ANALYSIS OF THE OZARK-ST. FRANCIS NATIONAL FORESTS REVISED LAND AND RESOURCE MANAGEMENT PLAN AND ANNUAL MONITORING REPORTS COMPATIBILITY WITH THE 2012 PLANNING RULE

The 2012 Planning Rule was effective May 9, 2012. Most provisions are applicable only when forests revise or amend land and resource management plans. However, for the monitoring requirements – the rule states that the responsible official shall "modify the plan monitoring program within 4 years of the effective date of this part, or as soon as practicable, to meet the requirements of this section" (36 CFR 219.12(c)(1)).

The purpose of this document is to provide an evaluation for transition of forest plan monitoring programs to meet the requirements of the 2012 Planning Rule (36 CFR 219.12).

Meeting the §219.12(a)(5) Monitoring Requirements

Each of the monitoring requirements from §219.12(a)(5) are *italicized* below, along with factors that were considered in determining if the existing forest monitoring plan addresses that requirement, or if any changes or additions may need to be made to meet that requirement.

(i) The status of select watershed conditions.

Watershed Condition

The Forests monitor the status of selected watershed conditions as required by the Forest Service Watershed Condition Framework (WCF) Implementation Guide dated November 12, 2010. The WCF is used nationally and ranks each 6th level Hydrologic Unit Code (HUC) watershed as either Functioning Properly, Functioning at Risk, or Impaired Function based on the 12 indicators listed below and described in the Watershed Condition Classification Technical Guide dated July 2011.

Aquatic Physical Indicators

1. Water Quality
2. Water Quantity
3. Aquatic Habitat

Aquatic Biological Indicators

4. Aquatic Biota
5. Riparian/Wetland Vegetation

Terrestrial Physical Indicators

6. Roads and Trails
7. Soils

Terrestrial Biological Indicators

8. Fire Regime or Wildfire
9. Forest Cover
10. Rangeland Vegetation
11. Terrestrial Invasive Species
12. Forest Health

Classification results are recorded in the Watershed Assessment and Classification Tracking Tool (WCATT) database.

(ii) The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems.

Terrestrial Systems

The following terrestrial systems are currently monitored and reported on:

MAJOR FOREST COMMUNITIES

DRY OAK FOREST AND WOODLAND - APPROXIMATELY 358,382 ACRES

Key Factor - Prescribed Fire

Vegetation Management

Key Factor - Abundance of Mature Forest (>70 years)
The desired level is over 50% in mature condition.

Key Factor - Abundance of Mature Woodland (>70 years)
Forest Service databases track stands over 70 years old that were thinned in this community type. These treatments help produce the desired woodland condition. In addition to stands thinned by timber sales, many stands in this community are "thinned" by severe ice storms or other natural events.

Key Factor - Abundance of Old Growth Condition (110+)
Plan direction is to maintain around 25% of this community in old growth conditions.

Key Factor - Abundance of Regenerating Forest (0 - 10 years)
Plan direction is to maintain at least 6% of this community in the 0-10 year age class.

Key Factor - Abundance of Regenerating and Young Forest Combined (0 – 40 years)
The desired amount of regenerating and young forest in this community type is around 25% with around 6% being in the 0 – 10-year age range.

Key Factor - Abundance of Mid-Aged and Mature Forest that is in Open Canopy Condition (>40 years; 61 – 80 BA)
The desired amount of mid-aged and mature forest in this community type that is in an open forest condition is around 30-40%

SHORTLEAF PINE-OAK FOREST AND WOODLAND - APPROXIMATELY 297,409 ACRES

The difference in Pine-Oak Forest and Pine-Oak Woodland is the density of the trees. Pine-Oak Forest has a high density of trees with canopy closures of 80% - 100%. Pine Woodland has tree densities with canopy closure of less than 80%.

Key Factor - Abundance of Regenerating Forest

Desired condition for this community, as listed in the Revised Land and Resource Management Plan (RLRMP), is to have at least 8% in regeneration (0 - 10 years old).

Key Factor - Prescribed Fire

The amount of burning in this community to maintain desired conditions is the 20 - 30% level.

The desired fire return interval in this community is two to five years.

SHORTLEAF PINE OAK WOODLAND (267,861 ACRES)

Key Factor - Prescribed Fire

The amount of burning in this community to maintain desired conditions is the 20 - 30% level.

The desired fire return interval in this community is two to five years.

Vegetation Management

Key Factor - Abundance of Mature Forest (>70 years)
The desired level is over 40% in mature condition.

Key Factor - Abundance of Old Growth Condition (110+)

The desired amount of stand acres of ages over 110 years old is about 15% of this community type. To satisfy all old growth requirements, increased rates of burning in this community will be needed.

Key Factor - Abundance of Regenerating Forest (0 - 10 years)
Desired levels of regeneration in this community type are around 8%.

Key Factor - Abundance of Regenerating and Young Forest Combined (0 – 40 years)

The desired level of 0 – 40-year age class is between 30% - 35%.

Key Factor - Abundance of Mid-Aged and Mature Forest that is in Open Canopy Condition (>40 years; 61 – 80 BA)

The desired condition is that most stand acres 40 years old or older in this community type are in a thinned condition.

DRY-MESIC OAK FOREST - APPROXIMATELY 444,518 ACRES

The desired fire return interval in this community is two to seven years.

Vegetation Management

Key Factor - Abundance of Mature Forest (>70 years)

The goal is to have at least half of the community in mature condition.

Key Factor - Abundance of Mature Woodland (>70 years)

The RLRMP lists a desired condition for this community type with most of the mature stands in a thinned condition.

Key Factor - Abundance of Old Growth Condition (110+)

The desired amount of old growth condition for this community type is 20%.

Key Factor - Abundance of Regenerating Forest (0 - 10 years)

The desired level of regenerating forest for this community type (at least 6%).

Key Factor - Abundance of Regenerating and Young Forest Combined (0 – 40 years)

The desired level of 0 – 40-year aged acres is around 25%.

Key Factor - Abundance of Mid-Aged and Mature Forest that is in Open Canopy Condition (>40 years; 61 – 80 BA)

The RLRMP direction is to maintain most of the mid-aged and mature acres of Dry-Mesic Oak Forest Community in a thinned condition.

MESIC HARDWOOD FOREST - 7,000 ACRES

Total abundance of the Mesic Hardwood Forest

The RLRMP states that we should monitor trends in total community acres for this community. There are no known management implications that can be derived from this item. Since the acres in this community type are static, it is recommended that this monitoring item be dropped.

RIPARIAN FOREST – APPROXIMATELY 11,484 ACRES

No new acres have been identified to add to this community. Information gathered for this report came from the Forest Service Activity Tracking System (FACTS) and age class distribution came from the Ozark NF GIS database.

Management Implications and Recommendations
Identify any stands that qualify for moving to this community as they are found.

LOESS SLOPE FOREST COMMUNITY - APPROXIMATELY 16,484 ACRES

Vegetation Management

Key Factor - Abundance of Mature Forest (>70 years)
The desired level of mature forest in this community is around 60%.

Key Factor - Abundance of Old Growth Condition (110+)
The desired level of old growth condition for this community type is 15%.

Key Factor - Abundance of Regenerating Forest (0 - 10 years)
The desired level of 0 – 10-year age class is at least 5

Key Factor - Abundance of Regenerating and Young Forest Combined (0 – 40 years)
The desired level of regenerating and young forest is about 20%.

