Monongahela National Forest
Review of New Information for Climate Change and Carbon Sequestration

Summary of Findings

New information, agency emphasis, and increased public interest on climate change and carbon sequestration prompted a review from the Monongahela National Forest (MNF or Forest) on the potential effects that climate change may have on Forest resources, and conversely, what effects Forest activities, management direction, and prescriptions—as described in the MNF Land and Resource Management Plan and its supporting Environmental Impact Statement—may have on climate change and carbon sequestration. An interdisciplinary team of MNF specialists and planning staff reviewed the best scientific information available with regard to climate change and carbon sequestration. Based on this review, the MNF Forest Supervisor has determined that the new information related to climate change and carbon sequestration does not require correction, supplementation, or revision of the Environmental Impact Statement prepared for the 2006 Forest Plan or the environmental analysis of any ongoing project. He has also determined that new information related to climate change and carbon sequestration does not require amendment or revision of the 2006 Forest Plan at this time.

However, the Forest Supervisor recognizes that the situation with climate change is ongoing and subject to change and uncertainty. Therefore the MNF is committed to:

- Keeping abreast of the latest information about climate change and its potential impacts on our Forest resources and activities,
- Continuing to apply Forest Plan direction, prescriptions, and monitoring that will provide for adaptation and mitigation strategies for responding to climate change, and
- Remaining open to possible adjustments in the Forest Plan that may help reduce potential impacts from climate change, as more information about this topic becomes available.

Introduction

The intent of this review is to provide a reasoned analysis of recent information on the potential effects of climate change and carbon sequestration and their relevance to ongoing and pending projects implementing the MNF Forest Plan. This documentation provides the decision maker a basis for determining whether to correct, supplement, or revise the environmental analysis supporting the MNF Land and Resource Management Plan, or projects implementing the Plan. New information, agency emphasis, and increased public interest on climate change and carbon sequestration prompted this review.

Background

Climate change is real and measurable at global and regional scales. The Intergovernmental Panel on Climate Change (IPCC) estimates that the average global surface temperature has risen 1.4^{o}F over the past 100 years (IPCC 2007a). Moreover, the rate of change is increasing, with the most dramatic rise in temperature occurring in the past 20-30 years. This spike has corresponded with a similar increase in greenhouse gas (GHG) emissions, most notably carbon dioxide. GHG

emissions from human activities increased 70% between 1970 and 2004, and carbon dioxide grew about 80% in the same time period. Although there is a fair amount of uncertainty in predicting long-range weather patterns and their influences, recent modeling projects that global temperature may increase from 2.0°F to 11.5°F by the end of the 21st century, depending in part on future emissions (IPCC 2007a).

As reported in the Forest Service Strategic Framework for Responding to Climate Change (USDA Forest Service 2008), we are already seeing the effects of changing weather patterns and extreme events on our Nation's forests and grasslands. Many of the urgent forest management problems of the past 20 years--including increased wildfire severity and area burned, large-scale bark beetle infestations, and changing water regimes--have been driven in part by changing climate. Land use changes, management practices, and forest disturbances can also contribute to increasing greenhouse gases.

Even if global GHGs were eliminated today, the IPCC predicts that global temperatures would continue to warm for the next 100 years (IPCC 2007a). The IPCC also predicts a broad range of effects of changing climate, including regional warming, changes in precipitation, extremes in weather, severe drought, earlier snowmelt, rising sea level, effects on water supply, and other changes that can lead to significant alterations in ecosystems and the societies that depend on them. Continued emission of GHGs at current rates would only intensify these impacts.

Ecosystem processes, water availability, species assemblages, and the structure of plant and animal communities and their interactions will likely change over time. Some of these changes may enhance ecosystem productivity and carbon storage. For example, increased moisture and warmth, combined with increased carbon dioxide (CO2), stimulate tree growth. Under a changing climate, however, many ecosystems will likely experience species mortality, increased fire and insect activity and other disturbances, changes in water regimes, with associated loss of productivity and resilience and stored carbon. However, disturbance events can also provide opportunities for recovery actions that will facilitate adaptation and enhance resiliency and ecosystem health in a changing climate. Managing vegetation within its historic range of variability may not be an option in many areas. Strategies based on historical or current conditions may need to be adjusted or replaced with approaches that support adaptation to the changing conditions of the future.

Forest Service Strategic Framework and Forest Planning

The Forest Service Strategic Framework for Responding to Climate Change (USDA Forest Service 2008) provides a framework to guide current and future Forest Service actions to meet the challenges of climate change. The framework includes seven key goals that will help the agency carry out its mission of sustaining forests for present and future generations under a changing climate.

1. Science – Will be used to advance our understanding of the environmental, economic, and social implications of climate change and related forest adaptation and mitigation activities.

2. Adaptation – Will enhance the capacity of forests to adapt to the environmental stresses of climate change and maintain ecosystem services.

3. Mitigation – Will promote the management of forests to reduce the buildup of greenhouse gases, while sustaining the multiple benefits and services of these ecosystems.

4. Policy – Will integrate climate change, as appropriate, into Forest Service policies, program guidance, and communications.

5. Sustainable Operations – Will reduce the environmental footprint of Forest Service operations and be a leading example of a green organization.

6. Education – Will advance awareness and understanding of principles and methods for sustaining forests, and sustainable resource consumption, in a changing climate.

7. Alliances – Will establish, enhance, and retain strong alliances and partnerships with federal agencies, state and local governments, tribes, private landowners, NGO's, and international partners to provide sustainable forests for present and future generations.

Of the seven goals described above, the Millar et al. (2007) note that national forests have the best potential for addressing the following:

- **Adaptation**, which refers to actions that adjust to and reduce the negative impacts of climate change on ecological, economic, and social systems. Adaptation strategies may include such actions as thinning forests to increase tolerance to drought and resistance to wildfire or insects, conserving species' genetics, developing wildlife corridors to facilitate migration, constructing new water storage facilities, planting different species from those that occurred on a site before disturbance, or converting vegetation structure to make tree stands more resilient to changing climate.

- **Mitigation**, which refers to actions that reduce emissions and enhance sinks of greenhouse gases, so as to decrease inputs to climate warming in the short term and reduce the effects of climate change in the long run. Mitigation strategies may include such actions as energy conservation, alternative fuels and clean energy, tree planting and regeneration, carbon sequestration, product substitutions to replace more energy-intensive materials, and increased use of energy from wood.

Forests act as carbon sinks, transforming CO_2 into trees and vegetation, roots, woody debris, litter, and forest soils (Murray et al. 2000). Net carbon uptake by terrestrial ecosystems in the United States, coupled with storage in wood products and landfills, currently offsets about 14 percent of United States greenhouse gas emissions from fossil fuel combustion and cement production (US EPA 2007a). Recent estimates suggest that this offset might be increased through forest and grassland management. Birdsey et al. (2003) noted that carbon stocks have increased in U.S. forests by about 190 metric tons per year since 1953. Although environmental groups have challenged the effects that timber harvest is having on carbon sequestration and global warming, carbon stock numbers indicate otherwise. For example, the United States'

growing stock of timber was estimated at 836 billion cubic feet in 1997, while the amount of timber removed from U.S. forests was only 16 billion cubic feet (Birdsey et al. 2003). Forests (including vegetation, soils, and harvested wood) accounted for 86 percent of total net carbon uptake in 2007. This net forest sequestration is a result of net forest growth and increasing forest area, as well as a net accumulation of carbon stocks in harvested wood pools (USEPA 2007).

Globally, loss of forest land cover is responsible for about 20 percent of human-caused carbon emissions. Most of this loss is occurring in the tropics. Management of forests to enhance terrestrial carbon storage—including planting trees, reforestation and avoiding forest conversion, storage in durable bio-products, and bio-energy—has considerable potential as an important component of the global capacity to mitigate effects of fossil fuel emissions (IPCC 2007a).

The Nation's forests contain vital components of biological diversity, an essential part of our national heritage. Their ecosystems, landscapes, and species provide us with ecosystem services on which society relies. These lands are the source of water used for drinking, agriculture, and industry. They supply fiber for paper, lumber, and other wood products, as well as a portion of our renewable energy. They provide recreation opportunities, clean air, and feed for domestic livestock; and they support biodiversity and habitat for plants and wildlife. Healthy and productive forests are, and can continue to be, significant sources of renewable energy and other offsets to fossil fuel emissions.

Maintaining ecosystem services while contributing to mitigation will require integrated, landscape-level and regional approaches to management across ownerships. A substantial knowledge base already exists from a century of Forest Service and partner research on natural processes, management in forests and grasslands, and utilization options, as well as over twenty years of targeted global climate change research. This information forms a scientific foundation for climate change adaptation and mitigation, decision support, monitoring, adaptive management, and new research.

West Virginia Information

Like many places in the East, the forests of West Virginia were almost entirely cutover in the 50-year period between 1880 and 1930. Large fires ensued in the dried-out slash and duff that were left behind from the complete removal of the forest canopy. Forests have been recovering since that time, restocking carbon and adding to their biological diversity.

West Virginia provides a good example of the regional variability that can be manifested with climate change. National Climatic Data Center statistics indicate that there has been little overall temperature increase in the past 100 years, although temperatures have slightly risen in winter. Unlike many other parts of the country, precipitation has increased over the entire state in the past 100 years, with much of that increase coming in the spring and fall months, while summer and winter months have shown slight decreases.

