation boundary, to target for future acquisitions by the GWJNF.
- Conduct studies to characterize environmental parameters of the sinkhole ponds.
- Conduct studies to characterize the hydrologic regime at selected sinkhole ponds.
- Alleviate site specific threats as the need and opportunity arise.
- Develop a monitoring plan including standard monitoring methodologies.
- Implement the monitoring plan.
- Conduct surveys for additional populations in Virginia.
- Develop guidelines as to what constitutes a self-sustaining population.
- Maintain seed sources for the species.

On the Forest all known populations of Virginia sneezeweed are located in Augusta County except for a very small population that was located in 2009 between Glasgow and Buena Vista in Rockbridge County.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.).

Exotic organisms may pose threats to *H. virginicum* populations in the near future. Purple loosestrife, *Lythrum salicaria*, is slowly spreading through Virginia and may eventually invade some *H. virginicum* sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, *Lymantria dispar*, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact *H. virginicum* populations. For example, as *H. virginicum* is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow *H. virginicum* to expand into areas from which it was formerly excluded.

The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000):

> The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. In contrast, actions have been taken at some of the Virginia sites to stop or lessen the periodic inundation. Significant ditches have been dug at two sites, with smaller ditching at three sites. Ditching and plowing occurred at one site in the past, and some evidence of the ditch remains, but does not significantly affect the hydrologic regime. Portions of the sites at 2 sites have been filled in. It is safe to assume that the pressure to control seasonal flooding will only increase, as the area of the Shenandoah Valley where the Virginia populations of *H. virginicum* are found is experiencing rapid growth, particularly in the building and expansion of residential subdivisions.

In addition to obvious hydrological alterations made directly to the sinkhole ponds, off-site actions may affect the hydrology of the ponds. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. Little is known about the relative importance of groundwater vs. surface flow to the hydrological regime of the sinkhole ponds, but preliminary research suggests that the relative importance of these water sources is unique for each pond (E. Knapp, Washington and Lee University pers. comm.).

A variety of site-specific threats to *H. virginicum* from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. The Virginia Department of Conservation and Recreation's Division of Natural Heritage reviewed the proposal for this project in 1991 and recommended against any road widening to the east in the area of the pond and further recommended that VDOT consult with the U.S. Fish and Wildlife Service before any construction began. While the long range plans still include widening Rt. 340 to 4 lanes in this section, this project is not active; VDOT will coordinate with USFWS whenever the project becomes active (S. Stannard, VDOT pers. comm.)

Another *H. virginicum* population is near the site of silos built in the early 1990s that are used to store septic waste. This waste is eventually dumped on the ground elsewhere on this landowners' ridge-top property and not near the *H. virginicum* site. However, in a 1995 site visit by DCR-DNH a large pile of soil was present on the north side of the shallow basin that supports the *H. virginicum* population. The landowner was considering pushing the soil into the seasonally wet basin to level it out, but was agreeable to not do that. In a 1997 site visit the pile was still present and was larger than in 1995. In 1995 and 1997, it was noted that sediment from the pile had washed into the edge of the pond site, creating different soil conditions in that area and making it more favorable for weedy species (DCR-DNH database).

Mowing occurs in at least 3 of the Virginia sites. Continued mowing may provide beneficial effects to the species; a site that is one of the largest if not the largest and densest population, has been periodically mowed and bush-hogged by the landowner for an extended period of time. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted.

Herbivory does not appear to be a problem; however, the threat to *H. virginicum* from cattle grazing needs evaluation. Large populations of *H. virginicum* co-exist in three sites with cattle grazing. This suggests that the species may respond favorably to limited amounts of disturbance. Knox and others (1999) tested the hypothesis that H. virginicum is unpalatable to generalist herbivores in a common garden study; none of the H. virginicum plants were grazed by either vertebrate or invertebrate herbivores. Knox notes that this is consistent with reports of toxicity in other *Helenium* species associated with the presence of sesquiterpene lactones (Hesker 1982; Anderson et al. 1983; Anderson et al. 1986; Arnason et al. 1987). *Helenium virginicum* has been shown to contain a sesquiterpene lactone, virginolide (Herz and Santhanam 1967). According to J.S. Knox (pers. comm.), the leaves of *H. virginicum* are bitter-tasting; selective grazing by cattle of more palatable associated species therefore may eliminate plant competitors. However, other effects on *H. virginicum* from cattle grazing such as the increased nutrient loads, soil compaction, and trampling of plants are unknown. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species.

With federally listed wetland species, the federal permitting process carried out by the US Army Corps of Engineers (USACOE) under authority of the Clean Water Act of 1977, is often the point at which proposed actions can be reviewed in light of their effect on a federally listed species and protection actions can be recommended. The isolated and often small seasonally wet habitat of *Helenium virginicum*, however, does not currently have direct federal protection. United States vs. Wilson 133 F. 3d 251(4th Cir. 1997) ruled that the USACOE has no jurisdiction over isolated water bodies that have no surface connection with any tributary stream that flows into traditional navigable waters or interstate waters. Nationwide Permit 26, under federal wetlands regulations (56 CFR 59134-59147, Part 330-Nationwide Permit Program), which has applied to headwater areas and isolated wetlands, is currently being revised including a lower minimum acreage (1/10 acre); the Norfolk District of the USACOE is proposing a regional minimum threshold of 1/4 acre (E. Gilinsky, DEQ, pers. comm.). These lower minimum acreages, however, will not apply to the *Helenium virginicum* habitat if the ruling in U.S. vs. Wilson stands.

Currently, so-called Tulloch ditching, draining by ditching in which excavation occurs by mechanical means that do not require placing excavated material into a wetland and in which the material is lifted and hauled to an upland disposal site, does not require that USACOE be notified or a permit obtained. Major ditching has been

used at three of the *H. virginicum* sites to control the seasonal flooding with more minor ditching used at another three sites.

As most of the populations of *H. virginicum* are on private lands, the current legal protections in place for this species will not be adequate to insure the long-term survival of *H. virginicum*. The effects of future regulation changes are not known.

Extremes in the fluctuating hydroperiod of the sinkhole ponds could, when preceded by low investment in the seed bank, result in the local extinction of populations. Extended drought at a site could make a site more favorable for colonization by other plants previously hampered by the periodic inundation of the site. This would include tree species, which could result in increased shading within the site and so reduce the areas favorable for *H. virginicum*. An extended period of inundation, coupled with development of a floating vegetation mat, such as occurred at one site (Knox 1997), could lead to local extinction if an insufficient seed bank existed to recover from the death of the vegetative plants. Either of these extremes in hydroperiod could result from normal variability in weather patterns or from larger scale climate changes, of either natural or human origin.

If found to hold true for other populations of *H. virginicum*, the self-incompatible breeding system of *H. virginicum* found in one of the populations may eventually lead to local extinction at sites with low population numbers as the chance of successful pollination decreases (Messmore and Knox 1997).

In Missouri threats include grazing and/or trampling of plants in the pasture sites and haying of the plants during the growing season. Herbicide or plant growth hormones used on roadside pose a threat to the roadside populations. All known locations of Virginia sneezeweed on the Forest are on land allocated to 4D Special Biological Area. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. There are still threats from illegal ATV use on this species.

Swamp Pink

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Swamp pink was listed as a threatened species under the Endangered Species Act on September 9, 1988. *Helonias bullata* is known from the Coastal Plain of New Jersey, Delaware, Maryland, and Virginia (formerly also Staten Island, NY, where now extirpated), as well as from higher elevations in northern New Jersey, Virginia, North Carolina, South Carolina, and Georgia. Restricted to forested wetlands that are perennially water-saturated with a low frequency of inundation, habitat specificity appears to be a critical factor in this species' rarity. Approximately 225 occurrences are believed extant, over half of which are in New Jersey; 80 additional occurrences are considered historical and 15 are extirpated. The species is locally abundant at several sites in New Jersey, Delaware, Virginia, and North Carolina; some have 10,000+ clumps of plants. In addition to sites known to have been extirpated, significant habitat has been lost throughout the range due to factors such as drainage for agriculture. A number of local population declines have also been documented in the past 20 years. Degradation of this species' sensitive habitat via changes to the hydrologic regime is the primary threat. Such changes can be direct (ditching, damming, draining) or indirect (from development in the watershed); indirect impacts are particularly difficult to address. Other threats include poor water quality, invasive species, trash, all-terrain vehicles, deer herbivory, trampling, and collection. Given this species' very specific hydrological requirements, climate change could also be an issue. *H. bullata* has limited ability to colonize new sites (low incidence of flowering, limited seed dispersal, and poor seedling establishment) and low genetic variation, limiting its ability to adapt to changing conditions and recover when sites are destroyed.

Overall trends of local population declines and extirpations are beginning to emerge (USFWS 2007). The number of occurrences considered historic has increased from 79 to 97 since 1991, a loss of 18 sites (8 in NJ, 8 in DE, and 2 in NC) (USFWS 2007). More than 20 occurrences in New Jersey and Delaware alone have

documented declines in population size or condition since the early 1990s (USFWS 2007). In New Jersey, the number of occurrences ranked A or B has decreased by 7 since 1991; comparing occurrence ranks from 1997 and 2004, 6 occurrences were upgraded while 20 were downgraded (USFWS 2007). Of the 27 occurrences discovered in Delaware between 1983 and 1999, 16 showed substantial declines in plant numbers during the most recent site visits (USFWS 2007).

Recovery tasks for Federal agencies in the swamp pink Recovery Plan include:

- Monitor threats to extant sites.
- Develop and maintain site-specific conservation plans.
- Enforce regulations protecting the species and its wetland habitat.
- Investigate population dynamics, using a standard method.
- Identify and, as needed, implement management techniques.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Habitat degradation is the primary range wide threat. This degradation is difficult to address through either land protection or regulatory mechanisms because it is often brought about by off-site land uses, particularly development. Evidence of detrimental effects of development on *H. bullata* habitat and population quality continues to accumulate; such impacts are anticipated to worsen as development continues (USFWS 2007). A major component of habitat degradation is changes to the hydrologic regime. Such changes can be direct (e.g., ditching, damming, draining) or indirect (i.e., from development in the watershed). Indirect impacts often result from increased impervious surface in the watershed, which reduces infiltration and increases overland flow of stormwater, leading to increased stream erosion, wetland sedimentation, flood volumes and velocities, water level fluctuations, and hydrologic drought (USFWS 2007). Other components of degradation associated with adjacent development include poor water quality, invasive exotic species, trash, all-terrain vehicles, herbivory by overabundant deer populations, trampling, and collection (USFWS 2007). Direct habitat losses have slowed, but historical losses were substantial (USFWS 2007). Because this species requires a very specific hydrology in order to thrive, climate change, which has the potential to either increase or decrease water levels at established sites, is an anticipated threat. For example, increased drought in southern Appalachians mountain bogs may already be having detrimental impacts. Also, about 10% of known occurrences are in areas with increased vulnerability to coastal flooding due to sea level rise (USFWS 2007).

The specific wetland habitat required by this species is easily degraded through both direct and secondary disturbances; among the wetland types it inhabits, some such as sphagnum bogs and Atlantic white cedar swamps are particularly fragile. A low incidence of flowering, limited seed dispersal, and poor seedling establishment combine to make colonization of new sites via reproduction from seed rare for this species (Godt et al. 1995; USFWS 2007). Finally, Godt and others (1995) found low overall genetic diversity both within the species and within populations, even relative to the means found for other endemic and narrowly distributed species. This suggests that *H. bullata* may have limited capacity to adapt to future environmental change.

Habitat specificity appears to be the critical factor in defining *H. bullata* as a rare species (USFWS 2007). Adapted to stable habitats with a number of specialized conditions (e.g., low light, limited nutrients, and saturated soils), this species appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (USFWS 2007). Habitat availability may be a limiting factor across much of the range; Coastal Plain forested headwater wetlands have been significantly reduced by development, and mountain bogs are both historically uncommon and impacted by agricultural conversion (USFWS 2007). Nevertheless, the New Jersey Pine Barrens contain some apparently suitable but unoccupied sites, suggesting that this species' habitat requirements are not fully understood and/or that low dispersal limits colonization of these areas (USFWS 2007). Efforts to create or restore *H. bullata* habitat have had limited success (USFWS 2007).

All known occurrences of swamp pink are on land that will be allocated to 4D, Special Biological Area, and/or 1A Designated Wilderness. These Special Biological Areas are managed specifically to restore and maintain

conditions to benefit the community and/or rare species for which the area was established. Herbivory and shading may continue to be threats. Use of wildland fire may be a tool to reduce shading in some areas.

Northeastern Bulrush

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Northeastern bulrush (*Scirpus ancistrochaetus*) was listed as endangered under the Endangered Species Act in 1991. Populations are known from MA, MD, NH, NY (presumed extirpated), PA, VA, VT, and WV. The habitat seems to vary geographically, although there are not enough sites to allow generalizations to be made. However, one does observe that in the south, sinkhole ponds are the most common habitat for the plant, and in the north, other kinds of wetlands, including beaver-influenced wetlands, provide suitable habitat. When this species was listed as endangered there were 33 known populations. As of 2007, there were about 113 extant occurrences known in the Appalachians from southern Vermont and New Hampshire to western Virginia, with most occurrences in Pennsylvania.

Most populations are in Pennsylvania (70) and Vermont (22) (USFWS 2008). The other populations are in Massachusetts (1), Maryland (1), New Hampshire (9), Virginia (7), and West Virginia (3) (USFWS 2008). There are about ten historical occurrences: New York (1), Pennsylvania (7), Virginia (1), Quebec (1). The plants are restricted to fairly specific wetland habitats that are infrequent, especially in the southern part of the range. Various threats are associated with the habitat, including drainage and development, agricultural runoff, and any developments that could alter the local hydrology. Additional, unsurveyed habitat does exist, and more populations of this species may be found in the future if the potential habitats remain intact.

Long-term monitoring of known sites is needed before any conclusions can be drawn about the habitat needs of the plant, or about the stability of its populations in changing environments.

The implementation schedule for the northeastern bulrush recovery plan (USDI Fish and Wildlife Service 1993) includes five items that directly relate to Forest Service management:

- Secure permanent protection for known populations;
- Resurvey sites thought to have suitable habitat;
- Verify, monitor, and protect any additional populations;
- Identify potentially suitable habitat for additional surveys; and
- Survey potential sites.

Throughout its range, northeastern bulrush is found in open, tall herb-dominated wetlands. Often it grows at the water's edge, or in a few centimeters of water, but it may also be in fairly deep water (0.3-0.9 m) or away from standing water. In the southern part of its range, the most common habitat is sinkhole ponds, usually in sandstone. Water levels in these ponds tend to vary both with the season and from year to year. At least one site (in Massachusetts) is in a sand plain, where water level fluctuates as well. Two sites in Vermont are influenced to some extent by beaver activity as well as other hydrological factors.

With the information available it is difficult to compare sites throughout the plant's range. For example, lists of associated species may represent an entire wetland or the immediate vicinity of the plant, but this is not always possible to determine from available information. Nevertheless, examination of field reports indicates that there is considerable variety in associated species. A few species, however, are common to several of the sites. These are *Dulichium arundinaceum, Scirpus cyperinus sens. lat., Glyceria canadensis*, and *Triadenum virginicum*.

Virginia. There are seven extant northeastern bulrush sites in Virginia, with two ranked as A/AB, two ranked B/BC, and one ranked E. The status of most of these sites is unknown because they have not been surveyed since the 1980s or 1990s. Habitat includes emergent ridgetop shallow ponds, shallow sinkhole depressions

and mountainside bench ponds. Four sites are located on private land, three are on public land, and ownership of one site is undetermined. In Virginia, the northeastern bulrush is listed as State endangered; however, no additional protection (e.g., buffers) is afforded to wetlands supporting the species. No upland buffers are regulated or protected around any wetlands in the State. The northeastern bulrush is protected under the Endangered Plant and Insect Species Act of 1979, which prohibits take without a permit, but individual landowners are exempt from these permitting requirements.

West Virginia. There are three northeastern bulrush populations in West Virginia, two of which are ranked B, and one of which is ranked D. According to the U.S Fish and Wildlife 5-year status review for northeastern bulrush these occurrences were surveyed and last observed in 2005, however, known populations on Forest Service property have been resurveyed (Cipollini and Cipollini 2011) and monitored annually, either by Forest Service personnel or by the West Virginia Department of Natural Resources WVDNR. Habitat includes sinkhole ponds atop a low, flat sandstone ridge, and small seasonal ponds. Two of these sites are located on private lands, and one is located on National Forest land managed by the U.S. Forest Service (USFWS 2008).

The northeastern bulrush has no official status in West Virginia, and this State does not have an endangered species law. No upland buffers are required around any wetlands in the State.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Among the potential human threats are agricultural runoff, construction of logging and fire roads, development, all-terrain vehicle use, collection, and dredging. In addition to human activity, there may be natural threats to the species as well, although more information about the biology and ecology of the species is needed before these threats can be fully assessed. Among possible natural threats are deer, beaver (one Vermont population has suffered fluctuations, apparently as a result of beaver activity), natural water level fluctuations, fire (this may have damaged a population in Pennsylvania), and succession. Fluctuations in population size have been observed at several localities for the species. It is very likely that botanists visiting the known sites for the species do not identify vegetative plants, and it is possible that, in some cases, the fluctuations are in number of flowering/ fruiting culms rather than actual number of plants.

The 5-year review of northeastern bulrush by the USFWS stated that new information indicates that shading may be a threat, "Therefore, in some cases, it may be helpful to manage the habitat surrounding these sites by selectively removing larger trees to reduce canopy cover to increase light exposure" (USFWS 2008). The 5-year review also noted that alterations of the hydrology of wetlands supporting northeastern bulrush could have negative effects.

Exotic organisms may pose threats to northeastern bulrush populations in the near future. Purple loosestrife, *Lythrum salicaria*, is slowly spreading through Virginia and may eventually invade some northeastern bulrush sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth (*Lymantria dispar*) is currently defoliating large areas of the Forest and adjacent lands but it is unclear whether if or how the gypsy moth will negatively impact northeastern bulrush populations.

The known occurrences of this species on the Forest are protected under all alternatives, except A (the 1993 Revised Forest Plan), as management prescription 4D, Special Biological Area. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. Without regular monitoring and maintenance the cumulative impacts of the OHV trail that passes near the pond on Potts Mountain have the potential to negatively affect the pond and the northeastern bulrush through illegal OHV use (or through maintenance of the OHV road affecting the hydrology of the area. The Pond Run Pond site is very near the intersection of two trails that are used by hikers and horses. In the past there has been evidence of horses in the pond basin, although there has been no apparent negative impact to the Northeastern bulrush. In 2009 the U.S. Forest Service constructed a barbed wire fence that is keeping horses out of the pond. Shading has also been a concern at this site and over the past several years a slow process of girdling trees has been occurring that appears to have increased the number of flowering columns.

Madison Cave Isopod

AFFECTED ENVIRONMENT

The Madison Cave isopod was federally listed as a threatened species in 1982. It is an eyeless, unpigmented, freshwater crustacean, belonging to a family that consists of mostly marine species. It is the only free-swimming stygobitic isopod known in the Appalachians (Holsinger et al. 1994). With a maximum length of 0.7 inches, its body is flattened and bears seven pairs of long walking legs; the first pair is modified as grasping structures (USDI 1996).

The Madison Cave isopod is found in flooded limestone caves beneath the Shenandoah Valley in Virginia and West Virginia where it swims through calcite-saturated waters of deep karst aquifers. It is known from 19 caves and wells, spanning a range 150 miles long and less than 15 miles wide, stretching from Lexington, VA to Charles Town, WV (Hutchins et al. 2010). There are documented population centers in the Waynesboro-Grottoes area (Augusta County, VA), the Harrisonburg area (Rockingham County, VA), and the valley of the main stem of the Shenandoah River (Warren and Clarke counties, VA and Jefferson County, WV) (USDI 2009).

The population size of the Madison Cave isopod is unknown at most sites. Sampling results suggest that the population is dominated by adults. It is thought that the isopod has a lengthy life span and low rate of reproduction; it is unknown how this species reproduces. Feeding habits are unknown, but it is believed to be carnivorous (USDI 2009).

Recent genetic studies of the Madison Cave isopod indicate there are three genetically distinct clades corresponding to three geographic groups of sites. The groups are strongly correlated with the geographic pattern of carbonate rock outcropping in the Shenandoah Valley indicating potential barriers to subterranean hydrologic connectivity (Hutchins et al. 2010).

The Madison Cave isopod is not known from the Forest, the closest occurrence is approximately four miles straight line distance to Forest Service land. To date, all known collections of the Madison Cave isopod have come from caves and wells that tap into the karst aquifer(s) hosted by and formed in Cambro-Ordovician aged carbonate bedrock (limestone and dolostone) of the Great Valley province in Virginia and West Virginia. Orndorff and Hobson (2007) combined Great Valley outcrop areas of the following units from the 1993 Geologic Map of Virginia (VA-DMR, 1993) to create a map of potential habitat for Madison Cave isopods in Virginia: Shady Dolomite, Tomstown Dolomite, Elbrook Formation, Conococheague Formation, Upper Cambrian and Lower Ordovocian Formations (undivided), Beekmantown Group (including Stonehenge, Rockdale Run, and Pinesburg Station Formations), and the Edinburg/Lincolnshire/New Market association. The following additional formations have some minor carbonate units, and have a small potential to host the species: Waynesboro Formation, Pumpkin Valley Shale (including Rome Formation). Carbonate rocks in the base of the Martinsburg Formation, immediately adjacent to the Edinburg/Lincolnshire/New Market association, may also host the species, but are generally confined to an area within a few hundred feet of the contact.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The potential habitat described above was divided into high, medium, and low probability of Madison Cave isopod occurrence by the Virginia Division of Natural Heritage (Orndorff and Hobson 2007). The high and medium likelihood potential habitat was intersected with Forest Service land boundaries to determine quantity and quality of potential habitat on National Forest. Only about 300 acres on National Forest System lands are in the high probability potential Madison Cave isopod habitat. About 400 acres are in the medium probability potential habitat. With no known populations on the GWNF and the very limited amount of land in potential habitat, none of the alternatives are expected to have any impact on this species.

The high probability potential habitat is within the Remote Backcountry Management Area Prescription (12D) along the western flank of Massanutten Mountain in all alternatives except Alternative C, where it is in Recommended Wilderness Study. The emphasis for this area is to provide recreation opportunities in large remote, core areas where users can obtain a degree of solitude and the environment can be maintained in a

near-natural state. There is little evidence of humans or human activities other than recreation use and nonmotorized trails.

In Alternatives A, B, D, E, G, H and I the majority of the medium probability potential habitat is within the Pastoral Landscapes and Rangelands Management Area Prescription (7G), along the South Fork Shenandoah River; emphasis is on maintaining high quality, generally open landscapes with a pastoral landscape character. These lands are unsuitable for timber production but allow limited recreational facilities, that might include pullouts, small parking areas, trailheads, bulletin boards, interpretive signage, fence stiles, rail, and other fences, and low development trails. In Alternative C the majority of the medium probability potential habitat is in the Eligible Recreation River Corridor Management Area Prescription (2C3).

The Madison Cave isopod appears to be long-lived and have low reproductive potential, suggesting that populations are highly sensitive to disturbance. As a subterranean aquatic obligate, potential threats include the loss and modification of habitat (including the surface environment that is their primary source of water and nutrients), groundwater contamination, and groundwater drawdown (USDI 1996). Agriculture and encroaching industrial and urban development threaten the quality and quantity of groundwater habitat and thus the survival of this species (USDI 2009).

To protect Madison Cave isopod habitat, the USDI Fish and Wildlife Service (2009) recommends avoiding chemical and fertilizer use where it could enter a waterway that supports the Madison Cave isopod, maintaining a buffer of natural vegetation along waterbodies and sinkholes to control erosion and reduce run-off, not disposing of waste or other material into sinkholes, fencing livestock out of streams, properly disposing of household wastes, including used motor oil, and properly maintaining septic tanks. Forest Service activities meet or exceed all of the above recommendations. Based on the limited amount and type of management proposed in the management prescriptions that intersect with potential Madison Cave isopod habitat, there will be no loss or modification of karst aquifer habitat, groundwater contamination, or groundwater drawdown from Forest Service activities; thus no effect to potential habitat.

The strategy on groundwater issues that cross national forest boundaries and are affected by multiple region-wide impacts such as increased agricultural use, growing urban development, is to focus on sustaining and improving watershed areas within national forest control while working cooperatively with other agencies and landowners to improve statewide watershed health.

The high probability potential Madison Cave isopod habitat identified by Orndorff and Hobson (2007) is 352,205 acres; the Forest Service portion of that is 280 acres, or 0.08%. The medium probability potential habitat is 513,215 acres, with the Forest Service owning 428 acres, or 0.08% (see table below).

Table 3B2-8. Percent Potential Madison Cave Isopod Habitat on the GWNF

Madison Cave Isopod habitat probability	Total acres potential habitat	FS acres potential habitat	Percent potential habitat on FS land
High	352,205	280	0.08
Medium	513,215	428	0.08

The species range is the Shenandoah Valley in Virginia and West Virginia; it is mostly private land, where agriculture, urban and industrial development dominate the landscape. Because there will be no direct or indirect effects to Madison Cave isopod from Forest Service management activities, and only a fraction (less than a tenth of one percent) of potential habitat is on Forest Service land, any cumulative effects to the quality or quantity of Madison Cave isopod habitat will be from private land.

Summary

Table 3B2-9. T&E species, Associated Ecological Systems, and Management Strategies

Species	Ecosystem	Management Strategies
Indiana Bat	Caves and Karstlands	Management Prescription Areas: designation of the primary and secondary Indiana bat cave areas Standards/Guidelines: standards for activities within the primary and secondary Indiana bat cave areas; standards for activities throughout the Forest in regard to leave trees during timber harvest activities Objectives: improvement of habitat through increased open woodlands
Virginia Big-Eared Bat	Caves and Karstlands	Standards: Cave standards
James Spinymussel	Floodplains, Wetlands and Riparian Areas	Standards: Riparian standards
Northern Flying Squirrel	Spruce, Northern Hardwoods	Management Prescription Areas: All known locations are in Special Biological Areas
Shale Barrens Rock Cress	Appalachian Shale Barrens	Management Prescription Areas: All known locations are in Special Biological Areas
Smooth Cone Flower		Management Prescription Areas: All known locations are in Special Biological Areas
Virginia Sneezeweed	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biological Areas Standards: Riparian standards
Swamp Pink	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biological Areas Standards: Riparian standards
Northeastern Bulrush	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas All known locations are in Special Biological Areas Standards: Riparian standards
Madison Cave Isopod	Caves and Karstlands	Standards: Cave standards Standards: Riparian standards

B2C – DEMAND SPECIES

The discussions of changes in habitat by alternative in the following sections are based on information from previous sections. The effects of each alternative on key habitat features across ecological forest types are discussed in detail in the Ecosystem Diversity Report (EIS, Chapter 3, Section B1 and Appendix E) and Species Diversity Report (EIS, Chapter 3, Section B2 and Appendix F). Tables 3B1-1, 3B1-2, 3B2-2, and 3B2-3 display Ecosystem and Species Group Indicators that quantify current conditions and desired conditions of these major habitat components, by ecosystem and alternative, over a ten and fifty year period. Unless otherwise noted, figures from these tables are used in the analysis of future trends.

The tables in this section are based on the levels of timber harvest and prescribed fire displayed in Table 3B2-11.

White-Tailed Deer

AFFECTED ENVIRONMENT

White-tailed deer (*Odocoileus virginianus*) use a wide variety of forest types and successional stages to meet their year-round needs. In the central Appalachians, deer are found in all forest types and use various successional stages during their annual life cycle (Johnson et al. 1995; VDGIF 2007; WVDNR 2011). Older forests are important in the fall and winter, when acorns become a dominant fall and winter food item (Wentworth et al. 1990a). Deer nutrition, reproduction, weights, and antler characteristics can be influenced by the availability of acorns (Harlow et al. 1975; Feldhammer et al. 1989; Wentworth et al. 1990a, 1992). Year-round use of vegetation in the form of woody browse, soft mast, forbs and grasses is extremely important and found most abundantly in early successional woody habitat, open woodland, grasslands, and shrublands of varying sizes (Wentworth et al. 1990b; Ford et al. 1993; VDGIF 2007). High quality deer habitat is characterized by the interspersion of mature forested and other habitats that provide not only food sources, but escape cover (VDGIF 2007). In eastern hardwood forests, Barber (1984) recommended that at least 50% of the landscape should consist of mature mast trees, with the remainder containing an interspersion of evergreens, shrubs and vines, and openings with herbaceous and early successional woody vegetation. Based on utilization data, current deer densities in the Southern Appalachians can be maintained by providing approximately 5% of the landscape in regenerating forest vegetation (Wentworth et al. 1990b). Wentworth and others (1989) concluded that approximately 2% of the area in high quality grasslands and shrublands would be necessary to adequately buffer the effects of a poor acorn year.

White-tailed deer are present throughout the Region. Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the Southern Appalachian Assessment area (SAMAB 1996). High population densities are associated with greater amounts of cropland and lesser amounts of developed and coniferous forestland. Current deer densities are generally higher on private lands than on national forest and state lands in Virginia (VDGIF 2007).

FOREST TRENDS

The GWNF comprises approximately 960,000 acres (90%) in thirteen Virginia counties and 105,000 acres (10%) in four West Virginia counties, for a total of 1,065,000 total acres, of which 1,058,000 is forested. There are approximately 240,000 hunters in Virginia and 245,000 in West Virginia that hunt deer (VDGIF 2007, WVDNR 2011). Recreation generated primarily by deer hunting produces approximately $221 million in Virginia and $247 million in West Virginia annually (USFWS 2011). Ninety-two percent of available deer habitat in Virginia exists on private land, whereas eight percent is found on public land (state, federal, other public ownership)(VDGIF 2007). Eighty-seven percent of available deer habitat in West Virginia is also found on private land, with 13 percent on public land (WVDNR 2011).

Virginia. Current population reconstruction models indicate that Virginia's statewide deer population has been relatively stable over the past decade, fluctuating between 850,000 and 1,000,000 animals (VDGIF 2012). In Virginia, deer population trends were evaluated by examining the annual rate of change in the population index (i.e., antlered buck harvest per unit area) over the 10-year period from 2000-2010. An exponential regression (y = aert; where, y = population index, a = intercept, e = 2.718, r = instantaneous rate of change, and t = year) was used to determine trends in population. The annual rate of change (R) = er – 1. The status of the deer population in each county was considered to be increasing or decreasing if the annual rate of change in the population index was >2.26% (either positive or negative) and the statistical significance level of the exponential regression model was $p < 0.10$ (r2 Value > 0.301). Annual rates of change that exceeded 2.26% represent a change of at least 25% in the population index over the decade (1.022610 = 1.25). Counties that displayed a rate of change between 0 and +2.26 were deemed to be stable. Overall on the GWNF in Virginia, 9 counties, representing 660,476 acres (69% of the 960,000 of total acres in Virginia) demonstrated stable population trends, and 4 counties, representing 295,788 acres (31%) demonstrated decreasing trends. Since 2000, VDGIF harvest data has suggested a more substantial decline across much of the GWNF. In contrast, private land in the same counties ranges from stable to increasing trends (VDGIF 2013).

Table 3B2-10. White-tailed Deer Population Index Trend across the GWNF in Virginia, 2000 to 2010 (Source: VDGIF)

County	Percent GWNF in County	Number of GWNF Acres in County	Ranger Districts Included	R[1]	p[2] Value	Status
Allegheny	49	141,873	James River, Warm Springs	-3.23%	0.180	Stable
Amherst	19	57,877	Pedlar	-6.90%	0.762	Decreasing
Augusta	30	196,057	North River, Pedlar	-1.80%	0.168	Stable
Bath	51	173,705	North River, Warm Springs	-4.70%	0.299	Stable
Botetourt	4	13,047	James River,	-3.04	0.325	Decreasing
Frederick	2	4,885	Lee	-4.58	0.297	Stable
Highland	22	58,267	North River, Warm Springs	-4.80%	0.269	Stable
Nelson	7	19,825	Pedlar	-4.39%	0.254	Stable
Page	13	27,082	Lee	-0.12%	0.002	Stable
Rockbridge	12	45,542	North River, James River, Pedlar	-3.85%	0.374	Decreasing
Rockingham	25	139,783	North River, Lee,	-5.15%	0.545	Decreasing
Shenandoah	23	76,057	Lee	-1.98%	0.284	Stable
Warren	5	6,290	Lee	2.95%	0.150	Stable

[1] R = Percent annual change in population index. Values less than -2.26% and values greater than 2.26% are considered significant (1.0226^{10} = 1.25 or a 25% increase or decrease over the 10-year period).
[2] p = Statistical significance level of exponential regression model. Values ($p < 0.10$) are considered significant.

Statewide, VDGIF reports an 8% decrease in total number of deer harvested in 2012 compared to 2011, with the total number harvested 8% below the last 10-year average of 232,573. The Department's primary deer management effort over the past five years has been to increase the female deer harvest over much of the state, especially on private lands. This higher level of deer harvest is intended to lead to a decrease in the statewide deer herd. The deer harvest totals over of the past three years would appear to suggest these management efforts have been successful (VDGIF 2013).

West Virginia. From 1945 through 2010, a total of 5,472,196 deer have been harvested in West Virginia, with 50% of the total recorded deer harvest during the period occurring in the last 15 years (WVDNR 2011). West Virginia estimates their current deer population as an index of antlered deer harvest. Estimated deer per square mile of land in West Virginia increased steadily from 1945 to 2001 to a peak of 43 deer/square mile, then declining from 2002 to 2010 to an estimated 25 deer/square mile or less (WVDNR 2011). As a basis for comparison with Virginia deer trends in terms of total deer harvested, West Virginia reported an increasing total of 150,000 to 250,000 annually from 1993 – 2002, then a decreasing total of 200,000 to 125,000 annually from 2002 – 2010.

Virginia's revised Deer Management Plan has an objective to stabilize deer populations on public land in western Virginia (VDGIF 2007). West Virginia's Revised Deer Management Plan has an objective to maintain a healthy deer population at levels compatible with biological and sociological conditions, while providing a diversity of hunting opportunities and other associated recreational benefits (WVDNR 2011). Both revised Deer Management Plans recommend supporting habitat management objectives on public lands that manipulate vegetation for early successional wildlife and promote restoration, regeneration, and productivity of plant species important to wildlife, particularly those that provide diverse hard and soft mast (e.g., American chestnuts, acorns, grapes, and berries). Deer densities are normally greater in areas of high quality browse, hard mast production of both red and white oaks, and well distributed, high quality grassland/shrublands. These conditions are most influenced by soil fertility and are more common where there is an intermingled ownership of private and National Forest System lands. Many deer populations, especially on private land, have experienced steady increases over the past decades (VDGIF 2007; WVDNR 2011). Deer densities are managed in part by controlling the number of antlerless deer hunting days. Liberalized hunting regulations over several years appear to have stabilized the herd growth for most areas in Virginia, especially on private land (VDGIF 2013).

Chronic Wasting Disease (CWD) was discovered in the deer population in Hampshire County, WV in 2005 and 2009 in Frederick County, VA (WVDNR 2011; VDGIF 2013). CWD is a fatal neurological disease impacting deer and other large herbivores such as elk and moose (VDGIF 2013). The long-term impacts to deer, elk, and moose populations are of serious concern to state and federal wildlife management agencies. A deer infected with CWD may take up to 5 years to show symptoms; CWD can be spread through deer to deer contact, as well as through contaminated soil and other surfaces (VDGIF 2013). Currently, there is no evidence that CWD is transmissible to humans, pets, or livestock, but public health officials recommend that human exposure to the CWD agent be avoided in areas where CWD in deer populations is documented (VDGIF 2013). A CWD Containment area has been established in portions of Hampshire, Hardy, and Morgan counties in West Virginia, and portions of Frederick and Shenandoah counties in Virginia. These containment areas include portions of the Lee ranger district on the GWNF. Personnel with the GWNF are working cooperatively with both state agencies as they enact their CWD Response Plans.