Key Factor - Abundance of Mid-Aged and Mature Forest that is in Open Canopy Condition (>40 years; 61 – 80 BA)
Thinning is important to promote growth of overstory and understory as well as to promote oak regeneration. Forest managers should provide thinned conditions on a continuous basis in this community.

Key Factor - Prescribed Fire
Burning should be at a 5- to 10-year interval.

BOTTOMLAND AND FLOODPLAIN FOREST - APPROXIMATELY 4,102 ACRES (ADDED STUMPY POINT)

Vegetation Management

Key Factor - Abundance of Mature Forest (>70 years)
The desired condition is to have approximately 65% of this community in mature condition.

Key Factor - Abundance of Regenerating Forest (0 - 10 years)
The desired condition is to have approximately 5% of this community in regenerating condition.

Key Factor - Abundance of regenerating and young forest combined (0 – 40 years)

Desired condition in regeneration and young forest for this community type is approximately 20%.

Key Factor - Abundance of Old Growth Condition (110+)

Desired condition in Old Growth Condition is approximately 33-47%.

Rare and Special Communities

Rare and special communities are monitored to report their current known extent on the forests and treatment acres to maintain the community. Communities tracked include:

- **GLADES AND BARRENS**
- **MONTANE OAK FOREST**
- **SINKHOLE AND DEPRESSION PONDS**
- **SEEPS AND FENS**
- **CANEBRAKES**
- **CAVES, MINES, AND KARST**
- **EMERGENT WETLANDS**
- **NATIVE GRASSLANDS**
- **BOTTOMLAND DEPRESSION**

Aquatic Systems

Aquatic

The current monitoring plan calls for monitoring two MIS species for aquatic communities which are smallmouth bass (streams) and largemouth bass (lakes). Smallmouth bass are monitored during stream surveys to determine the relative abundance of that species in relation to the other species. Largemouth bass are monitored for overall abundance as well as proportional stock density and relative weights to look at the overall health of the largemouth bass population within the lakes on the Forest. All of this is also matched with stream surveys across the Forest that measure relative abundance of all stream fish species and those numbers are used to determine an index of biotic integrity (IBI) score for each stream that is scored based on the ecoregion that the stream is within. This measures the overall health of the aquatic ecosystem.

The monitoring plan also measures the aquatic habitat health and what the Forest is doing to maintain and improve the habitat by looking at the number of stream miles and lake acres improved each year. This includes the miles of stream that large wood was added to meet the desired conditions in the Forest plan versus the number of miles that were inventoried each year that are not meeting those desired conditions. The monitoring plan measures the number of road crossings that were replaced each year to allow for aquatic passage versus the number of crossings that were inventoried each year and found to not allow for passage of aquatic organisms.

These terrestrial and aquatic system monitoring items certainly meet the intent of the 2012 Planning Rule.

(iii) The status of focal species to assess the ecological conditions required under § 219.9.

Focal species are to meet the following criteria:

1) the species population changes reflect direct effects of management,
2) the species has been found to occur on the Forests,
3) the species population is possible and practical to monitor,
4) the species is relatively habitat specific to represent the biological community for which it was selected,
5) the species is not rare or poorly distributed to adequately reflect management effects,
6) the species is not redundant with other indicators, and
7) the relationship between population changes and habitat condition are relatively well correlated.

FOREST MANAGEMENT INDICATOR SPECIES (MIS)

TERRESTRIAL MANAGEMENT INDICATOR SPECIES

The current monitoring plan utilizes bird species and game species as Terrestrial Management Indicator Species (TMIS). These species have been monitored to measure the effects from changing ecological community conditions on their populations. It is recommended that current MIS species, except for whitetail deer and black bear, be adopted as Focal Species. This is due to the effects of hunting on deer and bear.

Table 1: Analysis of Management Indicator Species (MIS) Species Suitability as Focal Species on the Ozark-St. Francis National Forests (OSFNFs).

MIS	Primary Reason(s) for Selection	Suitable Focal Species
Rufous-crowned Sparrow	To indicate effects of management on maintaining viability of this species through active maintenance of glades along bluff-lines on Mt. Magazine.	Yes
Pileated Woodpecker	To help indicate effects of management on large snags and snag-dependent wildlife on both forests.	Yes
Scarlet Tanager	To help indicate effects of management on forest interior bird communities and mature Dry-Mesic Oak Forest communities on the Ozark NF.	Yes
Acadian Flycatcher	To help indicate effects of management on forest interior bird communities on the St. Francis NF, and on mature mesic hardwood forest communities on both forests.	Yes
Prairie Warbler	To help indicate effects of management on regenerating forest communities on the Ozark NF.	Yes
Yellow-breasted Chat	To help indicate effects of management on regenerating forest communities on the St. Francis NF.	Yes
Cerulean Warbler	To help indicate effects of management on communities associated with mature hardwood forest with complex canopy structures, and dry-mesic oak Forest communities on the Ozark NF.	Yes
Northern Parula	To help indicate effects of management on communities associated with forests in riparian areas.	Yes
White-tail Deer	To help indicate management effects on meeting hunting demand for this species.	No
Wild Turkey	To help indicate management effects on meeting needs of species that need a mix of habitat conditions.	Yes
Black Bear	To help indicate management effects on meeting hunting demand for this species.	No
Largemouth Bass	To help indicate effects of management on warm water rivers and lakes.	Yes
Smallmouth Bass	To help indicate effects of management species, needing cool-water stream communities.	Yes
Northern Bobwhite	To help indicate effects of management on restoration of pine and oak woodland and native grasslands	Yes
Red-headed Woodpecker	To help indicate effects of management on oak woodland overstories.	Yes
Brown-headed Nuthatch	To help indicate effects of management on open pine forest and woodland.	Yes
Ovenbird	To help indicate effects of management on dry-mesic oak forests.	Yes

AQUATIC MANAGEMENT INDICATOR SPECIES (MIS)

Within the RLRMP, largemouth bass were included as a MIS for the sole purpose of monitoring conditions of lakes and ponds on the Forests. Smallmouth bass were chosen as a MIS species to monitor the effect of management activities on a stream-dwelling species.

LARGEMOUTH BASS

For largemouth bass the following items are tracked:

- Relative weights compared to ideal weight
- Proportional Stock Density
- Relative Stock Density

SMALLMOUTH BASS

For smallmouth bass the following items are tracked:

- Relative abundance
- Large woody debris (LWD) in streams
- Sediment inputs
- Road crossing/fish passage barrier replacement
- Road closing and/or road obliteration in riparian areas
- Cane restoration in riparian areas
- Trash cleanups in riparian areas

Monitoring of these items meets the requirements of the 2012 Planning Rule.

(iv) The status of a select set of the ecological conditions required under § 219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

"Species of Conservation Concern" (SCC) is a new category of species that did not exist before the 2012 Planning Rule. An SCC is defined as a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area.

At present the Regional Forester's Sensitive Species list covers several species that would qualify as species of conservation Concern. In addition, a viability assessment was completed in developing the current RLRMP. It evaluated species of viability concern. Special needs of these species were identified and provisions for providing the needs were incorporated into the RLRMP. See Appendix D in Appendices to the Final Environmental Impact Statement for the RLRMP.