Topography and vegetation likely influence these climatic variations. West Virginia is "The Mountain State", and the high ridges effectively ring condensation out of weather systems moving eastward and upward from the low-elevation farmlands of the Midwest. West Virginia

is also 79% forested, making it the second most heavily forested state in the country (WV DOF, In Prep). These forests act as sponges with the moisture they receive, keeping the landscape cooler and moister than surrounding areas, and contributing to the mesic hydrologic cycle. Extended droughts and large fires have been rare here over the past 20 years, the same period that has seen droughts and large fires increase in the South, Southwest, and Intermountain West. Although the state has an active timber industry, the cut volume has been well below the growth volume on an annual basis (Griffith and Widmann 2003).

Regional projections predict temperatures warming in West Virginia anywhere from 1-7^{o}F over the next century, depending on the rate of GHG emissions (US EPA 1998; IPCC 2007a). The Hadley Centre's climate model predicts a precipitation increase of 20% for the state, slightly higher in summer. Other models show somewhat different results, especially for precipitation. All of the models assume to some degree that as climate warms, forests will change. However, most modelers admit that climate projections have a fairly high degree of uncertainty due to the large amount of variables involved combined with the inherent unpredictability of weather.

"Climate Change and West Virginia", a 1998 report by the Environmental Protection Agency (EPA), notes that forests in the state could change little or decline as much as 5-10% over the next 100 years. Changes may be seen in species composition, geographic distribution, and health and productivity. Oaks and pines may become more prevalent and northern hardwoods and conifers decrease. Spruce forests, which are at the top end of the elevation gradient, have no where else to go in response to warming temperatures, and could be substantially reduced or disappear (USEPA 1998).

In the meantime, West Virginia forests sequester a tremendous amount of carbon. Birdsey et al. (2003) estimated that the state had 999,358 thousand metric tons of carbon storage in 1987, and that number had risen to 1,091,609 thousand metric tons by 1997, a 9% increase. This carbon was broken down into the following areas:

Type of Sequestration	Amount in Thousand Metric Tons	Percentage of Sequestration
Soil	584,592	54%
Tree vegetation	376,586	34%
Forest floor	97,237	9%
Understory vegetation	7,685	1%
Timber products	25,508	2%
Total	1,091,609	100%

From Birdsey et al. (2003)

Monongahela National Forest Information

At 920,000 acres, the Monongahela National Forest (Forest or MNF) is a carbon sink. Over 95% of NFS lands within our proclamation boundary are "forested", i.e., they grow trees that absorb carbon dioxide, produce oxygen, and store carbon. This nearly contiguous canopy of trees also contributes to and protects a vast storage reservoir of carbon on the forest floor and in the underlying soil layers. About three quarters of the forest stands are dominated by mature trees that are relatively vigorous and productive. The major threats to these stands are currently from non-native invasive species (gypsy moth, hemlock woolly adelgid, emerald ash borer, beech bark

scale, etc.) and potential soil productivity losses from acid deposition. Climate change has not been a major concern to this point, but we recognize that climate could influence non-native invasive species activity and disturbance events (fire, ice storms, wind storms, etc.) in the future.

In 2009 we calculated that there are roughly 63 million metric tons of carbon stored on the Forest. That amount includes both above-ground and below-ground carbon, and is likely conservative given that we are starting to find unexpectedly large reserves of carbons stored beneath wetlands and areas that once had ancient spruce forests. In comparison, current timber harvest levels on the Forest have been calculated to represent roughly 2 thousand metric tons of carbon a year, which is only about 0.00003 percent of the total carbon storage.

During our Forest Plan revision, we estimated the maximum potential timber production on the Forest to be 246 million board feet (USDA FS 2006b, p. C-25). We are currently harvesting timber at a rate of around 10 million board feet per year. Similarly, the results of a 1999-2001 inventory revealed that the net growth of trees on the Forest, including losses due to natural mortality, was nearly 4 times as much as the timber being harvested (Widmann and Griffith 2004). Thus the Forest is producing and storing far more carbon from trees annually than we are removing in the form of timber harvest. Additionally, the timber that leaves the Forest as a by-product of achieving vegetation management objectives is typically processed locally and regionally into products that represent long-term carbon sequestration, such as construction lumber, flooring, and molding. After being sequestered for 30-100 years inside buildings, the materials are typically taken to landfills where they are stored indefinitely.

The range program on the Forest is relatively small, with about 6,000 acres (0.6% of the Forest) managed for grazing by about 800 head of livestock, mostly cattle. Allotments are also small, averaging 125 acres, and comprising a mix of grass, herb, shrub, and tree vegetation. While the Forest expanded by roughly 70,000 acres over the last 30 years, the amount of land in forage production decreased by nearly 50 percent. Most of this land has returned to forested conditions. Much of the land we purchase from the private sector is abandoned farmland, strip mines, or timber land that becomes afforested under federal management.

Lightning and human-caused fires have generally burned less than 10 acres per year on the Forest over the last few decades. The prescribed fire program burned less than 100 acres per year prior to Forest Plan revision in 2006. The 2006 Plan calls for integrating fire management into oak ecosystem restoration, and the program has grown to several hundred acres per year, predominantly light-to-moderate under-burns that thin stand understories but retain the tree canopies. Fuel reduction measures such as prescribed burns may reduce carbon stores temporarily, but they can reduce the burning intensity in future fires and thus maintain higher carbon stores in forest landscapes over the long run (Krankina and Harmon 2006).

Disturbance and production from natural gas development has been far less than predicted in the reasonably foreseeable development projections made in 1990 and revisited during Forest Plan revision. For example, 136 new gas wells were projected to be drilled within our proclamation boundary between 1990 and 2009, while less than 30 have actually been drilled. Although West Virginia is one of the leading coal producers in the country, no coal is currently produced on the Forest, and all of the coal mineral leases on the Forest are now federally owned. The natural gas

that is produced on the Forest is almost pure methane, the cleanest burning of all fossil fuels, which is typically used in this part of the country as a replacement fuel for coal or fuel oil, which are known to produce substantially more greenhouse gas emissions per volume than methane.

Climate Conditions

Due to higher elevations and the predominant tree cover, the Forest tends to stay cooler than surrounding land in the Mid-Atlantic region. For example, Forest communities like Parsons or Thomas have average temperatures that are 5-10^{o}F lower than lower-elevation towns like Petersburg that are at roughly the same latitude and in a more open, developed setting.

The Monongahela is also fairly wet, averaging around 60 inches of annual precipitation on the western portion of the Forest, to around 30 inches in the far eastern portion. Climatological data indicates that precipitation levels in West Virginia have been somewhat above average over the past decade and the past 30 years, and that would include the Forest, which has most of the highest and wettest land in the state.

Forest Plan EIS and Climate Change

The MNF Environmental Impact Statement (EIS) for Forest Plan Revision (USDA FS 2006a) did not specifically analyze the effects of climate change on Forest resources for a number of reasons. As noted above, there had not been a discernable change in climate in West Virginia or the Forest over the past 100 years, and therefore climate was not identified as a need for change or an issue to be addressed in the EIS. Also, although there were existing predictions of climate change for West Virginia in 2006, they were not "reasonably foreseeable" due to the uncertain nature of climate and the long period (100 years in the future) to which they were applied. Plan revision analyses focused more on foreseeable events or effects that were likely to occur within the planning horizon of 10-15 years.

However, climate change was not totally ignored. It was instead viewed as one of many factors that could individually or cumulatively change conditions on the Forest, or result in disturbance events that could influence forest conditions. For example, the cumulative effects discussion for wildfire and prescribed burning includes the statement, "Extended periods of drought would increase risk of escalating fire intensity, and could result in stand-replacement events and potential damage to resources and property" (USDA FS 2006a, p. 3-336). These factors were considered cumulatively when developing Forest management strategies or alternatives for the EIS, and these strategies were in turn used in Forest Plan direction to sustain, restore, or enhance the resistance and resiliency of forest ecosystems.

Of the nearly 13,000 public comments we received on the Draft EIS for revision, only a few had any connection with climate change. One commenter wanted our air quality analysis to address the impacts of the alternatives on greenhouse gas emissions. We basically responded that such an analysis was beyond the scope of our Plan revision to address, but that research was being done at the regional and national level, and that climate change was addressed in the most recent national RPA assessment. We provided links to national websites addressing climate change (USDA FS 2006a, Appendix I, pp. I-96 to I-97).

Another commenter said that we should not over-emphasize spruce restoration because spruce is far south of its preferred range and subject to climate change. We responded that our area was well within the historic range of red spruce, and that red spruce had likely reached its optimal development here. We acknowledged that spruce is threatened by a number of factors, including climate change, but we felt that those threats provided more justification for spruce restoration so that the unique biodiversity associated with this community would not be lost (USDA FS 2006a Appendix I, p. I-148).

Another commenter said we should consider the possible impacts of global warming, including the possibility of cooler ridge tops eventually becoming refuges for species like Cheat Mountain salamander. We responded that effects projections for species viability were tenuous beyond the first few decades due to the uncertain effects of climate change and other external factors. We added that we had Forest Plan direction in place that protected the Cheat Mountain salamander from management activities, and therefore our management would not add to any effects that might occur from climate change to this species (USDA FS 2006a Appendix I, p. I-100).