VDGIF deer management objectives are based on the Cultural Carrying Capacity (CCC) and are intended to stabilize the deer population on public lands on all thirteen Virginia counties of the GWNF (VDGIF 2007). WVDNR deer management objectives are aimed to be compatible with biological and sociological conditions and are defined by administrative district (WVDNR 2011) The quality of deer habitat has declined in recent years on GWNF lands in many western Virginia and eastern West Virginia counties because of maturing forest habitat conditions, declining early successional woody habitat for browse and cover, and a declining number of maintained grassy/shrubby openings. The Virginia Department of Game & Inland Fisheries (VDGIF) and West Virginia Division of Natural Resources recommends implementation of habitat management improvements that are beneficial to deer on over 1% annually of the total GWNF acreage (VDGIF 2011; WVDNR 2011). This includes an increase in timber harvest and prescribed fire that creates early successional woody and open woodlands habitat, and restoration and maintenance of grasslands and shrublands. Such habitat creation should be well dispersed across the otherwise mature forested landscape of the GWNF.

DIRECT AND INDIRECT EFFECTS

Deer habitat quality and numbers are directly associated with soil quality, habitat type, successional stage, and the amount of habitat interspersion or edge (VDGIF 2007). The importance of a diversity of hard mast producers, successional habitat for browse, and grasslands/shrublands, each being well distributed across the landscape to meet the year-round needs of deer, has been previously discussed. The effects of each alternative on key habitat features across ecological forest types are discussed in detail in the Ecosystem Diversity Report (EIS, Appendix E) and Species Diversity Report (EIS, Appendix F). Tables 3B1-1, 3B1-2, 3B2-2, and 3B2-3 quantify current condition and desired conditions of these major habitat components, by ecosystem and alternative, over a ten and fifty year period.

Table 3B2-11 depicts the acres of active management activities planned annually under each alternative. The four activities that have the greatest influence on deer habitat quality is early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Table 3B2-11. Planned Annual Activities in acres, by Alternative

Active management activities	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Timber regeneration harvest	2,400	700	1,800-3,000	0	3,000-5,000	1,800-3,000	1,000-1,800	1,800-3,000	1,800-3,000
Prescribed fire	3,000	7,400	12,000-20,000	0	5,000-12,000	20,000	12,000-20,000	12,000-20,000	12,000-20,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving deer habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2007). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for deer. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for deer and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for deer. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat Dense grassy/shrubby escape cover for fawns vulnerable to predators such as coyotes and black bears is more effective when it is in a 500 to 1,000 acre patch of open woodlands (average prescribed burn block) than a 25-40 acre patch of early successional forest habitat (average timber treatment unit) or a 1-5 acre grassland/shrubland patch (average size of wildlife opening).

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 acres at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands. The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 86% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for white-tailed deer (VDGIF 2007).

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

Land ownership patterns. Land ownership patterns on the GWNF are characterized by a high percentage of ridges and sideslopes, with less than 10% percent in valley land. Valley land has historically been more profitable to own and has therefore tended to stay in private ownership. In the ridge and valley areas of Virginia and West Virginia, valley lands are characterized by a mixture of open fields, crops, some woodlands, and farms and communities. Deer populations routinely forage in the mix of valley habitats and move upslope onto mostly forested ridges and sideslopes to rest and forage when hard mast is seasonally available (Knox 2012; WVDNR 2011). Since much of the valley land where GWNF lands are found is privately owned, it is reasonable to assume many deer herds on the GWNF incorporate some percentage of adjacent private land in their home ranges. Mixed ownership patterns can affect deer population distribution on the GWNF in several ways. A mix of habitats may be provided on adjacent private lands that can help meet forage needs for deer along the public/private ownership zone Deer movement on and off GWNF lands and adjacent private lands can potentially cause damage to crops and pastures, becoming a nuisance to private landowners. Such movements can result in private landowner requests for kill permits and demands for increased harvest objectives on private lands to address these issues (Knox 2012; VDGIF 2007). The opportunity for hunting deer on the GWNF can be positively affected by increased foraging opportunities to local deer herds from adjacent private land, and can also be negatively affected by lower deer populations on GWNF, due to higher harvest objectives and kill permits on adjacent private lands where deer are consider a nuisance. Increased early successional habitat, open woodlands, and grasslands on GWNF in a number of alternatives will help provide year-round habitat for deer populations, but with the high amount of adjacent private land ownership in predominately richer valley habitat, it is reasonable to expect deer herds to continue moving on and off GWNF lands and adjacent private land as part of their home ranges, and therefore be impacted by higher private land harvest objectives and deer kill permits.

Predation and disease. In addition to habitat quality, white-tailed deer populations can be regulated by other factors, such as predation and disease. In recent decades, both black bear and coyote populations have increased across the state of Virginia and are known to opportunistically prey on white-tailed deer, especially fawns and older or diseased adults (Knox 2011; VDGIF 2012). The current and long-term impacts of these and other predators on the white-tailed deer population are unknown at this time (Knox 2011). Chronic Wasting Disease (CWD) was discovered in the wild deer population in Hampshire County, WV in 2005 and 2009 in Frederick County, VA (WVDNR 2011; VDGIF 2013). CWD is a fatal neurological disease impacting deer and other large herbivores such as elk and moose (VDGIF 2013). The long-term impacts to deer, elk, and moose populations are of serious concern to state and federal wildlife management agencies. A deer infected with CWD may take up to 5 years to show symptoms; CWD can be spread through deer to deer contact, as well as through contaminated soil and other surfaces (VDGIF 2013).

Deer browse impacts. Deer are large herbivores and their browsing activities can affect both plant and animal communities, either directly or indirectly (VDGIF 2007). Deer populations can increase to the point of exceeding the biological carrying capacity (overpopulation) of the area, where development of early successional habitat for food and hunting are not allowed (VDGIF 2007). Some plants of the families Liliaceae and Orchidaceae can be especially vulnerable to deer browse. The goal of both VDGIF and WVDNR is to

manage each state's deer population through hunting and other regulations to moderate populations below the biological carrying capacity (VDGIF 2007; WVDNR 2009). National Forest System lands receive annual hunting to control deer densities, with the goal of preventing over-population of these areas and thus reduce negative effects of browse pressure on plant diversity and protect the viability of herbaceous ground flora in these areas.

In summary, the combination of habitat components important for white-tailed deer habitat are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, G, H and I. In response to increased favorable habitat conditions, white-tailed deer populations would be expected to stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, white-tailed deer populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest. Under all alternatives, the high percentage of public/private interface on the GWNF will impact the deer population along this interface, as long as adjacent private lands have higher harvest objectives and are allowed kill permits in response to damage complaints.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for white-tailed deer. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including white-tailed deer. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for white-tailed deer at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term deer populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, H, I and D. Long-term deer populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Table 3B2-12. Projected Habitat Components in Acres and Percentage of Forested Landscape at 10 years by Alternative

Habitat Component	Units	Current Conditions	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Early Successional Forest from Natural Disturbances	Acres	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Early Successional Forest from Timber Harvest	Acres	13,600	24,000	7000	18,000-30,000	0	30,000 - 50,000	18,000-30,000	10,000-18,000	18,000-30,000
	%	1%	2%	1%	2-3%	0%	3-5%	2-3%	1-2 %	2-3%
Open Woodlands from Natural Disturbances	Acres	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Open Woodlands from Prescribed Fire	Acres	22,500	35,900	53,600	64,500 - 99,000	6,100	43,900 - 64,500	99,000	64,500 - 99,000	64,500 - 99,000
	%	2%	3%	5%	6 - 9%	1%	4 - 6%	9%	6 - 9%	6 - 9%
Grassland/ shrublands	Acres	4,300	5,400	5,800	6,700	3,400	6,000	6,700	6,700	6,700
	%	0%	1%	1%	1%	0%	1%	1%	1%	1%
Total acres of combined active management habitat components	Acres	40,300	65,300	66,3008	89,200 - 135,700	9,500	79,800 - 120,500	123,700 - 135,700	81,200 - 123,700	89,200 - 135,700
	%	4%	6%	6%	8 - 13%	1%	8 - 11%	12 - 13%	8 - 12%	8 - 13%
Mid- to late successional Hard Mast Producing Forest	Acres	937,800	927,300	950,400	921,300	951,300	908,300	933,300	941,300	921,300
	%	89%	88%	90%	87%	90%	86%	88%	89%	87%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Table 3B2-13. Projected Habitat Components in Acres and Percentage of Forested Landscape at 50 Years by Alternative

Habitat Component	Units	Current Conditions	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Early Successional Forest from Natural Disturbances	Acres	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Early Successional Forest from Timber Harvest	Acres	13,600	24,000	7,000	18,000-30,000	0	30,000 - 50,000	18,000-30,000	10,000-18,000	18,000-30,000
	%	1%	2%	1%	2-3%	0%	3-5%	2-3%	1-2 %	2-3%
Open Woodlands from Natural Disturbances	Acres	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Open Woodlands from Prescribed Fire	Acres	22,500	42,700	87,400	108,700 - 170,600	12,200	66,600 - 108,700	170,600	108,700 - 170,600	108,700 - 170,600
	%	2%	4%	8%	10 - 16%	1%	6 - 10%	16%	10 - 16%	10 - 16%
Grassland/ shrublands	Acres	4,300	5,500	6,400	8,100	3,500	6,900	8,100	8,100	8,100
	%	0%	1%	1%	1%	0%	1%	1%	1%	1%
Total acres of combined active management habitat components	Acres	40,300	72,300	100,800	134,800 - 208,800	15,800	103,500 - 165,500	196,700 - 208,700	126,800 - 196,700	134,800 - 208,700
	%	4%	7%	10%	13 - 20%	2%	10 - 16%	19 - 20%	12 - 19%	13 - 20%
Mid- to late successional Hard Mast Producing Forest	Acres	937,800	927,300	950,400	921,300	951,300	908,300	933,300	941,300	921,300
	%	89%	88%	90%	87%	90%	86%	88%	89%	87%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Eastern Wild Turkey

AFFECTED ENVIRONMENT

Eastern wild turkey (*Meleagris gallopavo*) occupies a wide range of habitats, with diversified habitats providing optimum conditions (Schroeder 1985; VDGIF 2013). This includes mature mast-producing stands during fall and winter, shrub dominated stands for nesting, and herb dominated communities, including grasslands, for brood rearing. Habitat conditions for wild turkey can be enhanced by management activities such as prescribed burning and thinning (Hurst 1978; Lafon et al. 2001; Norman et al. 2001; Pack et al. 1988; Steffen et al. 2002; VDGIF 2013), and the development of herbaceous openings (Nenno and Lindzey 1979; Healy and Nenno 1983).

For the eastern hardwood region, Wunz and Pack (1992) recommended maintaining 50 to 75% of the area in mast producing condition and approximately 10% in well distributed permanent grassland/shrublands and/or open woodlands, in addition to the early successional woody habitats that result from timber harvest and other activities. Forest thinning is recommended to enhance the herbaceous component of mid-successional forests. Prescribed burning to create and maintain open woodland structural conditions is important for brood and year-round foraging habitat. Other important habitat components include spring seeps, especially in areas with regular snow cover, and a diversity of soft mast producing plants (e.g. dogwood, black gum, grape, blueberries, etc.). Especially in northern hardwoods and high elevations in western Virginia, conifer cover (e.g., pines, cedars) provides an important roosting habitat for wintering birds (VDGIF 2013).

Eastern wild turkeys are present throughout the Region. Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the SAA area (SAMAB 1996; VDGIF 2013). High population densities are associated with greater amounts of oak forest and cropland, and lesser amounts of developed and coniferous forestland. Wild turkey populations have expanded in range and density in the last 25 years. As with deer, this increase likely is related to both nonhabitat factors such as extensive restoration efforts, protection, and conservative harvest strategies as well as increased acorn capability resulting from the increase in mid-to late successional oak forests.

FOREST TRENDS

Wild turkey population trends are monitored by the Virginia Department of Game and Inland Fisheries (VDGIF) and West Virginia Division of Natural Resources (WVDNR). Population trends, in terms of harvest/square mile, vary over the years, but indicate an overall stable to decreasing trend in counties with GWNF lands. WVDNR reported a decreasing trend in spring gobbling rate in 2012 (34.8 gobblers heard/ 100 hours), which was 17% lower than 2011 and 34% lower than the 30 year average of 52.6 gobblers heard/100 hours (WVNDR 2013). Total turkey brood observations in 2012 were 38.8% less than the 5-year average.

Table 3B2-14. Population Trends Based on Spring Gobbler Harvest on Counties with GWNF in Virginia, 2003-2012 (Source: VDGIF 2013)

County	Population Growth		
	Annual Growth (%)[1]	P-Value[2]	Trend Status[3]
Allegheny	-4.4	0	Decreasing
Amherst	-5.8	0.005	Decreasing
Augusta	-1.7	0.452	Stable
Bath	-6.4	0.012	Decreasing
Botetourt	-4.1	0.03	Decreasing
Frederick	-2.3	0.237	Stable
Highland	-3.7	0.22	Stable

County	Population Growth		
	Annual Growth (%)[1]	P-Value[2]	Trend Status[3]
Nelson	-3.3	0.068	Decreasing
Page	-3.8	0.15	Stable
Rockbridge	-3.2	0.016	Decreasing
Rockingham	-7.7	0	Decreasing
Shenandoah	-1.7	0.44	Stable
Warren	1.4	0.515	Stable

[1] Based on the 10-year (2003-2012) exponential regression, $N_{10}=N_0*I^{10}$; where N_0 = spring gobbler kill in 2012, N_0=spring gobbler kill in 2003, and I = finite population rate of change. The average growth rate (R) is: R = 100*(I -1).
[2] Probability that the growth trend was not significant.
[3] Trends that were either not significant (P>0.1) or had annual growth between -2.0% and 2.0% were considered stable. Counties with significant trends (P<0.1) and rates that exceeded 2.0% growth were considered increasing. Decreasing counties had significant growth rates less than -2.0%.

DIRECT AND INDIRECT EFFECTS

Wild turkeys require a mixture of various successional stage habitats to meet their year-round habitat needs, as previously mentioned. Key requirements include the interspersion of mature mast producing forest during fall and winter, early successional woody habitat, grassland/shrublands and open woodlands for nesting (early successional habitat), and grasslands and open woodlands for brood range and year-round foraging (Lafon et al. 2001; Norman et al. 2001; Steffen et al. 2002; VDGIF 2013).

Four management activities that have a significant influence on wild turkey habitat quality are early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving wild turkey habitat depends on many factors, including site quality,

stand conditions, and fire prescriptions (VDGIF 2010). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape can provide high quality year-round food, nesting, brood-rearing habitat, and seasonal cover for wild turkeys. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for wild turkeys and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for turkeys.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands (Table 3B2-12). The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 86% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for wild turkeys.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

The availability of grasslands/shrublands, open woodlands, and early successional woody habitat for nesting, brood range, and year-round forage is the most limiting factor to wild turkey populations on the GWNF (VDGIF 2013). The combination of habitat components important for wild turkeys are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, G, H and I. Wild turkey populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, wild turkey populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for wild turkey. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including wild turkey. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for wild turkey at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term wild turkey populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, H, I and D. Long-term wild turkey populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Ruffed Grouse

AFFECTED ENVIRONMENT

Ruffed grouse (*Bonasa umbellus*) utilize a variety of forest habitats, as well as openings within the forested landscape (ACGRP 2004; Harper et al. 2005). Each season brings changes in biological activities of ruffed grouse and the environment in which they live. In the Appalachians, grouse adjust by using forest stands with seasonal foods in or near adequate cover. Ruffed grouse reproduction, recruitment, and survival determine year-to-year grouse abundance. Lack of nutritious food and suitable cover are often cited as limiting factors for Appalachian grouse populations. The location, proximity, and design of active forest management, with respect to seasonal habitat requirements, in large part determine the success of ruffed grouse populations. Important components of grouse habitat include an interspersion of mesic forests with herbaceous ground cover, young hardwoods 3-20 years old with high stem densities, mature stands with mast producing trees, and grassland/shrublands, open woodlands, and gated forest roads with abundant legumes and other forbs.

Nesting cover generally is located in poletimber or larger hardwood stands (Harris 1981; Thompson and Dessecker 1997). Haney (1996) also reported use of mature cove hardwood forests in the Southern Appalachians for nesting and brood rearing.

Some key features of brood cover are security and an abundant high protein food source. Insects are most abundant in habitats characterized by dense herbaceous vegetation (Dimmick et al. 1996). Thompson and Dessecker (1997) describe brood cover as 3-7 year-old regenerating stands containing significant herbaceous component through shrub dominated old fields and herbaceous openings such as grasslands, open woodlands, and sides of roads. Dimmick and others (1996) suggest that the lack of interspersion of areas with a well-developed herb layer and areas of high stem density for protective cover may be one of the limiting factors in southeastern grouse populations. They suggest that brood habitat could be enhanced by the conversion of logging roads and log landings to linear food plots by planting clover/grass mixtures, which would provide bugging areas in close proximity to secure cover.

Adult cover, including drumming habitat, usually consists of young regenerating forest (6-15 year-old) or shrub cover (Thompson and Dessecker 1997). The dense cover provides protection from both avian and mammalian predators. Secure cover is provided in habitats with good vertical structure (8,000+ stems/acre) of 15-20 foot saplings (Kubisiak 1989). Dimmick and others (1996) reported that males began to orient their drumming sites around or in clearcuts within 3 years post-harvest. In Georgia, drumming habitat was associated with the presence of a relatively dense understory of heath shrubs; primarily flame azalea and mountain laurel (Hale et

al. 1982). No strong preference for timber types or stand condition classes was evident. Harris (1981) found that males preferred upland hardwood sawtimber, generally associated with evergreen shrub thickets during the breeding and post breeding seasons.

Dimmick and others (1996) found that breeding male density (based on drumming counts) increased significantly in response to clearcutting in Tennessee. A similar response to timber harvest was reported from oak-dominated forests in Missouri (Wiggers et al. 1992). Highest grouse densities occurred where 7-to-15 year-old hardwood regeneration comprised greater than 14% of the area.

In oak forests of the Central Hardwood region, Thompson and Dessecker (1997) recommended managing on an 80-year rotation that would maintain approximately 15% of the forest in brood or adult cover (3-15 years old). Appropriate regeneration methods include clearcut, seedtree, and shelterwood. Residual basal areas should not exceed 20 square feet per acre. Cutting units should be > 5 acres, and preferably 10-40 acres in size. Group selection is not recommended since the regeneration patches are too small to provide large enough patches of contiguous habitat. In oak-hickory forests, hard mast (acorns and beechnuts) is a critical winter food for grouse. Therefore, it is important to juxtapose mature oak stands adjacent to timber treatments so foraging opportunities for acorns and other mast are not limited (ACGRP 2004; Harper et al. 2005). Positioning timber treatments mid-slope can provide important escape cover for grouse traveling between ridge-top drumming sites, roost sites, and bottomland foraging sites. Another important consideration is to regenerate or, at least, to thin stands along riparian zones, which are preferred habitats for ruffed grouse during winter and summer when a dense stem density is present. Thinning forest stands can improve ruffed grouse habitat if those species that do not produce preferred food resources (e.g. maples, yellow poplar, ashes, and sourwood) are targeted for removal, while more desirable species (e.g. oaks, black cherry, serviceberry, birches, American beech) are retained. Thinning allows increased sunlight into the forest stand, stimulating understory vegetation. Typically, mesic sites will produce more herbaceous vegetation, while xeric sites will produce more woody cover. Regardless of site, soft-mast production by species such as blueberry, huckleberry, blackberry, and raspberry can be expected to increase 2-5 years post treatment. Where riparian issues do not allow removal of timber, 'wildlife' cuts, in which selected trees are cut and left on site, or girdled to become snags, is an alternative method to regenerate or thin along riparian zones (ACGRP 2004; Harper et al. 2005).

Although once commonly used, fire has been suppressed in the Appalachian region for at least 80 years, altering many of the associated forest types and wildlife communities (ACGRP 2004; Harper et al. 2005). Prescribed fire has proven beneficial for ruffed grouse, particularly in oak-hickory forests where burning can enhance brooding habitat. Grouse broods in the Appalachians select areas with abundant herbaceous vegetation, especially forb and fern cover, but also low-growing woody cover, such as blueberries and huckleberries. Prescribed fire in the Appalachians is restricted primarily to oak-hickory forests and other forest types associated with southern and western exposures and ridgetops. This offers numerous opportunities for habitat enhancement, especially where oak-hickory forests comprise 50 percent or more of the available forest cover. When burning oak-hickory stands, fire often feathers into coves and more mesic forest types, but intensity is much less due to more moisture. In fact, when burning relatively large areas (200 or more acres, which is usually necessary on National Forests where there is a lack of roads or firebreaks), coves, creeks, and northern/eastern exposures are commonly used as natural firebreaks. This provides a mosaic of conditions across the burned area, which can be favorable for ruffed grouse for both winter foraging and brooding habitat. Following prescribed fire, areas supporting a diverse herbaceous community can by utilized almost exclusively by grouse broods during the critical summer months. Utilizing prescribed fire after silvicultural treatments (e.g. clearcuts and shelterwood with reserves) to enhance oak regeneration, also improves grouse habitat by increasing invertebrate abundance and soft mast-producing plants. Basal area will fluctuate among sites, but reducing the canopy closure to 60-80 percent normally allows sufficient sunlight into the forest floor to develop the desired structure for brood habitat and will also promote additional soft mast production. The natural mosaic pattern of fire intensity created by prescribe fire across a forested landscape (especially in larger fire areas) often creates small patches of young forest on southern and western facing slopes, which further enhances ruffed grouse habitat. In areas where silvicultural treatments are not economical, or restricted for other reasons, prescribed fire is a critical tool for creating and maintaining ruffed grouse habitat (ACGRP 2004; Harper et al. 2005).

Forest roads (access routes) and grassy/herbaceous openings can provide critical habitat for ruffed grouse in the central and southern Appalachians (ACGRP 2004 and Harper et al. 2005). Forest roads and openings can be an important foraging habitat, especially within oak-hickory dominated forests during years with little mast. Ruffed grouse hens will utilize forest roads in the fall and winter and during the breeding season. Grouse forage on herbaceous material dominated by clover, cinquefoil, birdsfoot trefoil, coltsfoot, and wild strawberry. In most areas where grouse are found in the Appalachians, forest roads and openings comprise less than 1 percent of the land cover. Because they are such a critical habitat, managing roads and openings is paramount to ruffed grouse habitat.

Dominant fall and winter foods in the Southern Appalachians include leaves and fruits of greenbrier (*Smilax* spp.), the leaves of mountain laurel (*Kalmia latifolia*), fruits of grapes (*Vitis* spp.) and oaks (*Quercus* spp.), and Christmas fern (*Polystichum acrostichoides*) (Seehorn et al. 1981). Similarly, Stafford and Dimmick (1978) reported that greenbrier, mountain laurel, and Christmas fern were the dominant fall and winter food items in the Southern Appalachian region of Tennessee and North Carolina. When available, acorns comprise a significant proportion of the diet (Seehorn et al. 1981; Servello and Kirkpatrick 1987; Kirkpatrick 1989; Thompson and Dessecker 1997). They provide a high energy food source during the critical winter period when forage quality is limited (Servello and Kirkpatrick 1987; Kirkpatrick 1989). However, lack of secure cover in open oak stands may limit their use by grouse (Stafford 1989; Thompson and Dessecker 1997). Kubisiak (1985) suggested that 40-60% of a compartment be maintained in stands of mast-bearing age.

Ruffed grouse are found primarily in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, Blue Ridge Mountains, Northern Cumberland Plateau, and Southern Cumberland Mountains (SAA Terrestrial Report, pgs. 66-67). Low density populations also extend into the adjacent portions of the Central Ridge and Valley, Southern Cumberland Plateau, Southern Ridge and Valley, and Southern Appalachian Piedmont. Population densities generally are moderate in the Blue Ridge Mountains and low to moderate elsewhere. Current grouse densities generally are higher on national forest system lands, national parks, and the Cherokee Indian Reservation than on other ownerships. However, grouse population densities have declined over the last 25 years. The declining trend likely is largely due to the reduction of forest cover in the sapling-pole successional class, which is important to this species.

FOREST TRENDS

Areas of quality grouse hunting are in short supply today and do not meet hunter demands because of very limited habitats where they exist. Ruffed grouse populations on the GWNF appear to have declined over the last two decades as they have throughout the Southern Appalachians. In a recent Virginia monitoring study, the average flushing rate of grouse by participating hunters was 0.57 birds/hr. between 2010-2011 (Norman 2012). This is compared to the long-term flushing rate of 1.10 birds/hr. (1973-2010) and the average flushing rate of the past five years of 0.74 birds/hr. Trends and flushing rates reported by Virginia grouse hunters are similar to most states in the Mid-Atlantic region in recent years. In contrast to the flushing rate trends, results of recent population monitoring, based on spring drumming counts, indicate a more stable population (Norman 2012). The spring 2011 breeding population index was similar to the 2010 index. Likewise, the number of ground drumming per hunt by turkey hunters in the spring gobbler season increased slightly. While recent trends in breeding grouse population trends are encouraging, they are nevertheless significantly below historical levels. Trend analysis over the past 15 years suggest significant long-term annual declines in grouse breeding population levels based on drumming indices from roadside surveys (-3.4%) and spring gobbler hunter surveys (-3.4%) in Virginia (Norman 2012). Much of this decline is attributable to reduced availability of hardwood shrub-sapling habitat due to reductions in timber harvest levels across the Appalachian population, including the GWNF. Recent habitat trends have moved more toward mid to late successional forests with more than 87% of the forest exceeding 60 years of age and only 3% less than 20 years of age. Optimum habitat conditions consist of a variety of habitats and successional stages including 40-60% in mid-late successional forest for mast production and nesting, approximately 15% in (6-15 year old) early successional deciduous forest patches capable of producing 20-25,000 woody stems per hectare (Gullion 1984a; Kubisiak 1985; Stoll et al. 1999; Dimmick et al. 1998; Dessecker 2001) and shrub dominated old field habitats. Permanent openings are normally either too large, too open, or do not have thick escape cover nearby to be

considered optimum for grouse use. Mortality from avian and mammalian predators is also a significant factor limiting grouse populations in the Southern Appalachians (Reynolds et al. 2000).

DIRECT AND INDIRECT EFFECTS

The four activities that have the greatest influence on ruffed grouse habitat quality are early successional forest created by timber management, brood habitat created and maintained through prescribed fire, grassland/shrubland and open woodland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Prescribed fire and open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving ruffed grouse habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (ACGRP 2004; Harper et al. 2005). Prescribed fire often feathers into coves and more mesic forest types, but intensity is much less due to increased moisture. In fact, when burning relatively large areas (200 or more acres, which is usually necessary on national forests where there is a lack of roads or firebreaks), coves, creeks, and northern/eastern exposures are commonly used as natural firebreaks. This provides an exceptional mosaic of conditions across the burned area, which is quite favorable for ruffed grouse for both winter foraging and brooding habitat. Following prescribed fire, areas supporting a diverse herbaceous community can by utilized almost exclusively by grouse broods during the critical summer months. Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for ruffed grouse and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for ruffed grouse.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands (Table 3B2-12). The alternative with the highest

projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 86% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for ruffed grouse.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

The availability of early successional woody habitat, interspersion of suitable grasslands/shrublands, and open woodlands for nesting, brood range, and year-round forage and cover are the most limiting factors to ruffed grouse populations on the GWNF. The combination of habitat components important for ruffed grouse are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, G, H and I. Ruffed grouse populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, ruffed grouse populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for ruffed grouse. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including ruffed grouse. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for ruffed grouse at year 50 up to 208,700

acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term ruffed grouse populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, H, I and D. Long-term ruffed grouse populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Black Bear

AFFECTED ENVIRONMENT

The black bear (*Ursus americanus*) uses a wide variety of habitats in the southern Appalachians, occurring on National Forests and National Parks of the Southern Blue Ridge, Northern Cumberland, and Allegheny Mountains and the Northern Ridge and Valley. These public lands in Virginia, West Virginia, North Carolina, Tennessee, and Georgia connect to form a forested landscape of over 6 million acres where bears are generally distributed at low to medium densities. The increase of older oak forests in this large block of habitat, along with increased protection and conservative hunter harvest, has allowed bear populations throughout the southeastern mountain region to moderately increase over the past 30 years. Bears generally are absent from the Cumberland Plateau, Southern Cumberland Mountains, and Piedmont (SAMAB 1995:61). In the Central and Southern Appalachians, including the GWNF, important habitat elements are habitat remoteness, habitat diversity, den site availability, and availability of hard mast.

Black bears are opportunistic omnivores and consume a variety of seasonal plant and animal foods including flowering plants, grasses, various roots and tubers, and especially soft mast (grapes, berries, apples, etc.). More than 75% of the annual black bear diet consists of vegetative matter; the other 25% consists mostly of insects, insect larva, carrion, and small rodents and other mammals such as groundhogs, deer, and occasionally livestock (VDGIF 2013). Availability of hard mast (acorns and hickory nuts) is critical throughout the winter, and reproductive success can be closely related to this food source (Eiler 1981; Wathen 1983; Eiler et al. 1989, VDGIF 2013). Total production of hard mast and production by individual trees can fluctuate from year to year due to climatic and other factors (Downs and McQuilkin 1944; Fowells 1965). During time of poor mast crops, drought during summer months, and times of the year when food is naturally scarce (early spring), bears may forage around areas of human habitation and are more likely to impact agricultural crops, bee hives, livestock, and other food associated with humans (garbage, birdseed, pet food)(VDGIF 2013). Since bears utilize nearly any abundant plant or animal food, they are likely to thrive when a diversity of forest age classes and food sources are available. Vegetation management can provide much of this diversity (Reagan 1990; VDGIF 2013). Naturally occurring events such as ice storms, wildfires, and hurricanes provide habitat diversity, but at random intervals and locations, making benefits sometimes limited and unreliable.

Bears den in a wide variety of sites including bush piles, large snags, rock cavities and crevices, road culverts, abandoned buildings, and in vegetation (Carlock et al. 1983; VDGIF 2013). In western Virginia, nearly 70% of all dent sites are in hollow trees (VDGIF 2013). Large northern red and chestnut oaks are almost exclusively selected as den trees. Den re-use in Virginia is less than 10%, although some bears may prefer the same type of den (e.g. trees, rock cavities) year after year. Preference may be related to availability and may be a learned behavior (Brody 1984). Timing of den entrance depends upon age, sex, female reproductive status, weather conditions, and food availability (VDGIF 2013). Bears my enter winter dens earlier during poor mast years, which conserve accumulated resources. When mast crops are good, bears typically enter dens later in order to take advantage of additional opportunities to feed and gain weight. During particularly mild winters, some bears (especially males and females with yearlings) may not den at all. Usually pregnant females enter dens first, followed by subadults, then adult males. Individual bears enter dens in Virginia and West Virginia as early as the end of October and as late as the beginning of January (VDGIF 2013). Den emergence usually occurs in reverse order of den entrance. Females with cubs are the last to emerge from winter dens, typically between mid-March and mid-April.

Despite their adaptable food habits, black bears require extensive areas of diverse habitat types (VDGIF 2013). Although they are often considered a wilderness species, black bears can thrive in areas where forested habitats are interspersed among other land uses. Black bears are often found in large, contiguous tracts of forested lands, and smaller blocks of forested habitat that are linked by forested corridors. Based on known

and apparently viable black bear populations within the southeast, the observed minimum areas that support bear populations are at least 79,000 acres for forested wetlands, and 198,000 acres for forested uplands (VDGIF 2013). Land-use changes that create isolated populations through fragmentation of black bear habitats have serious implications for population viability. Roads with heavy traffic volumes have been shown to limit bear movements (VDGIF 2013). Bear movements that are restricted by heavily used roads may interrupt habitat linkages and contribute to fragmentation concerns.

FOREST TRENDS

With extensive forested areas and a variety of habitat types in all ecoregions, most of Virginia and eastern West Virginia can be considered potential bear habitat (VDGIF 2013; WVDNR 2013). The black bears in western Virginia and eastern West Virginia belong to the largest contiguous bear population in the southeast and mid-Atlantic. Bear population status on the GWNF is monitored by the state agencies of Virginia and West Virginia and uses a combination of indices derived from harvest, age structure, nuisance activity, and miscellaneous mortalities (VDGIF 2013; WVDNR 2013). These indices, coupled with computer modeling, provide a current statewide population estimate of 16,000-17,000 bears in Virginia and 10,000-12,000 in West Virginia. While monitoring indices may provide rough estimates of bear population size, their primary values are to reflect population trends and relative densities. Multi-year harvest trends for both states have indicated significant increases since 1974. Since 2001, trends in harvest and population modeling suggest that the bear population throughout the area encompassing the GWNF has been increasing at about 9% annually (VDGIF 2013; WVDNR 2013).

DIRECT AND INDIRECT EFFECTS

The four activities that have the greatest influence on black bear habitat quality are early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest with an abundance of cavities and den trees.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for black bear. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees

species for black bear and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for black bear. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands. The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 6% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and cavities and den trees for black bears (VDGIF 2009).

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

Remote habitat free from the regular presence of humans is an important component of bear habitat quality. Prescriptions with remoteness as a desired condition are found in Wilderness and recommended wilderness study areas (1A, 1B), Special Biological Areas (4D), Mount Pleasant National Scenic Area (4F), Recommended National Scenic Area (4FA), Shenandoah Mtn Crest–Cow Knob Salamander (8E7), Black Bear/Remote Habitats (8C), and Remote Backcountry (12D), and Mosaics of Habitat–Unsuitable (13U). Currently, 43% of the GWNF is in prescriptions with remoteness as a desired condition. The alternative with the highest percentage of the forest in remote conditions is C (838,698 acres, 79%), followed by Alternatives F, D, A, E, G, H and I [601,645 (56%), 494,291 (46%), 454,194 (43%), 443,771 (42%), and 421,586 (40%) acres, respectively]. The alternative with the lowest percentage of forest in remote conditions is B (361,267 acres, 33%). All alternatives except B have 40% or greater of the GWNF in prescriptions with remoteness as a desired condition.

In summary, the combination of habitat components important for black bear habitat are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) under Alternatives B, D, E, F, G, H and I, increase only slightly above current conditions under Alternative A, and decrease under

Alternative C. Mid- to late successional mast producing forest is projected to be stable over the next 10 years under all alternatives. Percentage of forest with remote conditions as a desired condition is 40% or greater in all alternatives except B. Given the current increasing population trend for black bears on the GWNF, black bear populations should continue to increase under all alternatives over the next decade.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for black bear. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including black bear. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for black bear at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Percentage of forest with remote conditions as a desired condition is 40% or greater in all alternatives except B and not expected to change between year 10 and 50. Long-term black bear populations are projected to continue to increase or stabilized due to factors other than habitat availability (territoriality and/or other population density pressures), under all alternatives.

Northern Bobwhite

AFFECTED ENVIRONMENT

Northern bobwhite (*Colinus virginianus*) numbers have declined steadily throughout their range for over 40 years and quite likely for much longer. From 1980 to 1999, fall bobwhite populations declined 66% and projected trends indicate a further decline of approximately 54% over the next two decades (Dimmick et al. 2002).

A lack of nesting and brood-rearing cover is considered the major limiting factor over much of the range of the northern bobwhite (Dimmick et al. 2002; VDGIF 2009). The loss of native warm season plant communities by planting non-native invasive grasses, planting dense pine forests, and intensive production of row crops is principally responsible for limiting bobwhite populations as well as those of other species such as loggerhead shrike, dickcissel, bobolink, Henslow's sparrow, Bachman's sparrow, and field sparrow. Managed warm season grasses with an adequate component of forbs provide good to excellent nesting and brood-rearing habitat. Hardwood forests provide important winter habitats for bobwhite throughout much of its range. Open woodland restoration and management provides habitat conditions that promote bobwhite productivity and survival.