With respect to addressing SCCs in this monitoring requirement during this transition period – A forest does not need to identify its SCCs at this time. Species of Conservation Concern will be identified during the plan revision process. For the purposes of this transition, identify any existing monitoring questions/indicators related to the ecological conditions of "at-risk" species, and then identify, which (if any) of those at-risk species being monitored will likely become "Species of Conservation Concern" when that list is developed. (Don't need to have a complete listing here, just need a few examples to show that you are monitoring the ecological conditions for such-and-such species, and these species are likely to be identified as SCCs.)

THREATENED, ENDANGERED, AND SENSITIVE (TES) SPECIES

The Forests monitor ecological conditions and species trends for Threatened/Endangered (T/E) species as well as Regional Forester's sensitive species. This is done in cooperation with U.S. Fish and Wildlife Service and Arkansas Game and Fish Commission. The bat species are managed through cave protection as well as the creation of feeding habitat and upland water sources on the Forests. These items are also tracked. The mussel species are monitored through monitoring best management practices on the Forests that protect stream conditions as well as monitoring fish community health. Open habitat created each year on the Mt. Magazine Ranger District is tracked as improvement of habitat for the American burying beetle. Species monitoring of American burying beetle is also conducted within the American Burying Beetle Area (ABBA).

Several T&E species have never been found on the Forests but suitable habitat exists for the species. Other T&E species have been found in close enough proximity to the Forests for activities on the Forests to potentially have an effect on these species. Inventories are done for these species before projects are completed and trends in the overall population of these species are monitored outside the Forest by other agencies.

Trends in Regional Forester's sensitive species populations are assessed during each assessment period. The habitat for these species is also assessed. Management Indicator Species are monitored both by the Forest and by our partners to determine trends in populations.
The following are some specifics on T&E and Sensitive Species on the Ozark-St-Francis NFs.

VASCULAR PLANTS

Ouachita False Indigo (*Amorpha ouachitensis*) (Regional Forester's Sensitive)
Bush's Poppymallow (*Callirhoe bushi*) (Regional Forester's Sensitive)
Ozark Chinquapin (*Castanea pumila* var. *ozarkensis*) (Regional Forester's Sensitive)
Southern Lady's Slipper (*Cypripedium kentuckiense*) (Regional Forester's Sensitive)
Moore's Delphinium (*Delphinium newtonianum*) (Regional Forester's Sensitive)
Glade Larkspur (*Delphinium treleasei*) (Regional Forester's Sensitive)
French's Shooting Star (*Dodecatheon frenchii*) (Regional Forester's Sensitive)
Gulf Pipewort (*Eriocaulon koernickianum*) (Regional Forester's Sensitive)
Large Witchalder (*Fothergilla major*) (Regional Forester's Sensitive)
Butternut (*Juglans cinerea*) (Regional Forester's Sensitive)
Alabama Snow-Wreath (*Neviusia alabamensis*) (Regional Forester's Sensitive)

Maple-Leaf Oak (*Quercus acerifolia*) (Regional Forester's Sensitive)
Bay Starvine (*Schisandra glabra*) (Regional Forester's Sensitive)
Blue Ridge Catchfly (*Silene ovata*) (Regional Forester's Sensitive)
Royal Catchfly (*Silene regia*) (Regional Forester's Sensitive)
Ozark Spiderwort (*Tradescantia ozarkana*) (Regional Forester's Sensitive)
Ozark Least Trillium (*Trillium pusillum var. ozarkanum*) (Regional Forester's Sensitive**)**
Ozark Cornsalad (*Valerianella ozarkana*) (Regional Forester's Sensitive)

SNAILS

Magazine Mountain Shagreen (*Mesodon magazinensis*) (Regional Forester's Sensitive)

INSECTS/ISOPODS

American Burying Beetle (*Nicrophorus americanus*) (Endangered)
Neoarctic Paduneillian Caddisfly (*Paduniella nearctic)* (Regional Forester's Sensitive)

CRAYFISH

William's Crayfish-(*Orconectes williams)* (Regional Forester's Sensitive)

Mussels

Rabbitsfoot (Threatened)

FISH

Pallid Sturgeon (Endangered)
Ozark Shiner (Regional Forester's Sensitive)
Longnose Darter (Regional Forester's Sensitive)
Southern Cavefish (Regional Forester's Sensitive)

AMPHIBIANS

Oklahoma Salamander (Regional Forester's Sensitive)

Reptiles

American Alligator (Threatened)

BIRDS

Interior Least Tern (*Sterna antillarum athalassos*) (Endangered)
Bald Eagle (*Haliaeetus leucocephalus*) (Regional Forester's Sensitive)
Bachman's Sparrow (*Aimophila aestivalis*) (Regional Forester's Sensitive)

BATS

Gray Bat (*Myotis grisescens*) (Endangered)
Indiana Myotis (*Myotis sodalist*) (Endangered)
Ozark Big-Eared Bat (*Corynorhinus townsendii ingens*) (Endangered)
Eastern Small-Footed Bat (*Myotis leibii*) (Regional Forester's Sensitive)

(v) The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Currently, the Forest Plan primarily uses visitor satisfaction in a recreation area as a major monitoring component we evaluate. The Forest Service Region Eight (8) 20/20 vision and sustainability evaluations processes address ways to evaluate sites for current and future recreation opportunities and needs. Lastly, scenic character is addressed and monitored by implementing Limits of Acceptable Change (LAC), Outstanding Remarkable Values (ORVs), Recreation Opportunity Spectrum (ROS) classes, Scenic Integrity Objectives (SIOs), all of which are monitored on a continuing basis as projects are initiated and completed. Additionally, steps have been taken to measure demographic and visitor satisfaction through National surveys and specific visitation (NVUM) site, road, and trail counters, and recreation trends analysis Limits of Acceptable Change (LAC).

The major indicator(s) that Transition Guidance asked to address were the following indicators:

- Indicator(s): Population and Demographics, Racial and Ethnic Composition, Population Growth, Density, and Change, Poverty, Social Vulnerability.
- Indicators(s): Jobs and Income, Personal Income, Forest Expenditures and Employment, and Payments to States and Counties.

On page 1-43 through 1-48, 2-34, 2-39, 2-44, 2-46, 2-48, 2-50, 2-52 through 2-56, G-1 through G-5 of the Forest Plan it requires the Forests to monitor:

- The number of recreation sites maintained to standard and occupancy/use rates
- Facility condition and maintenance
- Visitor satisfaction
- Public Health and safety
- Evaluate trends and visitor satisfaction every five years (currently through NVUM)
- Report Management projects that affected/maintained/achieved SIOs and monitor those projects
- Report annual miles of OHV roads and trails used
- Annually review OHV management plans
- Review strategy and designations every 3-5 years
- Limits of Acceptable Change (LAC) in wildernesses
- Visitor use in wild sections (Wild & Scenic Rivers)
- Changes in Outstanding Remarkable Values (ORVs)
- Completion of management plans in Special Interest Areas (SIAs)
- Recreation Opportunity Spectrum (ROS) & Scenic Integrity Objectives (SIOs)

The databases used to track this information are INFRA, NVUM, and MVUM. The information is also reported in the Annual Monitoring and Evaluation Reports.