Since Forest Plan revision in 2006, we have not received any project-level comments about climate change or global warming, although we recently received a protest on a mineral lease bid offering by the BLM for natural gas on our Forest. The protesters wanted us to do a climate change analysis (and one for white-nose syndrome) as part of their request for relief. The lease bid was later withdrawn by BLM, so we did not have to respond to the protest.

Other NFs in the Region have been receiving project-level comments on climate change, and the White Mountain NF has been compiling responses to past and/or recurring comments related to climate change. We agree with the White Mountain NF's assessment that global warming and climate change issues are most appropriately addressed at the policy scale. An estimated 75% of global carbon dioxide emissions are from fossil-fuel consumption, with the remainder coming primarily from land-use changes. Much of the land-use change contribution comes from the tropics (USDA Forest Service 2007b, IPCC 2007a). The Forest Service participates at the policy level, mostly through research efforts on a variety of climate change topics (USDA Forest Service 2007b). The agency prepares regular summaries of the effects of global climate change on forest and rangeland conditions. The most recent (2007) summary is available in the Interim Update of the 2000 Renewable Resource Planning Act Assessment (see especially pages 69-72, 74, 77 and 83-85; with the latter summarizing forest sequestration of carbon and avoidance of emissions through the use of wood products). More importantly, management of National Forest System lands by the agency contributes to mitigation of climate change.

Monongahela Forest Plan and Climate Change/Carbon Sequestration

There is nothing in the original 1986 or revised 2006 Forest Plans specifically about climate change, nor did we base our Plan direction or prescriptions or monitoring on climate change. During Forest Plan revision, we were more concerned with the effects of acid deposition than climate change, as we were already seeing effects from the acidification of aquatic ecosystems and soils. However, the sources of acid deposition and greenhouse gases are often the same.

We based many of our substantive changes in Plan revision on what we considered to be sound Ecosystem Management principles, such as looking beyond our borders, keeping ecosystem components intact or restoring components where needed, and collaborating with landowners and stakeholders. These principles were used to develop management prescriptions and direction that in most cases emphasized the sustainability and resiliency of Forest resources in actively managed areas of the Forest, while providing for significant carbon storage potential in areas that are not actively managed. Therefore, we feel that Forest Plan revision positioned the Forest well to address potential effects that we may see from climate change, as they take "integrative approaches that combine adaptation and mitigation practices" (Millar et al. 2007).

Due to renewed public interest, as well as national direction for incorporating climate change into agency policy, we have taken a look at the Forest Plan and its possible connections to climate change, and have noted our findings below. The discussion is divided into the three primary components of Forest Plans: management prescription areas, management direction, and monitoring and evaluation.

Forest Plan Management Prescription (MP) Areas

To provide more effective and efficient management, the Forest is divided into smaller units called Management Prescription (MP) areas, each of which is organized around a common management emphasis. This section looks at how each MP on the Forest is set up to address conditions that could be affected by climate change.

MP 3.0 – Age Class Diversity
This MP emphasized even-aged management and uneven-aged management in the 1986 Plan. It now emphasizes improving age class diversity across 197,000 acres (21% of the Forest) to provide for improved health and resiliency of stands where we would be doing a large portion of our active vegetation management.

MP 4.1 – Restoration of spruce and spruce-hardwood ecosystems
During Plan revision, research indicated that there was as much as 500,000 acres of spruce and spruce-hardwood ecosystems in central Appalachia historically, but through exploitation, they were reduced to essentially nothing. A good portion of these ecosystems were on what is now the MNF. Clearcuts and subsequent drying, duff/slash fires, bare ground, soil erosion, carbon losses, and floods influenced the creation of the MNF, as well as changes to Dolly Sods, Roaring Plains, and a number of rare species populations.

The ecosystems have recovered in extent to about 50,000 acres today, but they are not the same ecosystems functionally and they are fragmented. The cool, high-elevation ecosystems are also vulnerable to climate change. We developed MP 4.1 to help restore them, using both passive (80%) and active (20%) management strategies over 156,000 acres (17% of the Forest). Goals and objectives for restoration (USDA FS 2006b, p. III-14) focus on habitat enhancement, but they should also result in older, more conifer-dominated stands, more carbon sequestration, cooler temperatures, and more sustainable and resilient ecosystems over time.

MPs 5.0 (Wilderness), 5.1 (Recommended Wilderness), and 6.2 (Backcountry Recreation)
These MPs represent 203,500 acres (22% of the Forest) that preserve wilderness attributes or potential, while allowing for primitive or non-motorized recreation opportunities. Little if any active management is anticipated, and forests will continue to move toward late successional conditions, with natural processes predominating and high levels of carbon sequestration.

MP 6.1 – Wildlife Habitat Emphasis
The 1986 Plan had 284,000 acres in this prescription, and the 2006 Plan has 286,000 acres (31% of the Forest), so there has not been much change in size. The shift in this MP in Plan revision was in location and emphasis. The 1986 Plan emphasized creating remote habitat and reducing disturbance to wildlife habitat over many different areas of the Forest.

Our Plan revision research indicated where our fire-adapted ecosystems are, and monitoring showed that we are losing the oak component in these ecosystems to shade-tolerant species like striped maple and beech. Therefore, we expanded MP 6.1 emphasis to include oak restoration in fire-adapted ecosystems. Management in these areas focuses on retaining large fire-adapted oaks in overstory, opening up stands to encourage oak regeneration, reducing competition from striped maple and beech, and returning fire as a tool to maintain these ecosystems that are more resilient and adapted to warmer, dryer climatic conditions. This management should also make the ecosystems more resilient to changes related to climate change. Specific goals and objectives related to oak restoration can be found on page III-36 of the 2006 Plan (USDA FS 2006b).

MP 8.0 – Special Areas
These areas feature a mix of forested conditions and include a National Recreation Area (8.1), National Natural Landmarks (8.2), Scenic Areas (8.3), Ecological Areas (8.4), Research Areas (8.5), and Grouse Management Areas (8.6), for a total of 79,000 acres, or about 9% of the Forest. In the Spruce Knob-Seneca Rocks NRA (57,200 acres), vegetation may be managed to enhance recreation, to control insect or disease outbreaks, or to restore areas damaged by disturbances. In semi-primitive areas (24,900 acres) of the NRA, forests will continue to move toward late successional conditions, with high levels of carbon sequestration. For National Natural Landmarks, Scenic Areas, and Ecological Areas (8,010 acres), the emphasis is generally on preserving unique ecosystems or areas for scientific or recreational purposes. Little active management is anticipated, and forests will continue to move toward late successional conditions, with natural processes predominating and high levels of carbon sequestration. The Research Areas (6,840 acres) are set aside for research activities, especially to learn about the effects of management on Forest resources. Active management is common and could be used to explore aspects of climate change. Grouse Management Areas (8,600 acres) are actively managed to create and maintain habitat for grouse and other species that use early successional stand conditions for foraging, intermixed with older forests for nesting.

Forest Plan Management Direction

Forest Plan management direction guides Forest personnel to achieve desired outcomes and conditions for both land stewardship and public service. As noted previously, the Forest Plan has no management direction directly related to climate change. However, the Forest Plan has considerable direction related to maintaining, restoring, or enhancing ecosystem function,

resiliency, and sustainability, which in turn should help these ecosystems adapt to climate and other changes (insects, disease, non-native invasive species, acid deposition) over time. Some examples of Forest-wide management direction are given below. For a more comprehensive list of management direction related to this topic, see Appendix A of this document.

Air Quality

During Plan revision we added new direction for reducing air pollution. Although this pollution is measured in terms of particulate matter and effects to visibility, it is typically a by-product of processes that are contributing to greenhouse gas emissions and climate change. Standard AQ04 (p. II-8) is a good example of this new air quality direction.

> **Standard AQ04** - Conduct management activities (including permitted activities) in a manner that does not result in a significant contribution to a violation of National Ambient Air Quality Standards, a violation of applicable provisions in the State Implementation Plan, or an adverse impact to AQRVs in Dolly Sods and Otter Creek Wildernesses.

Soil Resource

We carried forward direction from the 1986 Plan and added new direction during Plan revision for the conservation of soil, particularly the upper soil horizons where most of the soil carbon is sequestered. Protecting the carbon stored in soil is an important component of addressing climate change. Guideline SW19 (p. II-11) is just one of many standards and guidelines that have been designed to protect soil quality and reduce potential loss of soil or soil productivity.

> **Guideline SW19** - Management activities that may result in accelerated erosion and loss of organic matter should have one or more of the following practices applied to mitigate potential effects:
> a) Limiting mineral soil exposure,
> b) Appropriately dispersing excess water,
> c) Ensuring sufficient effective groundcover,
> d) Stabilizing disturbed soils through revegetation, mulching, or other appropriate means,
> e) Preventing or minimizing excessive compaction, displacement, puddling, erosion, or burning of soils,
> f) Preventing or minimizing the initiation or acceleration of mass soil movement (e.g., slumps, debris flows, or landslides).

Water/Riparian/Aquatic Resources

We carried forward direction from the 1986 Plan and added new direction during Plan revision for the protection of water, riparian, and aquatic resources. Goal SW31 (p. II-12) addresses many concerns related to riparian vegetation, which provides shade and enhances stream habitat.