Northern bobwhite has specific seasonal needs that vary throughout the year. This species favors old fields and brushy areas such as wood margins, hedgerows, thickets and open woodlands (Hamel 1992). Summer nesting cover and summer brood habitat consisting of grassy areas (preferably bunch grasses) and weedy patches with exposed bare ground are needed to provide for the recruitment within a population. Winter food and winter cover of seed producing plants and shrublands are needed to carry populations through the dormant season (Rosene 1985). Habitat conditions for bobwhite quail require disturbances from prescribed burning and/or mowing or discing on 2 to 3 year intervals. Northern bobwhite are considered area sensitive in their habitat needs, requiring a landscape patch of 500 acres or greater of interspersed suitable habitat in order to persist over time (Dimmick et al. 2002; VDGIF 2009)

The recovery of bobwhite quail may be difficult with an accelerating loss of available land to create and maintain quail habitat throughout its range. Restoring bobwhite populations range-wide will depend upon: 1) the amount of agricultural lands that are enhanced to provide nesting, brood rearing, and roosting habitats for quail and other grassland species; 2) the amount of pine dominated and mixed pine hardwood lands that are managed to provide open grass- and forb-dominated ground cover through thinning, harvesting, and periodic burning; and 3) the amount of rangeland that is managed to improve native plant communities and provide quail food and cover.

FOREST TRENDS

Populations of bobwhite quail on the GWNF and surrounding landscape are very low, with small and widely scattered areas of occupied range. The population level is presently considered unhuntable, given their low numbers (Puckett VDGIF, personal comm. 2013).

DIRECT AND INDIRECT EFFECTS

Habitat needs for northern bobwhite were considered by reviewing and incorporating elements of the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002) and the Quail Action Plan for Virginia (VDGIF 2009). Habitat conditions recommended to improved conditions for quail include restoration of open woodlands, grasslands/shrublands, and creation of early successional forests.

The three activities that have the greatest influence on bobwhite quail habitat quality are early successional forest created by timber management and other disturbance regimes, open woodland habitat restored and maintained through prescribed fire, and grassland/shrubland restoration and maintenance.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving bobwhite quail habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2009). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for bobwhite quail. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for bobwhite quail and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for bobwhite quail. In

addition, open woodland habitat is restored at a larger scale than early successional forest habitat, usually 500 to 1,000 acres in size and greater.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands. (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

In summary, the combination of habitat components important for bobwhite quail habitat are projected to steadily increase above current conditions (combination of early forest, open woodlands, and grasslands/shrublands) over the next 10 years under Alternatives B, D, E, F, G, H and I. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. The greatest hope for reversing the declining trends of bobwhite quail is open woodland restoration at a scale of 500 acres or greater, in combination with early successional forest and grassland/shrubland management. Wild bobwhite quail coveys were recently found in a 1,000 acre open woodland patch created and maintained by prescribed fire called Second Mountain (Croy, personal comm. 2010). This is the first documented case of bobwhite quail colonizing open woodland habitat created by prescribed fire on the GWNF. Under all alternatives except A and C, increasing suitable habitat will provide greater opportunity for the northern bobwhite population to increase in the next decade.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for northern bobwhite quail. The amount of early successional forest, and grassland/shrubland acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for northern bobwhite quail at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term bobwhite quail populations have the greatest chance to increase under Alternatives B, E, F, G, H, I and D. Long-

term quail populations have very little chance of increasing due to low availability of suitable habitat, under Alternatives A and C.

American Woodcock

AFFECTED ENVIRONMENT

The American woodcock (*Scolopax minor)* is a migratory shorebird that has adapted to forested habitats. Its distinctive features include stocky body, camouflage feather coloration and a long prehensile bill used to probe moist soils for earthworms, its primary food (WMI 2008). American woodcock populations have steadily decreased over the last 25 years, at a rate of 1-2% per year (Krementz and Jackson 1999; WMI 2008). The general population decline has been attributed to loss of young forest and moist shrubland areas in the eastern and central United States, largely due to human development and changing forestry management practices (WMI 2008). In the Appalachians, breeding populations are highly variable in density and spotty in distribution (WMI 2008). Wintering population densities vary from year to year, but the species is much more common and widely distributed in winter than in summer in the South. According to conservation status rankings, the woodcock is listed as a priority species under the Forest Service's southern national forest migratory and resident landbird conservation strategy (Gaines and Morris 1996).

The American woodcock is closely associated with young, second-growth hardwoods and other early successional habitats that are a result of periodic forest disturbance (Straw et al. 1994; WMI 2008). Ideal habitat consists of young forests and grasslands/shrublands mixed with forested land (Keppie and Whiting 1994). These include forest openings, grasslands, or open woodlands for singing displays in spring, shrubby thickets or other young hardwoods on moist soils for feeding and daytime cover, early successional hardwoods for nesting, and grasslands/open woodlands for night-time roosts (Mendall and Aldous 1943; Andrle and Carroll 1988; Boothe and Parker 2000; WMI 2008). Rich moist habitats adjacent to second order and higher streams and other waterbodies characterized by low gradient, slow flowing, and flat topography are important foraging habitats for American woodcock. American woodcock are considered area sensitive, needing a landscape patch of 500 acres or greater of suitable interspersion of habitat mosaics in order to persist over time (WMI 2008).

Roosting and display habitat is typically open fields, open woodlands, and/or regenerating forests. Woodcock often leave diurnal feeding areas at dusk and fly to openings such as early successional woody patches, log landings, grassy openings, old field areas, and open woodlands. Use of roosting fields begins generally in July and continues to migration. In the Appalachians, roosting areas are used for protection from predators at night. The structure of roosting habitats needs to be open enough for woodcock to detect ground predators while affording scattered overhead protection from avian predators (WMI 2008). Maintenance of old fields for roosting and display habitat can be accomplished through disking, mowing, use of herbicides, and prescribed burns, although maintaining some small trees and shrubs is desirable. The goal is to create open habitats that are "patchy," rather than uniform in structure (Krementz and Jackson 1999).

Natural disturbances historically responsible for creation of early successional habitat also improve woodcock habitat. Beavers created extensive habitat, as did fire and possibly windstorms. In general, maintaining integrity of wetter sites such as springs, streams and creeks is beneficial to these species. Allowing thickets to grow in riparian areas will greatly improve habitat quality for woodcock, (Krementz and Jackson 1999). Grassy areas and open woodlands near water provide prime nesting and display grounds. Restoration of beavers on the GWNF would increase suitable foraging habitat.

Non-breeding, migrating and/or wintering habitat is similar to breeding habitat but includes more open conditions such as sedge meadows, beaver pond margins, rice fields, upper reaches of estuaries and occasionally coastal meadows (del Hoyo et al. 1996). Winter habitats range from bottomland hardwoods to upland pine forests, young pine plantations, and mature pine-hardwood forests, though in some pine habitats the birds tend to focus their activities in lowlands dominated by hardwoods (Roberts 1993). Unlike during breeding, mature pine-hardwood and bottomland hardwoods are often preferred (Krementz and Pendleton 1994; Horton and Causey 1979). During the non-breeding season, woodcock generally occupy moist thickets

in daytime, and shift to more open habitats such as pastures, fields (including agricultural), open woodlands, and young woody vegetation at night. A diversity of habitat types and age classes may be especially important to survival when severe weather forces woodcock from preferred sites (Krementz and Pendleton 1994). The use of prescribed burns is a common forest management practice and can be used to set back plant succession. A light, controlled fire can maintain habitat patchiness as well. Burns may also remove pine needle cover, opening the ground to woodcock foraging and roosting. Mowing can also be used to improve foraging habitat, but appropriate habitat should be maintained for nesting birds (Roberts 1993).

FOREST TRENDS

Most woodcock use the GWNF during migration periods, but breeding woodcock have been confirmed on the GWNF. Populations of woodcock appear very low and scattered on the forest (Norman VDIGF, personal comm. 2013).

DIRECT AND INDIRECT EFFECTS

The three activities that have the greatest influence on American woodcock habitat quality are early successional forest created by timber management for nesting and foraging if near riparian areas, open woodlands created and maintained through prescribed fire for singing grounds and evening roost areas, and grassland/shrubland restoration and maintenance for singing/roosting grounds, and nesting/foraging if near riparian areas.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving American woodcock habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (WMI 2008). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees. Such habitat is favorable for singing grounds and evening roost areas for American woodcock. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for American woodcock. Prescribed fire, especially when applied over large areas, feathers into more mesic sites. The lighter fire effects can create shrubby conditions in moist soil areas, creating suitable foraging areas for woodcock (WMI 2008).

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with up to 135,700 acres (13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,500 acres (1%) at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

The availability of early successional woody habitat, grasslands/shrublands, and open woodlands (especially near riparian areas) for nesting, singing grounds, diurnal feeding, and evening roosting, is the most limiting factor to American woodcock populations on the GWNF and the Appalachian region in general (WMI 2008). The combination of habitat components important for woodcock are projected to steadily increase above current conditions (combination of early forest, open woodlands, and grasslands/shrublands) under Alternatives B, D, E, F, G, H and I increase only slightly under Alternative A, and decrease under Alternative C over the next 10 years. American woodcock populations have the greatest chance to increase under Alternatives B, D, E, F, G, H and I. Woodcock populations are projected to stabilize or decrease under Alternatives A and C, due to low availability of suitable habitat components.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for northern bobwhite quail. The amount of early successional forest and grassland/shrubland acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for American woodcock at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term American woodcock populations have the greatest chance to stabilize and/or increase under Alternatives B, D, E, F, G, H and I.

Long-term American woodcock populations should be expected to stabilize and/or decrease due to low availability of suitable habitat under Alternatives A and C.

B2D – MIGRATORY SPECIES

AFFECTED ENVIRONMENT

Migratory birds have become a focus of conservation concern due to evidence of declining population trends for many species. To ensure that forest plan revision alternatives include provisions for migratory bird habitat, planning efforts included coordination with the Migratory Bird Office of the U.S. Fish and Wildlife Service and others under the umbrella of Partners in Flight (PIF) and the Appalachian Mountains Joint Venture (AMJV). Both PIF and AJV are cooperative efforts involving partnerships among federal, state, and local government agencies, foundations, professional organizations, conservation groups, industry, the academic community and private individuals. They were launched in response to growing concerns about declines in populations of all bird species and to emphasize conservation of birds not covered by existing conservation initiatives.

PIF and AJV have developed Bird Conservation Plans for each physiographic area relevant to the national forest planning area. These plans are science-based, long-term, proactive strategies for bird conservation across all land ownerships and are designed to ensure long-term maintenance of healthy populations of native land birds. Forest Service biologists work with PIF and AJV coordinators to identify key management issues and opportunities for high priority species on National Forest System lands, and developed related goals, objectives, and standards for incorporation into the Revised Forest Plan. In addition, *The Southern National Forest's Migratory and Resident Landbird Conservation Strategy* (Gaines and Morris 1996) was also reviewed and incorporated into planning efforts. This strategy identifies priority species and provides a framework for monitoring populations. The monitoring program described in this document is currently being implemented, and would continue under all alternatives.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Because migratory and resident landbirds are widespread and diverse, they are relevant to the majority of ecological communities and habitat elements considered during forest planning. As a result, provisions for these species are integrated into numerous plan objectives and standards focused on achieving desired habitat conditions. Effects of each alternative on ecological communities, associated species, and all relevant conservation priority species (as identified by the U.S. Fish and Wildlife Service) are addressed in the Ecological Diversity Analysis in the EIS (See Ecosystem Diversity and Species Diversity Sections, Chapter 3B 1 & 2) Effects to specific species of birds are addressed under appropriate sections for those chosen as Management Indicator Species (MIS).

The majority of the George Washington National Forest is contained within the Ridge and Valley Ecological Region, but there are also sections contained within the Blue Ridge and Allegheny Mountain Ecological Regions. The PIF plans and associated management issues for each of these areas will be addressed at some level in the Forest Plan Revision. Key landbird conservation issues within these Regions are summarized below.

- Creation and maintenance of early succession grassland/shrubland habitat is desirable in order to provide habitat for high priority species such as the golden-winged warbler, prairie warbler, mourning warbler and whip-poor-will. There are several management objectives that identify the need to provide large enough patches of early successional habitat for area-sensitive early successional species In addition, an objective to create or maintain at least 285 acres of high elevation early successional habitat through forest regeneration and/or maintenance of balds, utility rights of way, old fields, and open woodlands (See Ecological and Species Diversity Reports).
- Creation of structural diversity in mature stands to enhance conditions desirable for species such as the cerulean warbler, worm-eating warbler, and wood thrush. Mesic oak and mixed mesophytic

stands can be evaluated for addition of canopy gaps and vertical structure through group selection and commercial thinning harvest programs.

- Conservation and restoration of spruce-fir and northern hardwood forest communities are important for associated boreal bird species. Spruce-fir forests are treated as rare communities in the George Washington National Forest Plan and they will be maintained and restored across all alternatives. Standards protect the spruce-fir type from conversion to other forest types and from silvicultural practices except those designed to maintain or restore the type in all alternatives.

In addition to providing a diversity of habitats for migratory birds on the landscape, collision of migratory birds with communications towers was considered during plan revision. Two mechanisms for bird mortality occur at communications towers (FWS 2005). Many bird species are nocturnal migrants. Birds flying in poor visibility conditions (cloud cover and fog) may not see communication structures or supporting guy wires (i.e., blind collision). Towers that are lighted at night for aviation safety may help reduce blind collisions, but can cause a second potential mechanism for mortality in low cloud ceiling or foggy conditions. Refracted light creates an illuminated area around the tower. Migrating birds lose their stellar cues for nocturnal migration and a broad orienting perspective on the landscape in these weather conditions. The lighted area may be the strongest cue for navigation, and birds remain in the lighted space by the tower. Mortality occurs when they collide with the structure and guy wires, or even other migrating birds. The GWNF Plan adopts forestwide standards requiring removal of obsolete communications towers, location of new communication equipment on existing towers where possible, and coordination of new tower planning and construction with U.S. Fish and Wildlife Service in an effort to reduce tower collision mortality and to comply with the Migratory Bird Treaty Act, the Endangered Species Act, and the Bald and Golden Eagle Act.

B2E – MANAGEMENT INDICATOR SPECIES

National Forest Management Act regulations, adopted in 1982, require selection of management indicator species (MIS) during development of forest plans (36 CFR 219.19(a)). Reasons for their selection must be stated. This section describes the MIS selected for the revised Land and Resource Management Plan and the conditions they are to represent. A more complete documentation of the process is contained in the MIS Process Selection paper in the administrative record.

Management indicator species (MIS) are to be selected "because their population changes are believed to indicate the effects of management activities" (36 CFR 219 (a)(1)). They are to be used during planning to help compare effects of alternatives (36 CFR 219.19(a)(2)), and as a focus for monitoring (36 CFR 219.19(a)(6)). Where appropriate, MIS shall represent the following groups of species (36 CFR 219 (a)(1)):

- Threatened and endangered species on State and Federal lists;
- Species with special habitat needs;
- Species commonly hunted, fished, or trapped;
- Non-game species of special interest; and
- Species selected to indicate effects on other species of selected major biological communities.

Since adoption of these regulations, the management indicator species concept has been reviewed and critiqued by the scientific community (Caro and O'Doherty 1999; Simberloff 1998; Noss 1990; Landres et al. 1988; and Weaver 1995). These reviews identify proper uses and limitations of the indicator species concept. They generally caution against overreaching in use of indicator species, especially when making inferences about ecological conditions or status of other species within a community. Caution is needed because many different factors may affect populations of each species within a community, and each species' ecological niche within a community is unique.

To reflect this current scientific understanding while meeting the letter and spirit of regulations, we have made great effort to clearly define the legitimate uses and limitations of each selected MIS. The MIS process is but

one tool used to develop management strategies and monitoring programs designed to meet NFMA requirements related to diversity of plant and animal communities. Other elements used for comprehensive planning for plant and animal diversity include: objectives and standards for maintenance and restoration of desired ecological conditions based on knowledge of overall ecosystem structure and function; biological evaluations and assessments at both the forest plan and site-specific project levels; and evaluation of risk to species of viability concern at the forest plan level. Other elements important to monitoring effects of plan implementation on plant and animal diversity include, where appropriate, monitoring of key ecological conditions, levels of management activities important to restoration and maintenance of community diversity, species assemblages (birds, bats, fish, etc.), harvest levels of game and other demand species, and populations of threatened, endangered, and sensitive species.

Table 3B2-15. MIS for the GWNF

Species Common Name	Category (s)
Cow Knob Salamander	T/E/S Indicator, Special Interest Species Indicator
Pileated Woodpecker	Special Habitat Indicator
Ovenbird	Special Habitat Indicator
Chestnut-sided Warbler	Special Habitat Indicator
Acadian Flycatcher	Special Habitat Indicator
Hooded Warbler	Biological Community Indicator
Scarlet Tanager	Biological Community Indicator
Pine Warbler	Biological Community Indicator
Eastern Towhee	Biological Community Indicator
Wild Brook Trout	Biological Community Indicator, Demand Species
Eastern Wild Turkey	Demand Species Indicator
Black Bear	Demand Species Indicator
Deer	Demand Species Indicator
Beaver	Riparian Ecological System Indicator

AFFECTED ENVIRONMENT

Cow Knob Salamander

This salamander (*Plethodon punctatus*) is a species with a restricted range. It is endemic to the higher elevations of Shenandoah Mountain along the VA/WV border. It is a terrestrial salamander that occurs primarily above 2500 feet in elevation and mainly occurs in rocky talus areas on north to northeast aspects. It forages openly on cool to warm, dark, humid/rainy nights consuming small insects and other invertebrates. The Cow Knob salamander is an MIS because it is a Sensitive species and a narrow endemic that occurs almost entirely on the George Washington National Forest (North River Ranger District).

FOREST TRENDS

As documented in Appendix G of the 2004 Monitoring and Evaluation report, the habitat trend is one of an aging forest that benefits Cow Knob salamanders and should lead to a stable or increasing population. Recent

field surveys (2002-2003) discovered the Cow Knob salamander outside the current range south along Shenandoah Mountain to Hardscrabble Knob.

Table 3B2-16. Cow Knob Salamander Population Surveys

Location	Year of Survey	# of Adults	# of Juveniles	Total #
Sugar Grove, VA	2005	14	20	34
Sugar Grove, VA	2006	17	27	44
Sugar Grove, VA	2007	27	27	54
Tomahawk, WV	2004	1	9	10
Tomahawk, WV	2006	1	2	3

Pileated Woodpecker

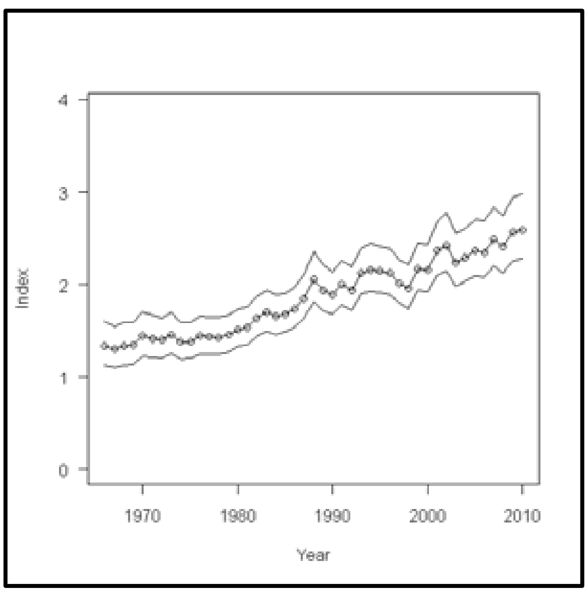
The pileated woodpecker (*Dryocopus pileatus*) was selected as an MIS because it requires large snags for nesting and feeding. The occurrence of this species may be correlated with forested habitats containing abundant large dead trees and fallen logs (Hamel 1992), which also are used by other birds, mammals, and amphibians. This species is selected to help indicate the effects of management activities on the availability of forests with desired abundance of snags. Population monitoring would be combined with information on forest age-class distribution and snag densities to provide a full picture of management effects on this species and other snag-dependent wildlife.

FOREST TRENDS

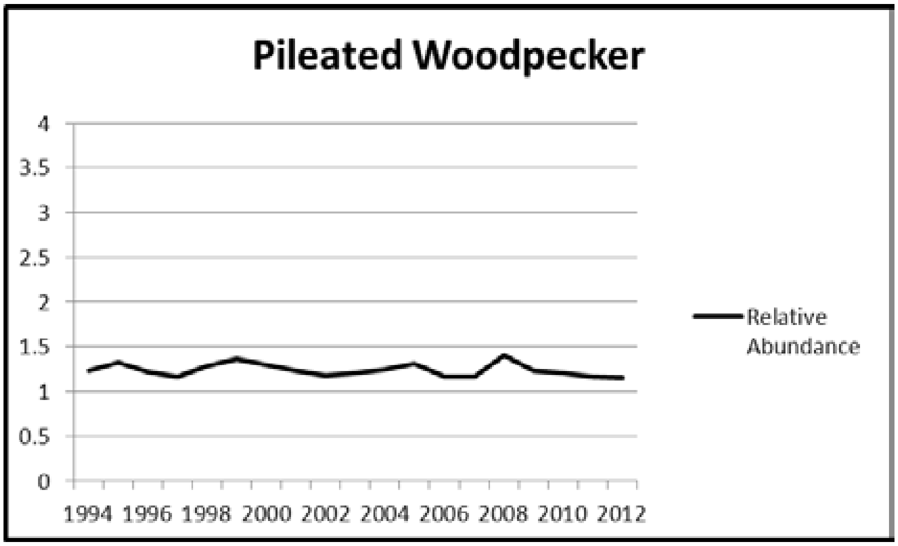
USGS Breeding Bird Survey (BBS) data indicates an increasing population trend of pileated woodpeckers in the Appalachian Region. USFS avian point count data from the GWJNFs indicate an overall stable population trend.

Trend in BBS Data of Pileated Woodpeckers across the Appalachian Region, 1966 To 2010.

Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Pileated Woodpeckers across the GWJNF, 1994 to 2012
Source: Southern Region Avian Monitoring Database



Pileated woodpeckers generally prefer mature forests near riparian areas. This species is a primary cavity nester/excavator, requiring large snags for nesting cavities and large dead trees for feeding. Generally, this species requires trees greater than 15 inches dbh for cavities, but prefers trees greater than 20 inches dbh. Based on the results of monitoring data, this species is showing stable population trends on the GWJNFs and increasing trends across the Appalachian Region. Pileated woodpeckers have the abundance and distribution across the Forest that will provide for its persistence into the foreseeable future.

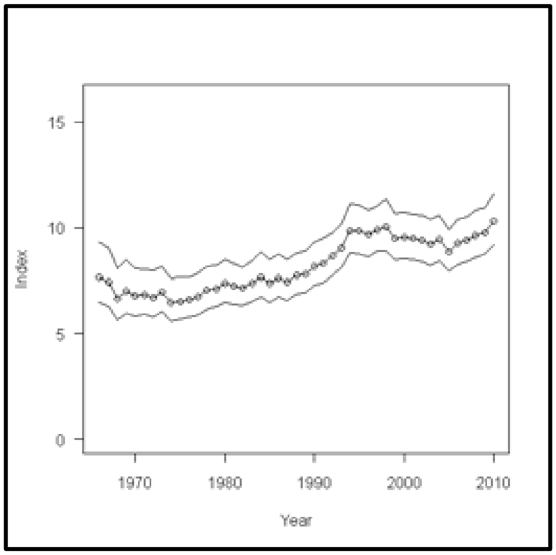
Ovenbird

The ovenbird *(Seiurus aurocapillus)* was selected as a MIS because it is associated with mid-successional to mature forest interior habitats (Hamel 1992; Crawford et al. 1981). This species is selected to help indicate the effects of management on the availability of suitable mature forest interior habitats. Other elements, such as landscape analysis of forest fragmentation using remote sensing data, would supplement information received from monitoring this species.

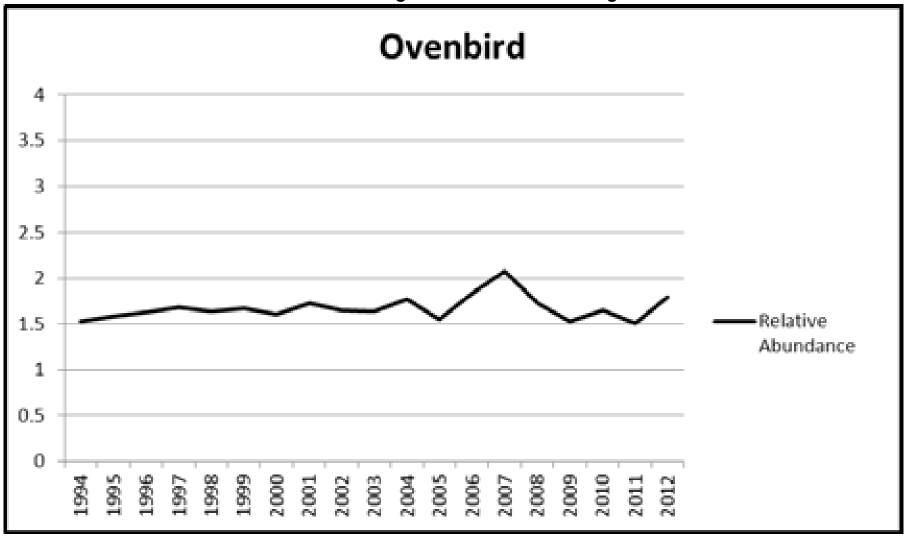
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable to increasing trends in the Appalachian region. USFS Avian point count data from the GWJNFs for ovenbird also indicates an overall stable to increasing population trend.

Trend in BBS Data of Ovenbirds across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Ovenbirds across the GWJNF, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Ovenbirds breed in upland deciduous or mixed deciduous/pine forests with a moderately dense understory. They nest on the ground and build a covered nest from leaf litter. They require large patches of mature forest for nesting. While the need for large patches of mature forested habitat has been well documented for many migratory bird species, including ovenbirds, evidence is mounting that early successional woody habitats are also important during the critical time period just after breeding and during migration (Bulluck and Buehler 2006). These areas provide safe havens for adult and fledgling ovenbirds for the following needs: molting, abundant food for the buildup of fat reserves for migration, and protection from predators. Studies strongly recommend conservation strategies that maintain large tracts of mature forest, within which there is a mosaic of different forest types and ages (early and mid-successional forest stands), to provide the habitat requirements needed by migratory birds such as ovenbirds during all of their life stages here in North America. Based on the results of monitoring data, this species exhibits stable to increasing population trends on the

GWNF, as well as region-wide, and have the abundance and distribution across the Forest that will provide for their persistence into the foreseeable future.

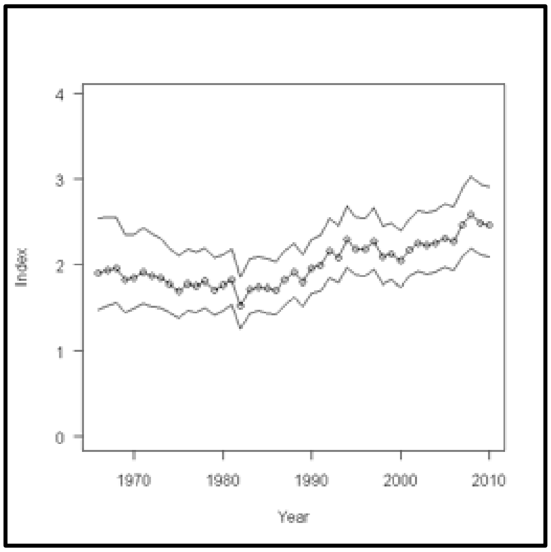
Chestnut-Sided Warbler

The chestnut-sided warbler (Dendroica pensylvanica) was selected as a MIS because of its association with high-elevation early successional habitats. This species is selected to help indicate the effects of management on the availability of higher elevation early successional habitat. Trends for these species will be evaluated along with trends in total acres, age-class distribution, and level of restoration and maintenance activities to provide a more complete picture of effects of management on this community.

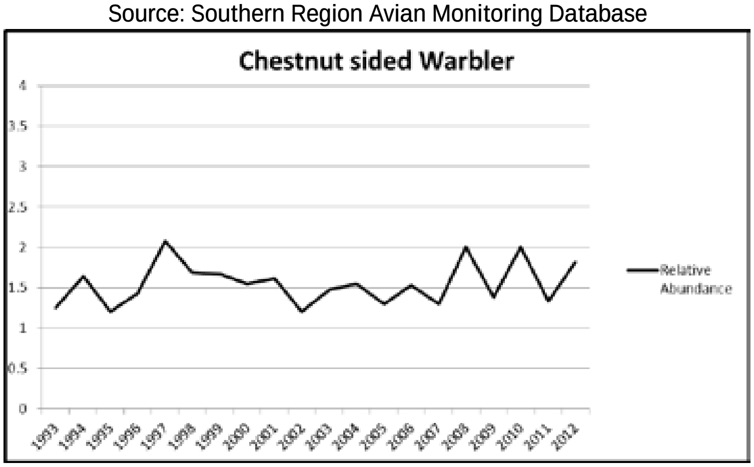
FOREST TRENDS

USGS Breeding Bird Survey data indicates a relatively stable trend in chestnut-sided warblers in the Appalachian region. USFS Avian point count data also indicates an overall stable population trend across the GWJNFs.

Trend in USGS BBS Data of Chestnut-sided warblers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Chestnut-sided warblers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Chestnut-sided warblers are associated with larger patches (e.g. greater than 12 acres) of early successional woodlands, mountain laurel thickets, and forest edge habitat above 2,000 feet (Hamel 1992; Hunter et al. 2001). Chestnut-sided warblers have exhibited significant continental population declines in the last couple of decades, mirroring an overall trend of decline of disturbance-dependent bird species associated with open habitats in eastern North America (Vickery 1992; Askins 2000; Hunter et al. 2001). A significantly greater proportion of bird species exhibiting steep population declines are associated with disturbance-mediated habitats than in forested or generalist habitat types (Brawn et al. 2001). Combined with recent research highlighting the importance of early successional woody habitat for post-breeding and migratory stop-over needs of forest-interior migratory bird species in a larger landscape of mature forest (see sections on ovenbirds, worm-eating warblers, and hooded warblers), the role of early successional habitat in largely mature, forested landscapes and the need to restore/maintain disturbance regimes creating such habitats is of vital importance in conservation planning (Brawn et al. 2001; Hunter et al. 2001). Based on the results of monitoring data, chestnut-sided warblers show a stable population trend on the GWNF, and the Appalachian region, with an abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

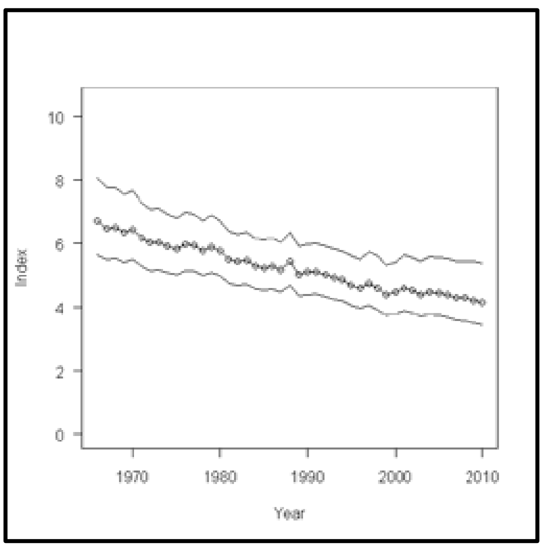
Acadian Flycatcher

The Acadian flycatcher (*Empidonax virescens*) was selected as MIS because of its association with riparian habitat in deciduous and mixed deciduous/coniferous forests. It is highly associated with riparian habitat streams and bottomland hardwoods (Hamel 1992).

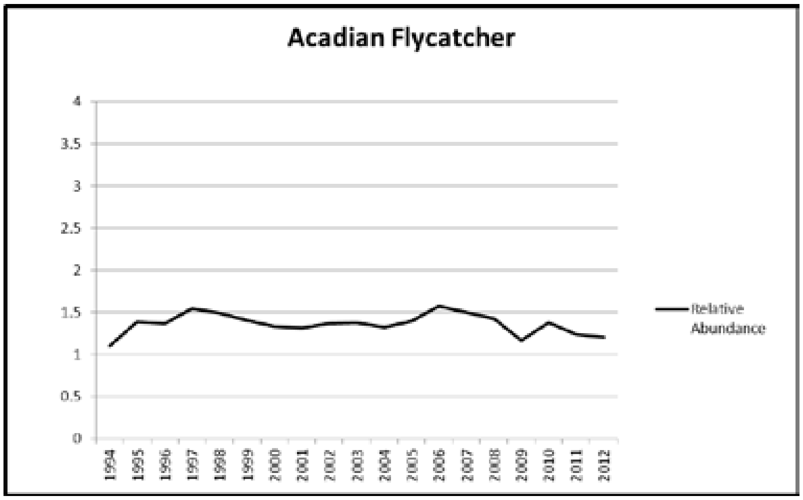
FOREST TRENDS

USGS Breeding Bird Survey data indicates declining trends in the Appalachian region. Data from the GWJNF point count data for the Acadian flycatcher indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Acadian flycatchers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Acadian flycatchers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Acadian flycatchers occur in deciduous, mixed deciduous/coniferous forest types, in riparian areas (Hamel 1992). Acadian flycatchers are often associated with closed overstory canopies and open understories. After breeding, Acadian flycatchers utilize open scrub and early successional woody habitat during migration. With overall stable population trends of Acadian flycatcher on the GWJNFs, Acadian flycatchers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future. Though such trends are not apparent on the GWJNFs, of concern are declining trends shown by USGS BBS data in populations of Acadian flycatcher throughout the larger Appalachian region.

Black Bear, Wild Turkey, and White-Tailed Deer

These species were retained as MIS because they are species of high demand in Virginia. The National Forest provides key habitat attributes for bear in Virginia including remoteness and the availability of den trees and mast. Many Virginia hunters must utilize public lands to pursue deer and turkey, thus management activities will influence their success and experience. The Virginia Department of Game and Inland Fisheries tracks annual harvest for these species; harvest data is identified by county and land ownership status (public versus private). These MIS are discussed under the Demand Species section of this Chapter.

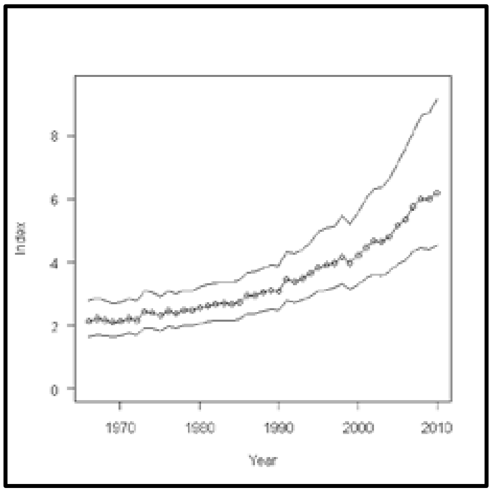
Hooded Warbler

The hooded warbler (*Wilsonia citrina*) was selected as an MIS for mid- to late-successional mesic deciduous forests. The hooded warbler is heavily associated with moist deciduous forests with fairly dense understories, where it breeds and feeds (Hamel 1992; Crawford et al. 1981). Management opportunities exist to increase the structural diversity of closed canopied habitats in this type to favor species, such as the hooded warbler, that optimize their life history in forests with canopy gaps and patches of dense understory. This species is expected to respond positively to management actions (including thinning and moderate frequency burning) that are designed to stimulate advanced oak regeneration and perpetuation of the forest type on these mesic sites. This species is deemed appropriate for helping to indicate the availability of mid- and late-successional mesic deciduous habitats and the efficiency of management intended to favor its habitat.