THE ANNUAL MONITORING REPORT TRACKS

RECREATION AND VISUAL MANAGEMENT

SCENIC BYWAY

- **Plans Completed**
- **Byway Areas**

WILD AND SCENIC RIVERS

- **Plans Revised**
- **Change in Outstandingly Remarkable Values**
- **Use Trend Changes**
- **Visitor Satisfaction**

WILDERNESS AREAS

- **Non-Native Invasive Species (NNIS) Inventoried**
- **Non-native Invasive Species (NNIS) Treated**
- **Old Roads Reverting Back to Natural**
- **Resource Damage Monitored Using Limits of Acceptable Change**

OZARK HIGHLANDS TRAIL (OHT)

- **Miles of Trail Maintenance**

EXPERIMENTAL FORESTS

- **Research Projects Developed**
- **Data Collected or Analyzed**
- **Management Implications and Recommendations**

SPECIAL INTEREST AREAS

- **Management Plans Completed**
- **Use Trends**

RESEARCH NATURAL AREAS

- **Research Natural Area Plan Priority**

STATE PARKS

- **Visitor Satisfaction Related to the Partnership**.
- **Public Health and Safety through Permit**

DEVELOPED RECREATION AREAS

- **Visitor Satisfaction**

PUBLIC HEALTH AND SAFETY

- **All recreation sites are inspected annually before each major recreation season (March/April).**
- **Rotary Ann Rest Stop on Arkansas Scenic 7 Byway continues to provide the only free FS public restroom facilities along the length of Arkansas Highway 7.**

RLRMP RECREATION PRIORITIES THAT ARE TRACKED IN THE ANNUAL MONITORING REPORT

WILDERNESS

Priority One - Protect and manage wilderness to improve the capability to sustain a desired range of benefits and value so that changes in ecosystems are primarily a consequence of natural processes. Protect and manage the areas recommended for wilderness designation to maintain their wilderness values.

Priority Two - Update all wilderness management plans, including monitoring components, wilderness education, and restoration needs. Original plans were signed in 1990.

Priority Three - Prohibit mining claim locations under the General Mining Law of 1872 in Designated Wildernesses. (MA 1.A)

DESIGNATED WILD AND SCENIC RIVER

Priority One - Manage designated wild and scenic river sections to perpetuate their free-flowing condition and designated classifications, and to protect and enhance their outstandingly remarkable values and water quality.

Priority Two - Manage designated wild and scenic rivers in accordance with their Comprehensive River Management Plan.

Priority Three - Review public access needs.

Priority Four - Prohibit mining claim locations under the General Mining Law of 1872 in designated wild sections of the Designated Wild and Scenic Rivers.

EXPERIMENTAL FOREST

Priority One - Protect and manage experimental forests to maintain them as a resource to be used to develop and disseminate scientific knowledge and silvicultural techniques needed to provide a full range of benefits to the OSFNFs and other Southern forests.

Priority Two - Continue to cooperate and assist the Southern Research Station to provide forest managers research data related to timber harvest, ecosystem management, prescribed burning, soil, water, and other related forestry and wildlife management activities**.**

RESEARCH NATURAL AREA

Priority One - Protect and manage research natural areas to maintain natural processes. Identify a sufficient range of opportunities to meet research needs. Compatible uses and management activities are allowed.

SPECIAL INTEREST AREA

Priority One - Protect and manage each special interest area (SIA) for its unique qualities and features. Allow uses and management activities, including access, that complement or are subordinate to the unique qualities and features.

Priority Two - Within the planning cycle, develop management plans and monitoring protocols for existing SIAs. Management plans for SIAs will be developed before implementing project work.

SCENIC BYWAY CORRIDOR

Priority One - Preserve view-shed quality when accomplishing other resource activities.

Priority Two - Develop public view points and interpretive opportunities.

Priority Three - Promote and manage the scenic byways within the Forests for the traveling public and the benefit of local communities.

Priority Four - Work toward state or national scenic byway designation for all byways.

Priority Five – All scenic byways are managed as a scenic byway management area with standards specified in the Forest Plan.

OZARK HIGHLANDS TRAIL (OHT) CORRIDOR

Priority One - Maintain a forest trail system across the Ozark NF.

Priority Two - Manage the Ozark Highlands Trail to protect the trail experience, and to provide for the conservation and enjoyment of its nationally important scenic, historic, natural, and cultural qualities.

STATE PARKS

Priority One - Work with the state parks to provide interpretive information about forest management activities.

DEVELOPED RECREATION AREA

Priority One - Supply a variety of recreational facilities that are responsive to user demands.

Priority Two - Operate developed recreation sites including campsites and picnic areas. Activities included in this endeavor are trash collecting, cleaning, maintaining equipment, monitoring water systems, and other activities associated with keeping the facilities clean, safe, and in good repair. These will continue to be managed utilizing meaningful measures standards or the appropriate Agency standards while stressing health and safety.

Priority Three - Focus investments and improve the cost effectiveness of operating recreational facilities by using one or more of the following techniques where feasible: decommissioning underused sites, maintaining concessionaire agreements, entering into management partnerships, and investigating other measures.

Priority Four - Focus developed recreation on the niche statement written during the recreation alignment process, which emphasizes water related day-use activities, scenic and wildlife viewing, and trail activities such as hiking, biking, horseback riding, and off-highway vehicle (OHV) riding. Overnight facilities will only be developed in support of the niche activities.

UPPER BUFFALO DISPERSED RECREATION AREA

Priority One - Maintain semi-primitive non-motorized management of activities.

WEDINGTON UNIT URBAN RECREATION AREA

Priority One – Provide urban recreation opportunities.

INDIAN CREEK DISPERSED RECREATION AREA

Priority One - Provide a combination of semi-primitive, non-motorized, and motorized management activities.

Priority Two - Maintain two major motorized routes through the Indian Creek Dispersed Recreation Area as the primary access with secondary routes supporting dispersed recreation opportunities. This includes access to trailheads for horseback riding, hiking, biking, and rock climbing activities, local historic points of interest, interpretive opportunities, and administrative uses including timber harvest for forest health. Development of motorized recreation opportunities will not be a priority in this area although they will exist due to motorized access to other recreational opportunities.

Priority Three - Determine where motorized access will be allowed by considering support of dispersed recreation activities; disturbance of solitude of large blocks of land; public health and safety; forest health; and local economic and administrative considerations.

Priority Four - The Forests' Trails Strategy Team will consider motorized opportunities in this area utilizing roads and trails developed for access to other dispersed recreation opportunities.

(vi) Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.

Climate Change

In addressing this monitoring requirement there will be both a broader-scale monitoring approach, and a forest-level monitoring approach. At the broader-scale, the Region and Southern Research Station (SRS) are involved in using climate projections and monitoring climate trends to aid in determining the effects of climate change on national forests. TACCIMO, Southern Forest Futures and CCAMMO are key resources that are being used. The R8 Broad-scale Monitoring Strategy addresses monitoring questions and indicators related to climate change that are relevant to multiple plan areas.

Best available science justification from broad-scale monitoring strategy climate change questions

Tables 2 through 4 present analysis of best available science supporting the development of broad-scale monitoring questions and associated indicators related to climate change. The Region's Broad-scale Monitoring Strategy is intended to be adaptive to new issues and changing information over time. Accordingly, it should be expected that the potential indicators identified here and the best available science supporting them will change based on the ongoing development and implementation of the Broad-scale Monitoring Strategy.