> **Goal SW31** - Maintain, enhance, or restore vegetation conditions that provide:
> a) Ecological functions of riparian, wetland, and aquatic ecosystems.
> b) Canopy conditions that regulate riparian and stream temperature regimes for native and desired non-native fauna and flora.
> c) Natural recruitment potential for large woody debris and other sources of nutrient inputs to aquatic ecosystems.
> d) Bank and channel stability and structural integrity.
> e) Habitat and habitat connectivity for aquatic and riparian-dependent species and upland species that use riparian corridors.
> f) Buffers to filter sediment.

Fire

We introduced new direction in the 2006 Plan for using fire as a tool to maintain, restore, or enhance fire-adapted ecosystems, which are primarily oak forests on the MNF. Goal FM05 (p. II-15) is a good example of this new direction.

> **Goal FM05** - Establish a framework for restoring and maintaining the role of fire in fire-adapted ecosystems. During watershed and project level planning, identify and prioritize opportunities to maintain, enhance, or restore fire-adapted ecosystems.

Vegetation

The Vegetation section addresses various concerns related to maintaining, restoring, or enhancing vegetation conditions and ecosystem resiliency across the Forest. Objective VE03 (p. II-18) recommends treatment on non-suited lands for ecosystem and habitat improvement.

> **Objective VE03** - Treat an estimated 4,000 to 12,000 acres over the next decade on lands not suited for timber production to help restore ecosystems and enhance wildlife habitat.

Guideline VE14 (p. II-19) is designed to help protect or restore rare plant communities that contribute to the overall biodiversity of the Forest.

> **Guideline VE14** - Rare communities should be identified during project analysis. Management actions should avoid rare communities unless management is necessary to maintain, enhance, or restore a particular community. Conservation and management measures for rare communities should be determined on a case-by-case basis.

Standard VE22 (p. II-19) is part of a new section of direction for non-native invasive species or noxious weed control that is needed to reduce impacts on native plants and ecosystems, which in turn should improve their resiliency and increase their sustainability.

> **Standard VE22** - Projects that may contribute to the spread or establishment of noxious weeds shall be designed to include measures to reduce the potential for spread and establishment of noxious weed infestations.

Management Prescription Direction

In addition to Forest-wide direction, the Forest Plan also has management direction for the MP areas that were described above. For instance, MP 4.1, which emphasizes restoration of spruce and spruce-hardwood communities, has the following objective (p. III-14):

> **Objective 4107** - Within stands where spruce can be restored or enhanced, conduct approximately 1,000 to 5,000 acres of species composition and habitat structure enhancement work over the next 10 years. Prioritize efforts in areas that would restore habitat connectivity, increase the size of existing habitats, and provide travel corridors between existing habitats.

MP 6.1, which emphasizes wildlife habitat and oak restoration, has a similar objective (p. III-36):

> **Objective 6106** - Over the next 10 years regenerate the following amounts of forest vegetation to begin moving toward desired age class and habitat diversity conditions for these forest types:
> White oak: 700 to 1,200 acres
> Red oak: 2,000 to 4,000 acres
> Mixed oak: 1,000 to 3,000 acres

Forest Plan Monitoring and Evaluation

Forest Plan monitoring and evaluation is designed to track how well Forest Plan goals and objectives are being met and how responsive we are to changing conditions and issues by providing a feedback mechanism for adaptive management. Monitoring results are used to identify whether changes are needed to the Forest Plan or the way it is implemented. The 2006 Forest Plan has many monitoring items related to specific goals and objectives to improve the resiliency and sustainability of Forest resources and ecosystems. A few examples are given below. For a more comprehensive list of monitoring related to this topic, see Appendix A.

Resource	Monitoring Question	Forest Plan Direction	Precision & Reliability	Measuring Frequency	Reporting Frequency
11. Air Quality	To what extent is Forest management contributing or responding to air pollution effects on ecosystems and visibility?	AQ01 AQ04	A/B	1-5 years	1-5 years
39. Watershed, Riparian and Aquatic Ecosystem Health	To what extent are Forest management and other external influences (such as acid deposition) affecting water quality, quantity, and physical conditions of aquatic ecosystems?	SW01, SW20, SW21, SW22, SW26, SW30	A/B	1-5 years	1-5 years
34.Vegetation	To what extent is the Forest providing a range of vegetative communities that address diverse public interests and needs while contributing to ecosystem sustainability and biological diversity?	VE01, VE02, VE06, TE01, Forest Plan Desired Conditions	A/B	1-5 years	1-5 years

Analysis

As noted above, we agree with the White Mountain NF's assessment that global warming and climate change issues are most appropriately addressed at the policy scale. The Forest Service participates at the policy level through research efforts on a variety of climate change topics (USDA Forest Service 2007b). The agency prepares regular summaries of the effects of global climate change on forest and rangeland conditions. The most recent (2007) summary is available in the Interim Update of the 2000 Renewable Resource Planning Act Assessment (see especially pages 69-72, 74, 77 and 83-85; with the latter summarizing forest sequestration of carbon and avoidance of emissions through the use of wood products). More importantly, management of National Forest System lands by the agency contributes to mitigation of climate change.

In the United States, improved forest management practices, afforestation of previously cleared forest areas (in which eastern National Forests have been active), as well as timber harvesting and use have resulted in net uptake (i.e., net sequestration) of carbon each year from 1990

through 2005. Regeneration success on the Monongahela is excellent. In 2005, land use, land-use change, and forestry activities resulted in a net carbon sequestration of 828.5 million metric tons of CO2 equivalents. This amount represents an offset of approximately 14 percent of total U.S. CO2 emissions. Total land use, land-use change, and forestry net carbon sequestration increased by approximately 16 percent between 1990 and 2005, primarily due to an increase in the rate of net carbon accumulation in forest stocks (USEPA 2007a: 7-1). Carbon sequestration is expected to continue for the foreseeable future, although at a reduced rate because of forest maturation and clearing of private land for development (USDA Forest Service 2007b: 84, Union of Concerned Scientists 2004). Forest productivity may even increase (IPCC 2007b: 6).

Due to improvements in U.S. agricultural productivity, the rate of forest clearing for crop cultivation and pasture slowed in the late 19th century, and by 1920, this practice had all but ceased. As farming expanded in the Midwest and West, large areas of previously cultivated land in the East were taken out of crop production, and were allowed to revert to forests or were actively reforested. The impacts of these land-use changes still affect carbon fluxes from forests in the East. In addition, carbon fluxes from eastern forests have been affected by a trend toward managed growth on private land. Collectively, these changes have nearly doubled the biomass density in eastern forests since the early 1950s. Forest management affects the net flux of carbon by altering the amount of carbon stored in forest ecosystems. For example, management of forests can increase both the rate of growth and the eventual biomass density of the forest, thereby increasing the uptake of carbon (USEPA 2007a: 7-5).

Even the removal of forest products does not contribute carbon to the atmosphere to the degree that many people believe. The advent of sealed landfills in the 1980s has resulted in an increasing rate of carbon accumulation in landfills, which counts as stored carbon (USDA Forest Service 2007b: 84-85; USEPA 2007a: 7-4, 7-5 & 7-6). Because most of the timber harvested from U.S. forests is used in wood products, and many discarded wood products are disposed of in sealed landfills rather than by incineration, significant quantities of carbon in harvested wood are transferred to long-term storage pools rather than being released rapidly to the atmosphere. The size of these long-term storage pools has increased in recent years, contributing to the net sequestration of carbon in the forestry sector (USEPA 2007a: 7-5 to 7-7). Additionally, the use of wood products in construction may substitute for the use of more carbon-intensive products such as steel and concrete (USDA Forest Service 2007b: 84).

Although we are have identified the current carbon stocks on the Forest, we do not believe it is realistic or necessary to pursue carbon accounting at the Forest Plan EIS or project levels for two reasons. First, the best available science indicates that sustainable harvest practices result in net sequestration of carbon over time, even when harvest operations, transportation, stand-tending, and manufacturing are taken into account. Markewitz (2006) concluded that a high-intensity pulpwood management scheme would result in little or no long-term sequestration, while carbon storage in wood products due to accelerated growth of trees to a saw log category might exceed the incurred emissions by three-fold. His calculations showed that there is a net carbon benefit to all but the most intense, shortest-rotation management systems. The MNF Forest Plan and its supporting EIS do not support short-term pulpwood rotations or high-intensity pulpwood management schemes.

The second reason that carbon accounting is not appropriate is because there is no reason to believe that the carbon benefits from the selection of any alternative (including no action) would be realized. Wood from other sources, or products that are more carbon-intensive, could readily be substituted for products that would be made available through implementation of and Forest- or project-level proposal ("leakage," see Cathcart and Delaney 2006: 160). For example, if timber products were obtained from industrial forestlands with shorter rotations, carbon sequestration potential would be less. The potential carbon benefits of foregoing action, or choosing a particular action alternative, are too tenuous to be useful in decision-making.

Although there is considerable public interest in how forest management may affect, or may be affected by such issues as climate change, carbon sequestration, and global warming, we have seen examples where specific criticisms have not been justified. For instance, in their article "Fact and Fantasy about Forest Carbon", Ter-Mikaelian et al. (2008) addressed questionable statements from environmental non-governmental organizations (ENGOs) describing detrimental effects of timber harvesting on forest carbon stocks, including:

- Logging releases large amounts of soil carbon into the atmosphere.
- Natural forests store significantly more carbon than managed forests.
- Carbon stored in wood products is undermined by significant carbon emissions resulting from their production and transportation.