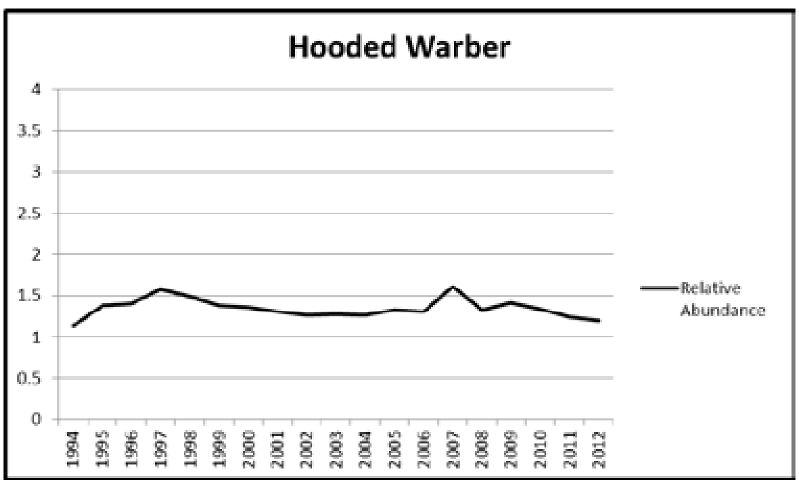
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable to slightly increasing population trends for hooded warbler in the Blue Ridge Mountain and Ridge and Valley regions. Data from the GWJNFs point count data for hooded warbler indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Hooded warblers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Hooded warblers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Hooded warblers occur in deciduous, mixed deciduous/coniferous forest types, near or in riparian areas (Hamel 1992; Robbins et al. 1989). Hooded warblers are associated with canopy gaps and other small patches of dense woody vegetation in an otherwise mature forest (Robbins et al. 1989; Hunter et al. 2001). After breeding, both fledglings and adults move to areas characterized by dense, woody vegetation, abundant insect availability, and the presence of ripe fruits (Morton 1990; Evans Odgden and Stutchbury 1997; Anders

et al. 1998; Vega Rivera et al. 1998, 1999). These areas provide safe havens for molting, abundant food for the buildup of fat reserves for migration, and protection from predators. Habitats supporting this kind of vegetation include open oak, oak/pine, and pine woodlands, patches of early successional habitat resulting from insect infestation and natural disturbance such as ice storms, patches of early successional habitat where the overstory had been thinned or harvested in some way (modified shelterwood, clear cut, high-grading), areas of second growth scrub/deciduous saplings located along forest borders and old fields, and mature riparian forests with a dense understory (Anders et al. 1998; Vega Rivera et al. 1998, 1999). Recent studies strongly recommend conservation strategies that maintain large tracts of mature forest, within which there is a mosaic of different forest types and ages (early and mid-successional forest stands), as well as mature riparian forest, to provide the habitat requirements needed by migratory birds during all of their life stages here in North America, including the hooded warbler (Kilgo et al. 1999; Suthers et al. 2000; Hunter et al. 2001). With overall stable population trends of hooded warbler on the GWJNFs and stable to increasing trends at the regional level, hooded warblers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

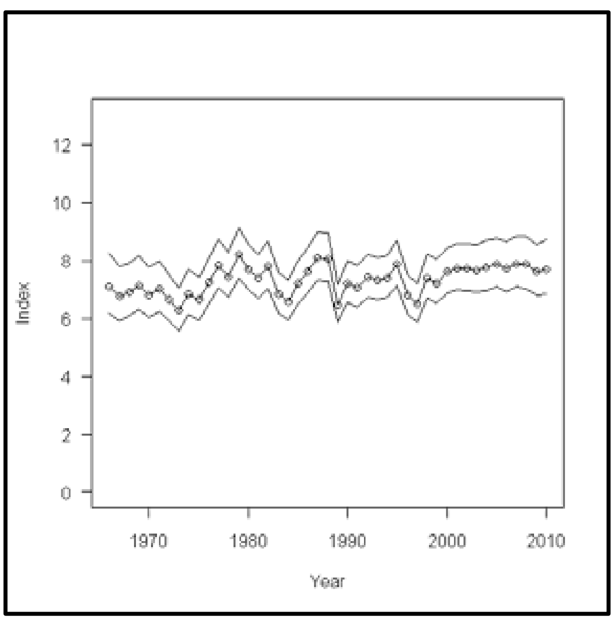
Scarlet Tanager

Drier oak forests support a slightly different mix of species due to their more open woodland condition. To represent this upland oak community, the scarlet tanager (*Piranga olivacea*) is selected as an MIS. This species is most abundant in upland mature forest (Hamel 1992). Trends for these species will be evaluated along with trends in total acres, age-class distribution, and level of restoration and maintenance activities in this forest type to provide a more complete picture of effects of management on this community.

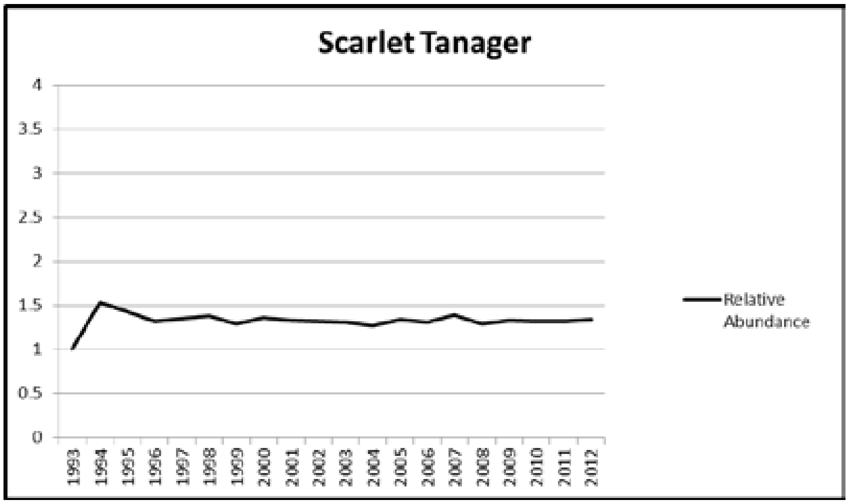
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable to slightly increasing population trends of scarlet tanagers for the Blue Ridge Mountain and increasing population trends in the Ridge and Valley regions. Data from the GWJNFs point count data for scarlet tanager indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Scarlet tanagers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Scarlet tanagers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Scarlet tanagers occur in deciduous, mixed deciduous/coniferous and coniferous forest types in the Appalachian region (Rosenburg et al. 1999). In the Appalachian region, research has indicated that scarlet tanagers do not show area sensitivity in moderately or heavily forested landscapes (Rosenburg et al. 1999). With overall stable to increasing population trends of scarlet tanagers on the GWJNFs and at the regional level, scarlet tanagers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

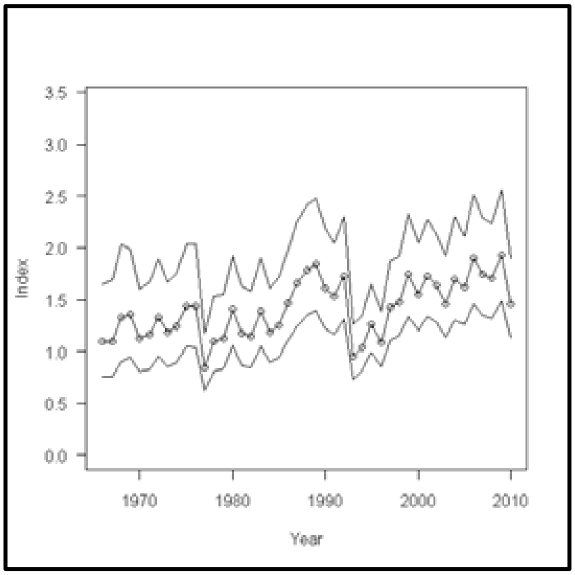
Pine Warbler

Pine forests have been in serious recent decline on the national forest as a result of southern pine beetle epidemics and lack of fire needed to maintain their dominance. Therefore, they will be the focus of ecological restoration and maintenance on some portions of the national forest. The pine warbler (*Dendroica pinus*) is closely associated with pine and pine-oak forests, generally occurring only where some pine component is present. It therefore is an appropriate indicator of the effects of management in restoring and maintaining pine forests. It should be noted, however, that this species does not discriminate as to the condition of pine stands relative to mid and understory, and so would indicate little more than the presence of pine. Other bird species that may be associated with desired fire-maintained conditions were not deemed sufficiently likely to be present to be appropriate MIS. Understory plant species also were considered and found to be too universal in association to be appropriate MIS. Therefore, pine warbler and various habitat-based elements, such as amount and effectiveness of prescribed burning, will be used to indicate effects of management on species associated with this community.

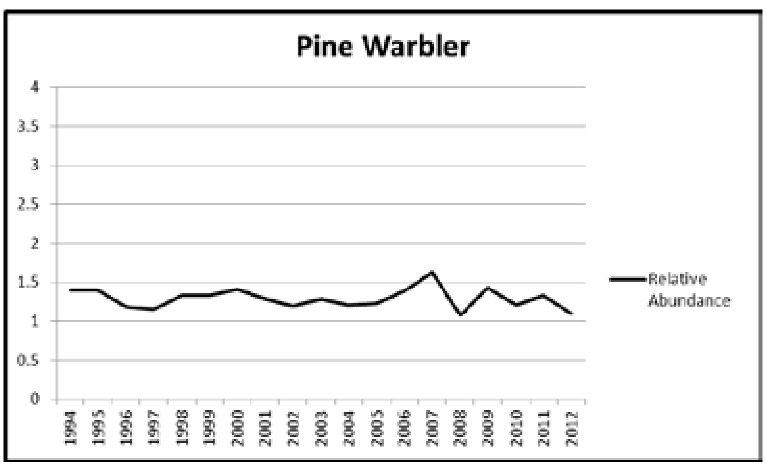
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable population trends of pine warblers for the Blue Ridge Mountain and stable to slightly increasing trends in the Ridge and Valley regions. Data from the GWJNF point count data for pine warbler indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Pine warblers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Pine warblers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Pine warblers occur in mid- to late-successional pine and pine/oak forest types throughout its range (Hamel 1992). It is rarely found in pure hardwood forest types. Pine warblers are temperate migrants in the Appalachians, shifting to the Piedmont and Coastal Plain during the winter months. They are mainly insectivorous during the breeding season, but shift to insects, berries, and small seeds the rest of the year. With overall stable population trends of pine warbler on the GWJNFs and stable to increasing trends in the Blue Ridge and Ridge and Valley regions, pine warblers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

Eastern Towhee

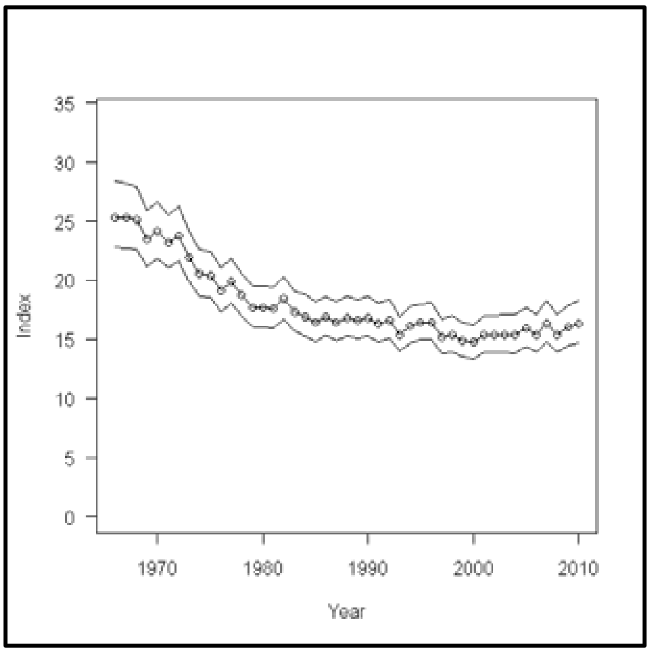
The eastern towhee (*Pipilo erythrophthalmus*) was selected as the most appropriate MIS to represent early successional forests. Eastern towhees are shrubland nesting birds that require thickets or brushy places on

the ground or in shrubs or saplings to 5 feet high for nesting. Providing early successional and open woodland forest is necessary to support populations of this species.

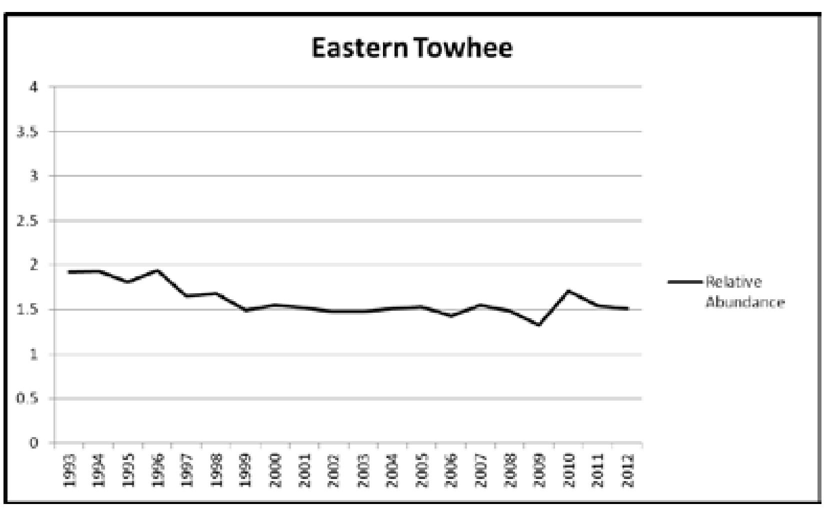
FOREST TRENDS

USGS Breeding Bird Survey data indicates decreasing to stable population trends of eastern towhees for the Blue Ridge Mountain and decreasing trends in the Ridge and Valley regions. Data from the GWJNF point count data for eastern towhee indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Eastern towhees across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Eastern towhee across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Eastern towhees inhabit early successional habitat associated with dense second growth, dense vegetation associated with open woodlands, and forest edge habitat (Hamel 1992; Hunter et al. 2001). Eastern towhees have exhibited significant continental population declines in the last couple of decades, mirroring an overall trend of decline of disturbance-dependent bird species associated with open habitats in eastern North America (Vickery 1992; Askins 2000; Hunter et al. 2001). A significantly greater proportion of bird species exhibiting steep population declines are associated with disturbance-mediated habitats than in forested or generalist habitat types (Brawn et al. 2001). Forty percent of all North American species associated with some type of disturbance-mediated habitat (grassland, shrub-scrub, open woodlands) have been significantly decreasing in population since 1966 (Brawn et al. 2001). Combined with recent research highlighting the importance of early successional woody habitat for post-breeding and migratory stop-over needs of forest-interior migratory bird species in a larger landscape of mature forest (see sections on ovenbirds and worm-eating warblers and hooded warblers), the role of early successional habitat in largely mature, forested landscapes and the need to restore/maintain disturbance regimes creating such habitats is of vital importance in conservation planning (Brawn et al. 2001; Hunter et al. 2001). With overall stable population trends of eastern towhees on the GWNF, and in the Blue Ridge region, eastern towhees have an abundance and distribution across the Forests that will provide for their persistence into the foreseeable future, though the steadily declining trends in the Ridge and Valley region are cause for concern.

Wild Brook Trout

Wild brook trout (*Salvelinus fontinalus*) were chosen as a MIS because many of the trout streams on the GW National Forest support wild native brook trout. Wild trout are indicative of cold water streams, good water quality and sedimentation rates that are in equilibrium with the watershed. In addition, trout are commonly fished and are a demand species. Furthermore, some management activities, such as stream liming and habitat restoration, are specifically designed to improve brook trout habitat and increase their populations. MIS population trends and changes are analyzed for wild trout, rather than hatchery reared fish, since many stocked streams are not suitable for year-round survival or recruitment of a self-sustaining population. VDGIF tracks wild brook trout populations on selected Forest streams. Wild trout are also a species that could be highly sensitive to stream temperature changes associated with climate change. This MIS is discussed under the Fisheries and Aquatic Habitat section of this Chapter.

Beaver

Beavers (*Castor canadensis*) were selected as an MIS because they are a keystone species that create wetland habitat with many physical and biological benefits. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent positive effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Restoring beaver populations to their maximum viability on public lands is desirable because of the beaver's capability to restore and maintain healthy riparian ecosystems. Key conservation elements for the beaver on National Forest System lands are, therefore, protection and enhancement of aquatic and riparian habitats by management of water resources and riparian vegetation, beaver population enhancement by natural recolonization and transplants where necessary, and proactive management of beaver damage issues.

FOREST TRENDS

The primary conservation concerns are to ensure that existing beaver populations remain viable and to restore beaver populations to unoccupied habitat where appropriate to take advantage of their capability to restore and strengthen the ecological integrity of aquatic and riparian ecosystems. Beaver management plans must take into account landscape-scale habitat management. To maintain viable populations, managers should ensure that land uses maintain connectivity between watersheds to facilitate long-range dispersal and gene flow. This scale of management maintains metapopulation dynamics and allows natural dispersal to repopulate watersheds where beavers have been reduced or extirpated by natural or human causes. At project-level scales, management practices that potentially affect riparian vegetation and stream hydrology or morphology should mitigate adverse impacts to beaver habitat, and enhance beaver habitat where possible.

Beavers are vulnerable to overharvest because of the relative ease of capture, their dependence on aquatic habitat, delayed sexual maturity, and a slow reproductive rate. Since beavers are regulated by the state wildlife agencies as a furbearer species, maintaining viable beaver populations will require cooperative management plans that account for overharvest vulnerability, to ensure that local or regional populations are not decimated by excessive exploitation and that National Forest wetland habitat conditions are being met. Ensuring a sustainable harvest may include designating some areas as off limits to trapping.

The following areas have been identified as important beaver habitat sites because of the quality and quantity of long-term wetland habitat that beavers have created. Since beavers are a new MIS there is no existing trend analysis. In the future, these areas will be monitored for beaver activity.

Table 3B2-17. Key Beaver Habitat Sites on the GWNF

Ranger District	Important Beaver Habitat Site	Current Beaver Activity
Warm Springs	Laurel Fork	Low
Pedlar	Maple Flats	Moderate
North River	Tillman Road	Low
Lee	Paddy and Cove Runs	High

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Future trends in MIS are discussed in various sections of this document. These are identified in Table 3B2-18. Table 3B2-19 displays the objectives for habitat management for each Management Indicator Species by alternative.

In summary, 14 species have been selected as management indicator species. They will be used to assess effects of alternatives and to help monitor effects of implementing the selected alternative.

Within specific major forest communities and terrestrial habitats there is discussion of individual MIS and their expected response to each alternative. Viable populations of management indicator species are expected within all alternatives, but the mix of habitat components, by alternative, will influence the degree to which increases or decreases are expected for each MIS.

Table 3B2-18. Location of Discussion of Management Indicator Species Effects

MIS Common Name	Location of Discussion of Future Trends by Alternative
Cow Knob Salamander	Habitat management is directed through establishment of the Shenandoah Mountain Crest-Cow Knob Salamander Management Prescription Area. The direction was prepared as part of the Conservation Agreement and is expected to maintain or improve current populations.
Pileated Woodpecker	This MIS is part of the Cavity Trees, Den trees and Snags group of species and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Ovenbird	This MIS is part of the Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Chestnut-sided Warbler	This MIS is part of the High Elevation Openings, grassy or shrubby or open woodlands Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Acadian Flycatcher	This MIS is part of the Riparian Area Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Hooded Warbler	This MIS is part of the Late Successional Hardwood Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Scarlet Tanager	This MIS is part of the Open woodlands Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter under Oak Forests and Woodlands. Population trends of the species in this group by alternative are found in Table 3B2-3.
Pine Warbler	This MIS is part of the Fire Dependent and Fire Enhanced Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter under Pine Forests and Woodlands. Population trends of the species in this group by alternative are found in Table 3B2-3.
Eastern Towhee	This MIS is part of the Regenerating Forests Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Wild Brook Trout	This MIS is discussed under the Fisheries and Aquatic Habitat section of this Chapter.
Eastern Wild Turkey	This MIS is discussed under the Demand Species section of this Chapter.
Black Bear	This MIS is discussed under the Demand Species section of this Chapter.
Deer	This MIS is discussed under the Demand Species section of this Chapter.
Beaver	With emphasis on beaver, it is expected that populations will increase under all alternatives.

Table 3B2-19. Management Indicator Species Habitat Management by Alternative

MIS Common Name	Objectives for Habitat Management by Alternative
Cow Knob Salamander	All alternatives utilize the Shenandoah Mountain Crest-Cow Knob Salamander Management Prescription Area to implement the Conservation Agreement for the salamander.
Pileated Woodpecker	All alternatives incorporate the suite of standards to address the needs of the cavity trees, den trees and snags groups of species. All alternatives also result in a large proportion of the forest in late successional stages.
Ovenbird	The ecological systems objectives all include a substantial portion of the systems meeting the needs of the area sensitive mature forest associate species group. This need will be met in all alternatives.
Chestnut-sided Warbler	All alternatives will meet some of the objectives for the high elevation openings species group. However, Alternative C relies on natural processes, so does not actively increase the amount of regeneration at high elevations. The amount of regeneration at high elevation varies by alternative.
Acadian Flycatcher	All alternatives have objectives for riparian areas. Alternatives B, C, E, F, G, H and I (D to a lesser extent) all expand the width of riparian area corridors.
Hooded Warbler	All alternatives have objectives to maintain large amounts of late successional habitat with Alternative C having the largest.
Scarlet Tanager	All alternatives utilize fire to some extent to create open woodland habitat. Alternative C relies on wildfire and Alternative A has a small amount of prescribed fire. The other alternatives all increase the level of prescribed fire to create this condition.
Pine Warbler	Pine habitat is also dependent upon wildland fire. See description for scarlet tanager.
Eastern Towhee	All alternatives will meet some of the objectives for the regenerating forest species group. However, Alternative C relies on natural processes, so does not actively increase the amount of regeneration. The amount of regeneration varies in each of the other alternative.
Wild Brook Trout	All alternatives address the objectives of maintaining and restoring the aquatic systems.
Eastern Wild Turkey	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Black Bear	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Deer	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Beaver	All alternatives address the objectives of maintaining and restoring the aquatic systems. Alternatives B, C, E, F, G, H and I (D to a lesser extent) all expand the width of riparian area corridors. Restoration of beaver habitat is an emphasis in Alternatives E, G, H and I.

B3 – 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 there is 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 Service1997). This report 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 dominant trees, but natural disturbance regimes (fire, ice storms, gap formation, etc.) and edaphic conditions (rainfall, slope, aspect, etc.) where they are 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 (2), 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 through 99 acres) possible old growth patches; and (2) representation of all possible 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 and 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 an 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 is 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 in the delineation of old growth, both possible 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 areas, 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.

AFFECTED ENVIRONMENT

Existing old growth was defined in the old growth report as '…forest stands that meet all four criteria (age, disturbance, basal area, and tree size) described in the operational definitions for that applicable old growth forest type. Possible old growth is defined as Forest stands which meet one or more of the preliminary inventory criteria from the Old Growth Guidance. FSVeg forest types were aggregated into the appropriate Old Growth Forest Type (OGFT) as described in the Regional Guidance Report and those stands meeting the minimum age were then tagged as the initial inventory of possible old growth. Ages have been determined for each stand on the Forest during the prescription process for all compartments and stands on the Forest. Most of the polygons identified through this process have not been visited to verify the existence of old growth per the four elements of the criteria. The current inventory is an initial screen and inventory. During project implementation those stands in the project area identified as possible old growth will be examined to determine if they meet the four criteria and are therefore considered existing old growth. Table 3B3-1 displays the current acres of possible old growth by type and compares that with the acreage of that type regardless of age. This table also projects the future amount of possible old growth at +10 and +50 years as the forest continues to get older.

Table 3B3-1. Amount of Possible Old Growth by Old Growth Forest Type as of 2010

OGF Type #	Old Growth Forest Type Name	Min. Age	Current Total Acres On GW All Ages	Current Areas Acres (& %) Possible Old Growth	Current Areas +10 yrs Acres & % Possible Old Growth	Current Acres +50 yrs & % Possible Old Growth
1	Northern Hardwood Forest	100	9,644	1,263 (13%)	4,491 (47%)	8,457 (88%)
2	Conifer-Northern Hardwood Forest	0	0	0	0	0
2a	Hemlock-Northern Hardwood	140	6,574	2,494 (38%)	3,010 (46%)	5,194 (79%)
2b	White Pine-Northern Hardwood	140	37,711	688 (2%)	1,741 (5%)	9,888 (26%)
2c	Red Spruce-Northern Hardwood	120	524	118 (23%)	118 (23%)	255 (49%)
5	Mixed Mesophytic Forest	140	57,515	5,064 (9%)	7,936 (14%)	32,905 (57%)
10	Hardwood Wetland Forest	120	111	0 (0%)	0 (0%)	0 (0%)
21	Dry- Mesic Oak	130	678,932	151,371 (22%)	207,224 (31%)	598,663 (88%)
22	Dry and Xeric Oak	110	492	331 (67%)	467 (95%)	467 (95%)
24	Xeric Pine and Pine Oak	100	124,374	66,468 (53%)	101,758 (82%)	118,709 (95%)
25	Dry and Dry Mesic Oak-Pine	120	122,525	16,850 (14%)	36,224 (30%)	113,658 (93%)
28	Eastern Riverfront Forest	100	194	6 (3%)	25 (13%)	76 (39%)
TOTAL Acreage and % of Current			1,038,596	244,653 (24%)	362,996 (35%)	888,271 (86%)

The network, or spatial distribution, of old growth by patch size is of importance as described in the Regional Guidance report. Currently (2010) the inventory of possible old growth identified 1,749 small patches (1-99 acres) totaling 58,773 acres, and 450 medium sized patches (100-2,499 acres) totaling 152,657 acres, and 7 large patches (>2,499 acres) totaling 33,107 acres across the GWNF. The average size of small patches is 34 acres, 339 acres for medium sized patches, and 4,730 acres for large patches. Table 3B3-2 shows the current condition of patches and their condition projected to be in 10 and 50 years from now.

Table 3B3-2. Number and acreage of small, medium, and large patches

Patch Size	Current (2010)		Current +10 years		Current +50 years	
	# of Patches	Acres	# of Patches	Acres	# of Patches	Acres
Small (1-99 acres)	1,749	58,828	1,846	60,534	234	7,476
Medium (100-2,499 acres)	450	152,714	522	202,909	108	56,050
Large (>2,499 acres)	7	33,111	19	99,553	32	824,745
Total	2,206	244,653	2,387	362,996	374	888,271

DIRECT AND INDIRECT EFFECTS

Each alternative evaluated in detail includes management prescriptions that either have the intent of protecting possible old growth and expanding it, or of providing old growth indirectly as the result of management that limit timber harvest. But, as noted in the old growth report, the primary focus of old growth management in the near and medium term is restoring it on the landscape. And the primary (not the only) component of restoration is simply time; time for existing stands to age through the gradual development of old growth conditions. For that reason, alternatives are compared by how old growth forest types will be managed and the sum of the acreage they allocate to old growth compatible prescriptions.

Table 3B3-3 displays the amount of possible old growth that is located in management prescription areas that are unsuitable for timber production. Tables 3B3-4 and 3B3-5 display the same information, but projected out 10 and 50 years.

Table 3B3-3. Current Percent of Possible Old Growth in Prescriptions Unsuitable for Timber Production

OGF Type #	Old Growth Forest Type Name	Current Acres (2010) of Possible Old Growth	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
1	Northern Hardwood Forest	1,263	90%	90%	100%	91%	91%	96%	91%	91%
2	Conifer-Northern Hardwood Forest	0	0	0	0	0	0	0	0	0
2a	Hemlock-Northern Hardwood	2,494	95%	92%	100%	92%	94%	96%	94%	94%
2b	White Pine-Northern Hardwood	688	53%	33%	100%	35%	44%	66%	40%	40%
2c	Red Spruce-Northern Hardwood	118	100%	100%	100%	100%	100%	100%	100%	100%
5	Mixed Mesophytic Forest	5,064	61%	55%	100%	56%	63%	66%	60%	61%
10	Hardwood Wetland Forest	0	0	0	0	0	0	0	0	0
21	Dry- Mesic Oak	151,371	58%	46%	100%	46%	55%	68%	54%	54%
22	Dry and Xeric Oak	331	71%	48%	100%	48%	48%	71%	48%	48%
24	Xeric Pine and Pine Oak	66,468	51%	40%	100%	41%	50%	62%	47%	46%
25	Dry and Dry Mesic Oak-Pine	16,850	55%	49%	100%	48%	60%	69%	55%	56%
28	Eastern Riverfront Forest	6	0%	0%	94%	0%	0%	0%	0%	0%
TOTAL Acreage		244,653	56%	45%	100%	46%	55%	67%	53%	53%

Table 3B3-4. Percent of Possible Old Growth in 2020 in Prescriptions Unsuitable for Timber Production

OGF Type #	Old Growth Forest Type Name	Acres of Possible Old Growth in 2020	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
1	Northern Hardwood Forest	4,491	91%	90%	100%	90%	90%	94%	90%	90%
2	Conifer-Northern Hardwood Forest	0	0	0	0	0	0	0	0	0
2a	Hemlock-Northern Hardwood	3,008	90%	87%	100%	87%	89%	91%	89%	89%
2b	White Pine-Northern Hardwood	1,745	39%	27%	100%	27%	37%	49%	35%	37%
2c	Red Spruce-Northern Hardwood	118	100%	100%	100%	100%	100%	100%	100%	100%
5	Mixed Mesophytic Forest	7,936	58%	52%	100%	52%	60%	65%	58%	58%
10	Hardwood Wetland Forest	0	0	0	0	0	0	0	0	0
21	Dry- Mesic Oak	207,333	56%	44%	100%	45%	53%	67%	52%	52%
22	Dry and Xeric Oak	467	56%	40%	100%	40%	40%	56%	40%	40%
24	Xeric Pine and Pine Oak	101,728	52%	40%	100%	40%	49%	62%	46%	46%
25	Dry and Dry Mesic Oak-Pine	36,379	48%	39%	100%	39%	51%	63%	47%	47%
28	Eastern Riverfront Forest	25	24%	0%	101%	0%	0%	24%	0%	0%
TOTAL Acreage and % of Current		362,230	55%	44%	100%	44%	53%	66%	51%	51%

Table 3B3-5. Percent of Possible Old Growth in 2060 in Prescriptions Unsuitable for Timber Production

OGF Type #	Old Growth Forest Type Name	Acres of Possible Old Growth in 2060	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
1	Northern Hardwood Forest	8,457	87%	87%	100%	87%	87%	92%	87%	87%
2	Conifer-Northern Hardwood Forest	0	0	0	0	0	0	0	0	0
2a	Hemlock-Northern Hardwood	5,193	77%	70%	100%	72%	74%	82%	74%	75%
2b	White Pine-Northern Hardwood	9,896	31%	23%	100%	24%	29%	42%	28%	28%
2c	Red Spruce-Northern Hardwood	255	65%	65%	100%	65%	65%	65%	65%	65%
5	Mixed Mesophytic Forest	32,854	55%	48%	100%	49%	54%	63%	53%	53%
10	Hardwood Wetland Forest	0	0	0	0	0	0	0	0	0
21	Dry- Mesic Oak	598,543	53%	41%	100%	41%	49%	64%	48%	48%
22	Dry and Xeric Oak	467	56%	40%	100%	40%	40%	56%	40%	40%
24	Xeric Pine and Pine Oak	118,636	52%	40%	100%	40%	49%	62%	46%	46%
25	Dry and Dry Mesic Oak-Pine	113,820	50%	40%	100%	40%	50%	63%	47%	47%
28	Eastern Riverfront Forest	76	22%	14%	100%	14%	14%	22%	14%	14%
TOTAL Acreage and % of Current		888,196	53%	41%	100%	42%	49%	63%	48%	48%

In addition to old growth allocated to management prescription areas that are unsuitable for timber production, some alternatives have additional protections for old growth. Possible old growth identified by type and minimum age plus areas identified in the field as old growth according to the 4-part Regional criteria in old growth forest types (OGFT) 1, 2a, 2b, 2c, 5, 10, 22, 24, and 28 will be considered unsuitable for timber production in all alternatives. In Alternatives C, E, and F OGFTs 21 and 25 are added to the list as unsuitable for timber production. In Alternative A and B possible and existing OGFT 21 stands on suitable ground remain suitable. In Alternative D, G, H and I possible and existing old growth in both OGFTs 21 and 25 stands on suitable ground remain suitable.

In Alternatives A and B it is estimated that the amount of timber harvested from stands in OGFT 21 that meet the definition of old growth would be less than 3,000 acres during the next ten years. In Alternative D it is estimated that the amount of timber harvested from stands in OGFTs 21 and 25 that meet the definition of old growth would be less than 5,000 acres during the next ten years, with about 4,000 in OGFT 21. In Alternatives G, H and I, it is estimated that the amount of timber harvested from stands in OGFTs 21 and 25 that meet the definition of old growth would be less than 3,000 acres during the next ten years, with about 2,400 in OGFT 21.

Therefore, prior to scheduling any silvicultural practices on lands classified as suitable for timber production in OGFT 21 (dry-mesic oak forests) and/or OGFT 25 (dry and dry-mesic oak-pine forests), stands are inventoried using the Southern Region's Guidance (Forestry Report R8-FR 62) depending on the alternative. Silvicultural practices could proceed after site-specific analysis and disclosure which included a discussion on the old growth characteristics found in the stand(s) of the project area, the effect of the action on these characteristics, and the effect the action would have on the contribution of the area to the Forest's "old growth" inventory.

Currently the GWNF Forest Plan states that timber harvesting can only occur within the Dry Mesic Oak Type (OGFT 21), as all other stands meeting the minimum age in other groups were classified during the Forest Plan revision process as unsuitable for timber production. While some individual old age stands of the Dry Mesic Oak type were cut for timber during the past 18 years (<1,000 acres), the total acreage of stands meeting the minimum age within the that group continues to increase. From 1993 to 2010 there was an increase of 63,379 acres (72%) from 87,889 to 151,268 acres in OGFT 21. Thus, timber harvesting is not significantly limiting the old growth forest conditions on the GWNF, and in particular OGFT 21 since it is the most common and widespread group on the GW. However, it is recognized that once a specific acre of existing old growth is regenerated, that acre will not achieve old growth characteristics within our lifetime.

Fire is a natural disturbance process common to most OGFTs (but is very infrequent in northern hardwoods, spruce/fir, and riverfront forests) (USDA 1997; Trombulak 1996). Thus, the increased use of prescribed fire is not affecting the overall amount of old growth across the Forest, but instead is restoring and maintaining vegetation in species composition and structure more typical of the fire regime these forests experienced prior to active fire suppression (~1930s). In the absence of fire as a major landscape scale disturbance (which it once was) the structure and composition of forests, regardless of age, will not meet historic old growth conditions (NatureServe; Landfire; Native Tree Society). These forests will be much more closed canopy and closed understory as opposed to the open canopy and very open understory that historically existed. We will meet the age requirements for an old growth forest but will lack much of the associated structure. Thus, the acreage of all old growth forest types meeting minimum necessary ages is steadily increasing as the forest continues to increase in age, but stand structure in most types is not being met due to lack of fire related disturbances.

"Future old growth" are those forest stands or patches allowed to develop old growth characteristics through lack of timber harvest, but which do not currently meet the operational definition for existing old growth. Table 3B3-6 shows that Alternative C provides for the greatest level of future old growth being found in larger blocks. This alternative contains the greatest acreage within future old growth since over one-third of the total Forest acreage is in Recommended Wilderness Study Areas. It also would contain the largest potential old growth blocks. This is followed by Alternatives F, A, E, G, H and I respectfully. Alternatives B and D provides the least amount of future old growth.