Table 2. Best Available Science Justification for Climate Monitoring Question.

Question	How has climate variability changed and how is it projected to change across the region?
Potential Indicator(s)	(1) Climate extremes, (2) Precipitation and temperature, (3) Trends in sea level rise and land cover changes, (4) Water balance
Requirement	(vi) Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.
References	Biasutti, M., Sobel, A. H., Camargo, S. J., & Creyts, T. T. (2011). Projected changes in the physical climate of the Gulf Coast and Caribbean. Climatic Change, 112(3-4), 819–845. doi:10.1007/s10584-011-0254-y Brooks, H. E. (2013). Severe thunderstorms and climate change. Atmospheric Research, 123, 129–138. doi:10.1016/j.atmosres.2012.04.002 Coopersmith, E. J., Minsker, B. S., & Sivapalan, M. (2014). Patterns of regional hydroclimatic shifts: An analysis of changing hydrologic regimes. Water Resour. Res., 50(3), 1960–1983. doi:10.1002/2012wr013320 Craft, C. B. (2012). Tidal freshwater forest accretion does not keep pace with sea level rise. Global Change Biology, 18(12), 3615–3623. doi:10.1111/gcb.12009 Jiang, X., & Yang, Z. (2012). Projected changes of temperature and precipitation in Texas from downscaled global climate models. Clim. Res., 53(3), 229–244. doi:10.3354/cr01093 Karl, T. R., Melillo, J. M., & Peterson, T. C. (2009). Global climate change impacts in the United States. New York, NY, USA: Cambridge University Press. Dai, Z., Amatya, D. M., Sun, G., Trettin, C. C., Li, C., & Li, H. (2011). Climate Variability and Its Impact on Forest Hydrology on South Carolina Coastal Plain, USA. Atmosphere, 2(4), 330–357. doi:10.3390/atmos2030330 Laseter, S. H., Ford, C. R., Vose, J. M., & Swift, L. W. (2012). Long-term temperature and precipitation trends at the Coweeta Hydrologic Laboratory, Otto, North Carolina, USA. Hydrology Research, 43(6), 890. doi:10.2166/nh.2012.067 Chen, G., Tian, H., Zhang, C., Liu, M., Ren, W., Zhu, W., Lockaby, G. B. (2012). Drought in the Southern United States over the 20th century: variability and its impacts on terrestrial ecosystem productivity and carbon storage. Climatic Change, 114(2), 379–397. doi:10.1007/s10584-012-0410-z Lockaby, G., Nagy, C., Vose, J. M., Ford, C. R., Sun, G., McNulty, S., Caldwell, P., Cohen, E., Moore Myers, J. Forests and Water (2013) In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures

	Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Marion, D., Sun, G., Caldwell, P., Miniat, C., Ouyang, Y., Amatya, D., Trettin, C. (2013). Managing Forest Water Quantity and Quality under Climate Change. Climate Change Adaptation and Mitigation Management Options, 249–306. doi:10.1201/b15613-10 McNulty, S., Moore Myers, J., Caldwell, P., Sun, G. Climate Change Summary (2013) In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Walls, S. C. (2009). The role of climate in the dynamics of a hybrid zone in Appalachian salamanders. Global Change Biology, 15(8), 1903–1910. doi:10.1111/j.1365-2486.2009.01867.x
Indicator Rationale	(1) Climate variability and extremes, including climate related disturbance, directly influence ecosystems and management. (2) Spatial and temporal patterns of precipitation and temperature are key long-term system drivers that influence landscape ecosystem dynamics. Temperature and precipitation patterns also influence management activities (e.g., prescribed burning). (3) Coastal forests in the region, especially those systems that are hydrologically influenced by the ocean, are expected to experience sea-level rise related impacts. (4) Water balance accounts the interactions of temperature and precipitation as well as the cumulative influences of these parameters overtime. Products like the NOAA's Palmer Drought Severity Index (PDSI) provide important insight into water balance and soil moisture conditions that are meaningful to assessing ecosystem conditions.
Accurate	(1) Climate extremes are routinely measured and evaluated based on historic, current, and projected conditions (e.g., NOAA's U.S. Climate Extreme's Index) with adequate accuracy to evaluate regional and subregional conditions and trends. (2) Temperature and precipitation are the most widely used variables used variable for measuring and evaluating historic and future trends in climate. With respect to future projections, there is more confidence in temperature than precipitation. (3) Sea-level rise is measured with accuracy sufficient to detect subtle, but long-term trends (e.g., NOAA - Tides and Currents: Sea Level Rise Trends). More challenging, however, is the geomorphological processes that control land-cover change driven my sea-level rise. (4) Water-balance is sufficiently accurate for routine evaluation of moisture stress in the context of historic, current, and future conditions.
Reliable	Information considered in the development of this monitoring question and associated indicators is based on analysis of findings from peer reviewed scientific literature available from in the Template for Assessing Climate Change Impacts and Managements Options (TACCIMO).
Relevant	**Sea level rise and land cover changes** **Southern Region**: Sea-level may rise from 0.4 to 2.0 m by the end of the 21st century. If sea level rose 1.5 m it is estimated that ~1.6 million acres of forests could be affected along the Atlantic Coast, ~2.1 million acres of forests could be impacted along the Gulf Coast. When physical processes are considered by the coastal vulnerability index, along the Atlantic Coast North Carolina and Virginia have the most coastline in the very high-risk class, and along the Gulf Coast, Louisiana and Texas have the most coastline in the very high-risk class (Lockaby et al. 2013). **South Atlantic Coastal Plain:** Tidal forests are early indicators of sea level rise because they are sensitive to saltwater intrusion. Saltwater intrusion at low salinities reduces water use, growth, height and basal area of bald cypress and tupelo gum. Where marsh accretion rates are lower the sea level rise rate, land cover change will results, including forest death and replacement by brackish marsh vegetation or open water (Craft et al. 2009). **Climate extremes** **Southern Region:** While no significant region-wide changes in drought intensity and duration have been found, extreme high rainfall events appear to be increasing, which might imply an increased flooding frequency (Chen et al. 2012). **South Central**: Particularly during summer and fall, it expected that droughts could become more common (Biasutti et al. 2011). **Southern Appalachian**: In addition to more intense precipitation, recent climate patterns trend toward more frequent periods of prolonged drought. Drought severity is increasing (Laseter et al. 2012).

	Temperature
	Southern Region: Air temperature across the South is projected to increase significantly from historical and current levels (McNulty et al. 2013). **South Atlantic:** Temperatures have increased at a rate of 0.26 °C per decade on the Santee Experimental Forest, South Carolina since 1946 (Dai et al. 2011). **Southern Appalachian**: The mean annual air temperature at the Coweeta Laboratory [North Carolina] keeps rising; from 1998 to 2007, the mean of the annual mean was 14.0 °C, 1.2 °C above the long-term (73 years) mean (Walls 2009). **South Central:** Simulations all show more warming in summer than in winter. Surface air temperatures are projected to increase by 2.30°C on an annual basis, and 2.49°C and 1.92°C for summers and winters during the period 2040−2069 (Jiang et al. 2012).
	Precipitation
	Southern Region: Precipitation predictions are better agreement than those of previous climate model assessments, results are divergent for the remainder of the Southeast (Karl et al. 2009), except for indications that the amount of rainfall from individual hurricanes may increase (Gutowski et al., 2008). **South Atlantic:** Spring and summer rainfall is projected to decline in South Florida during this century (Karl et al. 2009). **South Central**: Overall variability has increased since 1980, especially during the winter months (Coopersmith et al. 2014). **Southern Appalachian:** Modeled future precipitation out to year 2050 were significantly different from the mean of observed conditions. Projections range from warmer and drier conditions with increased drought frequency to wetter conditions frequency of extreme wet years increasing (Marion et al. 2013).
	Water balance
	Southern Region: Because higher temperatures lead to more evaporation of moisture from soils and water loss from plants, moisture stress is expected to increase (Karl et al. 2009).