The authors found these statements to be unsupported by current science, and they also found that in many cases the research studies cited in these questionable statements had either been misinterpreted or misrepresented by the ENGOs who cited them. The authors concluded:

> "…sustainable forest management and use of wood products helps to mitigate climate change. Criticism of logging on a sustainable managed forest on the grounds that it contributes to climate change is unfounded. In fact, if one is truly concerned about the risks to the environment from climate change, the case can be made that logging of sustainably managed forests should be encouraged." (Ter-Mikaelian et al. 2008)

Overall, we believe that the information presented and cited in our response to comments on the DEIS for Forest Plan revision (Appendix I) remains relevant and accurate. We have not heard any compelling reasons why we should go back at this time and re-analyze our Plan revision alternatives for effects to or from climate change, global warming, or carbon sequestration.

We recognize that new tools are being developed and refined at the policy scale—such as Climate Wizard, the Climate Change Tree Atlas, and the Climate Change Vulnerability Index Tool—for agency use to help identify potential effects from climate change that may have relevance to long-term forest planning. We may incorporate the use of these tools without the need for supplementing the Forest Plan EIS or amending the Forest Plan, and these tools may help us over time develop more adaptation and mitigation techniques or strategies for responding to climate change. We would add that the Forest Service is continuing and expanding its research activities in the area of climate change and carbon sequestration. Summaries are available from: http://www.fs.fed.us/kidsclimatechange/climate.shtml, and http://www.fs.fed.us/ecosystemservices/carbon.shtml.

The Forest Plan and the FS Strategic Framework for Responding to Climate Change

As noted above, the Forest Service Strategic Framework for Responding to Climate Change (2008) includes seven key goals that will help the agency carry out its mission of sustaining forests for present and future generations under a changing climate. This section examines existing or potential connections between these goals and the Forest Plan.

1. Science – Will be used to advance our understanding of the environmental, economic, and social implications of climate change and related forest adaptation and mitigation activities.

National Forests are not mandated to specifically conduct research. However, the MNF does have research areas (operated by the Northern Research Station) within the Forest boundary, and we have collaborated on research projects in the past. Also, we will likely benefit from the science that is learned through research activities, with opportunities to incorporate appropriate science into our Forest Plan and our management practices over time.

2. Adaptation – Will enhance the capacity of forests to adapt to the environmental stresses of climate change and maintain ecosystem services.

The Forest Plan has management direction and prescriptions that are designed to maintain or enhance the capacity of our forest to adapt to environmental stresses, including climate change. Monitoring and evaluation in the Forest Plan can also play a key role in adaptive management related to climate change and maintaining ecosystem services. The monitoring and evaluation process can be used to change Forest Plan direction and management practices as needed.

3. Mitigation – Will promote the management of forests to reduce the buildup of greenhouse gases, while sustaining the multiple benefits and services of these ecosystems.

The Forest Plan has management direction and prescriptions that promote carbon sequestration and tree regeneration that would help reduce greenhouse gases. Sustainable operations (see #6, below) that would reduce emissions and conserve energy have also been identified in a Forest Sustainability Action Plan, which was developed in 2008 and is now being implemented independent of the Forest Plan.

4. Policy – Will integrate climate change, as appropriate, into Forest Service policies, program guidance, and communications.

The MNF does not set policy for the agency. However, the Forest Plan is an essential part of program guidance for the Forest, and opportunities to integrate climate change into the Plan may come out of agency policy changes in the future.

5. Sustainable Operations – Will reduce the environmental footprint of Forest Service operations and be a leading example of a green organization.
The Forest completed a Sustainability Action Plan in 2008 that should help us reduce our environmental footprint. As noted above, this Sustainability Action Plan is being implemented

independent of the Forest Plan, as Forest Plans do not normally address day-to-day business or administrative actions of a Forest.

6. Education – Will advance awareness and understanding of principles and methods for sustaining forests, and sustainable resource consumption, in a changing climate.

There may be educational opportunities through incorporating climate change information into Forest planning documents and other Forest literature. However, many of our opportunities in this arena would likely come in public outreach programs that the Forest already participates in, such as outdoor education classes, fishing derbies, public presentations, and volunteer teaching.

7. Alliances – Will establish, enhance, and retain strong alliances and partnerships with federal agencies, state and local governments, tribes, private landowners, NGO's, and international partners to provide sustainable forests for present and future generations.

The Forest Plan describes consultation, cooperation, and coordination relationships and opportunities with current partners on pages II-2 through II-4. We value these relationships and the many agreements and mutual benefits they have fostered. For example, we are now part of CASRI (Central Appalachian Spruce Restoration Initiative) with Northern Research Station, Fish and Wildlife Service, WV Division of Natural Resources, The Nature Conservancy, and WV University, a group that is pooling resources to restore spruce-hardwood ecosystems. We are also working with the Native Seed Bank of West Virginia to collect and store seed from native plants on the Forest for future adaptation needs. Another recent collaborative effort concerns Cooperative Weed and Pest Management Areas.

Potential Changes to the Forest Plan Related to Climate Change
There may be opportunities to update the current language in the Plan to add "climate change" and related components as additional reasons why we want to provide for diversity and ecosystem resiliency in a multiple use context, particularly in Desired Condition sections, including the Integrated Desired Condition section at the beginning of Chapter II.

For example, there is a bullet statement in the Forest Integrated Desired Conditions (p. II-6) that says: "Ecosystems on the Forest…are dynamic in nature and resilient to natural and man-caused disturbances." This statement could be supplemented to say: "Ecosystems on the Forest…are dynamic in nature and resilient to natural and man-caused disturbance **and change, including climate change**."

Another example on the same page is: "Soils are productive and in a condition that promotes vegetative growth, hydrologic function, long-term nutrient cycling, and erosional stability." This statement could be augmented to say: "Soils are productive and in a condition that promotes vegetative growth, hydrologic function, long-term nutrient cycling, erosional stability, **and carbon sequestration**."

We may also consider adding a new Forest Plan monitoring item that would track temperature and precipitation changes through time. This information could be compared with other monitoring data to see if there are correlations between climate change and ecosystem or species

changes that are occurring on the Forest. As monitoring items do not affect the overall outputs or services provided in the Forest Plan, they can be added to the Plan using an administrative correction. The same can be said for clarifying statements like those suggested above.

Another suggestion has been made to incorporate the findings of this RONI into the Forest Plan as an appendix. This addition would not change the overall direction, products, and services provided by the Plan, but it would serve to help Forest Plan users and the public understand the Plan's role in addressing concerns related to climate change and carbon sequestration.

We recognize that the situation with climate change is ongoing and subject to change and uncertainty. Therefore we are committed to:

- Keeping abreast of the latest information about climate change and its potential impacts on our Forest resources and activities,
- Continuing to apply Forest Plan direction, prescriptions, and monitoring that will provide for adaptation and mitigation strategies for responding to climate change, and
- Remaining open to possible adjustments in the Forest Plan that may help reduce potential impacts from climate change, as more information about this topic becomes available.

Determination

It is my determination that the new information related to climate change and carbon sequestration does not require correction, supplementation, or revision of the Environmental Impact Statement prepared for the 2006 Forest Plan or the environmental analysis of any ongoing project for the following reasons:

- This Environmental Impact Statement for the 2006 Forest Plan revision was prepared in 2006 and was based on the best available scientific information.

- The effects of Forest activities on climate change were not specifically analyzed at that time because the small scale at which the activities occur was thought to be inappropriate to compare with the vast scale of global warming and climate change—i.e., the effects were incapable of being accurately or meaningfully measured and were therefore beyond the scope of revision. This situation has not significantly changed since 2006.

- The effects of climate change on Forest resources or activities were not specifically analyzed at that time because: 1) climate had not had any discernable effects on resources or activities in the past 20 years and was therefore not identified as an issue or need for change in Forest Plan revision, and 2) the potential effects of climate were uncertain and projected over a time period that was much greater (100 years) than the planning horizon (10-15 years) for most resources or activities. This situation has not significantly changed since 2006.

- Climate change was considered as one of many potential influences that could stress Forest resources, and these stresses were considered in developing management strategies (including EIS alternatives) and prescriptions that would lead to resource conditions that would make them more resilient and resistant to stress, disturbance, and change over time.

- New information from research has shown that sustainable forest management—similar to that described in the Forest Plan Revision EIS—has overall positive effects related to carbon sequestration and maintaining, restoring, or enhancing forest conditions so that forest stands are more resilient and resistant to changes from disturbances and stress, including those created by climate change.

- New information from research has also affirmed that effects from and to climate change should be addressed at the policy scale. It is not realistic or necessary to do carbon accounting at the Forest Plan EIS or project levels. The best available science indicates that sustainable harvest practices result in net sequestration of carbon over time, even when harvest operations, transportation, stand-tending, and manufacturing losses are taken into account. Also, because wood from other sources, or products that are more carbon-intensive, could be substituted for products that would be made available through implementation of and Forest- or project-level proposals, the potential carbon benefits of foregoing action, or choosing a particular action alternative, are too tenuous to be useful in decision-making.

It is also my determination that new information related to climate change and carbon sequestration does not require amendment or revision of the 2006 Forest Plan at this time for the following reasons:

- The current management direction in Chapters II and III of the Forest Plan provides for plant and animal diversity and addresses concerns related to maintaining, restoring, or enhancing vegetation diversity and ecosystem resiliency and sustainability, as well as mitigation to help sequester carbon and ensure tree regeneration.