Table 3B3-6. Acreage in Key Management Prescriptions that will provide for Most Large Blocks (>= 2,500 acres) of Future Old Growth, by Alternative

Management Prescription	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
Designated Wilderness	42,954	43,049	42,992	42,992	42,992	42,992	42,992	42,992
Recommended Wilderness Study	1,413	20,422	386,786	14,627	24,325	112,144	20,314	27,365
Research Natural Area	2,808	1,980	1,979	1,979	1,979	1,979	1,979	1,979
Special Biological Area	24,454	51,427	21,303	51,574	51,574	30,438	51,565	52,585
Key Natural Heritage Community Area	0	0	0	0	0	0	3,308	3,324
Mt Pleasant National Scenic Area	7,753	7,742	7,744	7,744	7,744	7,744	7,744	7,744
Recommended National Scenic Area	0	0	0	8,241	0	107,717	0	67,479
Mix of Successional Habitats – Unsuitable	69,736	0	0	0	0	0	0	0
Black Bear / Remote Habitats - Unsuitable	61,204	0	0	0	0	0	0	0
Shenandoah Mtn Crest – Cow Knob Salamander	43,137	46,692	20,343	53,855	49,644	23,382	46,812	23,832
Remote Backcountry	198,858	191,935	113,852	190,423	264,184	167,845	252,159	200,814
Mosaics of Habitat - Unsuitable	0	0	245,678	0	3,308	109,380	0	0
Total Acres	452,317	363,247	840,677	371,435	445,750	603,621	426,873	428,114

A comparison of the patches of old growth that are in management prescription areas that are unsuitable for timber production is shown in Table 3B3-7.

Table 3B3-7. Percent of Old Growth Patches in 2010, 2020, and 2060 in Prescriptions Unsuitable for Timber Production

Patch Size	# of Patches	Acres	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
Current Condition (2010)										
1 (1-99 acres)	1,749	58,828	44%	31%	100%	32%	39%	55%	37%	37%
2 (100-2,499 acres)	450	152,714	56%	45%	100%	45%	55%	67%	53%	54%
3 (>2,499 acres)	7	33,111	79%	73%	100%	74%	81%	88%	76%	76%
Total # and acres	2,206	244,653	56%	45%	100%	46%	55%	67%	53%	53%
Condition in 10 Years (2020)										
1 (1-99 acres)	1,846	60,481	43%	30%	100%	30%	37%	53%	35%	35%
2 (100-2,499 acres)	522	202,857	52%	40%	100%	40%	47%	63%	46%	46%
3 (>2,499 acres)	19	99,547	69%	59%	100%	59%	73%	79%	69%	69%
Total # and acres	2,387	362,885	55%	44%	100%	44%	52%	66%	51%	51%
Condition in 50 years (2060)										
1 (1-99 acres)	234	7,379	25%	11%	100%	12%	13%	32%	12%	13%
2 (100-2,499 acres)	108	55,872	39%	11%	100%	11%	13%	41%	12%	12%
3 (>2,499 acres)	32	824,517	54%	44%	100%	44%	52%	65%	51%	51%
Total # and acres	374	887,767	53%	41%	100%	42%	49%	63%	48%	48%

CUMULATIVE EFFECTS

Beyond the expected and naturally occurring disturbances like wind, ice, fire, native insects and disease the biggest impact upon existing and future old growth will be alterations in disturbance regimes and effects of non-native insect and disease events. Hemlock woolly adelgid is likely to have as large of an impact on eastern and Carolina Hemlocks as chestnut blight had on American chestnuts. Other major impacts will result from naturalized non-native pests like gypsy moths, European boars, beech-bark disease, and butternut blight and their induced mortality is expected to severely impact certain old growth types. The greatest effect of alteration in natural disturbance regimes is the decrease in fire disturbance across most OGFTs. Fire is discussed elsewhere in this EIS but the overall effect of an altered fire regime has been to alter many old growth characteristics related to species composition and structure with current conditions much more closed canopy and species tolerant to shade species such as red maple and white pine increasing while fire tolerant species decrease. But, regardless of alternative, the maturation of the Forest will continue and an increase in old growth as a function of age is expected into the future. Tables 3B3-1 and 3B3-2 show how the acreages increase and shift in 10 and 50 years for the types and the patches. Continued inventory for old growth will occur at the project level.

B4 – AQUATIC SPECIES DIVERSITY

B4A - FISHERIES AND AQUATIC HABITAT

AFFECTED ENVIRONMENT

The Forest has approximately 1,171 miles of perennial streams and 2,348 miles of intermittent streams. Of the perennial streams, about 702 miles are classified as supporting a cold water (less than 70 degree water temperatures) fishery, and 469 miles are classified as supporting cool or warm water fisheries (temperatures greater than 70 degrees during summer months). In addition, the Forest has 3,229 acres of lakes, ponds, wetlands and reservoirs greater than 1 acre.

Habitats

Water Quality

Water quality has been systematically monitored on Forest streams since 1988. As expected, the general water quality of any given stream is strongly tied to the underlying geology coupled with prevailing air quality. The collected data has been used to determine trends and changes in stream water composition, and to project the future chemical status of native trout streams. Water quality in the cold water stream habitat is generally described as infertile with total alkalinity less than 20 parts per million (ppm), and slightly to very acidic with pH as low as 4.8. A 1998 report (Bulger et al. 1998) found that of the study streams in non-limestone geology, 50 percent are "non-acidic." An estimated 20 percent are extremely sensitive to further acidification. Another 24 percent of the streams experience regular episodic acidification at levels harmful to brook trout and other aquatic species. The remaining 6 percent of streams are "chronically acidic" and cannot host populations of brook trout or any other fish species. Modeling conducted by the Southern Appalachian Mountain Initiative (SAMI), showed that even with sulfate deposition declining considerably, as new air regulations are implemented, stream recovery will be slow or non-existent over the next 100 years (Sullivan et al. 2004). Chronically acidic streams on the Forest may improve slightly and be only episodically acidic by 2100, but they will still be marginal for brook trout.

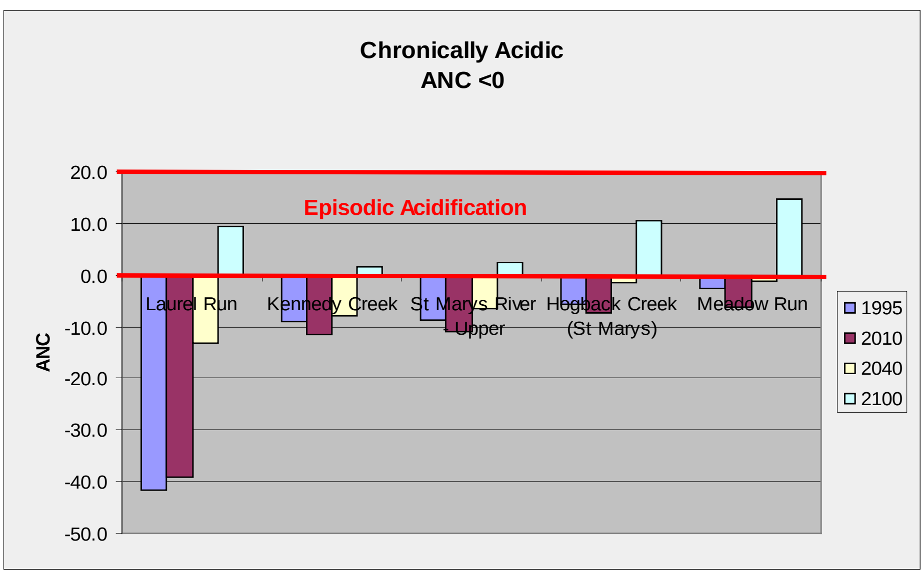


Figure 3B4-1. Chronically Acidic Streams

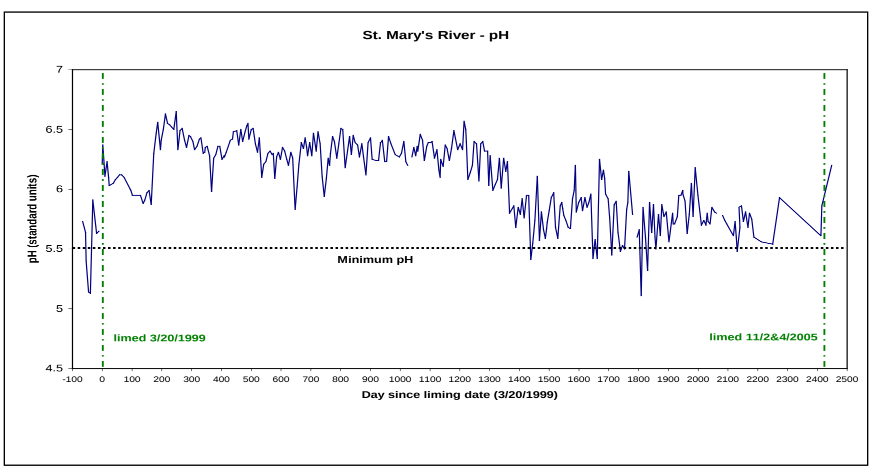
More recently, water chemistry analysis of 345 of Virginia's mountain streams sampled in 1987, 2000, and 2010 found that median acid neutralizing capacity (ANC) increased and median sulfate concentrations declined, indicating at least a partial recovery from acidification; with most of the recovery occurring since 2000. This recovery has been linked to the Clean Air Act Amendments of 1990 aimed at curbing emission, which have resulted in a significant decrease in rates of acidic atmospheric deposition (Miller 2011). However, analysis of quarterly stream chemistry data indicates that acidification is continuing in some Virginia brook trout streams (as indicated by a decrease in ANC and increase in sulfate concentrations), and that recovery from surface water acidification in western Virginia is generally less than in other eastern U.S. areas affected by acidic deposition (Webb 2011).

Due to the lengthy recovery time anticipated for acidified streams on the Forest, selective liming to improve water has been considered. The following streams have been limed on the GW Forest since 1989:

Table 3B4-1. George Washington National Forest Stream and Lake Liming

Date	Stream	County
1990, 1997	Cedar Creek	Shenandoah
1993, 1994, 1997	Laurel Run	Shenandoah
1997, 2000, 2003, 2006, 2009	Little Passage Creek	Shenandoah
1989, 1990,1991, 1998, 2001, 2004, 2007, 2010	Little Stony Creek	Shenandoah
1990, 1998, 2001, 2007	Mill Creek	Shenandoah
1993,1997, 1999, 2002, 2005, 2008	Mountain Run	Rockingham
2011	Pitt Spring Run	Page
1999	St. Mary's River & 5 tribs	Augusta
2005	St. Mary's River & 6 tribs	Augusta
1995, 1996, 1997, 1998, 1999	Trout Pond Run	Hampshire, WV

Trend in pH for one of the limed streams is shown below.



Water quality in the warm water stream habitat is generally higher in alkalinity and hardness, and not as susceptible to impacts from acid deposition because of more carbonate geology in the valley bottoms. Impacts to warm water streams often come from non-point source pollutants that enter the streams as they flow through private land.

For additional discussion on water quality, impaired waters, drinking water, and outstanding natural resource waters see the Water Resource section of EIS.

Physical Stream Condition

Large woody debris within a stream is ecologically important for instream habitat and productivity. Within the stream system, downed wood from riparian trees and shrubs greatly influence channel morphology and aquatic ecology. By altering stream flow, large woody debris stores and distributes sediment, and creates channel features, such as pools, riffles, and waterfalls. Wood also traps organic matter, which allows this material to be processed by instream organisms. Fish and insects occupy the pools and riffles created by the large woody debris, and riparian forest regeneration occurs on deposited sediment (Lassettre and Harris 2001).

Forest personnel surveyed stream habitat to measure desired parameters identified in the 1993 Revised GWNF Forest Plan. Surveys were conducted on portions of the Pedlar Ranger District in 1995 and 2005, Lee District in 2001, North River District in 2002, 2003, 2004 and 2005, and the Warm Springs in 2005. Overall, 631 km (392 miles) of streams were surveyed using a modified Basinwide Visual Estimation Technique (BVET [Dolloff et al. 1993]) to estimate woody debris loading, percentage of pool and riffle area, and the width of the riparian area of streams. The distribution of woody debris was also mapped. See Table 3B4-2 for a summary of LWD and % pool area.

Table 3B4-2. Miles of Stream Habitat Surveyed from 1995-2005 on GWNF

Year Surveyed	# of Stream Miles Surveyed	% of Streams Below Minimum Pool Area DFC	% of Streams Below Minimum LWD DFC
1995	113	48	44
2001	75	75	35
2002	57	62	33
2003	55	70	19
2004	35	71	78
2005	57	96	83

A comparison of individual streams surveyed in 1995 and again in 2005 on the Pedlar District showed a decrease in the median number of pools, number of riffles, and total LWD per km, while the median pool and riffle surface area increased. This report suggests that in 1995 only 25% of streams met the desired parameters for stream area in pools and less than half of streams met the desired conditions for total LWD. By 2005 no streams met the desired conditions for pool area and 75% of streams did not meet the desired conditions for total LWD. The changes in pool/riffle ratio, number of pools and riffles per km, and pool and riffle surface area are all consistent with decrease in total LWD. The largest decrease of LWD was in the smallest size class. These pieces most often form pool habitat by combining with other small woody debris to form debris jams. In general the smallest size classes are the most easily dislodged and transported downstream or out of the active stream channel during high flows (Hilderbrand et al. 1998; Montgomery et al. 2003). Loss of debris accumulations from long riffle areas following flood events could result in the changes in stream habitat observed. The median amount of the largest size classes of LWD either remained the same or increased in the reaches between 1995 and 2005.

Following 1993 Plan approval, across all Ranger Districts, large woody debris was deliberately added to many streams that did not meet the desired conditions. In addition, efforts were made in the North River to return a highly modified stream channel to a more natural condition. Past hydrological modifications of the North River include bank armoring with rock gabions and channelization to protect the road from frequent floods. These modifications resulted in a wide, shallow channel that lacks fisheries habitat complexity. Under a recent project, rock veins and weirs, and other structures made of natural materials were placed in the stream

channel to consolidate streamflow and increase sinuosity. Non-functional rock gabions blocking the natural floodplain were removed.

Physical Reservoir and Pond Condition

There are approximately 34 large man-made reservoirs on the GWNF; they were constructed by various agencies for the purposes of flood control, drinking water, hydro-electric and/or recreation between 30 and 80 years ago. The dams have affected the dammed streams in three ways: alteration of downstream flux of water and sediment, changed water temperatures, and barriers for upstream-downstream movement of organisms and nutrients. The resultant lake habitat has often been managed for fisheries (see next section). Many of these dams are aging; they were built to accommodate an estimated fifty year filling of the sediment pool and these life expectancies are being met or exceeded. In a new flood storage dam, the sediment pool is entirely occupied by water. Over time, the water is gradually replaced by sediment as the feeder stream transports material into the reservoir. An aged dam may thus have a recreational pool that is shallow and of limited habitat for fish, thus reducing recreation, while creating an area with greater likelihood for warming surface waters. In addition, the accumulated sediment may serve as a trap for airborne toxins such as mercury. Furthermore, the underwater structural habitat diversity (generally, trees and shrubs) that may have been present at time of lake development is decaying and needs to be replaced in order to maintain a healthy, self-sustaining warm water fish population within the reservoir.

Aside from the loss of recreation that accompanies the filling of the sediment pool, structural deterioration in primary spillways, degradation of secondary spillways, under-dam seepage and other problems are developing that can lead to dam failure. Many of these dams are under special use permits and owned by local entities such as Soil and Water Conservation Districts or municipalities, but the land on which they sit is National Forest. As these dams come up for refurbishment, the National Forest will review the purpose and need in light of its obligation to maintain integrity of the forest both for the use of humans and flora and fauna.

Small, natural impoundments such as beaver dams can be ecologically beneficial to an area. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. They create open, early successional habitat near riparian areas favored by species like woodcock.

The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Because they are porous and often have multiple channels through the dam, beaver dams generally do not restrict upstream or downstream movement of aquatic organisms. Beavers have disappeared, probably trapped out, from areas where they have previous played an integral habitat-maintaining role for many rare species (for example, the headwaters of Laurel Fork). Maintenance and restoration of beaver habitat across the Forest is necessary. Because of their role as a keystone species that create wetland habitat with many physical and biological benefits, beavers were chosen as Management Indicator Species (MIS).

Biota

The Southeastern United States supports the greatest diversity of freshwater mussel species in the world (Parmalee and Bogan 1998), and the richest freshwater fish fauna in North America north of Mexico (Warren et al. 2000). Looking at those species that are on or near the George Washington National Forest, 22 species of fish, aquatic invertebrates, and aquatic plants and mammals are listed as threatened, endangered, or sensitive (see Table 3B4-3). Because these species are associated with aquatic habitats, the effects to these and aquatic locally rare (LR) species are included in the general direct, indirect, and cumulative effects analyses below, and also addressed in the next section.

Table 3B4-3. Federally Threatened (T) or Endangered (E), and Forest Service Sensitive (S) Aquatic/Riparian Species On or Near the George Washington National Forest.

Scientific Name	Common Name	Status
Alasmidonta varicosa	Brook floater	S
Boltonia montana	Doll's daisy	S
Cicindela ancocisconensis	Appalachian tiger beetle	S
Elliptio lanceolata	Yellow lance	S
Fusconaia masoni	Atlantic pigtoe	S
Helenium virginicum	Virginia sneezeweed	FT
Helonias bullata	swamp pink	FT
Hydraena maureenae	Maureen's shale stream beetle	S
Iliamna remota	Kankakee globe-mallow	S
Isoetes virginica	Virginia quillwort	S
Lasmigona subviridis	Green floater	S
Notropis semperasper	Roughhead shiner	S
Noturus gilberti	Orangefin madtom	S
Peltigera hydrothyria	waterfan	S
Pleurobema collina	James spinymussel	FE
Poa paludigena	bog bluegrass	S
Potamogeton hillii	Hill's pondweed	S
Potamogeton tennesseensis	Tennessee pondweed	S
Scirpus ancistrochaetus	northeastern bulrush	FE
Sida hermaphrodita	Virginia mallow	S
Sorex palustris punctulatus	southern water shrew	S
Vitis rupestris	sand grape	S

Common native fish species in the cold water stream environments include brook trout, mottled sculpin, fantail darter, blacknose dace, longnose dace, and torrent suckers. Introduced species such as rainbow trout and brown trout are routinely stocked for sport fishing. In some Forest streams, these species have developed into naturalized populations. An effort has been made to eliminate introduced species from some native brook trout watersheds.

Wild trout (brook, rainbow, and brown) are indicative of cold water streams, good water quality and sedimentation rates that are in equilibrium with the watershed. In addition, trout are commonly fished and are a demand species. Wild brook trout were chosen as a MIS because many of the trout streams on the GW National Forest support wild native brook trout. MIS population trends and changes are analyzed for wild trout, rather than hatchery reared fish, since many stocked streams are not suitable for year-round survival or recruitment of a self-sustaining population.

Virginia has one of the strongest native brook trout resources in the Southeast. Wild brook trout populations are generally limited to higher elevations in the western mountains of the state. However, brook trout were once found throughout the limestone spring creeks in the Great Valley region located between the Blue Ridge and Allegheny mountain ranges and along some of the smaller tributaries of the Potomac at least as far east

as Fairfax County. Most of the valley limestone stream populations were likely extirpated a century or more ago with the agricultural development of the valley but some persisted as late as the mid-1960s. The populations within Potomac River tributaries were known to be strong through the 1950s and still persisted as late as the early 1980s. These populations were eliminated with residential development of the region. Recent research supports the relationship between forested watersheds and presence of brook trout; conversely, watersheds with extensive development (with as little as 4% impervious cover) were unable to support brook trout in their streams (Stranko et al. 2008). It is estimated that at least 38% of the original brook trout populations have been extirpated from Virginia.

Most of the remaining populations are well protected from land use changes due to public ownership. Land management agencies include the George Washington and Jefferson National Forests, the Shenandoah National Park and scattered holdings of the Virginia Department of Game and Inland Fisheries. The GWNF has 1,120 miles potential brook trout habitat in Virginia and West Virginia (see Aquatic Ecological Sustainability Analysis). The threats to this habitat that are not within the control of the National Forest include acid deposition and altered streamflow and temperature from climate change (see Climate Change section). However, impacts to trout and other cold-water species can hopefully be reduced by implementing the management strategies within the Forest Plan designed to maintain and protect healthy watersheds and support watershed resilience.

The Eastern Brook Trout Joint Venture (EBTJV) is a unique partnership between state and federal agencies, regional and local governments, businesses, conservation organizations, academia, scientific societies, and private citizens that is a geographically focused, locally driven, and scientifically based effort to protect, restore and enhance aquatic habitat throughout the range of the Eastern brook trout. Many of the watersheds identified as having “in-tact” brook trout populations by the EBTJV are on the GWNF; they have been identified as priority watersheds.

Cool/warm water streams across the Forest vary greatly in water quality and productivity. Common game fish species found in cool/warm water stream environments on the Forest include smallmouth bass, largemouth bass, redbreast sunfish, channel catfish, and rock bass. Typical non-game species include white sucker, carp, redhorse sucker, yellow bullhead, and a large variety of minnow and darter species. Chronic spring-time fish mortality and disease events occurred in the Shenandoah River 2004-2009, and in the upper James River 2007-2010. These episodes have not been uniform in location or severity over these time periods. Adult smallmouth bass, redbreast sunfish and rock bass have been the primary fish affected. However, several additional species have also been inflicted. Affected fish typically exhibit open sores or "lesions" on the sides of their bodies. Some dead and dying fish have no visibly external abnormalities. Other external symptoms include: dark patches of skin, raised bumps, loss of scales, split or eroded fins, and discolored/eroded gills. Determining the cause of these mortality and morbidity events has proven to be extremely difficult. Scientists have conducted in-depth studies on fish health, pathogens, water quality, and contaminant exposure. The fact that these events have occurred in two separate watersheds that differ in many ways has added to the complexity of understanding the cause. In the initial years of these events there was higher mortality observed and biologists estimated that fish losses were quite high. Fish biologists stressed that these were estimates and that the severity of the mortality and disease was not uniform throughout the rivers that were affected. However, several factors have allowed these fish populations to recover faster than anticipated; the most significant of these being excellent smallmouth reproduction between 2004 and 2007. The years 2004 and 2007 were two of the best spawning years in the past decade in the Shenandoah River. Virginia biologists have documented that river flow in the spring/early summer is what determines the success of the smallmouth bass spawn. It also only takes a small number of successful spawning fish to keep the population viable.

Most of the lake habitats on the Forest are small in size and relatively infertile with limited productivity. They routinely contain introduced largemouth bass, bluegill, and channel catfish. Trout species are stocked in lakes that have significant cold water environments. The largest reservoir on the Forest is Lake Moomaw, which was completed by the U. S. Army Corps of Engineers in 1981, and is the second largest impoundment in western Virginia. It covers 2,530 surface acres and the average depth of the reservoir is 80 feet, with the maximum depth at 150 feet near the dam. The impoundment is "drawn down" between 10-15 feet annually, beginning slowly in June and reaching its lowest level usually by September. There are 43 miles of undeveloped, wooded shoreline.

Lake Moomaw's geographic location and its operational procedure lend itself to thermal stratification in the summer. As much as 60,000 acre-feet of coldwater fisheries habitat is available in later summer for species such as brown and rainbow trout. Coldwater habitat varies annually depending on flow into the lake and downstream release loads. In summer 1993, the Corps of Engineers changed the way they released water out of the impoundment during summer/early fall. The Corps is required to provide 21° Celsius water at Covington, 30 km downstream of Gathright Dam, throughout this period. Currently, water from the epilimnion is mixed with cold, anoxic water from the hypolimnion, meeting downstream temperature requirements and preserving summer trout habitat in the lake. Alewives, the primary forage base, also thrive in the lake's two-story environment. Trout are the only sport fish that are stocked annually.

Changes in Moomaw's physical habitat have focused primarily on black bass populations. Warmwater fish species such as black bass, black crappie, rock bass, sunfish, chain pickerel, channel catfish, and yellow perch reproduce and grow in the flats, drop-offs, brush, and standing timber afforded to them along the lake's shoreline. Common carp found their way into the reservoir through bait introductions in the late 1990s. Artificial habitat such as tire reefs, artificial grass, cedar tree shelters, crappie stakes, pallet structures, log cribs, hinge trees, brush/tree piles, concrete structures, and PVC attractors have been deployed at various times in Lake Moomaw since 1981. Prior to impoundment, the Corps of Engineers left 40 hectares of standing timber in several coves and a few boulder piles in deep sections of the lower lake. Hundreds of stumps were also left along the shoreline, providing exceptional cover/nesting habitat for channel catfish. Addition of physical habitat has been accomplished jointly by DGIF, USFS, and local angling clubs. An inventory of past projects is maintained by USFS at the Warm Springs Ranger District office. A lake management plan was also jointly developed by DGIF and USFS in 1993.

Aquatic macroinvertebrates integrate the physical, chemical, and biological components of the riparian ecosystem and have been successfully used as biological indicators of change and impacts (Environmental Protection Agency 1989). Aquatic insects make up the largest group of invertebrates that live in streams and other water bodies. Because of their usefulness as biological indicators, aquatic macroinvertebrates will be used in monitoring the Forest Plan. Analysis of 925 sites on the George Washington and Jefferson National Forests established the current range of conditions for aquatic macroinvertebrate communities across the four ecological units found on the Forests. In order to evaluate the current condition of a stream relative to others within the same ecological unit, a compilation of nine ecological aspects, or metrics, of these communities were developed based on the EPA's Rapid Bioassessment Protocol II. The combined nine metrics, called the Macroinvertebrate Aggregated Index for Streams (MAIS) result in scores ranging from 0 to 18 (Smith and Voshell 1997). MAIS scores of 17-18 are "very good", 13-16 are "good", 7-12 are "poor/fair", and 1-6 are "very poor". The majority of the streams inventoried on the Forests (79%) fall into the "good" or "very good" category. These metric scores will be used as a tool for monitoring the effectiveness of the Forest Plan. Below is additional information about the individual nine metrics that make up the MAIS score.

Metric	Type of Metric	Description
EPT Index	Community Structure	The EPT Index is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. This value summarizes taxa richness within the insect orders that are generally considered to be pollution sensitive. EPT index decreases in response to increasing perturbation, and generally increases with increasing water quality.
Number Ephemeroptera	Community Structure	The total number of distinct taxa within the order Ephemeroptera. Mayflies are generally considered to be pollution-sensitive. Therefore, the number of mayfly taxa decreases in response to increasing perturbation.
Percent Ephemeroptera	Community Composition	The percent abundance of mayflies. Mayflies are particularly sensitive to a wide variety of impairments. This order is often missing in polluted streams.
Percent 5 most dominant taxa	Community Balance	The percent contribution of the five most numerically dominant taxa to the total number of organisms is an indication of community balance. A community dominated by a relatively few species would indicate environmental stress. This index generally increases in response to increasing perturbation.
Simpson's Diversity Index	Community Balance	Incorporates both richness and evenness in a measure of general diversity and composition. Diversity generally declines as impacts increase. Therefore, Simpson's index of diversity decreases in response to increasing perturbation.
Intolerant index	Tolerance	The number of macroinvertebrate taxa with tolerance values of 5 or less. Tolerance values taken from Family Biotic Index. Assumes that a greater percent abundance of intolerant macroinvertebrates indicates an unperturbed condition.
Family Biotic Index	Tolerance	This metric measures the proportion of sensitive to tolerant organisms in the community. The greater the proportion of sensitive organisms, the lower the index value. The greater the proportion of tolerant organisms, the greater the index value. This index generally increases in response to increase perturbation.
Percent Scrapers	Trophic	The relative abundance of scrapers in the riffle habitat provides an indication of the periphyton community composition. Scrapers increase with increased abundance of diatoms and decrease as filamentous algae and aquatic mosses (which cannot be efficiently harvested by scrapers) increase. Percent scrapers generally decrease in response to increasing perturbation.
Percent haptobenthos	Habit	Percent abundance of taxa requiring clean coarse substrate. Silty or scummy rocks are primarily inhabited by pollution-tolerant macroinvertebrates. Percent haptobenthos decrease in response to increasing perturbation.

Macroinvertebrate Monitoring Objective: Streams are managed in a manner that results in sedimentation rates that stabilize or improve the biological condition category of the stream as monitored using aquatic macroinvertebrates. Aquatic macroinvertebrates will be measured using EPA's Rapid Bioassessment Protocol II (EPA 1989), with modifications by Smith and Voshell (1997).

DIRECT AND INDIRECT EFFECTS

Currently, the biggest concerns for aquatic habitats on the Forest are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, impacts from roads, and acid rain. Ground disturbing management activities, particularly in the riparian areas, have the most potential for effects on fisheries and aquatic habitat resources on the Forest. Other threats include the removal of large trees that are located close to aquatic systems. These large trees provide shade, which aids in the regulation of stream temperatures. In addition, they are essential components in the continuous replacement of large woody debris to stream channels. Large logs and stumps create diverse habitat niches in streams vital to aquatic organisms.

Timber harvesting can directly affect sediment transport in streams if it increases (or decreases) the supply of sediment, if it alters the peak flow or the frequency of high flows, and if it changes the structure of the channel by removing the supply of large woody debris that forms sediment storage sites. Bank erosion and lateral channel migration also contribute sediments if protective vegetation and living root systems are removed.

If a forested riparian corridor were not left along the streams in a project area, reduction of streamside canopy could affect the physical characteristics of the stream channel and could also affect food quality and quantity for macroinvertebrates and other stream organisms directly and indirectly. Direct effects occur by changing the input of particulate food (leaf litter). Indirect effects come from alteration of the structure and productivity of the microbial food web through increased sunlight and modifying the levels of dissolved organic carbon and nutrients. Indirect effects of canopy removal may include increases in stream temperature. A 2-5^{o} C warming of small streams can affect life history characteristics of macroinvertebrates and developmental time of fish eggs (Sweeney 1993).

Roads affect the timing and volume of stream discharges by: intercepting and concentrating surface and subsurface flows; expanding or decreasing the channel networks; and reducing infiltration. The historic hydrological patterns within a watershed may be altered affecting the functions and processes to which the riparian and its inclusive aquatic communities have adapted. Roads located within the riparian corridor that either parallel or cross a stream present the greatest potential for allowing pollutants into surface waters. The use and construction of roads, log landings, trails, and other ground disturbing activities (including those associated with the development of wind energy that can increase erosion and sedimentation and concentrate runoff) could increase the amount of erosion during periods of high flow. Sediment loading in streams affects the aquatic fauna directly and indirectly. Direct effects include damage to gills and body surface by abrasion by suspended particles. Indirect effects come from a reduction in available dissolved oxygen, a reduction in suitable habitat due to substrate being covered with sediment, a reduction in pool volume, and the filling of interstitial spaces. These all affect habitat quality and complexity.

Large, human-built impoundments can alter flow regimes by changing the timing and quantity of instream flow below the reservoir. A decrease in water volume can lead to changes in channel morphology and an increase in water temperature. Increased flow below an impoundment can lead to channel scour and flow levels that disrupt the reproductive cycle of aquatic organisms. For example, high flows could wash away glochidia or juvenile mussels. Impoundments also affect dissolved and particulate organic matter in the water column and can change the natural temperature regime of a downstream river reach. These changes can affect the available food for aquatic organisms and create unsuitable thermal habitat. River habitat above an impoundment ultimately changes from a lotic to a lentic system.

Large, anthropogenic impoundments, as well as poorly designed road and trail stream crossings, can block fish passage thereby isolating upstream populations. Migration and movement of aquatic species are primarily restricted at road crossings by hanging culverts, high water velocity, inadequate swimming depth, or any combination of these three factors. Migration and movement barriers may be desirable (in rare cases) to protect a native species (brook trout) from a non-native competitor (rainbow trout). During watershed level analysis, the aquatic communities should be sampled above and below any culverts that could be barriers. Where the aquatic community above a culvert appears to have lost components, a decision should be made to either restock the unoccupied habitat through seining or electro-fishing or replace the culvert to facilitate natural movement back into the area.

The limiting factor for meeting the chemical desired future condition is atmospheric deposition, something the Forest Service cannot control. This effect will not vary by alternative. The only way to change the chemical condition of the streams is to mitigate acidification directly through addition of limestone, or indirectly through participation in the development of air pollution emission regulations.

Management activities, particularly in riparian areas, have the most potential for effects on aquatic and riparian habitat resources on the Forest. As previously stated, the biggest concerns for aquatic habitat are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, acid rain, and aquatic organism passage. Prescription areas and riparian management activities vary by alternative. Table 3B4-4 shows by alternative the general riparian

approach for species sensitivity factors. An additional sensitivity factor of "riparian integrity" was added to display the differences in approach between alternatives.

Table 3B4-4. General Riparian Direction by Forest Plan Alternative

Species Sensitivity Factor	Forest Plan Alternative Measure	Alt A	Alt A1	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H & I
Riparian Integrity	riparian corridor width-perennial	66'+	66'+	100'	100' [1]	66'+ [2]	100'	100'	100'
	riparian corridor width-intermittent	33'+	33'+	50'	50' [1]	33'+ [3]	50'	50'	50'
	riparian corridor width-ephemeral			25'	25'		25'	25'	25'
Sediment	acres of soil disturbance	182	72	178-262	66	276-413	175-254	138-200	183-267
	filter strip zone-perennial	66-200'	66-200'	100-150'	100-150'	66-200'	100-150'	100-150'	100-150'
	filter strip zone-intermittent	33-100'	33-100'	50-100'	50-100'	33-100'	50-100'	50-100'	50-100'
	filter strip zone-ephemeral			25'	25'		25'	25'	25'
Habitat Complexity	LWD desired conditions -cold water	125-300	125-300	200+	200+	125-300	200+	200+	200+
	LWD desired conditions -cool water	75-200	75-200	200+	200+	75-200	200+	200+	200+
Temp-erature	shade strip width-perennial	66'	66'	100'	100'	66'	100'	100'	100'
	shade strip width-intermittent	33'	33'	50'	50'	33'	50'	50'	50'
	shade strip width-ephemeral			25'	25'		25'	25'	25'
Acid deposition	Treatment of acid streams with lime a priority?	yes	yes	yes	no	yes	yes	yes	yes
Passage	Total road system at end of 10 years, mile	1,834	1,823	1,660	1,521	1,763	1,653	1,633	1,659*

A1 represents the actual implementation level of the 1993 Revised GWNF Plan
[1] width is larger than 100 feet in source watersheds and by impaired streams
[2] 100 feet in aquatic threatened and endangered species watersheds and 66 feet in other watersheds
[3] 50 feet in aquatic threatened and endangered species watersheds and 33 feet in other watersheds
*The total miles of road system at the end of 10 years for Alternatives H and I is 1,657.

Riparian integrity, sedimentation, large woody debris, canopy cover, acid rain, and aquatic organism passage are addressed differently by alternative. They are addressed either by mitigation, a resource approach (active management to meet desired conditions), or a natural processes approach (limited active management).

Alternatives A and D use an approach that resembles current management. The riparian areas are managed as a separate prescription area based on ecological parameters (width determined by true riparian characteristics defined by soils, vegetation, and biota). The desired conditions for fisheries and aquatic habitats are defined and buffered from other management activities through defined shade strips, filter strips, and vehicle exclusion zones. Aquatic habitats and fisheries are sustained in a healthy condition. Timber harvesting occurs in the riparian area outside the 66' buffer. There are no standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. Alternative D implements the Federally Listed Mussel and Fish Conservation Plan in those 6th level HUC watersheds that contain the James spinymussel, where riparian widths would be wider than for the rest of the Forest

Alternatives B, E, F, G, H and I also use a resource approach where riparian areas are managed as a separate prescription area, but defined widths are based on maintaining the desired ecological conditions of the entire riparian area, not just aquatic habitat. Riparian and aquatic habitats are sustained in a healthy condition. Timber harvesting occurs in the core riparian area only when needed to protect or enhance riparian-dependent resources; it is not suitable for timber production. Tree removal can occur in the extended riparian corridor to meet objective of adjacent management prescription, although vehicles are excluded. There are forestwide standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. The forestwide desired conditions and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan. The riparian corridor will be managed to retain, restore, and/or enhance the inherent ecological processes and functions of the aquatic, riparian, and upland components within the corridor in these alternatives. These standards should have a beneficial effect on the communities and their associated species.

Alternative C uses a natural processes approach, identifying riparian areas as a separate prescription area as in B, E, F G, H and I; but excluding most management activities to attain desired conditions in riparian areas. The forestwide desired conditions and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan; however, many fish management activities such as stocking, habitat improvement, and mitigation for acid deposition are restricted or prohibited. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. Species that require management to maintain suitable habitat (such as brook trout in acidified streams) would decline.