Table 3: Best Available Science Justification for Climate Effects Monitoring Question.

Question	**How is climate variability and change influencing the ecological, social, cultural, and economic conditions and contributions provided by national forests in the region?**
Potential Indicator(s)	(1) Jobs and Income & Recreation user satisfaction, (2), Non-native invasive plant species, (3) Phenology, (4) Wildfire and prescribed fire, (5) Trends in forest health status and risk
Requirement	(vi) Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.
References	Bowker, J., Askew, A., Poudyal, N., Zarnoch, S., Seymour, L., & Cordell, H. (2013). Climate Change and Outdoor Recreation Participation in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 421–450. doi:10.1201/b15613-13 Conner, R. N., Saenz, D., Schaefer, R. R., McCormick, J. R., Rudolph, D. C., & Burt, D. B. (2005). Rainfall, El Niño, and Reproduction of Red-cockaded Woodpeckers. Southeastern Naturalist, 4(2), 347–354. doi:10.1656/1528-7092(2005)004(0347:renaro)2.0.co;2 Duehl, A. J., Koch, F. H., & Hain, F. P. (2011). Southern pine beetle regional outbreaks modeled on landscape, climate and infestation history. Forest Ecology and Management, 261(3), 473–479. doi:10.1016/j.foreco.2010.10.032 Firth, L. B., Knights, A. M., & Bell, S. S. (2011). Air temperature and winter mortality: Implications for the persistence of the invasive mussel, Perna viridis in the intertidal zone of the south-eastern United States. Journal of Experimental Marine Biology and Ecology, 400(1-2), 250–256. doi:10.1016/j.jembe.2011.02.007 Friedenberg, N. A., Sarkar, S., Kouchoukos, N., Billings, R. F., & Ayres, M. P. (2008). Temperature Extremes, Density Dependence, and Southern Pine Beetle (Coleoptera: Curculionidae) Population Dynamics in East Texas. Environmental Entomology, 37(3), 650–659. doi:10.1093/ee/37.3.650 Gramling, J. M. (2010). Potential Effects of Laurel Wilt on the Flora of North America. Southeastern Naturalist, 9(4), 827–836. doi:10.1656/058.009.0417

	Gunderson, C. A., Edwards, N. T., Walker, A. V., O'Hara, K. H., Campion, C. M., & Hanson, P. J. (2012). Forest phenology and a warmer climate - growing season extension in relation to climatic provenance. Global Change Biology, 18(6), 2008–2025. doi:10.1111/j.1365-2486.2011.02632.x Koch, F. H., & Smith, W. D. (2008). Spatio-Temporal Analysis of *Xyleborus glabratus* (Coleoptera: Circulionidae: Scolytinae) Invasion in Eastern U.S. Forests. Environmental Entomology, 37(2), 442–452. doi:10.1603/0046-225x(2008)37(442:saoxgc)2.0.co;2 Liu, Y., L. Goodrick, S., & A. Stanturf, J. (2013). Future U.S. wildfire potential trends projected using a dynamically downscaled climate change scenario. Forest Ecology and Management, 294, 120–135. doi:10.1016/j.foreco.2012.06.049 Liu, Y., Prestemon, J., Goodrick, S., Holmes, T., Stanturf, J., Vose, J., & Sun, G. (2013). Future Wildfire Trends, Impacts, and Mitigation Options in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 85–126. doi:10.1201/b15613-6 Nuckolls, A. E., Wurzburger, N., Ford, C. R., Hendrick, R. L., Vose, J. M., & Kloeppel, B. D. (2008). Hemlock Declines Rapidly with Hemlock Woolly Adelgid Infestation: Impacts on the Carbon Cycle of Southern Appalachian Forests. Ecosystems, 12(2), 179–190. doi:10.1007/s10021-008-9215-3 Park, I. W., & Schwartz, M. D. (2014). Long-term herbarium records reveal temperature-dependent changes in flowering phenology in the southeastern USA. International Journal of Biometeorology, 59(3), 347–355. doi:10.1007/s00484-014-0846-0 Pattison, R. R., & Mack, R. N. (2008). Environmental constraints on the invasion of Triadica sebifera in the eastern United States: an experimental field assessment. Oecologia, 158(4), 591–602. doi:10.1007/s00442-008-1187-7 Olatinwo, R., Guo, Q., Fei, S., Otrosina, W., Klepzig, K., & Streett, D. (2013). Climate-Induced Changes in Vulnerability to Biological Threats in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 127–172. doi:10.1201/b15613-7 Stanturf, J., and Goodrick, S. L. (2013) Fire. In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Todd, B. D., Scott, D. E., Pechmann, J. H. K., & Gibbons, J. W. (2010). Climate change correlates with rapid delays and advancements in reproductive timing in an amphibian community. Proceedings of the Royal Society B: Biological Sciences, 278(1715), 2191–2197. doi:10.1098/rspb.2010.1768 Zhang, C., Tian, H., Wang, Y., Zeng, T., & Liu, Y. (2010). Predicting response of fuel load to future changes in climate and atmospheric composition in the Southern United States. Forest Ecology and Management, 260(4), 556–564. doi:10.1016/j.foreco.2010.05.012
Indicator Rationale	(1) The social, cultural, and economic contributions that national forests make to their plan areas are commonly measured in terms of jobs and income and recreation user satisfaction, both of which are influenced directly and indirectly by climate. (2) Non-native invasive plant species, some of which are already problematic, are expected to shift ranges in response to changing temperature and precipitation patterns. (3) Changes in phenology of plants and animals is a useful measure of how changing climate is influencing ecological systems and their management. (4) The conditions that contribute to wildfire and the ability to conduct prescribed fire are directly influenced by climate at short- and long-term time scales. (5) Factors influencing forest health, including insects and disease, are often driven by climate and some are expected to change as temperature and precipitation patterns change.
Accurate	(1) Social, cultural, and economic sustainability are often analyzed in terms of jobs and income using economic impact and contribution analysis (e.g., IMPLAN, National Forest Economic Contributions), which is sufficiently accurate for comparing alternatives during plan development and for monitoring plan implementation. Recreation use and satisfaction available through National Visitor Use Monitoring can help identify (2) Non-native invasive species (NNIS) already pose management challenges and responding to these challenges may be helped or hindered by changing climate. (3) There are a variety of sources of information on phenology based on both observed and remotely sensed responses plant and wildlife to the timing of seasonal changes (e.g., National Phenology Network, USFS ForWarn) that provide insight into the ecological implications of changing climate.