- The current Management Prescriptions in Chapter III of the Forest Plan are adequate for addressing concerns related to maintaining, restoring, or enhancing vegetation diversity and ecosystem resiliency and sustainability, and to sequestering carbon.

- The monitoring items in Chapter IV of the Forest Plan are adequate for tracking effects or changes to vegetation/species diversity and ecosystem resiliency and sustainability.

- We can add information or monitoring related to climate change through administrative corrections rather than through Plan amendments or revisions.

I therefore conclude—based on the information I considered in the Forest Plan, Environmental Impact Statement, Record of Decision, planning record, resource monitoring, and research presented in this document—that a correction, supplement, or revision to the environmental documentation for the 2006 Forest Plan or an amendment, revision, or correction of the 2006 Forest Plan is not necessary at this time.

/s/ CLYDE N. THOMPSON 06/05/09
Clyde N. Thompson Date
Forest Supervisor

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Appendix A - Forest Plan/Climate Change Tables

There are many ways in which Forest Plan prescriptions, direction, and monitoring would provide benefits related to counteracting effects or trends commonly described for climate change. Virtually all of these ways fall under the *Adaptation* or *Mitigation* strategies described in the "Forest Service Strategic Framework for Responding to Climate Change" (USDA FS 2008). The tables below indicate connections between Forest Plan components and the following potential beneficial effects that correspond to the Strategic Framework strategies:

1) Maintain, restore, or enhance ecosystem resiliency *(facilitated adaptation/mitigation)*
2) Promote carbon sequestration *(mitigation)*
3) Promote air or water quality, cooler temperatures, moister conditions *(facilitated adaptation)*
4) Reduce or prevent NNIS establishment and spread *(facilitated adaptation)*
5) Retain or promote biological diversity *(facilitated adaptation)*

Forest Plan Management Prescriptions and Climate Change

Management Prescription	Management Emphasis	Connection to Climate Change
3.0 – Vegetation Diversity (196,900 acres or 21% of Forest)	Age class diversity, sustainable timber, variety of habitat and forest scenery	1), 5)
4.1 – Spruce and Spruce-Hardwood Ecosystem Restoration (155,700 acres or 17% of Forest)	Active and passive restoration of spruce-hardwood communities, spruce research, recovery of T&E and other rare species	1), 2), 3), 4)
5.0 – Designated Wilderness (116,500 acres or 13% of Forest)	Preserve wilderness attributes and natural environment	2), 3), 5)
5.1 – Recommended Wilderness (0 acres or 0% of Forest)	Maintain wilderness attributes and natural-appearing environment	2), 3), 5)
6.1 – Wildlife Habitat Emphasis (286,400 acres or 31% of Forest)	Enhance wildlife habitat through vegetation management, active restoration of oak communities	1), 5)
6.2 – Backcountry Recreation (96,400 acres or 10% of Forest)	Variety of non-motorized recreation opportunities in a semi-primitive setting and largely natural environment	2), 3), 5)
8.0 – Special Areas (73,600 acres or 8% of Forest)	Preservation of unique ecosystems or areas for scientific or recreational purposes, research areas, biodiversity	1), 2), 3), 5)
• 8.1 – SKSR National Recreation Area (57,200 acres)	A variety of recreational settings and opportunities; conservation of scenic, scientific, historic and other values	2), 5)
• 8.2 – National Natural Landmarks (2,460 acres)	Preservation of nationally significant ecological and geological natural areas	2), 3), 5)
• 8.3 – Scenic Areas (2,470 acres)	Preservation of outstanding beauty and visual quality areas for public enjoyment	2), 3), 5)
• 8.4 – Ecological Areas (3,080 acres)	Preservation of rare ecosystems to enhance biodiversity and provide for scientific or recreation activities	2), 3), 5)
• 8.5 – Research Areas (6,840 acres)	Areas set aside for research purposes, includes Fernow Experimental Forest	1), 2), 5)
• 8.6 – Grouse Management Areas (8,570 acres)	Establish and maintain habitat suitable for ruffed grouse and other species that need an early successional component in habitat	1), 5)

Forest Plan Management Direction and Climate Change Connections

The following tables, presented by resource area, provide a variety of examples of how Forest-wide management direction in the Plan is connected to adaptation and mitigation strategies for addressing potential effects from climate change.

Air Quality (p. II-8)

Management Direction Type, Number and Description	Connection to Climate Change
Goal AQ01 - Improve and maintain air quality and Air Quality Related Values (AQRVs) through a cooperative working relationship with agencies managing air quality, while achieving management goals and objectives. a) Review, evaluate, and provide recommendations on Prevention of Significant Deterioration (PSD) permits that may affect current class I area AQRVs. b) Provide comments to air quality agencies on regulatory efforts that impact air quality in Dolly Sods and Otter Creek class I areas. c) Participate in regional planning organizations and efforts that are examining ways to reduce impacts to visibility and other AQRVs in Class I areas of the region.	3) Promote improved air quality, cooler temperatures, and moisture retention.
Objective AQ02 - Reduce air pollution impacts to the AQRVs of the class I areas on the Forest to improve AQRV conditions over current adversely affected levels.	3) Promote improved air quality, cooler temperatures, and moisture retention.
Standard AQ04 - Conduct management activities (including permitted activities) in a manner that does not result in a significant contribution to a violation of National Ambient Air Quality Standards, a violation of applicable provisions in the State Implementation Plan, or an adverse impact to AQRVs in Dolly Sods and Otter Creek Wildernesses.	3) Promote improved air quality, cooler temperatures, and moisture retention.

Soils (pp. II-9 through II-11)

Management Direction Type, Number and Description	Connection to Climate Change
Goal SW01 - Maintain, restore, or improve soil quality, productivity, and function. Manage soil disturbances from management activities such that they do not result in long-term loss of inherent soil quality and function.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Standard SW03 - Disturbed soils dedicated to growing vegetation shall be rehabilitated by fertilizing, liming, seeding, mulching, or constructing structural measures as soon as possible, but generally within 2 weeks after project completion, or prior to periods of inactivity, or as specified in contracts. Rip compacted sites when needed for vegetative re-establishment and recovery of soil productivity and hydrologic function. The intent is to minimize the time that soil is exposed on disturbed sites or retained in an impaired condition.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Standard SW03 - Erosion prevention and control measures shall be used in program and project plans for activities that may reduce soil productivity or cause erosion.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Standard SW08 - Management actions that have the potential to contribute to soil nutrient depletion shall be evaluated for the potential effects of depletion in relation to on-site acid deposition conditions.	1) Maintain, restore, or enhance ecosystem resiliency

Guideline SW11 - Soil stabilization procedures should take place as soon as practical after earth-disturbing activities are completed or prior to extended periods of inactivity. Special revegetation measures may be required.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 4) Reduce or prevent NNIS est. and spread
Guideline SW14 - Mulch should be applied on severely eroded areas, or areas with high potential for erosion, such as new road cut and fill slopes.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Guideline SW15 - Topsoil should be retained to improve the soil medium for plant growth on areas to be disturbed by construction. Topsoil should be salvaged from an area during construction and stockpiled for use during subsequent reclamation, or obtained from an alternate site. On some areas, soil material may have to be added to obtain vigorous plant growth. Soil to be used for this purpose should have chemical tests made to determine its desirability for use.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Guideline SW19 - Management activities that may result in accelerated erosion and loss of organic matter should have one or more of the following practices applied to mitigate potential effects: g) Limiting mineral soil exposure, h) Appropriately dispersing excess water, i) Ensuring sufficient effective groundcover, j) Stabilizing disturbed soils through revegetation, mulching, or other appropriate means, k) Preventing or minimizing excessive compaction, displacement, puddling, erosion, or burning of soils, and l) Preventing or minimizing the initiation or acceleration of mass soil movement (e.g., slumps, debris flows, or landslides).	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 4) Reduce or prevent NNIS est. and spread

Water Quality and Hydrology (p. II-11)

Management Direction Type, Number and Description	Connection to Climate Change
Goal SW20 - Manage watersheds to sustain healthy aquatic systems, achieve desired conditions, and meet state designated water uses.	1) Maintain, restore, or enhance ecosystem resiliency
Standard SW23 - Logging and construction equipment shall not be washed in stream courses, nor shall material from washed equipment be allowed to drain into surface waters.	4) Reduce or prevent NNIS establishment and spread

Stream Channels, Lakes, and Wetlands (pp. II-11 through II-14)