Overall, aquatic habitats are included in Management Prescription 11-Riparian Corridors. Under this management prescription, riparian areas and aquatic resources are managed to encourage the processes that maintain or lead to desired conditions for fisheries and aquatic habitats. Riparian habitats and fisheries are sustained in a healthy condition. In most riparian areas, a slow progression toward a mature forest of more shade tolerant species occurs. More large woody debris is deposited into streams. Riparian vegetation protects and stabilizes the stream bank, preventing accelerated erosion (Miller 1987). In addition, trees falling in the channel produce log steps, which dissipate energy and reduce associated sediment production and movement (Swanson and Lienkaemper 1977). Vegetated riparian areas also increase shade cover and thereby reduce water temperature, and contribute allochthonous organic matter (e.g., leaf litter and woody debris), directly and indirectly influencing food availability and aquatic organism populations (Fischer et al. 2010); they act as buffers between terrestrial and aquatic ecosystems, slowing the velocity of water flow, which results in the deposition of sediment and nutrient loads prior to reaching the stream channel (Edwards and Williard 2010). A recent study in Virginia showed that streamside management zone buffers (7.6m to 30m wide) were all equally effective at protecting water quality from forest harvest sedimentation; most of the sediment that entered stream systems came from the concentrated flow from roads, skids trails, or firelines (Lakel et al. 2006). Following an extensive literature review of riparian buffers, Tiner (2003) recommends vegetated widths of 30 meters to maintain aquatic food webs. This supports the expanded riparian and vehicle exclusion zone widths found in Alternatives B, C, E, F, G, H and I. When projects are implemented with full consideration of the riparian management prescription and channeled ephemeral stream standards, no direct or indirect adverse effects to aquatic organisms or to the aquatic habitat that sustain them should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for: filter strip widths

(implementation monitoring); off-site sediment movement and aquatic invertebrate community composition (effectiveness monitoring).

CUMULATIVE EFFECTS

The area considered for cumulative effects includes the fifth-level watersheds within the Forest proclamation boundary, and the analysis includes the potential effects of Forest, state and private activities on the waters within and leaving the Forest. Cumulative effects address the environmental consequences from activities implemented or projected within the watersheds in the past, present and reasonably foreseeable future. The combination of activities on National Forest System, state and private lands can create an effect at a watershed scale that otherwise would not be perceived as a problem at the project or subwatershed scale. In addition to their natural variability, watersheds differ by their management history, ownership patterns, and the types and levels of contemporary management activity. The combination of natural variables, ownership patterns and management activities contribute to the cumulative effects that shape the current conditions of the aquatic ecosystems within the analysis area. Given the variability in watershed conditions, both natural and management related, the discussion of cumulative effects will be general in nature (Reid 1998).

The current watershed and aquatic resource conditions in the analysis area are a reflection of the cumulative effects of past and present actions. Streams are deficient in LWD largely due to historic logging activities, sediment levels are elevated due to past and present management activities, and the hydrology of the watersheds is altered due to past and present land uses. Future activities can contribute to these effects or alleviate some of the problems. On NFS lands, the reasonably foreseeable future actions are considered to be the continuation of existing programs such as timber management, roads, developed and dispersed recreation, gas and mineral development, grazing allotments, special uses, fish and wildlife management, and other activities. On a broad scale, the effects of future management on NFS lands may result in some localized effects, but overall should not contribute to any measurable downstream impacts. This is due in part to Forest Plan direction for the protection of soil, water, and riparian resources, the continued natural recovery of watershed conditions across the Forest, and the implementation of watershed, riparian, and aquatic restoration projects. The level of potential harvest, and its distribution across watersheds, should not result in any hydrologic effects at the fifth-level watershed scale. With the exception of areas where roads, trails, or other facilities cross channels, riparian standards and guidelines should maintain the current level of stream shading and LWD recruitment. Opportunities also exist to revegetate and restore areas of degraded riparian conditions.

One concern is that future ground-disturbing activities have the potential to contribute to existing sediment sources, primarily associated with the forestwide transportation system. Roads continue to be a chronic source of sediment and additional inputs may be detrimental to the health of aquatic ecosystems depending on the existing site-specific conditions. The recovery of disturbed soils can be relatively quick, which reduces the erosion potential following the disturbance. But sediment that enters a channel can remain in the system for years, even decades, depending on the level of inputs and channel characteristics. Potential new sources could be off-set, in part or wholly, by correcting existing problems and reducing current inputs.

The influence of NFS land on cumulative effects for waters draining the analysis area largely depends on the level of ownership. NFS lands average 24 percent of the fifth-level watersheds within the proclamation boundary, ranging from .75 percent in the Craig Creek watershed to 59 percent in Dry River-North River watershed. NFS lands are typically located in the higher elevations and headwaters, and the influence of state and private lands increases going downstream. In watersheds where NFS lands are limited, the influence of state and private activities is greater.

Assuming the activities on state and private lands remain relatively constant, existing watershed and stream conditions within those areas should persist in the foreseeable future. Watershed, riparian, and aquatic conditions are modified by roads, rural and agricultural developments, logging, mining, housing developments, and other activities. Direct impacts to aquatic habitats occur through road crossings and flood control efforts. Reduced riparian vegetation effects stream shading, bank stability, LWD recruitment, and channel stability. A wide range of ground disturbing activities result in soil erosion and sedimentation in streams.

Implementation of forestwide standards would minimize the potential effects of land management activities on NFS lands and the Forest's potential contribution to cumulative effects. The existing transportation system continues to affect aquatic resources and water quality, and foreseeable actions that improve road-related problems can reduce the potential effects and the contribution to cumulative effects. Foreseeable harvest activities have the potential to contribute to sedimentation and cumulative effects associated with conventional logging and road-related impacts. Future harvest activities also provide an opportunity to correct or reduce existing road-related problems and sediment source. Alternative C has the lowest potential for ground-disturbing activities associated with management activities, followed by Alternatives F, A, E, B, G, H, I and D. However, Alternative C also has the highest potential for un-mitigated impacts from acid deposition or other anthropogenic activities, because of the natural processes approach. Alternative A has the highest projected mileage of system roads at the end of 10 years, followed by D, B, G, H, I, E, F and C.

B4B - AQUATIC SPECIES VIABILITY EVALUATION

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). For planning purposes, a viable population is one that has numbers and distribution of reproductive individuals to insure its continued existence and is well distributed in the planning area. USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in persistence of the species over time.

Aquatic habitats are unique in that they are found in and adjacent to streams and lakes. The mobility of aquatic species is usually limited to these habitats. Habitat alteration is probably the major cause of decline of aquatic diversity in the South. Channelization, impoundment, sedimentation, and flow alterations are the most common physical habitat alterations associated with the decline of aquatic species (Walsh et al. 1995; Etnier 1997; Burkhead et al. 1997). Other human-induced impacts to aquatic species include pollution, introduced species, and over-harvesting (Miller 1989).

Species are tied to specific habitat; when this relationship is known, the amount of suitable habitat can be estimated. Plan direction was designed to address the key factors that maintain the physical, chemical, and biological aspects of suitable habitat on the Forest. Aquatic habitats on the Forest are protected, restored, or enhanced to maintain the ecological integrity of the system. However, habitat quality within a freshwater ecosystem is determined by activities within the watershed (Abell et al. 2000; Scott and Helfman 2001), both on and off National Forest System land. For administrative purposes these watersheds are described as 5th level hydrologic units (HUCs). The planning areas for aquatic species are 5th level hydrologic units or watersheds at the Forest Plan level.

AFFECTED ENVIRONMENT

There are hundreds of aquatic species found in the 29 5th level HUCs associated with the GWNF. It is impossible to determine viability for each of these individual species. As a surrogate, the viability of proposed, endangered, threatened, sensitive, and locally rare (TESLR) aquatic species are assessed and threat to their viability determined; as well as Management Indicator Species and Species of Management Concern. Other species with wide ranges are generally not at risk.

To determine effects to habitat of these species, the condition of individual watersheds was evaluated. Watershed condition is determined from the physical and anthropogenic interactions within the watershed. Ideally, watershed condition would be developed from stream surveys. However, the extent and detail required to address all watersheds, including private land, with stream surveys is not available. To address habitat condition at the watershed level it is necessary to derive values from geographic data. These values were compared among the watersheds and a condition or set of conditions was determined.

Viability Evaluation Process

SPECIES LISTS AND STRESSORS

A comprehensive list of aquatic and riparian species with potential viability concern was compiled for the George Washington National Forest; the species list and associated documentation is found in Section 3, Species Diversity in the Aquatic Ecological Sustainability Analysis (Appendix G). The list included those species found both on and downstream (within the 5th level HUC) from National Forest in the following categories:

- Species listed as proposed, threatened, or endangered under the federal Endangered Species Act,
- Species listed on the Regional Forester's Sensitive Species list,
- Species identified as locally rare on the National Forest by Forest Service biologists,
- Management Indicator Species and Species of Management Concern

There are a number of physical, biological and chemical factors that influence populations; a thorough discussion of the key habitat factors that maintain aquatic ecological integrity, along with current condition and trend, is found in Section 2, Ecosystem Diversity in the Aquatic Ecological Sustainability Analysis. The stressors addressed here relate to these key habitat factors and the anthropogenic change processes discussed in Section 2.4a, Disturbance Processes. They are specific to forest management activities and our potential to affect population viability. The primary concerns associated with land management activities are 1) increased sedimentation due to ground disturbing activities, 2) decreased habitat conditions and channel stability due to reduced recruitment of large woody debris, 3) increased stream temperatures due to reduced riparian vegetation and stream shading, and 4) fragmentation of habitat and isolation of populations due to passage barriers associated with road crossings. In addition to these land management factors, much of the Forest is underlain by geologic formations that are sensitive to acid deposition and streams in watersheds with poorly buffered geologic types are susceptible to acidic conditions.

The threat analysis evaluated the sensitivity of species to the different stressors (sediment, habitat complexity, temperature, acidic conditions, and passage). Sensitivity to the stressors was assigned for each species, based on the published literature and personal communications; where there was a lack of detailed life history information, the following assumptions are used to evaluate species sensitivity:

Sedimentation: Benthic organisms, or life stages, are susceptible to sedimentation and the filling of interstitial spaces that affect habitat and food supplies.

Habitat Complexity: Species that prefer pool habitat are more sensitive to a loss of channel structure and habitat complexity than riffle and run dwelling species. Large woody debris plays a greater role in forming habitat in smaller headwater streams than in larger main stem systems, so species occupying headwater streams are more sensitive to losses of LWD.

Water temperature: Cold water species are more sensitive to changes in stream temperature than the cool and warm water species that are more tolerant.

Acid deposition: At times, the literature referred specifically to a species' sensitivity to acidic conditions. These species have been identified as being acid sensitive, when in actuality all species are susceptible to low pH levels. We also assumed that species in headwater streams are generally more susceptible to acidic conditions than species inhabiting main stem rivers with broad drainage areas, along with those that occur in watersheds highly sensitive to acidification (see Section 3.4, Species Groups in the Aquatic Ecological Sustainability Analysis).

Passage barriers: Road crossings on small streams are more likely to create passage barriers and reduce the habitat available to headwater species than crossings on larger main stem streams.

The list of species, potential habitat on national forest, ranks, and sensitivity factors are found in Table H-4 (EIS Appendix H).

Overall, the potential of the Forest to influence population viability either positively or negatively is greater in the headwaters than the larger main stem rivers. Headwater streams are usually in closer proximity to Forest management activities and the relative influence of management on NFS lands typically decreases as the drainage area increases downstream.

WATERSHED CONDITION

Species sensitivity to the five stressors was compared with the condition of their respective watersheds to determine the threats to their persistence in the planning area. The watershed condition was assessed using metrics representing each of the identified stressors. The metrics were a compilation from geographic information layers. These layers include ownership, streams, roads, geology, and land use. The metrics and combinations of data used to determine the metrics are outlined in the following list of watershed measures; an expanded discussion and data sources are found in the Watershed Analysis for GW Plan Revision (Appendix 5) within the Aquatic Ecological Sustainability Report (EIS Appendix G), and EWAP (2002).

Stressor	Watershed Measure
Sedimentation	Percent High Erosion Potential
Habitat Complexity	Percent Forested Riparian
Temperature	Percent Forested Riparian
Acid Deposition	Percent High Acid Sensitivity
Passage barriers	Road Density

Aquatic Viability Determinations

Separate viability determinations were made for each watershed where a species occurs, because in many cases watersheds support separate populations, and because factors affecting viability can vary considerably from watershed to watershed. Viability outcomes from each species by watershed were determined by incorporating elements of species distribution, abundance, and sensitivities to environmental factors; watershed condition relative to the species' environmental sensitivities; and the national forest role in the watershed. Viability outcomes are:

Outcome A. Species is well distributed and abundant within watershed. Forest Service may influence conditions in the watershed to keep it well distributed. Likelihood of maintaining viability is high.

Outcome B. Species is potentially at risk in the watershed; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome C. Species is potentially at risk within the watershed; however, the extent and location of NFS lands with respect to the species is NOT conducive to positively influence the sustainability of the species within this watershed. Therefore, species viability in the watershed may be at risk.

Outcome D. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome E. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk. Forest Service ability to influence the species is limited. Therefore species viability in the watershed may be at risk.

An assumption inherent in the determination of population viability outcomes is that a viable population currently exists. Often, this could not be confirmed using the available information. If a species was reported within a watershed, the assumption was other individuals exist and habitat conditions occur within that watershed to support a viable population.

Viability Evaluation Results

A summary of stressors and viability outcomes by watershed for each species is found in Table H-3 (EIS Appendix H).

For the species that are in watersheds with a viability outcome B and D, the species are potentially at risk in the watershed because of one or more stressors; however, the species are actually on the Forest, and through riparian management prescription direction the Forest Service may positively influence conditions at those localized sites. Therefore, through proactive management where the species occur on National Forest land, the likelihood of maintaining viability in that watershed is moderate.

Watershed stressor and species viability associations are primarily a result of historical influences that have reduced distribution and abundance of some habitat elements and species populations. This viability analysis was based on the assumption that the riparian corridor width is that found in Section 2.6 Plan Components for Ecosystem Diversity, in the Aquatic Ecological Sustainability Analysis. In general, effects of proposed management strategies are small relative to historical impacts and future external threats. Risks to species viability are minimized by thorough riparian management prescription direction and standards, as well as applicable common standards.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Alternative Comparison

Viability outcomes by watershed were then evaluated in light of species sensitivities and Forest Plan Alternatives (see Table 3B4-4. General Riparian Direction by Forest Plan Alternative in the Fisheries and Aquatic Habitat Section), and assigned a rating of:

+, increased protection for aquatic and riparian habitat from current plan
-, decreased protection for aquatic and riparian habitat from current plan
o, no change in protection for aquatic and riparian habitat from current plan

Although ratings could vary between stressors in the same alternative, only one rating was given for each species and watershed based on the overall potential for change.

The changes to viability outcome by species, watershed, and Forest Plan alternative are found in Table H-5 (EIS Appendix H). A summary of the changes by alternative is below. The changes to aquatic species viability based on the additional stressor of gas drilling are found in EIS, Chapter 3, Section D Federal Oil and Gas Leasing Availability.

Table 3B4-5. Number of Species/Watershed Combinations with Increased (+), Decreased (-) or No Change (o) in Protection for Aquatic and Riparian Habitat from Current Plan

Change in Viability Rating	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
Increased Protection (+)		150	131	9	150	150	150	150
Decreased Protection (-)			19					
No change (o)	150			141				

Riparian integrity, sedimentation, large woody debris, canopy cover, acid rain, and aquatic organism passage are addressed differently by alternative. They are addressed either by mitigation (protection from other management activities), a resource approach (active management to meet desired conditions), or a natural processes approach (limited active management).

Alternatives A and D use an approach that resembles current management. The riparian areas are managed as a separate prescription area based on ecological parameters (width determined by true riparian characteristics defined by soils, vegetation, and biota). The desired conditions for fisheries and aquatic habitats are defined and buffered from other management activities through defined shade strips, filter strips, and vehicle exclusion zones. Aquatic habitats and fisheries are sustained in a healthy condition. Timber harvesting occurs in the riparian area outside the 66' buffer. There are no standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Alternative D implements the Federally Listed Mussel and Fish Conservation Plan in those 6^{th} level HUC watersheds that contain the James spinymussel; therefore this alternative has increased protection in 9 of the species/watershed combinations. The increased protection comes from widened riparian corridors, through recognition of channeled ephemeral streams, by avoiding activities that would increase sedimentation within those widened corridors, by prioritizing restoration and enhancement of water quality and aquatic habitat, and by providing the optimal aquatic habitat and water quality which cannot be ensured on private lands.

Alternatives B, E, F, G, H and I also use a resource approach where riparian areas are managed as a separate prescription area, but defined widths are based on maintaining the desired ecological conditions of the entire riparian area, not just aquatic habitat. Riparian and aquatic habitats are sustained in a healthy condition. Timber harvesting occurs in the core riparian area only when needed to protect or enhance riparian-dependent resources; it is not suitable for timber production. Tree removal can occur in the extended riparian corridor to meet objective of adjacent management prescription, although vehicles are excluded. There are forestwide standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. The forestwide desired condition and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan. These alternatives have increased protection in all of the species/watershed combinations. The increased protection comes from widened riparian corridors, through recognition of channeled ephemeral streams, by avoiding activities that would increase sedimentation within those widened corridors, by prioritizing restoration and enhancement of water quality and aquatic habitat, and by providing the optimal aquatic habitat and water quality which cannot be ensured on private lands.

Alternative C uses a natural processes approach, identifying riparian areas as a separate prescription area as in Alternatives B, E, F, G, H and I; but excluding most management activities to attain desired conditions in riparian areas. The forestwide desired conditions and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan; however, many fish management activities such as stocking, habitat improvement, and mitigation for acid deposition are restricted or prohibited. Species that require management to maintain suitable habitat (such as brook trout in acidified streams) would decline. Therefore, there is increased protection in most of the species/watershed combinations for the reasons previously stated, but decreased protection in 19 species/watershed combinations that involve high elevation, acid sensitive aquatic species, in watersheds with significant National Forest ownership and a large proportion of acid sensitive geology.

B4C – FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

James Spinymussel

AFFECTED ENVIRONMENT

The James spinymussel was federally listed as endangered in 1988 (USDI Fish and Wildlife Service 1990). Historically, this species was apparently throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all the major upstream tributaries (Clarke and Neves 1984). The species remained widespread through the mid-1960s, but now appears extirpated from 90% of the historic range. Since 1990, James spinymussel populations have been found in three tributaries to the Dan River in Virginia and North Carolina, which is outside of the species' range known at the time of listing.

This species is found in slow to moderate currents over stable sand and cobble substrates with or without boulders, pebbles, or silt (Clarke and Neves 1984). Hove and Neves (1994) found James spinymussels in 1.5 to 20 m wide second and third order streams at water depths of 0.3 to 2 m. Seven fish hosts, all in the family Cyprinidae, have been identified (Hove 1990): bluehead chub, rosyside dace, blacknose dace, mountain redbelly dace, rosefin shiner, satinfin shiner, and stoneroller. Freshwater mussels are filter feeders taking organic detritus, diatoms, phytoplankton, and zooplankton from the water column. The following excerpt from Hove and Neves (1994) states the current thinking on threats:

"There are several anthropogenic and natural threats to the James spinymussel's continued existence. Nearly all the riparian lands bordering streams with the James spinymussel are privately owned. With more intensive use of the land, it is probable that water quality and habitat suitability will deteriorate. At present, the most detrimental activities include road construction, cattle grazing, and feed lots that often introduce excessive silt and nutrients into the stream."

The introduced Asian clam is also considered to be a threat to the James spinymussel and is beginning to invade several sites (Hove and Neves 1994).

Occurrences of the James spinymussel near the Forest include Potts Creek, Craig Creek, Pedlar River, Cowpasture River, Bullpasture River, Mill Creek, and there are historic records from the James and Calfpasture Rivers. In the Craig Creek watershed, the species is stable due to population(s) in Johns, Dicks, and Little Oregon creeks (near the Jefferson National Forest). The species appears to be extirpated in Potts Creek or at such low numbers that detection is extremely difficult. In the Cowpasture River watershed, population status in the Cowpasture and Bullpasture is uncertain with the population in Mill Creek stable (see Table 3B4-6, Watson 2010).

Table 3B4-6. Location and Status of James Spinymussel Populations in the James River Watershed.

Watershed	Tributary	County/State	Status
James River	Bullpasture River	Highland/VA	Unknown
James River	Calfpasture River	Rockbridge/VA	Extirpated?
James River	Catawba Creek	Botetourt/VA	Extirpated?
James River	Cowpasture River	Bath & Alleghany/VA	Stable?
James River	Mill Creek	Bath/VA	Stable
James River	Craig Creek	Craig/VA	Declining
James River	Dicks Creek	Craig/VA	Stable to increasing
James River	James River mainstem	Various	Extirpated
James River	Johns Creek	Craig/VA	Stable
James River	Little Oregon Creek	Craig/VA	Stable to increasing
James River	Patterson Creek	Botetourt/VA	Extirpated?
James River	Pedlar River	Amherst/VA	Stable
James River	Potts Creek	Monroe/WV	Stable
James River	Potts Creek	Craig & Alleghany/VA	Extirpated?
James River	Upper Potts Creek	Monroe/WV	Stable?

Despite extensive searches, no occurrences of the spinymussel have been located on the Forest (Watson 2010). The 14 miles of potential habitat modeled for this species in the Ecological Sustainability Analysis assumes all of the river mileage is suitable substrate, which is not probable; in all of the watersheds with spinymussels near the Forest, the occurrences are all on private land. The James spinymussel does occur both upstream and downstream from the Forest. Current Forest management provides for water quantity and quality that contributes to the persistence of mussel populations. The main avenues for the Forest to aid in this species recovery are through land acquisition, assisting in augmentation efforts, and working with landowners to protect streams and streamside habitat. Several isolated reaches of habitat on the Forest could provide sites for augmentation if the substrate were suitable. Working cooperatively with State biologists, university experts, and the US Fish and Wildlife Service, the Forest developed a pro-active conservation plan for federally listed fish and mussels in 2004. The standards and guidelines in the plan are implemented in 6th level HUC watersheds that contain listed fish or mussel species. The following watersheds on the Forest are covered by the Federally Listed Mussel and Fish Conservation Plan.

Table 3B4-7. Sixth Level HUC Watersheds on the George Washington National Forest Included in the Federally Listed Mussel and Fish Conservation Plan

6th Level HUC	Watershed Name
020802010403	Mill Branch-Potts Creek
020802010404	Cast Steel Run-Potts Creek
020802010405	Hays Creek-Potts Creek
020802010601	Wolfe Draft-Cowpasture River*
020802010602	Shaws Fork*
020802010603	Benson Run-Cowpasture River*
020802010701	Scotchtown Draft-Cowpasture River
020802010702	Dry Run*
020802010703	Thompson Creek-Cowpasture River*
020802010801	Mill Creek-Cowpasture River*
020802010803	Simpson Creek-Cowpasture River
020802011201	Rolands Run Branch-Craig Creek
020802011202	Barbours Creek*
020802011205	Roaring Run-Craig Creek
020802011302	Town Branch-Catawba Creek
020802020104	Hamilton Branch*
020802020105	Fridley Branch-Calfpasture River*
020802020106	Cabin Creek-Mill Creek
020802020108	Guys Run-Calfpasture River*
020802020506	Poague Run-Maury River*
020802030201	Lynchburg Reservoir-Pedlar River
020802030202	Browns Creek-Pedlar River
020802030203	Horsley Creek-Pedlar River

* No spinymussel occurrence in this watershed, but is found in downstream HUC(s)

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The decline and extirpation of most populations of the James spinymussel may be attributed to habitat modification, sedimentation, eutrophication, and other forms of water quality degradation. Restricted movement of host fish may also be a factor in the decline of this species. For populations of the James spinymussel on or near the Forest, potential management influences include sedimentation, altered flow, and blockage of host fish passage associated with roads and crossings. Forestwide and riparian standards will protect the James spinymussel and its habitat from sediment released during management activities. The expansion of riparian areas in Alternatives B, C, D, E, F, G, H and I will manage all riparian areas in watersheds that support James spinymussel in line with the Forests' Federally Listed Mussel and Fish Conservation Plan. Instream flow needs will be quantified and maintained to protect aquatic organisms when new water use authorizations are proposed. Prior to the stocking of any non-native species, the Forest coordinates with the appropriate State agencies to ensure populations and habitats of native species are maintained.

The Forest will manage and protect extant populations and historical habitats of the James spinymussel. Protection and active management will be implemented where the species is physically on or historically occurred on Forest lands. Protection, monitoring, and augmentation will be the primary recovery objectives. Actions will be taken in order to identify additional suitable habitat and restore fish hosts and mussels to areas

on Forest lands. Recovery objectives will include annual or bi-annual monitoring within Virginia of representative populations by qualified biologists for populations trend and habitat quality. Monitoring will include either search indices or transects depending on local conditions and mussel densities. Inventories of additional potential habitat will also be conducted.

A cumulative effects analysis should consider incremental impacts of actions when added to past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time. For this document, cumulative effects were analyzed through a two-part watershed analysis, which included resource assessment and management prescription (Reid 1998).

Throughout the planning process, the Forest evaluated watersheds using information including, but not limited to: Virginia Department of Environmental Quality 303d report for impaired waters; Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation 305b report on non-point source pollution; Virginia Department of Game and Inland Fisheries collection records; West Virginia Division of Natural Resources collection records and reports; local knowledge of forest recovery from past conditions; local knowledge of current watershed problems; macroinvertebrate, stream habitat, and water chemistry information; and geographic information system layers of land use, point source, road and mine locations. Through this resource assessment, the Forest evaluated cumulative watershed effects associated with land use practices at the 5th Hydrologic Unit Code (HUC) watershed level, and their effect on aquatic fauna and habitat.

Concurrently, the Forest carried out an interdisciplinary analysis looking at interactions between resources with a goal of managing riparian corridors to retain, restore, and /or enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the corridor, while minimizing effects to aquatic and riparian resources from other activities. This was done through many meetings and discussions, which included not only multi-agency resource professionals, but members of the public as well. From this work, prescriptions, goals, objectives, and standards were developed in order to focus management on riparian, aquatic, and healthy watershed needs. They were designed to not only minimize adverse impacts to aquatic and riparian areas, but to maintain them as healthy, functioning systems.

Resulting from the careful development of prescriptions and standards, there should be beneficial effects on in-stream uses (including federally listed aquatic species) during the implementation of the proposed Forest Plan. These beneficial effects include, but are not limited to: watershed restoration activities, and road and recreation site maintenance, reconstruction, relocation, and/or closure/rehabilitation; control and management of livestock grazing will reduce sediment that is currently entering the stream system. Buffer zone filter strips will limit sediment produced by ground disturbing activities (including road construction, firelines, trails, livestock grazing, wildlife habitat improvements, prescribed and wildland fire, recreation development, and timber harvest) from entering a stream system. Management of streamside areas for riparian purposes and needs will increase large woody debris and shade. Stream crossings of roads and trails will allow the passage of desired aquatic organisms.

Any effects from management activities will be insignificant or discountable, therefore there will be no adverse direct or indirect watershed effects to the James spinymussel. Since it does not occur on the National Forest, the main avenues for the Forest to aid in this species recovery are through educating and working with landowners to protect streams and streamside habitat, and assisting efforts to identify additional suitable habitat and restore these species to historical habitats as appropriate. In some cases, acquisition of lands within the Forest's Proclamation Boundary may also be part of recovery actions.

B5 – FOREST HEALTH AND PROTECTION

Beginning about 18,000 years ago during the peak of the last major glacial period, the forest communities of the GWNF that we know today began to be shaped by global climate changes, indigenous human cultures, lightning, windstorms, beavers, large ungulates, and native insects and diseases. In the more recent past, European settlement and modern society have disrupted some of these natural processes (fire, beavers, and large ungulates) and introduced new disturbances like air pollution, gypsy moth, and hemlock woolly adelgid. The Southern Forest Resource Assessment (USDA Forest Service 2002) and the Southern Appalachian Assessment (SAMAB 1996) provide a vast amount of information regarding the history of native plant communities in the southeast. This section of Chapter 3 will focus on non-native invasive species, insects and diseases, wildfire suppression, and use of wildland fire. Other aspects of Forest Health such as age class and species diversity, as well as species composition, are addressed in the Ecological Systems section of this chapter.

Non-Native Invasive Species

A multitude of non-native invasive species including non-native plants, insects, and pathogens threaten the integrity of native ecosystems in the southern Appalachian area. The Chief of the U.S. Forest Service (USFS) has identified non-native invasive species as one of the four critical threats to USFS ecosystems. In the United States, invasive species are reported to be the second-most critical threat to conservation of biodiversity (Wilcove et al. 1998). The Southern Appalachian Assessment (SAMAB 1996: 109) discusses a number of non-native invasive forest pathogen and pest organisms that have or are currently affecting the GWNF. Insects and diseases of most concern for the purposes of this analysis include European gypsy moth, hemlock woolly adelgid, and southern pine beetle. Emerging pests of concern, but for which the potential to impact the GWNF is yet unknown, include the emerald ash borer, ramorum blight, and Thousand Cankers Disease. A new non-native invasive aquatic species found on the Forest since the last planning cycle is the diatom, *Didymosphenia geminata* (didymo).

Non-Native Invasive Plants

AFFECTED ENVIRONMENT

Non-native plants are known to occur across Southern and Central Appalachian forests, often accounting for 25% or more of the documented flora. While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. As defined in Executive Order 13112 issued February 3, 1999, an invasive species is one that meets the following two criteria: “1) it is non-native to the ecosystem under consideration and, 2) its introduction causes or is likely to cause economic or environmental harm or harm to human health.”

The Plan objective is to protect native populations of plants and animals through the timely treatment of non-native invasive plant (NNIP) infestations and to prevent or reduce the spread of NNIP infestations to high quality natural habitats. In selecting treatment methods, minimizing effects to native species and natural communities is a priority.

One of the goals of both the George Washington and Jefferson National Forest Land and Resource Management Plans is to maintain and enhance the diversity of plant and animal communities of the Central Appalachians, favoring plant and animal communities that warrant special attention. Given the current distribution of NNIP infestation sites on the Forest, there is a need to implement a comprehensive and integrated program of NNIP control to protect the integrity of natural plant communities. The integrity of natural communities on the Forest will be compromised if NNIP infestations are allowed to continue to spread and invade previously unaffected areas. In addition, management of NNIP infestations sites will help slow the spread of NNIPs in the Southern and Central Appalachians by minimizing the degree to which the Forest is a source of infestations for surrounding lands, both public and private.

To fulfill the goals of Executive Order 13112, NNIP treatments are intended to be adaptive in nature and allow the use of integrated methods for the future treatment of invasive plant infestations.

The Forest recognizes that prevention is critical in NNIP management. Prevention includes educational efforts as well as Forest Plan standards that reduce the probability of NNIPs being spread by Forest management activities.

A list of the high priority invasive plant species across the Forest has been developed both from botanical surveys completed during the past 18 years and by consulting NNIP information provided by the Virginia Division of Natural Heritage, the Virginia Native Plant Society, and the West Virginia Division of Natural Resources. The exact infested acreage within the Forest is unknown and changes annually. Most of the 26 species identified in Table 3B5-1 are prevalent across the region and are continuing to spread, actively impacting biodiversity. A review of Forest field survey data from 2001 to 2010 indicated that 60% of the sites had one or more NNIP species present (Fred Huber pers comm.). These species were assigned a relative priority for treatment based on their known impacts on rare species and communities, their ability to rapidly spread, and their ability to persist in the forest. These species have been identified as the highest priority species on the Forest at the present time but the list will be updated as needed, based on new information regarding species' spread, invasion by new species, and infestation characteristics.

Table 3B5-1. Priority Species for Non-Native Invasive Plant Control

Scientific Name	Common Name	Invasiveness*	Ranking**	Priority‡
Ailanthus altissima	tree of heaven	1	77	1
Alliaria petiolata	garlic mustard	1	62	3
Buddleja davidii	butterfly bush	L	50	2
Berberis thunbergii	Japanese barberry	L	44	1
Carduus nutans	musk thistle	2	47	2
Celastrus orbiculatus	oriental bittersweet	1	71	1
Centaurea biebersteinii	spotted knapweed	1	67	3
Cirsium vulgare	bull thistle	2	49	2
Elaeagnus umbellata	autumn olive	1	73	2
Lespedeza cuneata	sericea lespedeza	1	46	2
Ligustrum spp.	Privet	1	50	2
Lolium arundinaceum	tall fescue	2	57	1
Lonicera japonica	Japanese honeysuckle	1	80	3
Lonicera maackii	Amur honeysuckle	2	65	1
Lonicera morrowii	Morrow's honeysuckle	1	65	1
Lonicera tatarica	Tartarian honeysuckle	2	65	1
Lythrum salicaria	purple loosestrife	1	73	1
Microstegium vimineum	Japanese stiltgrass	1	69	3
Paulownia tomentosa	princess tree	2	50	2
Perilla frutescens	beefsteak plant	3	40	1
Persicaria perfoliatum	mile-a minute	1	73	1
Polygonum cuspidatum	Japanese knotweed	1	55	1
Pueraria montana var. lobata	kudzu	1	52	2

Scientific Name	Common Name	Invasiveness*	Ranking**	Priority‡
Rosa multiflora	multiflora rose	1	78	2
Spiraea japonica	Japanese spiraea	2	44	2
Tussilago farfara	coltsfoot	L	60	3

* Invasiveness based on Virginia Department of Conservation and Recreation:
1=Highly Invasive;
2=Moderately invasive;
3=Occasionally invasive;
L=Locally invasive
**Ranking based on Hiebert and Stubbendieck 1993
‡ Priority: 1=high, eradicate wherever found
2=medium, control source populations and eradicate outliers
3=low, prevent invasion of last areas not invaded; eradicate high priority areas

Of the non-native invasive plant species found on the Forest, 26 species are particularly troublesome and are anticipated to make up the largest percentage (by acreage) of actual treatments implemented. Of these 26 species, 15 are listed as Highly Invasive by the Virginia Department of Conservation and Recreation, 7 are listed as Moderately Invasive, one is listed as Occasionally Invasive, and three are locally invasive on the Forest.

DIRECT AND INDIRECT EFFECTS

While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpating rare species; impacting recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Infested areas represent potential seed sources for continuation of the invasion on neighboring lands. Alternative A follows the current Plan which is not as aggressive in controlling NNIP as Alternatives D, E, F, G, H and I. Alternative B only includes integrated pest management and is less aggressive at controlling NNIP than D, E, F, G, H and I. Alternative C would result in the least amount of ground disturbance which could reduce the potential for NNIP infestations; however, the decrease in accessibility could result in less aggressive treatment of NNIP infestations. Alternatives D, E F, G, H and I, all have similar language regarding pre-treatment of areas that will be disturbed. Therefore, the potential for NNIP infestations from ground disturbing activities could be offset by aggressive NNIP treatments.

Treatment options for NNIP include manual, biological, mechanical (e.g. mowing), and chemical (e.g. herbicide). While all control methods have an appropriate place depending on the site and plant targeted, we expect the majority of acres controlled to utilize herbicide. Herbicide use can result in non-target impacts to desirable plants, other organisms, and resources such as water quality. No use of aerial application of herbicide is contemplated under any alternative. Targeted applications such as cut surface, basal bark, and target foliar applications with a backpack sprayer will be the application method of choice. Broadcast spraying may be utilized in specific circumstances, such as roadside maintenance, or when treating plants that completely dominate a large area (e.g. fescue). Targeted applications greatly reduce the chance for non-target impacts (Marshall, 2001). Standard drift control measures such as applying large droplets, in low wind speeds, and higher relative humidity conditions also reduce non-target impacts, especially for the rare broadcast application.