	(4) Prescribed fire and wildfire indicators are among the most commonly tracked and reported on indicators and are available in centralized database (e.g., FACTS, Monitoring Trends in Burn Severity (MTBS)) that represent both observed and remotely sensed information with known methods and data quality. (5) Forest health is tracked for the purpose of evaluating current conditions and trends in risk. Key sources of information that are designed to be accurate and relevant for this purpose include Forest Pest Conditions, National Insect and Disease Risk Map available from the Forest Service Forest Health Technology Enterprise Team (FHTET), and the Early Detection & Distribution Mapping System available from University of Georgia - Center For Invasive Species and Ecosystem Health.
Reliable	Information considered in the development of this monitoring question and associated indicators are based on analysis of findings from peer reviewed scientific literature available in the Template for Assessing Climate Change Impacts and Managements Options (TACCIMO).
Relevant	**Non-native invasive species (NNIS)** **Southern Region:** Garlic mustard (Alliaria petiolata) is projected to shift northward by 2060, limiting suitable habit in the region to the Southern Appalachians (Olatinwo et al. 2013). Cogongrass (Imperata cylindrical) is favored by a warming climate with predictions that potential habitat for cogongrass will cover the majority of the South in (Olatinwo et al. 2013). Kudzu (Pueraria lobata) habitats are predicted to contract, with a notable shift to the northeast likely by 2060 (Olatinwo et al. 2013). Chinese privet (Ligustrum sinense Lour.) is predicted to contract to upper portions of the South (Olatinwo et al. 2013). Chinese tallowtree (Triadica sebifera) may shift its range into the central portion by 2020 and into the central–northern portion by 2060, rendering the currently invaded areas as unsuitable (Olatinwo et al. 2013) **Forest health** **Southern Region:** Southern pine beetles (Dendroctonus frontalis) are expected to maintain a considerable suitable habitat from, with a slight northern shift (Olatinwo et al. 2013). Change in the frequency of extreme precipitation and temperature patters could alter population dynamics, ecological feedbacks, and leave pines more vulnerable to increased southern pine beetle activity (Olatinwo et al. 2013; Duehl et al. 2011; Friedenberg et al. 2008). Gypsy moth (Lymantrai dispar) range will may extend northward as a result of climate change (Olatinwo et al. 2013). Emerald ash borer (Agrilus planipennis) is predicted to be significantly larger in 2020 compared to 2060 (Olatinwo et al. 2013). Annosus root disease (Heterobasidion annosum, Fomes annosus) suitable habitat is expected to cover most of the South (Olatinwo et al. 2013). Sirex woodwasp (Sirex noctilio) is predicted to see a northward expansion in suitable habitat (Olatinwo et al. 2013). Fusiform rust (Cronartium quorum f. sp. fusiforme) will likely extend throughout most of the region with a few unsuitable habitats below the south limit (Olatinwo et al. 2013). **Coastal Plain:** Redbay ambrosia beetle (Xyleborus glabratus) may see a range expansion throughout the coastal plain. Laurel wilt (Raffaelea lauricola) may see range expansion during the winter and contraction from the western portion of the region by mid-century (Olatinwo et al. 2013). **Southern Appalachian**: Hemlock wooly adelgid populations may grow as a result for less frequent occurrence of severe winter temperatures in the southern Appalachians (Nuckolls et al. 2008; Olatinwo et al. 2013). **Indicator(s): Wildfire & Prescribed fire** **Southern Region:** Fire potential is expected to increase in the South as the result of climate change with seasonal subregional differences across the region. The length of fire seasons is likely to increase by a few months. Projected fire potential is unlikely to increase significantly until 2030–2040. (Liu et al. 2013). Actual burned areas for a specific landscape would not necessarily increase, due to interactions with landcover change and sources of ignition (Liu et al. 2013). Fuels may increase or decrease depending on temperature and precipitation patterns, among other factors, with current expectations supporting a future decrease in the western areas of the region and increase in the eastern areas (Liu et al. 2013; Zhang et al. 2010). **Indicator(s): Jobs and Income & Recreation use and satisfaction** **Southern Region:** While overall demand for recreation is expected to increase due to population growth, climate change is expected to have negative consequences for day hiking, horseback riding, off-road driving, nonmotorized water activities, and fishing. Hunting forecasts remain largely unchanged (Bowker et al. 2013) **Indicator(s): Phenology**

	Southern Region: Migratory bird phenology is changing as a result of climate change for certain species (Todd et al. 2010). Egg laying and reproductive success of red-cockaded woodpeckers is also responsive to climate variability (Conner et al. 2005). Plant phenology (e.g., bud break, flowering, and senescence) has been shown to change as the result of temperature change (Gunderson et al. 2012; Park et al. 2014).

Table 4: Best Available Science Justification for Carbon Monitoring Question.

Question	**What effect do national forests in the region have on a changing climate?**
Potential Indicator(s)	(1) Carbon Stocks and Trends, (2) greenhouse gas emissions
Requirement	(vi) Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.
References	Dale, V. H., Lannom, K. O., Tharp, M. L., Hodges, D. G., & Fogel, J. (2009). Effects of climate change, land-use change, and invasive species on the ecology of the Cumberland forests. Can. J. For. Res., 39(2), 467–480. doi:10.1139/x08-172 Remucal, J. M., McGee, J. D., Fehrenbacher, M. M., Best, C., & Mitchell, R. J. (2013). Application of the Climate Action Reserve's Forest Project Protocol to a Longleaf Pine Forest under Restoration Management. Journal of Forestry, 111(1), 59–66. doi:10.5849/jof.11-094 Song, X., Tian, H., Xu, X., Hui, D., Chen, G., Sommers, G., Liu, M. (2013). Projecting terrestrial carbon sequestration of the southeastern United States in the 21st century. Ecosphere, 4(7), art88. doi:10.1890/es12-00398.1 Wang, F., Xu, Y. J., & Dean, T. J. (2011). Projecting Climate Change Effects on Forest Net Primary Productivity in Subtropical Louisiana, USA. AMBIO, 40(5), 506–520. doi:10.1007/s13280-011-0135-7
Indicator Rationale	(1) Tracking trends in carbon stocks and fluxes at appropriate temporal and geographic scales provides insight into how implementation of the forest plan is contributing to rates of carbon sequestration and the subsequent lifecycle of harvested forest products as one of many ecosystem services provided by the forest. (2) Maintaining awareness of greenhouse gas emissions from all aspects of forest plan implementation, including management activities, operations, and development of multiple-uses, are important to evaluating the contributions of forest plan implementation to climate change at relevant and meaningful scales.
Accurate	(1) Changes is carbon stocks and fluxes are derived analysis of Forest Inventory and Analysis (FIA), which provides acceptable precision and accuracy for evaluating rends in carbon at scales relevant to the question. (2) Greenhouse gas emissions estimates are becoming increasingly standardized. Operational emissions will be available from the GSA Carbon Footprint Tool. The information needed to address emissions related to oil and gas developer are available from U.S. Energy Information Administration, the USDA - ERS - Oil and Gas Production by County, and the EPA - Facility Level Information on GreenHouse gases Tool (FLIGHT). When these sources are evaluated together, a complete emissions picture can be presented that is sufficiently accurate to gauge current emissions and change over time.
Reliable	Information considered in the development of this monitoring question and associated is based on analysis of findings from peer reviewed scientific literature available from in the Template for Assessing Climate Change Impacts and Managements Options (TACCIMO). Indicators related to greenhouse gas emissions were selected from reliable sources with published and available methodologies from GSA, USDA, and EPA.
Relevant	**Indicator(s): Carbon stocks and fluxes** **R8: Southern**: Since forests account for more than half of the land area, the largest potentials for carbon sequestration in Southeastern United States may continuously serve as a strong carbon sink in the 21st century, though the carbon sink strength is projected to decrease (Song et al. 2013). **Southern Appalachian:** Resulting from slower growth and species composition change, total carbon stocks and productivity may decline in the Cumberland Mountains and Plateau (Dale et al. 2009). **South Central:** In the Gulf Coast, carbon sequestration is projected to increase through mid-century (Wang et al. 2011). **South Atlantic and South Central:** The resulting changes in forest structure associated with longleaf pine restoration may result in reduced overall productivity and carbon stocks, but a more resilient landscape (Remucal et al. 2013). **Indicator(s): Greenhouse gas emissions**