Management Direction Type, Number and Description	Connection to Climate Change
Goal SW29 - Maintain or restore riparian and floodplain function, including floodwater retention and storage.	1) Maintain, restore, or enhance ecosystem resiliency
Goal SW30 - Maintain surface and ground water sources to support healthy riparian and aquatic habitats, wetlands, channel function, and downstream uses.	1) Maintain, restore, or enhance ecosystem resiliency
Goal SW31 - Maintain, enhance, or restore vegetation conditions that provide: g) Ecological functions of riparian, wetland, and aquatic ecosystems. h) Canopy conditions that regulate riparian and stream temperature regimes for native and desired non-native fauna and flora. i) Natural recruitment potential for large woody debris and other sources of nutrient inputs to aquatic ecosystems. j) Bank and channel stability and structural integrity.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 3) Promote air or water quality, cooler temperatures, moister conditions

k) Habitat and habitat connectivity for aquatic and riparian-dependent species and upland species that use riparian corridors. l) Buffers to filter sediment.	
Standard SW34 - No programmed timber harvest shall occur within the channel buffers identified in the table in SW37. Tree removal from the buffers may only take place if needed to meet aquatic or riparian resource management needs, or to; a) Provide habitat improvements for aquatic or riparian species, or threatened, endangered, sensitive, and locally rare species; b) Provide for public or worker safety; c) Construct or renovate an approved facility; d) Construct temporary road, skid road, or utility corridor crossings; e) Conduct aquatic or riparian-related research, or f) Allow for cable yarding.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 3) Promote air or water quality, cooler temperatures, moister conditions
Standard SW36 - When stream crossing structures are removed, stream channels shall be restored to their near-natural morphology (width, depth, and gradient associations for streambeds, bands, floodplains, and terraces). Disturbed soil shall be stabilized.	1) Maintain, restore, or enhance ecosystem resiliency
Standard SW39 - Use no-till cultivation methods for wildlife opening maintenance within channel buffers.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Standard SW40 - Skid trails and landings shall not be constructed within 100 feet of perennial, intermittent, and ephemeral channels except at crossings or when location outside the 100-foot zone pose a greater risk to aquatic or riparian resources. The 100-foot filter strip may be modified based on site-specific conditions such as soil type, slope, and stability.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions
Standard SW41 - Corralling or overnight tethering of horses or other livestock is not allowed within 100 feet of stream courses or lakes. Existing corral sites may be maintained until alternative sites are developed, provided impacts to water quality and stream channels are mitigated.	1) Maintain, restore, or enhance ecosystem resiliency
Standard SW42 - New trails, campsites, and other recreational developments shall be located, constructed, and maintained to minimize impacts to channel banks and other riparian resources.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions
Standard SW43 - Channel buffers shall not be available for commercial mineral material development.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions
Standard SW44 - New roads are allowed within channel buffers but are restricted to essential crossings. Construction of roads parallel to the channel shall be avoided within the channel buffer.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions
Standard SW45 - New roads within the channel buffer shall be designed to minimize impacts on aquatic and riparian resources.	1) Maintain, restore, or enhance ecosystem resiliency
Guideline SW50 - Maintained wildlife openings and associated access routes identified as degrading riparian or aquatic conditions should be mitigated or closed and restored. New wildlife openings within channel buffers may occur where needed to provide habitat for riparian species, or TEP, RFSS, or locally rare species, and where maintenance for these openings and their access routes can be achieved without degrading riparian or aquatic conditions.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions 4) Reduce or prevent NNIS establishment and spread 5) Retain or promote biodiversity
Guideline SW51 - Ground disturbance should be avoided within seeps, vernal pools, bogs, fens, and other wetlands during project	1) Maintain, restore, or enhance ecosystem resiliency

implementation. These areas should be managed to protect wet soils and rare plants and provide wildlife watering sources using the following protection: a) No new system roads or skid roads should be located within these areas except at essential crossings. Such crossings should be designed to minimize disturbance to the extent practical. b) Logs should not be skidded through these areas. Keep slash and logs out of them. c) Where available, a canopy of 60-100 percent crown closure should be maintained within and adjacent to these areas, unless a more open canopy is needed for TEP species or RFSS management. d) Mast trees or shrubs may be planted in seeps if mast plants are currently lacking.	2) Promote carbon sequestration 3) Promote air or water quality, cooler temperatures, moister conditions 4) Reduce or prevent NNIS establishment and spread 5) Retain or promote biodiversity
Guideline SW52 - Cable yarding that crosses channel buffers should avoid or mitigate adverse effects to the stream channel. Crossing should be at as near a right angle as possible, with full suspension preferred. Trees cut within channel buffers to provide cable corridors may be left on site for woody debris recruitment and erosion control.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 3) Promote air or water quality, cooler temperatures, moister conditions
Guideline SW53 - Use existing fire barriers, such as streams, roads, and trails for control lines where possible.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Guideline SW54 - Hand lines, wet lines, or black lines should be used where appropriate within channel buffers to minimize soil disturbance from fire suppression or control.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
Guideline SW55 - New trails should not be located within channel buffers except at crossings, to control access to water bodies, or when location outside the buffer would pose greater risk to aquatic or riparian resources.	1) Maintain, restore, or enhance ecosystem resiliency
Guideline SW56 - Designated livestock stream crossings and watering points should be located, sized, and maintained to minimize impacts to aquatic and riparian resources.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread
Guideline SW57 - Improvements that invite concentrated livestock use—such as feed troughs, corrals, or salt/mineral blocks—should be located at least 100 feet from a channel, lake, or wetland.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread
Guideline SW58 - Watering troughs should be used where feasible to protect aquatic and riparian resources.	1) Maintain, restore, or enhance ecosystem resiliency
Guideline SW59 - Where private minerals are explored or developed within channel buffers, work with mineral developers to minimize disturbance to aquatic and riparian resources.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread
Guideline SW61 - Work with special use permittees to mitigate effects from their operations to soil, water, and aquatic resources within channel buffers.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread
Guideline SW62 - Stream crossing construction on temporary and permanent roads should be completed as soon as practical, with mitigation as needed to minimize the potential for sedimentation.	1) Maintain, restore, or enhance ecosystem resiliency

Fire Management (pp. II-15 through II-16)

Management Direction Type, Number and Description	Connection to Climate Change
Goal FM03 - Reduce wildfire risk to communties, municipal water supplies, and at-risk federal land by maintaining or restoring fire-resilient forest stands.	1) Maintain, restore, or enhance ecosystem resiliency
Goal FM04 - Maintain or restore late successional stands to a pre-fire suppression condition consistent with management prescription	2) Promote carbon sequestration

emphasis and desired conditions.	
Goal FM08 - Design and implement prescribed fire projects so that emissions do not hinder the state from meeting air quality standards and attaining visibility goals.	3) Promote air or water quality, cooler temperatures, moister conditions
Objective FM09 - Over the next 10 years use prescribed fire on 10,000 to 30,000 acres. Emphasize use in areas to reduce hazardous fuels and fire risk to property or investments, and/or in areas to maintain, restore, or enhance wildlife habitat or other ecosystem components.	1) Maintain, restore, or enhance ecosystem resiliency
Standard FM12 - A prescribed burning plan must be prepared and approved prior to using prescribed fire as a management tool. The plan shall address protection or maintenance of TEP species and habitat, cultural resources, watershed resources, air quality, private property, and other resources or investments as needed or appropriate.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Guideline FM20 - After a fire is controlled, rehabilitate those areas that have the potential to adversely affect soil, water, or other resources. Fire lines should be revegetated and water-barred, where necessary, to prevent erosion. Water diversions may be used to keep sediment out of channels.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration

Vegetation (pp. II-18 through II-20)

Management Direction Type, Number and Description	Connection to Climate Change
Goal VE01 - Provide vegetative diversity through a mix of natural and maintained openings, wetlands, and early, mid, and late successional forests to support a wide variety of habitats, forage, scenery, recreational settings, and socio-economic opportunities.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Objective VE02 - Maintain or create age class diversity on suitable timberlands to provide for sustainable timber production and a variety of structure and wildlife habitat. Treat an estimated 20,000 to 40,000 acres over the next decade to move toward desired age class conditions.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Objective VE03 - Treat an estimated 4,000 to 12,000 acres over the next decade on lands not suited for timber production to help restore ecosystems and enhance wildlife habitat.	1) Maintain, restore, or enhance ecosystem resiliency
Guideline VE04 - Use lands unsuited for timber production (MPs 5.0, 6.2, 5.1, portions of 8.0) as patches of potential old growth. In MPs with suitable timberlands (MPs 3.0, 6.1, portions of 4.1), identify potential old growth areas based on management direction and emphasis, as well as information on delineating potential old growth in Appendix B.	2) Promote carbon sequestration
Goal VE07 - Maintain or restore rare plant communities or individual populations to contribute to the biodiversity of the Forest.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Standard VE12 - Allow collection of RFSS plants only for research or scientific purposes.	5) Retain or promote biological diversity
Standard VE13 - For management actions that have been identified by the Forest as likely to cause a negative effect on RFSS populations, negative effects shall be avoided or minimized to the maximum extent practical while still accomplishing the purpose of the project or action. Unavoidable negative effects shall be mitigated to the extent practical and consistent with the project purpose.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Guideline VE14 - Rare communities should be identified during project analysis. Management actions should avoid rare communities	1) Maintain, restore, or enhance ecosystem resiliency

unless management is necessary to maintain, enhance, or restore a particular community. Conservation and management measures for rare communities should be determined on a case-by-case basis.	5) Retain or promote biological diversity
Goal VE19 - Manage NNIS with an Integrated Pest Management approach, using prevention, education, eradication, containment, and control strategies in a coordinated effort that includes potentially affected resources, users, funding sources, and activities. a) Work to prevent new infestations of NNIS, with emphasis on areas where species have a high probability for establishment and spread. b) Work with WVDNR, utility companies, and special use operators to control NNIS in openings, rights-of way, and other use areas. c) During project-level analysis, identify and map areas of non-native invasive plants. Identify areas with extensive infestations where precautionary measures are necessary when planning and implementing management activities. d) Develop a Forest Non-native Invasive Species Management Plan in coordination with county, state, and federal agencies, including USFWS. e) Provide training to field-going personnel for detecting evidence of NNIS with potential for broad-scale vegetation impacts. f) Use the Forest-wide database and map library of NNIS and susceptibility to develop site-specific Integrated Pest Management approaches and strategies to manage these species.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread 5) Retain or promote biological diversity
Standard VE22 - Projects that may contribute to the spread or establishment of noxious weeds shall be designed to include measures to reduce the potential for spread and establishment of noxious weed infestations.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread 5) Retain or promote biological diversity
Guideline VE25 - Special use permits should include language where appropriate to reduce the risk of NNIS invasion and spread.	4) Reduce or prevent NNIS est. and spread
Goal VE26 - Use Integrated Pest Management methods to minimize or prevent the development of pest problems (includes all pests, e.g., insects, disease, vegetative, or animal). Provide training to field-going personnel for detecting evidence of insect or disease activity.	1) Maintain, restore, or enhance ecosystem resiliency 4) Reduce or prevent NNIS est. and spread
Standard VE32 - Unless specifically registered for aquatic use, ground application of pesticides shall be conducted such that they do not enter surface waters, wetlands, or sink holes.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity

Threatened, Endangered, and Proposed Species (pp. II-22 through II-24)

Management Direction Type, Number and Description	Connection to Climate Change
Goal TE01 - Provide habitat capable of contributing to the survival and recovery of species listed under the ESA. Provide habitat that may help preclude Proposed species from becoming listed.	5) Retain or promote biological diversity
Goal TE04 - Within watershed-level planning units, identify TEP species habitat and opportunities to maintain, restore, or enhance habitat conditions. Design and implement management actions at the project level to address opportunities and provide for ecological conditions, population viability, reproductive needs, and habitat components for TEP species.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Goal TE29 - Manage naturally occurring tree species composition to provide a continuous supply of suitable roost trees and foraging habitat for Indiana bat. Achieve vegetative diversity that maintains or improves Indiana bat habitat. Where consistent with management	2) Promote carbon sequestration 5) Retain or promote biological diversity

prescription emphasis, use a variety of silvicultural methods to create desired age class diversity.	
Objective TE30 - Provide a continuous supply of suitable roost trees by maintaining a minimum of 50 percent of each primary range on NFS lands in any combination of mid successional (40-79 years), mid to late successional (80-120 years), and late-successional (>120 years) age classes.	2) Promote carbon sequestration 5) Retain or promote biological diversity
Standard TE31 - Management of vegetation 5 inches dbh or greater may only be implemented if activities: a) Maintain or improve Indiana bat or other TEP or Sensitive species' habitat, or b) Address public or worker safety concerns, or c) Achieve research objectives.	2) Promote carbon sequestration
Standard TE36 - Maintain a component of large over-mature trees, if available, in all uneven-aged harvest units to provide suitable roosting habitat.	2) Promote carbon sequestration

Wildlife and Fish (pp. II-29 through II-31)

Management Direction Type, Number and Description	Connection to Climate Change
Goal WF01 - Provide habitat diversity that supports viable populations of native and desired non-native wildlife and fish species, including Management Indicator Species (MIS), game species, and furbearers, and keeps RFSS from a trend toward federal listing. a) During watershed or project-level analysis, identify and prioritize opportunities to maintain or restore habitat for RFSS, Birds of Conservation Concern, and other species of interest. b) Within watershed-level planning units, maintain, enhance, or restore representative examples of habitats that would be expected under unmanaged conditions, to the extent allowed by land ownership patterns, existing conditions, and management prescription emphasis.	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biological diversity
Goal WF04 - Manage cold water streams to maintain or restore suitable habitat and native aquatic communities. a) During watershed or project-level analysis, identify and prioritize opportunities to improve water temperature and other habitat conditions. b) Restore connectivity in currently fragmented habitat where the risk of genetic contamination, predation, or competition from undesired fish species is not a concern. c) Use stream improvement structures where desirable to maintain or improve pool/riffle ratios, stream cover, and bank stability.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions 5) Retain or promote biological diversity
Objective WF08 - Actively restore aquatic and riparian habitat conditions in 30-50 miles of stream over the next 10 years. Activities that restore or improve the natural structure and function of channel and riparian conditions may include the installation of instream structures, large woody debris loading, riparian fencing, riparian planting, and bank and channel stabilization.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions 5) Retain or promote biological diversity
Objective WF09 - Maintain at least 50,000 acres of mid-late and late successional (>80 years old) mixed mesophytic and cove forest to meet habitat needs for cerulean warbler, a Management Indicator Species.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 5) Retain or promote biological diversity
Objective WF10 - Maintain at least 150,000 acres of 50-150 year old oak and pine-oak forest in MPs 3.0 and 6.1 to meet habitat needs for	1) Maintain, restore, or enhance ecosystem resiliency

wild turkey, a Management Indicator Species.	2) Promote carbon sequestration 5) Retain or promote biological diversity
Objective WF11 - Maintain at least 20,000 acres of mid-late and late successional (>80 years old) spruce forest to provide optimum habitat for West Virginia northern flying squirrel, a Management Indicator Species. The long-term objective is to increase mid-late and late successional spruce forest to at least 40,000 acres.	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration 5) Retain or promote biological diversity
Objective WF12 - Maintain at least 560 miles of coldwater stream habitat capable of supporting wild, naturally producing brook trout, a Management Indicator Species.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions
Standard WF13 - For management actions that have been identified by the Forest Service as likely to cause a negative effect on RFSS or Birds of Conservation Concern populations, negative effects shall be avoided or minimized to the maximum extent practical while still accomplishing the purpose of the project or action. Unavoidable negative effects shall be mitigated to the extent practical and consistent with the project purpose.	5) Retain or promote biological diversity
Standard WF14 - For protection of cold water fisheries, apply the following to the channel buffers of perennial trout streams (stocked and native) during the period of October 1 to June 1: a) Potential sediment-producing ground disturbance exceeding two consecutive days shall only be initiated after consultation with a Forest fisheries biologist. b) Potential sediment-producing ground disturbance allowed during this period shall employ additional erosion control measures, seeding or mulching, applied concurrently with the activity.	1) Maintain, restore, or enhance ecosystem resiliency 3) Promote air or water quality, cooler temperatures, moister conditions

Forest Plan Monitoring and Climate Change

This table displays monitoring items in the Forest Plan Monitoring Matrix (Chapter IV) and how they are connected to beneficial effects related to climate change *(facilitated adaptation)*.

Monitoring Item Number and Description	Connection to Climate Change
3. Are insect and disease populations compatible with objectives for restoring or maintaining healthy forest conditions?	1) Maintain, restore, or enhance ecosystem resiliency
4. To what extent is the Forest managing undesirable occurrences of fire, insect and disease outbreaks through prevention, suppression, and integrated pest management?	1) Maintain, restore, or enhance ecosystem resiliency
6. Are the effects of Forest management, including prescriptions, resulting in significant changes to productivity of the land?	1) Maintain, restore, or enhance ecosystem resiliency
7. Are harvested lands adequately restocked after five years?	1) Maintain, restore, or enhance ecosystem resiliency
9. How much even-aged management (especially clearcutting) should be used, and in what forest types should it be used?	1) Maintain, restore, or enhance ecosystem resiliency 2) Promote carbon sequestration
10. To what extent is Forest management moving toward desired habitat conditions for MIS and species associated with MIS habitats?	5) Retain or promote biodiversity
11. To what extent is Forest management contributing or responding to air pollution effects on ecosystems and visibility?	3) Promote air quality
12. Are Air Quality Related Values of the Dolly Sods and Otter Creek Wildernesses improving over current adversely affected levels?	3) Promote air quality
13. What are the trends in ambient air pollutant concentrations near the Forest?	3) Promote air quality
16. How, where, and to what extent is prescribed fire being used to mimic natural processes, or maintain/improve vegetation conditions, or restore natural processes and functions to fire-adapted ecosystems?	1) Maintain, restore, or enhance ecosystem resiliency
31. Is soil detrimental disturbance associated with land management activities below the 15% soil productivity loss threshold?	1) Maintain, restore, or enhance ecosystem resiliency
32. Is acid deposition affecting soil productivity loss and if so, is it affecting land sustainability?	1) Maintain, restore, or enhance ecosystem resiliency
34. To what extent is the Forest providing a range of vegetative communities that address diverse public interests and needs while contributing to ecosystem sustainability and biological diversity?	1) Maintain, restore, or enhance ecosystem resiliency 5) Retain or promote biodiversity
35. To what extent are Forest management, natural disturbances, and subsequent recovery processes changing vegetation composition and structure?	1) Maintain, restore, or enhance ecosystem resiliency
37. Are non-native invasive plants located and treated to prevent or limit further spread?	3) Reduce or prevent NNIS est. and spread
38. To what extent is Forest management contributing to the protection and recovery of threatened and endangered species?	5) Retain or promote biodiversity
39. To what extent is Forest management contributing to the conservation of sensitive species and maintaining or restoring their habitat conditions?	5) Retain or promote biodiversity
40. To what extent are Forest management and other external influences, such as acid deposition, beneficially or adversely affecting water quality or quantity?	1) Maintain, restore, or enhance ecosystem resiliency
43. To what extent is Forest management influencing the viability of native and desired non-native species, or otherwise affecting species composition and habitat productivity?	5) Retain or promote biodiversity
44. To what extent is management on Forest lands influencing populations of terrestrial or aquatic non-native species that threaten native ecosystems?	3) Reduce or prevent NNIS est. and spread