Herbicide application has the potential to develop resistance of some plants to specific herbicides. This occurs when repeated applications of the same herbicide or herbicides using the same mode of action fail to kill the entire treated population. In time, this repeated treatment selects for plants that are resistant to the herbicide. This effect is most often noted in control of weeds on crop lands and is not identified as a common occurrence in forested situations (Weed Science Society of America, Managing Herbicide Resistant Weeds by State, http://www.weedscience.org/usa/statemap.htm). We do not expect resistance to herbicides to develop under

any alternative given the relatively low level of use as compared to cropland management of weeds. However, in the spirit of Integrated Pest Management, it is appropriate to incorporate certain mitigation measures into our herbicide treatments to guard against the development of herbicide resistance. Such measures include (source Herbicide Resistance Action Committee Guidelines for Herbicide Labels: http://www.hracglobal.com/Publications/HRACStewardshipGuidelinesforHerbicideLabels/tabid/604/Default.aspx)

1. Apply integrated weed management practices. Use multiple herbicide modes-of-action with overlapping weed spectrums in rotation, sequences, or mixtures.
2. Use the full recommended herbicide rate and proper application timing for the hardest to control weed species present in the field.
3. Scout fields after herbicide application to ensure control has been achieved. Avoid allowing weeds to reproduce by seed or to proliferate vegetatively.
4. Monitor site and clean equipment between sites.

CUMULATIVE EFFECTS

Left unmanaged, NNIP infestations will continue to spread, not only on National Forest System lands but potentially on adjacent private and other ownership lands. Even without active management NNIP infestations will occur across the Forest. Insect and disease outbreaks, wildfires, storm events (including wind thrown trees, flooding, landslides, and ice damage) encourage NNIP establishment. More areas of the Forest will be affected and the areas that are affected now will grow in size. Native species diversity and the integrity of natural communities will decline. Some threatened, endangered, sensitive or locally rare species may become extirpated from the Forest. Wildlife species will lose food sources and habitat structure will be modified. Plan alternatives that emphasize wilderness and limit accessibility will reduce somewhat the likelihood of NNIP infestations, but they will also reduce the ability to actively restore and maintain habitat using fire and timber management. Private land, state and federal roads, and streams adjacent to the Forest are all potential sources for NNIP to affect the Forest. It can be expected during the life of the Plan that development will occur near the Forest that will facilitate the spread of NNIP onto the Forest.

Didymo

AFFECTED ENVIRONMENT

Didymo (*Didymosphenia geminata*) is a freshwater diatom (type of alga) that historically was only found in pristine lakes and streams of northern latitudes. Its range is now expanding in North America to include lower elevation clear, cool streams. It can form massive blooms on the bottoms of streams and rivers where it attaches itself to the streambed by stalks. These stalks can form a thick brown mat that smothers rocks, submerged plants and other materials. Established mats form flowing streamers that can turn white at their ends and look similar to tissue paper. Although the alga appears slimy, it feels like wet cotton wool. Didymo was found in the Jackson River (GWNF) and Smith River tailwaters in Virginia in spring of 2006, the Pound River tailwater (JNF) in 2007, and Dan River in 2008. Information sheets were posted at Forest Service angler access points along the Jackson River to inform anglers and instruct them on how to prevent the spread of this invasive species. The Smith and Dan Rivers are not on or near National Forest System land.

DIRECT AND INDIRECT EFFECTS

Didymo colonization was monitored monthly over a 24 month period at a single transect in the Jackson River downstream of Gathright Dam to observe its growth over time. In 2008-2009, didymo density steadily increased from February–April, peaked in May-June, and then rapidly declined in the period from July–October. Transect scores were plotted against discharge, water temperature, and depth to evaluate relationships between alga density and non-biological factors. Positive, but weak, relationships were determined with all three criteria, but the strongest was between transect score and discharge. Biological response to didymo infestation was also examined by electrofishing and benthic macroinvertebrate monitoring before and after 2006. Post-infestation catch rates for wild rainbow trout (*Onchorhynchus mykiss*) in the Gathright Dam area were not significantly different than historic values (t0.05, 5 = 0.949). Stream metrics calculated for macroinvertebrates from the Gathright Dam area in 2007-08 showed a decline in ecological health from 1992-

93 samples. Results from this preliminary investigation indicated that didymo infestation has had a variable impact on aquatic fauna in one reach of the Jackson River Tailwater.

CUMULATIVE EFFECTS

Directly below Gathright Dam, the density of didymo varies by season from thick mats covering the stream bed during May-June, to a few scattered "buds" during the winter. Didymo has been observed at FS access points further downstream, but at much lower density, and has not developed into thick mats, even during the summer months. It is assumed that the water temperature is too warm and/or other factors keep the algae from surviving in the river past Covington. Didymo is currently unknown from other streams on the GWNF.

European Gypsy Moth

AFFECTED ENVIRONMENT

The European gypsy moth, *Lymantria dispar* (L.), is a major defoliator of deciduous hardwood forests. This non-native pest was first introduced from Europe into Massachusetts in 1869, and because one of the favored hosts (oak) is widespread in the eastern deciduous forests, it thrived and continues to expand its range west and south each year. By the 1980s, the gypsy moth was established throughout the Northeast (SAMAB, 1996). The generally infested, or quarantine area, extends from New England, south into Virginia, west to Ohio, and includes all of Michigan. The entire GWNF is considered generally infested by the gypsy moth and is wholly within the quarantine area. Meanwhile the gypsy moth continues to move southward.

The gypsy moth completes a single generation each year. First instar larvae (caterpillars) emerge from egg masses in April or early May. As temperatures increase, the caterpillars leave the egg masses during daylight hours and climb into the forest canopy. Upon reaching the tips of branches, larvae may spin down on silken threads and disperse on the wind. Most larvae are dispersed within the local area, but some may be carried for distances greater than twelve miles (Taylor and Reling 1986). Larvae may repeat this dispersal process several times before settling down to feed. Male caterpillars usually pass through five larval instars (or, growth stages) and females pass through six. Larvae usually complete their development by early to mid-June and seek a sheltered location for pupation. The pupal stage lasts about 2 weeks at which time the adult emerges. The male adult moth is dark brown and bears several black bands across the front wings and are capable fliers. The female moth is nearly white, with black bands across the front wings.

Females cannot fly but they can travel short distances from their site of pupation. This fact results in a relatively slow rate of natural spread of this pest. Females release a potent sex attractant (pheromone) to allure male moths for mating. Once mated, the female deposits her brood in a single mass of eggs and dies. The egg mass may contain from 75 to 1,000 eggs. Within four to six weeks, embryos develop into larvae within the eggs, overwinter, and hatch the following spring.

The gypsy moth's primary natural mode of spread over relatively short distances is by ballooning of first instar caterpillars on wind currents. The insect also may spread over much greater distances via human transport. Long distance spread occurs by two mechanisms, the transport of caterpillars or the transport of egg masses. People may pick up larvae in infested areas and carry them on their vehicles, belongings, or clothing to uninfested forested areas. The transport of the gypsy moth via egg masses occurs when vehicles, equipment, or household belongings infested with egg masses are brought into an uninfested area.

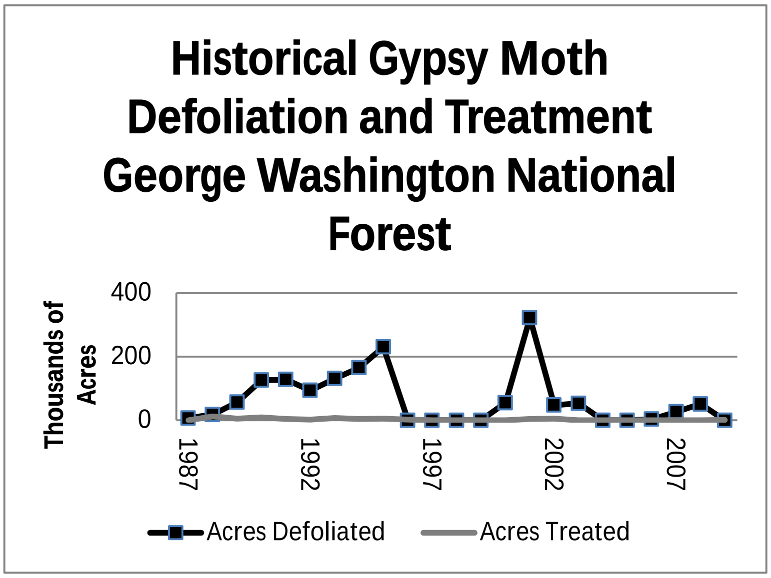
Gypsy moth larvae feed on more than 500 species of trees, shrubs, and vines. Favored hosts include oak, apple, birch, basswood, witch hazel, and willow. Hosts moderately favored by gypsy moth include maple, hickory, beech, black cherry, elm, and sassafras. Least favored hosts include ash, yellow poplar, American sycamore, hemlock, pine, spruce, black gum, and black locust. Late instar larvae can feed upon tree species that younger larvae avoid, such as hemlock, maple, pine, and spruce (Gansner and Herrick 1987). Feeding on less favored host plants usually occurs when high density larval populations defoliate the favored tree species and move to adjacent, less favored species of trees to finish their feeding and development. An individual gypsy moth caterpillar consumes the equivalent of approximately one square meter (10.75 square feet) of foliage during its development. A typical upland oak forest has 2.5 - 4.5 square meters of foliage per square

meter of ground surface area. Thus, the feeding of a relatively few, healthy caterpillars can result in severe defoliation of oak in a stand.

Defoliation by the gypsy moth may induce oak decline in healthy trees, resulting in reduced growth of shoots and stem, dieback of the crown, a failure in hard mast production, and a sufficiently weakened tree such that it is attacked and killed by woodboring insects and root disease fungi (Oak et al. 1991). Oaks in vigorous condition often can tolerate a year or two of defoliation before oak decline becomes pronounced. However, oaks that are stressed by pre-existing oak decline, drought, or some other factor tolerate defoliation less well. Tree mortality can be widespread and severe after a single defoliation under severe or compounding stress conditions. The damage caused by gypsy moth feeding in spring is harmful because trees must draw upon reserve carbohydrates and nutrients to produce a second canopy of leaves following defoliation (a process referred to as refoliation). Generally, a tree refoliates when approximately 50-75 percent of its canopy is consumed (Wargo 1979). Production of a new set of leaves following defoliation restores the photosynthetic capability of a tree's canopy; however, the refoliation process draws upon nutrient reserves that would be used for shoot growth and foliage production the following spring. The refoliated canopy is not able to fully replace the nutrients and stored reserves mobilized by the tree during refoliation, leaving the tree in a weaker condition the following spring. As a result, trees exposed to repeated defoliation and refoliation are weaker and more susceptible to attack by wood-boring insects and root-decay fungi.

Gypsy moth populations are cyclic. Generally populations build to epidemic proportions for a few years and then crash to low levels for a few more years. The entire cycle may range from three to ten years. At low densities, the gypsy moth is regulated, but not eliminated, by natural enemies such as parasitic insects and predaceous vertebrates, particularly small mammals. As populations increase beyond the control of these natural enemies, the gypsy moth is regulated by different mortality factors, primarily diseases and starvation. Of these two factors, diseases caused by the nucleopolyhedrosis virus (gmNPV) and the gypsy moth fungus (*Entomophaga maimaiga*) lead to the collapse of outbreak populations of gypsy moth. Generally speaking, the period between outbreaks may range from 2 to 5 years and the actual outbreak period may range from 1 to 3 years. On a region-wide basis, gypsy moth populations develop to outbreak levels across wide areas of the northeast, mid-Atlantic, and Lake States for a period of years and then drop to very low levels for several years. Factors regulating these regional outbreaks and collapses of gypsy moth populations are not well understood.

The first record of gypsy moth defoliation on the GWNF occurred in 1987. Since that time the forest has experienced 3 to 4 outbreak cycles with a total of about 1.5 million acres defoliated. Many areas have been defoliated several times resulting in severe mortality (Figure 3B5-1). However, no good estimate of acres within various levels of mortality has been attempted. In response to these outbreaks, the GWNF has participated in suppression efforts treating approximately 61,000 acres through aerial application of insecticides, primarily the biological insecticide *Bacillus thuringiensis var. kurstaki (Btk).*



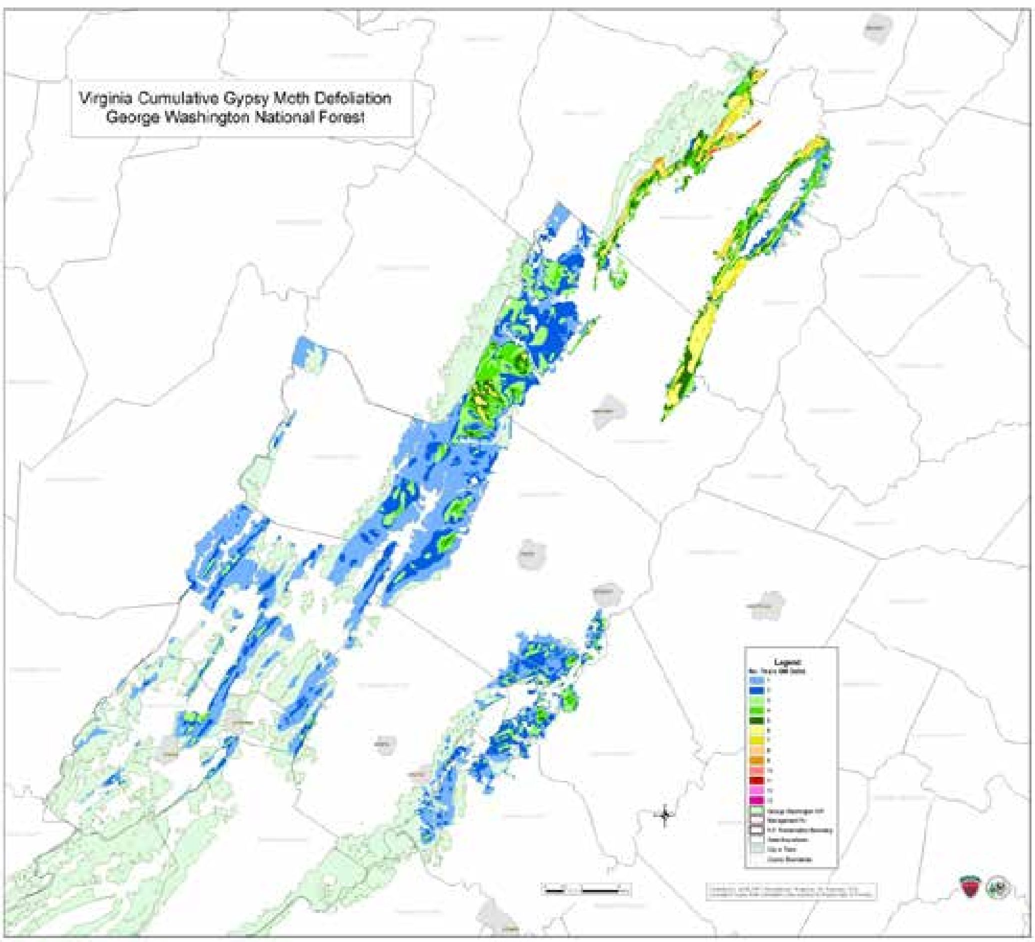


Figure 3B5-1. Cumulative Gypsy Moth Defoliation, George Washington National Forest

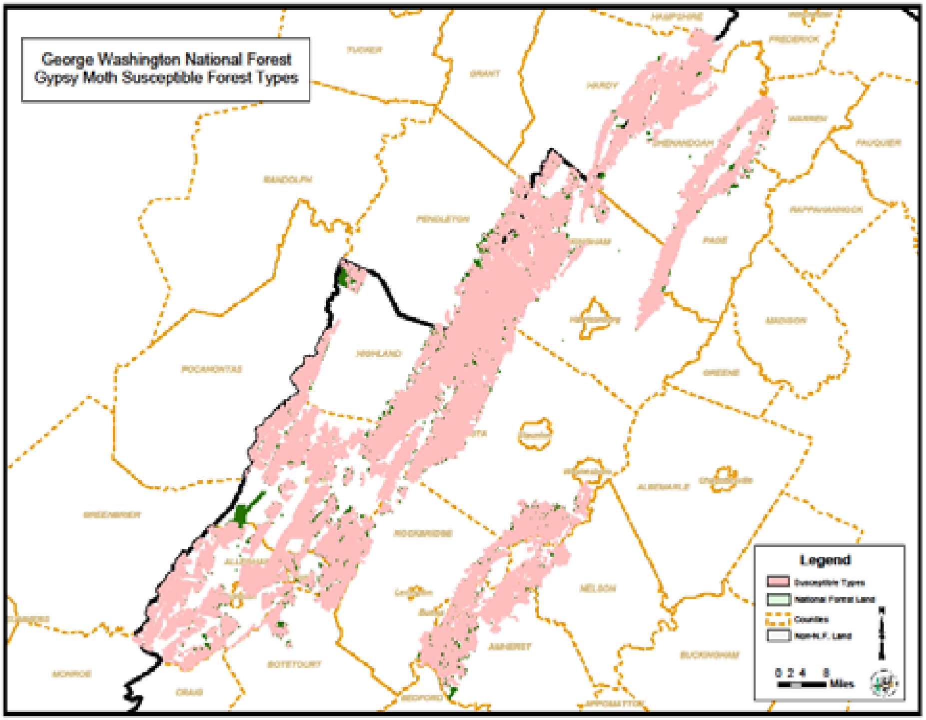


Figure 3B5-2. Gypsy Moth Susceptible Host Types

Approximately 867,000 acres of the GWNF is comprised of forest types susceptible to gypsy moth infestation (types where oak either dominates or is a significant portion of the stand). This represents approximately 72% of the forest in a moderate or severely susceptible host type. Figure 3B5-2 displays the distribution of these stands. As one would expect, the susceptible forest types are found evenly distributed across the entire GWNF.

A gypsy moth risk rating system has been developed for use with Forest Service Vegetation database (FSVeg) maintained by the GWNF. Entomologists at the Forest Health Protection field office in Asheville, NC developed this risk rating system. The model utilizes variables such as forest type, condition class, site index (a measure of site productivity) and age to assign a risk to each stand. Risks are categorized as Unaffected, Low, Moderate, High, or Extreme. This model was applied to the GWNF FSVeg information. Table 3B5-2 displays the existing condition pertaining to these gypsy moth risks.

Table 3B5-2. Number of Acres and Percent of the GWNF within 5 Gypsy Moth Risk Categories

Risk Category	Acres	Percent
Unaffected	280,500	27%
Low	78,000	7%
Moderate	65,000	6%
High	398,000	37%
Extreme	216,000	20%
Insufficient Data	28,000	3%

Thus, while almost one-third of the GWNF is currently considered to be at no risk (unaffected) from gypsy moth impacts, primarily by virtue of ineligible forest types (that is, they contain a predominance of tree species immune or not preferred by the insect), almost two-thirds of the Forest has a moderate to extreme risk of experiencing gypsy moth-related impacts.

DIRECT AND INDIRECT EFFECTS

While suppression of gypsy moth populations would be permissible under all alternatives, the economic cost and concern for environmental impacts of widespread use of current treatment tactics, primarily the aerial application of insecticides, would result in only a very small amount of the Forest receiving such management actions. Generally, gypsy moth outbreaks on most Forest lands will not be managed actively and population outbreaks will be brought to an end through the action of natural control agents (primarily by disease epidemics caused by fungal and viral pathogens). However, where high value resources, such as developed recreation areas, are threatened with defoliation and damage, treatment with insecticides may be considered to manage gypsy moth populations and limit damage. The impacts associated with such treatments are well documented in the Final Environmental Impact Statement (FEIS) for Gypsy Moth Management in the United States: A Cooperative Approach and in the Final Supplemental EIS (2012). This document and associated Record of Decision (ROD) analyzes the impacts of various aerially applied pesticides on control of the gypsy moth, impacts to non-target organisms, as well as impacts to human health. The FEIS and ROD indicate that the use of suppression, eradication, and slow the spread treatments fully meet the USDA goal of reducing the adverse effects of the gypsy moth, addresses the major issues associated with gypsy moth and their treatment, and provides the greatest amount of flexibility in managing ecosystems affected by the gypsy moth. Means to avoid or minimize adverse non-target impacts due to gypsy moth treatment are discussed in Chapter 2 of that FEIS and have been adopted. The findings from the FEIS are hereby incorporated by reference. It should be noted that such treatments do nothing to alter the risk associated with a vegetative condition; they merely control the pest.

Oaks are a favored host species and their density is a primary indicator of the susceptibility of a stand to gypsy moth defoliation (Gansner and Herrick 1987). Oak and mixed oak-pine forest types contain oaks at a high density and are therefore most susceptible to defoliation. Gypsy moth outbreaks may tend to be more frequent and the damage most severe where these stands occur in low-rainfall areas of the Forest. Hardwoods that are stressed by drought, oak decline, or some other factor tolerate defoliation less well (Witcosky 2000). Furthermore, outbreaks occurring simultaneously with severe spring droughts often lead to relatively high levels of mortality (>15% mortality following a single year of severe drought and defoliation; 30% mortality following 2-3 years of severe drought and defoliation). Long-term detrimental changes in forest composition and structure following gypsy moth outbreaks will be most frequent under conditions corresponding to high oak decline risk; stands with a large red oak component (especially black and scarlet oak) of advanced age growing on soils with low moisture availability. Outbreaks that cause defoliation for 2-3 years in a row will lead to more severe levels of damage to affected stands and outbreaks that recur in the same stand after very short intervening time intervals will lead to greater levels of damage. Mast production may be reduced or fail in affected oak stands during and following gypsy moth outbreaks (Gottschalk 1988).

As stated previously, factors that determine gypsy moth risk include forest type (oak density), site productivity (site index), age, and stand condition (condition class). Managers have no control over site productivity. Thus, species composition (forest type), stand condition, and age are the factors that managers can manipulate to alter the risk of gypsy moth impacts. Thinning and/or regeneration harvests can alter species composition and stand condition while only regeneration harvests can alter age of a given stand. Thus, our best tool in reducing the risk of receiving gypsy moth-related defoliation and/or mortality is vegetation manipulation through various types of timber harvesting and prescribed fire.

By modeling oak and oak-pine community types on the George Washington National Forest, we can obtain indications of how gypsy moth risk and active forest management actions interact. In the absence of management we can expect approximately 1% of the GWNF to move from a moderate to a high risk by the end of the first decade. The acres in a high or extreme risk category would increase by 27% to 84% of the Forest.

Harvesting of these stands in a timely fashion improves the risk of the stands in experiencing gypsy moth-related impacts. Harvesting can accomplish this goal through reducing the percentage of susceptible host types (primarily oak trees) and/or altering the stand condition (removing weakened or decadent trees) during a thinning or other partial harvest. Regeneration harvests also have this affect while reducing stand age, thereby increasing stand vigor and ultimately reducing the vulnerability of the stand to gypsy moth-related mortality in the event of a defoliation event (adapted after Gottschalk 1993.) In theory, managed fire may have similar results with stand replacing fires acting as regeneration harvests and less severe burning perhaps acting as a

thinning. The logical conclusion is that those alternatives that harvest and/or utilize prescribed fire on more acres in upland oak and mixed oak-pine stands will have a more positive impact on reducing gypsy moth risk. Table 3B5-3 displays the acres estimated to be regenerated in these forest types by alternative. Because fire is a less precise tool and it is difficult to predict acres regenerated or "thinned" through the use of fire, the effect of fire on gypsy moth risk is not quantified in this analysis.

Table 3B5-3. Estimated Acres Harvested within Gypsy Moth Susceptible Forest Types in the Next Decade and Acres of Moderate-High Gypsy Moth Risk at the End of the Next Decade, acres

Activity in Susceptible Types	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H & I
Acres Regenerated	17,000	5,000	11,000	0	23,000	11,000	8,000	11,000
Acres Thinned	6,000	2,000	4,000	0	8,000	4,000	2,000	4,000
Total Acres Harvested	23,000	700	15,000	0	31,000	15,000	10,000	15,000
Total Acres Moderate – High Risk	599,000	617,000	607,000	622,000	591,000	607,000	617,000	607,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Based in part on the Desired Condition of the alternative, an estimate of the above management activities' effects on the number of acres and percent of susceptible forest types within each risk category is presented. The focus of each alternative was used to estimate the percent of acres regenerated that would occur in each gypsy moth risk category. The base assumption is that the acres regenerated under each alternative would be equally distributed across all four gypsy moth risk categories. This assumption was then altered only for those alternatives where the focus would clearly change this distribution. For example, the focus of Alternative D is commodity driven and strives toward a balanced age class distribution and includes active control of insects. In this case, the total acres regenerated under Alternative D where allocated to acres of high and extreme gypsy moth risk. Conversely, Alternative F focuses on a variety of recreation opportunities and, in terms of forest health, emphasizes the maintenance of recreational experiences (e.g. user safety and visual quality). In this case the total acres regenerated were equally distributed across all risk categories.

Upon examining the results of Table 3B5-2 above, it is apparent that there is very little difference between the alternatives in altering gypsy moth risk after the first decade. The percentage of the oak and oak-pine community types in a high or extreme risk category range from 56% to 59% of the forest under all alternatives. Ten years is simply not enough time to seriously alter age class or species composition under any alternative.

Upon examining Table 3B5-4, we begin to see how the alternatives vary in their effect on gypsy moth risk at the end of 50 years of management. Alternative D would have the greatest impact with approximately 45% of the GWNF in a high or extreme gypsy moth risk. This is consistent with Table 3B5-3 above as Alternative D would regenerate the most acres of these susceptible community types. Alternative D would reduce gypsy moth risk better than any other alternative.

Table 3B5-4. Gypsy Moth Risk, percent

Risk	Alt A		Alt A[1]		Alt B		Alt C		Alt D		Alt E		Alt F		Alts G, H & I	
	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr
Low	7%	7%	7%	7%	7%	6%	7%	7%	7%	7%	7%	7%	7%	6%	7%	7%
Moderate	5%	5%	5%	5%	5%	3%	5%	5%	5%	5%	5%	5%	5%	3%	5%	5%
High	37	34	38	39	38	37	38	39	37	32	38	36	38	38	38	36
Extreme	19	15	20	20	20	19	20	21	19	13	20	17	20	19	20	17

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Alternatives A, E, G, H and I have a more moderate effect; approximately 49% and 52%, respectively, of the GWNF would be in a high or extreme gypsy moth risk. This is also consistent with the acres managed shown in Table 3B5-3 as these alternatives have a relatively high number of acres managed. Alternatives F, B, and C have less effect on gypsy moth risk; these alternatives range from 57% to 60% of the GWNF in a high or extreme risk category.

CUMULATIVE IMPACTS

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding gypsy moth risk are somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway) and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to be altered through vegetation management actions to any great degree. Thus, gypsy moth risk can be expected to increase slightly (similar to that modeled for the Forest without action) on these acres, where the proper forest type exists, for all of the reasons described previously. However, since these areas focus so heavily on recreation, they are likely to suppress gypsy moth populations on relatively more acres. Since lands administered by these agencies comprise a very small percentage of the area as a whole, such suppression is unlikely to have any effect on population dynamics of the general area. But, they may experience less gypsy moth-related impacts regardless of their vegetative condition simply due to repeated suppression activities on their lands.

Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation and is unlikely to receive a large amount of suppression efforts. Presumably, this area would be similar to the GWNF National Forest Alternatives B, E, F, G, H and I with respect to the ability to reduce the risk of gypsy moth.

Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Certainly those forested acres held by private industry are likely to be intensively managed and gypsy moth populations may be suppressed. However, as noted in the Timber Demand Analysis, very little industrial private forest remains in this area. Non-Industrial Private Forests (NIPF) account for almost 80% of the lands in the general area. The Timber Demand Analysis also found that perhaps as much as 55% of this land would not be available for vegetation management due to landowner attitudes and/or economic return. Perhaps increased gypsy moth activity may result in increased gypsy moth suppression activities and pre-salvage efforts ahead of defoliation as has been observed on some privately held acres. However, many acres of privately held lands would remain unmanaged and likely increase the risk of gypsy moth-related impacts.

Oak Decline

AFFECTED ENVIRONMENT

Oak decline is a complex native disease involving interactions between environmental and biological stresses and subsequent attacks by insects and pathogens of opportunity. The disease generally progresses slowly over several years. It begins with a long-term predisposing stress such as prolonged drought or advanced age. These stressed or older trees are often subsequently damaged by short-term inciting factors such as insect defoliation (e.g. gypsy moth), spring frosts, or acute drought. In their weakened condition, the trees may be attacked by insects and diseases that normally do not invade healthy trees. At this point, classic decline symptoms appear, beginning as dieback from branch tips inward and ultimately resulting in the death of the tree. The most important underlying factor when resource damage is severe may be a tree population dominated by senescent overstory oaks lacking vigor (Oak et al. 1991).

Oak decline is a serious forest health concern on upland hardwood forests in the Southern Appalachian National Forests. Stand and site factors that determine oak decline risk in the Southern Appalachians include forest type (oak density), site productivity (site index), age, and stress factors such as spring defoliation and drought or combinations of these stresses (Oak and Croll 1995). The highest risk conditions are stands with a large oak component (especially red oak of advanced age), growing on sites of average or lower productivity, with a recent defoliation history and prolonged growing season drought. Risk may be reduced by reducing

stand age through regeneration harvests, altering species composition through thinning (reduce or eliminate oak component), and/or preventing stress factors (treating spring defoliating insects with insecticides is the only feasible option but is often not economically justifiable).

Oak decline is so pervasive in the Southern Appalachians that no reasonable alternative can adequately address risk at the landscape scale in the short-term. Management actions can lower risk locally and sustained effort over the long-term can gradually lower risk on more area. Based on SAA analyses, the GWNF (along with the neighboring Jefferson National Forest) has the highest incidence of oak decline vulnerability and damage of all the Southern Appalachian Forests (SAMAB 1996). Indeed, Oak et al. (1991) found that approximately 30% of the oak forest types in the Northern Mountain Survey Unit of Forest Inventory and Analysis (FIA) data, which includes the GWNF, had oak decline symptoms. This area also had the highest losses due to oak decline ranging from 14 to 25 cubic feet per year. Vulnerability to oak decline refers to the probability that oak decline is expected to occur in a given stand. Approximately 288,000 acres of the GWNF is highly vulnerable to oak decline (chestnut oak stands), representing about 24%. Another 452,000 acres, or 33% of the GWNF, is moderately vulnerable to oak decline (oak-hickory stands). The remaining 475 of the GWNF is in forest types of low vulnerability. (Adapted after Oak et al. 1991)

DIRECT AND INDIRECT EFFECTS

There are a number of parallels between oak decline and gypsy moth impacts and our ability to manage them. For this reason, many of the conclusions and affects presented for gypsy moth above also apply to this discussion regarding oak decline. Like the gypsy moth, oak decline risk factors include forest type (oak density), site productivity (site index), age, and stress factors such as spring defoliation and drought or combinations of these stresses. Of these, managers have no control over site productivity and/or drought and little control over defoliating insects. Attempts to suppress insect pests over the entire, or even a significant part, of the landscape cannot be justified economically or environmentally. Thus, species composition (forest type) and age are the factors that managers can manipulate to alter the risk of oak decline. Thinning and regeneration harvests can alter species composition and only regeneration harvests can alter the age of a given stand. Thus, similar to gypsy moth, our best tool in combating oak decline is vegetation manipulation through various types of timber harvesting.

The ratio of site index (SI) to age can be used to estimate the vulnerability of an oak stand to oak decline. A SI/age ratio of less than 1.0 indicates a highly vulnerable stand and a SI/age ratio between 1.0 and 1.3 indicates a moderately vulnerable stand (Oak et al. 1991). Oak found that 60% of oak decline affected stands in western Virginia had SI/age ratios less than 1.0 and an additional 24% of the affected acres had SI/age ratios less than 1.4. However, the risk of mortality once a stand becomes oak decline affected appears to be higher in oak stands with an SI/age ratio less than 1.4. For the purpose of this analysis, we will consider stands with a SI/age ratio less than 1.4 to be vulnerable to oak decline and at a high risk for mortality if oak decline affected.

Regenerating these stands to a younger age class in a timely fashion reduces the risk of oak decline. This means that those alternatives that regenerate more acres in Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest Ecological Systems, especially in, black oak and scarlet oak stands, will have a more positive impact on oak decline risk and the preservation of related forest values such as wildlife habitat, recreation, and wood products. Table 3B5-5 displays the acres estimated to be regenerated in the vulnerable ecological systems and the acres at risk from oak decline effect at the end of the next decade by alternative.

Table 3B5-5. Acres in Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest Ecological Systems regenerated and at risk from oak decline effects at the end of the next decade by alternative

Activity in Susceptible Types	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Acres Regenerated	20,200	5,000	25,300	0	38,600	15,200	8,400	22,800
Total Acres Vulnerable/High Risk	736,100	751,300	731,000	756,300	717,700	741,100	747,900	733,500

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Alternatives B, E, F, G, H and I have a more moderate effect on reducing oak decline vulnerability and risk; approximately 67% to 69% of the forest would be in a vulnerable and high risk of mortality to oak decline effects.

Alternatives D and A have the greatest effect on reducing oak decline vulnerability and risk; these alternatives range from 61% to 64%, respectively, of the forest in a vulnerable and high risk category. Alternative C would be expected to have the least impact as compared to all other alternatives on reduction of oak decline effects.

CUMULATIVE IMPACTS

In the description of the oak decline disease complex above, the role of both the long-term predisposing stress agent(s) and a short-term inciting agent was discussed. The entire GWNF experienced droughty conditions from 1999 through 2002 and most recently in the summer of 2010. This, coupled with the advancing age of our oak forests, results in an existing condition that is ripe for serious oak decline incidence. The potential consequences of this condition have been illustrated in recent catastrophic decline episodes in the Ozark-Ouachita Highlands of Arkansas and Missouri during the past five years (Starkey et al. 2004). The gypsy moth, an insect defoliator, has repeatedly defoliated several portions of the GWNF. More discussion on the gypsy moth and its impacts are disclosed elsewhere in this document, however it deserves discussion here as well. The gypsy moth is likely to be a short-term inciting agent that has and will continue to trigger oak decline events as populations of this insect continually cycle up and down. The combined effect of older aged oaks, past drought, and gypsy moth defoliation is likely to result in serious and widespread oak decline-related mortality of oaks.

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding oak decline risk are somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to be regenerated through management actions. Thus, oak decline risk can be expected to increase dramatically where the proper forest types exist as stands age without regeneration, for all of the reasons described previously. Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation. Presumably, these areas would be similar to the GWNF Alternatives B, E, F, G, H and I with respect to the ability to reduce the risk of oak decline.

Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Certainly those forested acres held by private industry are likely to be intensively managed and gypsy moth populations may be suppressed. However, as noted in the Timber Demand Analysis, very little industrial private forest remains in this area. Non-Industrial Private Forests (NIPF) account for almost 80% of the lands in the general area. The Timber Demand Analysis also found that perhaps as much as 55% of this land would not be available for vegetation management due to landowner attitudes and/or economic return. Perhaps increased gypsy moth activity may result in increased gypsy moth suppression activities and pre-salvage efforts ahead of defoliation as has been observed on some privately held acres. Both of these activities would result in a reduction of the risk of oak decline effects. However, many acres of privately held lands would remain unmanaged and likely increase the risk of gypsy moth-related impacts. Furthermore, the

encroachment of residences in the urban/wildland interface results in a desire to keep older oak trees intact for aesthetic reasons. Unfortunately, construction of house foundations in proximity to such trees often creates another stress through disturbance of the root zone. Often, such trees ultimately die unless care is taken in protecting them during construction. Therefore, the increase in residences encroaching on the GWNF is likely to result in more oak decline incidence in the general area.

Hemlock Woolly Adelgid

AFFECTED ENVIRONMENT

The hemlock woolly adelgid (HWA), *Adelges tsugae*, an insect species native to Asia, was first identified in the eastern United States in 1951 in Richmond, VA, but it has recently expanded into the Southern Appalachians and threatens to spread throughout the ranges of eastern and Carolina hemlock (USDA FS 2005). This non-native pest is currently established along the mountainous regions of western Virginia throughout the entire GWNF. The adelgid may be spread by wind, birds, or mammals (McClure 1990). Long-range movement of the adelgid by migrating songbirds in the spring could explain why northward spread has been faster than southward spread. Although individual stands of hemlock may not yet be infested by this insect pest, for all intents and purposes, the entire GWNF has been impacted by the HWA. A vast majority of hemlocks in the GWNF are in advanced stages of damage and widespread mortality is evident, although the number of acres of mortality and/or damage has not been estimated at this time.

There are two species of hemlock in the SAA area, eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*). Both species are included in the hemlock and northern hardwood forest community type. The former is an important component of riparian ecosystems, providing cooling shade for streams, contributing nutrients for streams through litterfall, and providing winter shelter for wildlife. It may also be important as a feeding and nesting niche for neotropical migratory birds (Rhea and Watson 1994). Carolina hemlock, on the other hand, is less understood ecologically and much less common on the GWNF. It generally occupies more xeric sites on ridges and rock outcrops, but it also probably provides cover and nesting sites for birds and small mammals. Both eastern hemlock and Carolina hemlock are threatened by the adelgid.

Approximately 8,000 acres of the GWNF is classified as containing a hemlock component, comprising less than 1% of the Forest. The highest concentration of the host type is located along the Blue Ridge and in the central portion of the forest on the North River Ranger District. The GWNF has been treating HWA infestation associated with a few recreation sites that still contained relatively healthy hemlocks in the late 1990s. These efforts focused on Brandywine campground in West Virginia and Hone Quarry and Todd Lake in Virginia. Originally an insecticidal soap was applied to the foliage annually. This treatment was abandoned in favor of the more effective soil injection of imidacloprid. These treatments have been effective in maintaining the health of these isolated hemlock stands. Meanwhile, a vast majority of hemlocks on the GWNF have experienced severe mortality.

DIRECT AND INDIRECT EFFECTS

Once infested by the adelgid, hemlocks are weakened, gradually lose their foliage, and are unable to refoliate or produce cones. Mortality occurs after complete defoliation, generally within 5 years of initial infestation (McClure 1987). There is no known genetic resistance to adelgids in either of the native Appalachian hemlock species, but resistance is known to occur in hemlocks native to Asia and in the two species native to the Western United States. Individual hemlock trees can be protected by spraying or soil treatments, but due to the advanced stages of decline and mortality found in a vast majority of hemlock stands on the GWNF, these treatments will not protect the trees. Except for those areas that have been protected in the past and a few isolated hemlock populations that have not yet been infested, it is simply too late to save most of the hemlock on the GWNF. It appears that all untreated hemlocks, with the possible exception of small geographically isolated populations, could eventually be killed by the adelgid. Loss of hemlock will negatively impact riparian ecosystems and may result in a substantial reduction in habitat quality for birds and other wildlife (Rhea 1995).

On the GWNF, both horticultural oil and imidacloprid (a soil injected insecticide) have been used to reduce adelgid populations and impacts on about 30 acres in three developed recreation areas. This treatment is likely to continue under all alternatives. Any healthy hemlock populations that may be found in the future may also be treated under all alternatives. Therefore, no substantial difference between the alternatives regarding treatment of or impacts from HWA is identified in this analysis. The impact of any treatment under any alternative is inconsequential to the landscape scale of this analysis. The extremely small areas treated have negligible influence on the impacts of the adelgid or hemlock forests on the GWNF.

Indirect effects may result in a loss of thermal insulation (summer cooling and winter insulation) along streams and riparian areas. In some areas, white pine may be able to fill this ecological niche, but it will take time for white pine to fully occupy the sites formerly held by hemlock. Loss of cover is likely to also adversely affect a myriad of bird and wildlife species on the GWNF.

CUMULATIVE EFFECTS

The situation described above can also be applied to surrounding lands held by private interests and other agencies. The adelgid infests hemlock regardless of ownership and active management or the lack thereof has no influence on the pest or its impacts on the host. The very sad fact is that hemlocks throughout the Appalachian mountains of Virginia will continue to deteriorate and die and there is very little anyone can do about it at a landscape scale at this time.

Southern Pine Beetle

AFFECTED ENVIRONMENT

Southern pine beetle (SPB) (*Dendroctonus frontalis*) infestations have occurred cyclically throughout recorded history in the South. This is a native pest. SPB outbreaks move from low levels of infestation to high levels over several years. The cycles may be localized or regional and depend upon weather and other stress factors as well as the interrelationship between the populations of SPB and its predators (SAMAB 1996e).

The female SPB kills pines and occasionally other conifers by boring under the bark and destroying the cambium layer of the tree. They construct winding galleries while feeding and laying eggs. During outbreaks, trees are usually mass-attacked by thousands of beetles. The crowns of trees attacked by SPB during warm, dry weather may fade in color within weeks. Once a tree is successfully attacked, the tree usually turns light greenish-yellow, then yellow, and finally reddish-brown. This color change pattern can vary depending on the tree and environmental conditions.

SPB outbreaks in the SAA area are generally less dramatic than those on the Piedmont and Coastal Plain of the south because yellow pine forests types are less common in the Appalachian Mountains (SAMAB 1996e). However, in rare instances, as occurred in the mid-1990s on the GWNF, SPB populations can build to such high levels that they attack and kill white pine. On the rare occasions when they do occur in the Appalachians, SPB outbreaks have significant ecological implications, not only because of the loss of relatively scarce habitat, but because at least one yellow pine species, table mountain pine, is largely fire dependent (SAMAB 1996e). Table mountain pine stands killed by SPB rarely regenerate, and are permanently lost.

Factors that determine SPB hazard include the proportion of the stand in susceptibility host trees (primarily the southern yellow pine species, although white pine can rarely be a susceptible species as well) and the radial growth of those trees over the past five years. Trees with a relatively high radial growth are less susceptible to SPB-related mortality (Mason et al. 1991). While we do not have individual tree radial growth data to estimate susceptibility, we can use the Culmination of Mean Annual Increment (CMAI) as a proxy for radial growth. Trees within stands that have passed beyond CMAI are growing relatively slower and radial growth should be slower. Previous modeling using the Forest Vegetation Simulator indicates that CMAI for the Yellow Pine working group ranges from 35 to 50 years old depending upon site productivity. For the purpose of this analysis we will consider stands equal to or older than 60 years old to be of a higher susceptibility to SPB. While thinning of these stands can increase radial growth and reduce SPB susceptibility, little or no thinning of yellow pine is implemented on the GWNF since most of these types occur on less productive lands.

Currently there are approximately 124,000 acres, or 12% of the GWNF, in the Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland ecological systems, without the white pine forest types. These ecological systems correspond to the host types susceptible to SPB. Of this acreage, approximately 118,000 acres, or 95% of the ecological system (without white pine types), are greater than 60 years old. Approximately 61,000 of these acres, or 49% of the ecological system (without white pine types), are greater than 100 years old. We conclude that for all intents and purposes, all of the Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland ecological systems on the GWNF are susceptible to SPB and roughly half of these systems are highly susceptible to SPB.

DIRECT AND INDIRECT EFFECTS

Managers can control both the proportion of susceptible species and the radial growth of trees through vegetation manipulation activities. Thinning and/or regeneration harvests can alter both species composition and radial growth of the trees within a stand. However, thinning in these stands that often occur on relatively poor sites is rarely economically, or even logistically, viable. Many of these stands occur on lands unsuitable for timber production. The use of prescribed fire can reduce stand density, much as a thinning would, and ultimately increase radial growth on the residual stems. Fire can also regenerate some forest types, especially table mountain and to a lesser extent pitch pine. Thus, while timber harvest can help to lower SPB risk, the use of prescribed fire can treat the most acres and represents our best tool in lowering SPB risk.

Table 3B5-6. Acres in Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland Ecological Systems burned, regenerated, and thinned and at risk from Southern Pine Beetle effects at the end of the next decade by alternative

Activity in Susceptible Types	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Acres Managed by Fire	3,000	7,400	16,000	10,000	12,000	70,000	16,000	70,000
Acres Regenerated by Harvest	2,000	300	700	0	3,000	1,500	1,000	1,500
Acres Thinned by Harvest	0	0	0	0	0	200	0	200
Total Acres Vulnerable/High Risk	114,000	111,000	102,000	109,000	104,000	48,000	102,000	48,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Between 39% and 92% of the ecological systems of concern would be in a SPB susceptible condition under the various alternatives analyzed given the objectives for prescribed fire and timber harvesting under each alternative. Alternatives E, G, H and I would reduce SPB risk the most as it is projected to utilize the most prescribed fire and any timber harvesting would be focused on ecological restoration and maintenance objectives. Alternatives B and F are ranked next highest in the number of susceptible acres due to a somewhat lower prescribed fire objective. Alternative D is not much different than B and F; in this case the greater timber harvest objective compensates somewhat for a lower prescribed fire objective. Conversely, because Alternative C allows for an expanded use of wildfire, it is projected to result in slightly less SPB susceptible acres as compared to Alternative A, which improves SPB susceptibility the least of all alternatives.

CUMULATIVE IMPACTS

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding SPB hazard is somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway) and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to receive significant vegetation management actions. Thus, SPB susceptibility can be expected to increase dramatically where the proper forest types for all of the reasons described previously. Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation. Presumably, these areas would be similar to the GWNF Alternatives B, F, G, H and I with respect to the ability to reduce the susceptibility to SPB.

Conversely, management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. However, one commonality on privately held lands would be the very low use of prescribed fire and aggressive attack of wildfire. The role of fire in lowering susceptibility to SPB on these lands is expected to be negligible. Certainly those forested acres held by private industry are likely to be intensively managed and SPB outbreaks aggressively fought using timber harvest. However, many acres of privately held lands would remain unmanaged and likely increase in hazard of SPB outbreaks.

Emerald Ash Borer

AFFECTED ENVIRONMENT

The Emerald Ash Borer (EAB) (*Agrilus planipennis*) is an insect pest of recent concern for the GWNF. This non-native boring insect was first identified in the United States in 2002. Initial infestations were located in Michigan and Ontario, Canada. The insect has rapidly spread south and east and now occurs in Maryland, West Virginia, and Virginia. As of this writing, the nearest known infestations of EAB are located in Morgan County, WV, and Frederick, Fairfax County, Prince William, Pittsylvania, Halifax, Prince Edward, and Mecklenburg Counties in Virginia. EAB trapping has occurred in and around the GWNF since 2009; however no EAB have been detected as yet. Like the SPB, the EAB also feeds on the cambium of ash trees as larvae. It is the destruction of the cambial layer that disrupts the transport of water and nutrients up the tree and causes mortality. Unlike SPB, a single generation of larvae occurs in any given season, with the larvae overwintering in the sapwood of the tree. Beetles emerge in May or early June to mate and start a new cycle. At this time, only ash trees are believe to be susceptible to this species of borer. Infested trees decline over a few years and may die after 3 to 4 years of heavy infestation.

Ash is rarely a dominant tree in our forested stands with only about 100 acres of the GWNF being classified in a Forest Type containing ash species. However, ash species are often found as a minor component throughout the entire GWNF in the more mesic sites. While this insect pest is not likely to cause widespread severe mortality at the stand or landscape level because the host tree is not a dominant species in our Forest, it certainly could lead to severe decline and impact of ash species throughout the GWNF.

DIRECT AND INDIRECT EFFECTS

As there are few management actions or treatments identified that can prevent EAB susceptibility or risk, it is difficult to display differences in impacts amongst the alternatives. At this time the most effective activities in combating EAB on the GWNF involve continued detection, cooperating with enforcement of quarantines (administered by the Animal and Plant Health Inspection Service), and perhaps restrictions on the importation of firewood. We expect all these activities would continue under all alternatives.

In the event that an infestation is discovered on the Forest, removing the infested trees is about the only tactic that would prevent further spread. It is expected that all alternatives would utilize this approach. Perhaps the only difference between alternatives that can be expected is that this activity could be a commercial activity under all alternatives except Alternative C. For that reason, this activity may cost less to implement under all alternatives as compared to Alternative C.

CUMULATIVE IMPACTS

Unfortunately, we cannot be optimistic regarding this insect pest. The activities described above on the GWNF are likely to occur on all lands in the area regardless of ownership. However, despite these efforts in the past, new infestations of this pest continue to be found. It is very likely that this pest will continue to expand its range and mortality of ash trees in and around the GWNF is likely to increase despite any individual or agency action.

Ramorum Blight

AFFECTED ENVIRONMENT

Ramorum blight, also known as Sudden Oath Death Syndrome (SODS), is caused by the fungal pathogen (*Phytopthora ramorum*). This disease was first reported in 1995 in central California where it has caused widespread mortality in tanoak and oak species. The disease also manifests as a twig and foliar disease on many other species including members of the Rhododendron genus, including camellia species which prove to be a potential route of spread as infected nursery stock is moved around the country for ornamental landscaping purposes. *P. ramorum* has been confirmed in various states in the southeast, most recently in Greenville County, SC where a residential landscape site is confirmed to have a *P. ramorum*-positive *Rhododendro*n Sp. *'Catawbiense Boursault'*. No evidence of *P. ramorum* has been recovered from early detection surveys in Virginia. However, in the event that this organism is introduced to our forests, most likely through infected nursery stock utilized in surrounding areas, the GWNF would be at a moderate to moderately high risk for impacts from ramorum blight. Figure 3B5-3 displays a map of risk for ramorum blight (Kelley, et al. 2005).

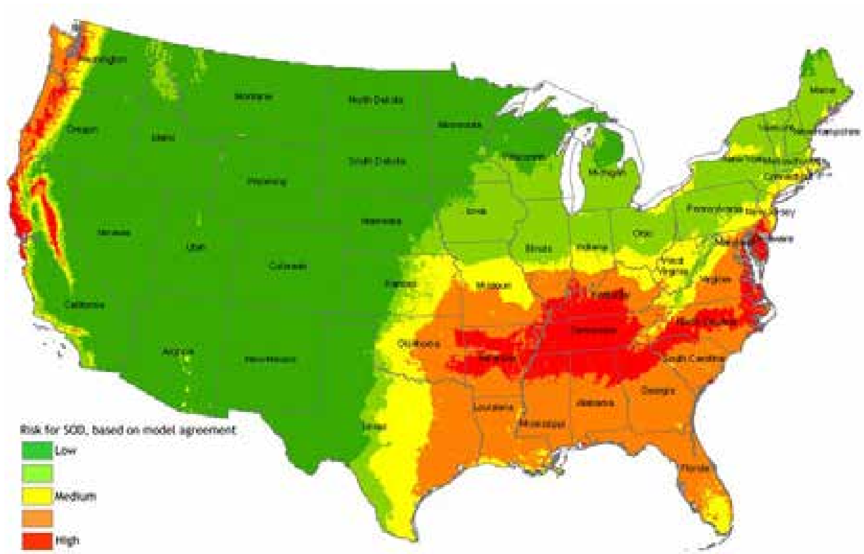


Figure 3B5-3. Risk for Sudden Oak Death in the conterminous United States: results from five spatially referenced models

DIRECT AND INDIRECT EFFECTS

Given the risk and the widespread occurrence of susceptible host types (oaks, rhododendrons, and mountain laurel) on the GWNF, there is a concern about the potential impact of this disease in our ecosystems. Unfortunately, very little is known regarding the potential impacts of ramorum blight here in the east or possible treatments to manage this disease at this time. No difference regarding the risk or treatment of ramorum blight is expected between the alternatives.

CUMULATIVE IMPACTS

Similar to the discussion above, there is a concern about the potential impact of this disease in our ecosystems. Unfortunately, very little is known regarding the potential impacts of ramorum blight here in the east or possible treatments to manage this disease at this time. We cannot identify any cumulative actions or activities that would combine with the GWNF activities to alter the impacts of ramorum blight.

B6 – FIRE - WILDFIRE AND PRESCRIBED FIRE

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 1670s, 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 1800s, 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).

Wildfire Suppression

Fires generally fall into one of two categories: wildfires or prescribed burns. A wildfire is a fire resulting from an unplanned ignition; it usually requires a management response to control its spread based on resources at risk, fuel conditions, and predicted weather and fire behavior. A prescribed fire is any fire ignited by management actions to meet specific objectives. The term “wildland fire” is an inclusive term to refer to both wildfires and prescribed fires.

AFFECTED ENVIRONMENT

In a study of wildfire records on the George Washington National Forest, (Adams 1994) found that, between 1915 and 1993, there were 2,198 fire records on file. The vast majority (76%) were small fires less than 10 acres. Only 1% of the fires were greater than 1,000 acres. Early records, prior to 1950, are incomplete, but several significant trends can be determined. Nearly 40% of the fire starts were attributed to arson and smoking. An additional 14% were of unknown origin. Lightning accounted for approximately 14% of all fires

during that time period. Though this data is from in-service records of fire reports, it is assumed to accurately reflect trends in the data. The study also shows a typical spring and fall (April and November) fire season, attributed mostly to human starts. Lightning fires occur from the late spring through the summer with the highest months being May, July, and April (see Table 3B6-1). During the 20 year period, 1990 through 2010, lightning fires accounted for 25% of all fires while the remaining 75% were attributed to human causes, with arson accounting for 36% of the total fire workload. During that same period the statistics were nearly identical as what Adams had found, 73% of all fires were 10 acres or less and only 1% of all fires reached 1,000 acres in size or greater. Since suppression action was initiated on all the wildfires, there is no conclusive way to now accurately predict how large the fires would have become had suppression action not been taken. This information would assist in helping managers apply prescribed fire to the various forested ecosystems at levels to mimic the role of what naturally occurred.

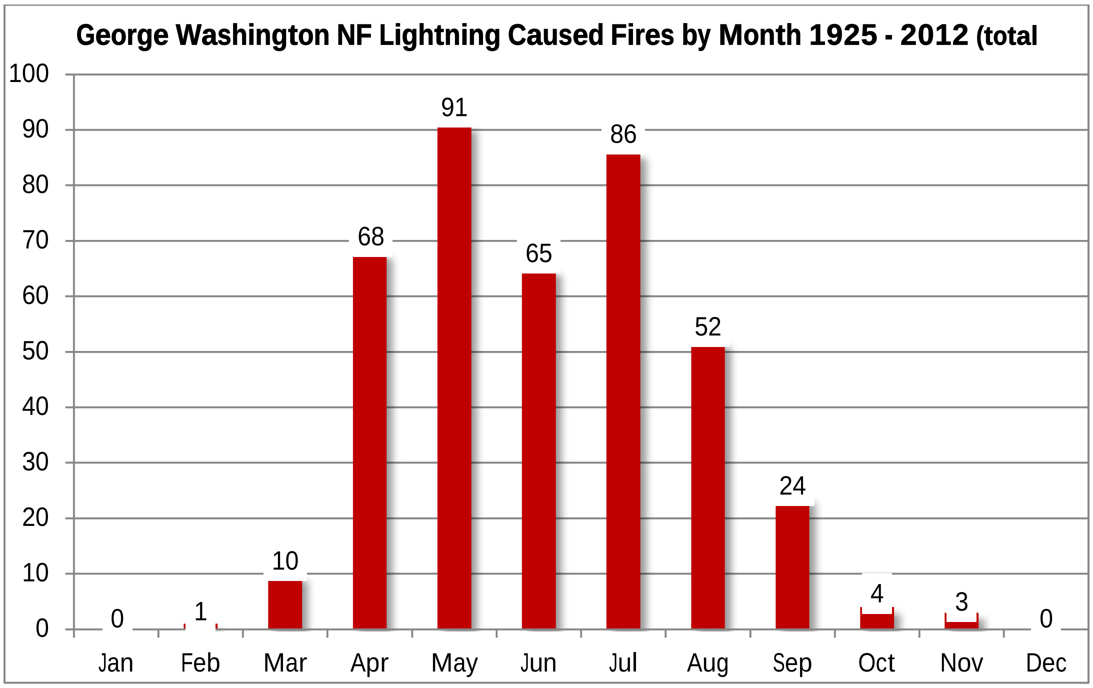


Figure 3B6-1. Lightning Fires

Fire is a random event and is therefore unpredictable as to its spatial occurrence. During spring and fall fire seasons, arson and carelessness is the leading cause of our human wildfire starts. Though we may know the area an arsonist is working, the next start is always an unknown. Law enforcement officials on the George Washington and Jefferson National Forests have been very successful in recent years in apprehending and prosecuting a number of arson cases on the forests that have led to prison sentences. We may be able to reduce, to a degree, human-caused fires through active fire prevention, education, and enforcement programs. The second leading cause of wildfire starts is lightning. Lightning is an extremely random event that is dependent upon the weather systems that occur.

Table 3B6-1 shows the wildfire history for 1990-2010 for both the George Washington and Jefferson National Forests. The largest lightning fire on the George Washington National Forest during the 21 year time period was 914 acres and occurred on the Eastern Divide Ranger District in June 2008. The largest human-caused fire during that same time period was 4,505 acres and occurred on the Glenwood Pedlar Ranger District in March of 2008. The average number of fires per year during the time period was 44 and the average acres burned were 2,441.

Generally, southern aspects had higher occurrences. Human-caused fires began largely on the lower slopes (following road and settlement patterns) and lightning was distributed on mid to higher slopes.

Volunteer Fire Departments (VFDs) gradually assumed the role of the local, less formal warden crews. VFDs are well-distributed through the valleys and are trained, equipped and quick to respond. Their rapid response has kept most roadside fires to minimal acres. Not all areas of the Appalachians have this committed response. VFDs have, no doubt, prevented many wildfires from involving homes and structures.

Table 3B6-1. Recent Wildfire History for the George Washington and Jefferson National Forests

Year	No. of Fires by Cause		Total	
	Lightning	Human	No. of Fires	Acres Burned
1990	3	44	47	1,197
1991	6	52	58	2,028
1992	3	20	23	408
1993	6	20	26	362
1994	12	50	62	572
1995	3	49	52	5,685
1996	2	20	22	89
1997	6	37	43	1,013
1998	2	59	61	2,754
1999	30	43	73	2,028
2000	16	43	59	2,126
2001	3	64	67	2,650
2002	28	3	61	5,426
2003	0	18	18	128
2004	4	14	18	213
2005	1	24	25	382
2006	11	25	36	6,813
2007	12	35	47	3,886
2008	10	37	47	10,750
2009	4	24	28	594
2010	14	35	49	2,162
Total	176	716	922	51,266
Average/Yr	8	34	44	2,441

The firefighting organization continues to evolve, as interagency and intra-agency cooperation multiplies available resources, communication improves, and aircraft is utilized. Firefighter and public safety is always the primary consideration for all suppression strategies and tactics. The full range of management responses from direct attack to monitoring a fire is available to the fire manager and line officer. Strategies and tactics for the fire should be commensurate with resource values at risk. Natural barriers such as rock slides, riparian areas, roads, etc. are used whenever possible to construct firelines to mitigate impacts to soil, vegetation and water; reduce costs of line construction; and to provide for additional safety considerations. The Fire Management Plan (FMP) is the implementation guide for the Fire Management program on the National Forest. The FMP describes in detail the fire suppression organization, the prescribed fire program, smoke management concerns and guidelines, the prevention program and all other relevant aspects of the Fire Management program.

The George Washington National Forest is relatively fragmented and therefore is adjacent to private land along much of its boundary. There is increasing pressure as additional growth occurs in these areas. More people desire to live in wooded surroundings and typically work at maintaining a natural vegetative state surrounding their property to provide a more isolated setting that will block the view of any adjacent structures. While this is aesthetically pleasing, the increased vegetation can quickly become hazardous fuel in the event of a wildfire.

From a suppression standpoint, anytime there is a wildfire in the wildland urban interface, more resources respond with a threat of structure involvement. These fires are much more expensive to suppress and are almost always multi-jurisdictional.

Wildfires occurring in the wilderness use MIST (Minimum Impact Suppression Techniques) techniques for fire suppression operations. Safety is still the primary consideration though when selecting strategies and tactics, tools and equipment, we utilize those that will have the least impact on the environment. Strategies that allow the fire to burn to natural barriers are favored and if fireline must be constructed, then it should be of a minimum width and depth to check fire spread. Limbing, bucking, and felling of trees or snags are minimized unless they are a safety hazard or threaten security of the fireline and then are only removed to a level to prevent additional fire spread.

Fuels Management

AFFECTED ENVIRONMENT

Recent research (Pyne 1982; Sutherland 1993; Hicks 2000; Hutchinson and Sutherland 2000; Kay 2000; Shumway et al. 2001; Schular and McClain 2003) and research recently completed (Lafon and Grissino-Mayer 2007) has shown the frequency and role that periodic fire (both human and lightning caused) has played in shaping the vegetation our landscape supports. Historical records indicate that Native Americans used low intensity fires in our area prior to European settlement and early European settlers continued this practice. Fire was used in efforts to drive game, but more importantly to improve wildlife habitat, maintain open meadows and grasslands, and clear undergrowth, especially in proximity to settlements (Pyne 1982; Van Lear and Waldrop 1989; Delcourt and Delcourt 1997, 1998). The woodland structure (open park-like understory) and tree composition (American chestnut, oak, & yellow pine) of these forests was long influenced and maintained by these fires. Ongoing tree-ring and fire scar studies being conducted in the mid-Appalachians (including western and southwest Virginia) indicate that from at least the early-1700s until the 1930s our forests burned on an interval of approximately three to ten years and that occasionally more intense stand-replacing fires occurred. Earlier than the 1700s, studies of charcoal deposits in pond and wetland sediments indicate fire has been common in our landscape for thousands of years. However since the 1930s suppression became the way all fires were managed. All wildfires were immediately suppressed regardless of cause and low intensity burning (commonly called light burning) methods were abandoned. All fire, both wildland and low intensity burning, was considered harmful to the forest. With seventy years of fire exclusion, forest structure and composition has, and is continuing, to change. Oak dominated forests are being replaced by more shade-tolerant species, such as white pine, red maple, and striped maple. Table mountain pine, pitch pine, and even oak (all fire-adapted and/or fire-maintained species) are in sharp decline over most of their natural range. Rhododendron, which should be located in moist north-facing drainages, is now encroaching onto upper drier slopes. Today, prescribed burning is used to mimic the early Native American, settler, and lightning caused fires.

For years 1993 through 2010, the George Washington National Forest (not including the Jefferson National Forest) prescribed burned a total of 89,577 acres ranging from a low of 170 acres in 1991 to a high of 10,156 acres in 2010. The 21-year average is 4,266 acres per year and the past 10-year average is 6,388 acres. Not all of these acres are separate and unique burns. Several of these prescribed burn areas have been burned two or three times during this period. Factors such as appropriate weather and fuel conditions, availability of equipment (e.g. helicopter, engine, dozer, UTV, etc.), availability of qualified personnel, ongoing wildfires, and funding play a critical role in determining how many acres are prescribed burned in any given year. Most prescribed burns on the George Washington National Forest are conducted between late February and early May. All prescribed burn projects must have a NEPA analysis completed and a burn plan prior to burn implementation. The burn plan contains specific burning objectives and parameters under which the burn will be conducted to meet specific resource management objectives.

Table 3B6-2. Number of Acres Prescribed Burned by Year 1990 – 2010 on GWNF

Year	Prescribed Burning
1990	1,092
1991	170
1992	970
1993	1,870
1994	795
1995	1,741
1996	1,339
1997	1,465
1998	6,564
1999	5,523
2000	4,172
2001	3,135
2002	2,322
2003	7,188
2004	7,103
2005	9,285
2006	4,914
2007	3,335
2008	9,563
2009	6,875
2010	10,156
Total	89,577

Prescribed fire is an important and ecologically appropriate management tool. Both natural fuels and artificially produced management-activity fuels must be managed over time to meet long-term resource management objectives. Artificially produced fuels have been of little concern, because of the small volume generated, but may have to be managed in the future. In a research burn conducted in the Blue Ridge Experimental Forest in Macon County, NC, (Clinton et al. 1998) more than 50 percent of the mass in litter and small wood was lost during burning. In this study, both fire intensity and severity were moderate. In addition to fire behavior, fuel size and flammability were important determinants of fuel mass consumption. Small wood is more completely consumed at lower temperatures than larger wood; plots high in wood mass in small size classes would lose more mass than plots with similar mass in larger size classes. Burning conditions that produce a more intense fire i.e. longer flame lengths with shorter residence times which equates to a lower severity fire with higher rates of spread would consume less of the humus layer and the associated nutrients though overstory mortality could become an issue dependent upon the type of commercial harvest method. Thus, this proves a strong case for using prescribed burning to treat the resultant slash from commercial harvest operations. Small logging slash, primarily in the form of foliage and fine branches, although temporarily dangerous as a fuel carrier in the case of an ignition, are a short-term problem, often decomposing within the first 4-5 years by white rot fungi in warm, moist environments according to Harvey and others. On the George Washington National Forest, logging contractors leave tops cut at 4” DBH left where the tree was felled and the rest of the logging slash is lopped and scattered to decay more quickly which consequently lessens the threat of a fire threat and distributes the fuel more evenly so if a fire did occur, or a prescribed fire were utilized to treat the slash, the fire severity would be lower and less intense. The EPA states, in their 1998 policy document entitled Interim Air Quality Policy on Wildland and Prescribed Fires, that while future air quality concerns from prescribed fire may arise, the EPA is on record stating that fire should function, as nearly as possible, in its natural role in maintaining healthy wildland ecosystems and to protect human health and welfare by mitigating the impacts of air pollutant emissions on air quality and visibility.

Fuels management considers both the dead and live fuel components within the fuel complex. These components vary widely across the forest according to ecosystems, insect and disease outbreaks, moisture or drought conditions, and the natural processes that occur without active vegetative management.

The dead fuel components are snags, dead pine needles and leaf litter, dead trees on the forest floor, and shrubs, forbs and graminoids that have fuel moisture low enough to be consumed in the flaming front of a fire. They comprise the available fuels and these values vary seasonally. Snags are becoming more of a hazard on the George Washington National Forest with the increasing incidence of gypsy moth, southern pine beetle and oak decline. Snags create a significant safety hazard during wildfire suppression and prescribed fire implementation.

Prescribed fire and mechanical fuels treatments are designed to reduce the risk of intense and unplanned wildfires by decreasing the amount of available fuel that the fire is able to consume and thus carry the fire. Both methods are utilized to restore fire regimes within or near an historical range. Since 2001 when the National Fire Plan (NFP) was implemented, there has only been one mechanical fuels treatment completed on the George Washington National Forest. A couple of reasons for the low number of completed mechanical treatments are the high cost per acre of the treatments, mechanical treatments are almost 10 times the cost of prescribed burning, most projects range in size from 20 – 70 acres in size so they are usually much smaller and are much more labor intensive hence the higher cost per acre. Examples of mechanical fuels treatments are lopping and scattering of branches of larger diameter trees, thinning of small diameter saplings and the mastication or mowing of large grassy openings.

Fire Regime Condition Class (FRCC), developed by the Forest Service with partners in nine other land management agencies and nongovernmental organizations, is a "standardized tool for determining the degree of departure from natural vegetation, fuels and disturbance regimes". (For detailed information on this subject, visit http://www.frcc.gov). Agencies involved in developing the FRCCs were the Forest Service, National Park Service, U.S. Fish and Wildlife Service, The Nature Conservancy, U.S. Geologic Survey, Systems for Environmental Management, Bureau of Land Management, Missoula Fire Lab, and Bureau of Indian Affairs.

Condition Classes are a function of the departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, stand structure, successional stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of non-native invasive plant species, insects and disease (introduced or native), or other past management activities.

Fire Condition Class is a measure of general wildfire risk and ecosystem condition defined as follows:

Condition Class 1:

- Fire regimes are within or near an historical range.
- The risk of losing key ecosystem components is low.
- Fire frequencies have departed from historical frequencies by no more than one return interval.
- Vegetation attributes (species composition and structure) are intact and functioning within an historical range.

Condition Class 2:

- Fire regimes have been moderately altered from their historical range.
- The risk of losing key ecosystem components has increased to moderate.
- Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This results in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns.
- Vegetation attributes have been moderately altered from their historical range.

Condition Class 3:

- Fire regimes have been significantly altered from their historical range.
- The risk of losing key ecosystem components is high.
- Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns.
- Vegetation attributes have been significantly altered from their historical range.

There is a need to change the Fire Regime Condition Class (FRCC) on the GWNF from a FRCC 3 towards a FRCC 2 and eventually perhaps a FRCC 1 on as much of the Forest as possible. FRCC 3 is a condition of the landscape that is highly departed from its natural (historical) regime of vegetation characteristics; fire frequency, severity and pattern; and other associated disturbances. FRCC 2 defines a condition that has moderately departed from the natural (historical) regime and FRCC 1 defines a fire regime that is within the natural (historical) range of variability. The George Washington National Forest uses both prescribed fire and mechanical treatments to reduce fuel loading, to break-up fuel continuity (both vertically and horizontally), and to reduce rates of spread and therefore fire size, intensity, and severity. Nationally, the direction is to increase hazardous fuels treatment in the wildland urban interface areas. Those areas are the most expensive areas to suppress wildfires and pose the greatest threat to public and firefighter safety. Though there is not a one-to-one correlation between acres treated and suppression dollars saved or fewer acres burned, there is sufficient evidence to show that areas that have been treated typically exhibit lower rates of spread, less intensity, less severity, and a smaller final fire size under normal conditions.

In addition to prescribed fire, wildfire management includes the ability to utilize unplanned lightning ignitions by analyzing various parameters such as weather, fuel conditions and expected fire behavior to determine if the lightning fire is within prescription parameters so the fire could be purposefully used to meet prescribe fire management objectives.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Prescribed fire is also a valuable tool to provide wildlife habitat; for managing rare communities that require periodic fire to maintain plant viability; for pine species such as pitch and table mountain pine; for a silvicultural site preparation tool; for increasing forage; and for regenerating oak stands on productive sites (Brose and Van Lear 1999). Table 3B6-3 displays the acres of prescribed fire by alternative in an average year over the next decade.

Table 3B6-3. Prescribed Burning by Alternative

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Acres Prescribed Burned annually	3,000	7,400	12,000-20,000	Limited TES	5,000-12,000	20,000	12,000-20,000	12,000-20,000
Acres of Fireline (dozer)	2	5	8-13	0	3-8	13	8-13	8-13

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Alternative E would be the largest prescribed burn program since it has a strong focus on restoration. Alternative C would generate the smallest prescribed burn program as prescribed burning would be limited to managing TES species without an emphasis on ecosystem restoration. Alternative A has the acres estimated to be prescribed burned annually in the current Plan. Alternative D has an emphasis on commodity production and opportunities for prescribed burning are limited. Alternatives B, F, G, H and I have a program that includes an emphasis on restoration while taking into account fluctuations in weather and funding that may limit the number of acres likely to be burned annually.

Prescribed fire can have short-term negative effects on air quality. These effects may be mitigated by burning at certain times of the year, at certain fuel moisture thresholds, and under meteorological conditions that promote smoke dispersion. This information is provided in the burn plan that is prepared for each prescribed fire. A smoke management plan is required for each burn plan. More detail on smoke and air quality is provided in the Air Resource section of Chapter 3 of the EIS.

Prescribed fire can have positive and negative effects on non-native invasive plants. These effects may be mitigated by pre-treating NNIS to reduce the ability of that species to disperse and become established in the burn area and along control lines. After burning follow-up treatments can suppress or eliminate NNIS from the

area. This information is analyzed for each burn and addressed in the burn plan that is prepared for each prescribed fire. More detail on NNIS is provided in the Non-native and invasive species section of Chapter 3 in this EIS.

Our strategy for responding to wildfires is based on the ecological, social, and legal consequences of each fire. The circumstances under which the fire occurs and the likely effects on firefighter and public safety dictate the appropriate response and subsequent management. Wildland fires are unplanned natural ignitions that may be human-caused or result from natural storm events (i.e. lightning). All wildland fires are managed according to the prevailing Federal Wildland Fire Management Policy. All wildfires managed for resource benefits follow appropriate unplanned natural ignitions use, implementation procedure reference guides, and are assessed following a decision support process that examines the appropriate range of responses within the context of the LRMP. All alternatives will treat response to wildfire similarly; main factor that would affect response most notably would be the amount of Wilderness and the strategic differences in management.