	As part of Executive Order 13514, which calls on Federal agencies and departments to increase sustainability and energy-efficiency, agencies are required to report and reduce greenhouse gas pollution to meet energy, water, and waste reduction targets. Greenhouse gas emissions serve as a useful metric to measure the effectiveness of agency energy and fuel efficiency efforts as well as renewable energy investments.

The Ozark-St. Francis National Forests monitor many aspects of the Forests that may be affected by a changing climate. The category, indicator monitored, and supporting science linking the monitoring to climate change are included in Table 5.

Table 5: Category, Indicator Monitored, and Supporting Science Linking the Monitoring to Climate Change.

CATEGORY	INDICATOR	SUPPORTING SCIENCE
Amphibians	Oklahoma Salamander	Blaustein, A. R., Walls, S. C., Bancroft, B. A., Lawler, J. J., Searle, C. L., & Gervasi, S. S. (2010). Direct and Indirect Effects of Climate Change on Amphibian Populations. Diversity, 2(2), 281–313. doi:10.3390/d2020281
Birds	Bachman's Sparrow (*Aimophila aestivalis*), Bald Eagle, Eastern small-footed bat, gray bat, Indiana bat, Interior Least Tern (*Sterna antillarum athalassos*), Ozark Big-Eared Bat (*Corynorhinus townsendii ingens*)	Matthews, S. N., O'Connor, R. J., Iverson, L. R., & Prasad, A. M. (2004). Atlas of climate change effects in 150 bird species of the Eastern United States (General Technical Report NE-318). Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 1-46.
Dry Oak Forest and Woodland	Early-successional habitats, late-successional habitats, mature forest (>70 years), mature woodland (>70 years), mid-aged and mature forest that is in open canopy condition (>40 years; 61 – 80 BA), mid-successional condition, Old growth, Prescribed fire, regenerating and young forest combined (0 – 40 years), regenerating forest (0 – 10-years), Vegetation Management Treatments	Liu, Y., Prestemon, J., Goodrick, S., Holmes, T., Stanturf, J., Vose, J., & Sun, G. (2013). Future Wildfire Trends, Impacts, and Mitigation Options in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 85–126. doi:10.1201/b15613-6 Olatinwo, R., Guo, Q., Fei, S., Otrosina, W., Klepzig, K., & Streett, D. (2013). Climate-Induced Changes in Vulnerability to Biological Threats in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 127–172. doi:10.1201/b15613-7 Stanturf, J., and Goodrick, S. L. (2013) Fire. In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station Ames, G. M., Vineyard, D. L., Anderson, S. M., & Wright, J. P. (2015). Annual growth in longleaf (Pinus palustris) and pond pine (P. serotina) in the Sandhills of North Carolina is driven by interactions between fire and climate. Forest Ecology and Management, 340, 1–8. doi:10.1016/j.foreco.2014.12.020

Table 5 (Continued): Category, Indicator Monitored, and Supporting Science Linking the Monitoring to Climate Change.

CATEGORY	INDICATOR	SUPPORTING SCIENCE
Fire	Communities at Risk, Fire Regime Condition Class (FRCC), Firewise Communities, Native American Firefighter Program, Smoke and Prescribed Burning, Wildland Urban Interface (WUI), Wildfire, Wyden Amendment and Stevens Act	Liu, Y., L. Goodrick, S., & A. Stanturf, J. (2013). Future U.S. wildfire potential trends projected using a dynamically downscaled climate change scenario. Forest Ecology and Management, 294, 120–135. doi:10.1016/j.foreco.2012.06.049 Liu, Y., Prestemon, J., Goodrick, S., Holmes, T., Stanturf, J., Vose, J., & Sun, G. (2013). Future Wildfire Trends, Impacts, and Mitigation Options in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 85–126. doi:10.1201/b15613-6 Zhang, C., Tian, H., Wang, Y., Zeng, T., & Liu, Y. (2010). Predicting response of fuel load to future changes in climate and atmospheric composition in the Southern United States. Forest Ecology and Management, 260(4), 556–564. doi:10.1016/j.foreco.2010.05.012
Management Indicator Species (MIS)	Acadian flycatcher, black bear, Bobwhite quail, Brown-headed Nuthatch, Cerulean Warbler, eastern wild turkey, Largemouth Bass, Northern Parula, ovenbird, pileated woodpecker, prairie warbler, Rufous crowned Sparrow, scarlet tanager, Smallmouth Bass, white-tailed deer, Yellow-breasted chat	Lusk, J. J., Guthery, F. S., & DeMaso, S. J. (2001). Northern bobwhite (Colinus virginianus) abundance in relation to yearly weather and long-term climate patterns. Ecological Modelling, 146(1-3), 3–15. doi:10.1016/s0304-3800(01)00292-7 Brittain, R. A., & Craft, C. B. (2011). Effects of Sea-Level Rise and Anthropogenic Development on Priority Bird Species Habitats in Coastal Georgia, USA. Environmental Management, 49(2), 473–482. doi:10.1007/s00267-011-9761-x Whitledge, G. W., Rabeni, C. F., Annis, G., & Sowa, S. P. (2006). RIPARIAN SHADING AND GROUNDWATER ENHANCE GROWTH POTENTIAL FOR SMALLMOUTH BASS IN OZARK STREAMS. Ecological Applications, 16(4), 1461–1473. doi:10.1890/1051-0761(2006)016[1461:rsageg]2.0.co;2 Brown, D. R., Sherry, T. W., & Harris, J. (2011). Hurricane Katrina impacts the breeding bird community in a bottomland hardwood forest of the Pearl River basin, Louisiana. Forest Ecology and Management, 261(1), 111–119. doi:10.1016/j.foreco.2010.09.038
Shortleaf Pine-Oak Forest and Woodland	Early-successional habitats, late-successional habitats, mature forest (>70 years), mature woodland (>70 years), mid-aged and mature forest that is in open canopy condition (>40 years; 61 – 80 BA), mid-successional condition, Old growth, Prescribed fire, regenerating and young forest combined (0 – 40 years), regenerating forest (0 – 10-years)	Liu, Y., Prestemon, J., Goodrick, S., Holmes, T., Stanturf, J., Vose, J., & Sun, G. (2013). Future Wildfire Trends, Impacts, and Mitigation Options in the Southern United States. Climate Change Adaptation and Mitigation Management Options, 85–126. doi:10.1201/b15613-6 Stanturf, J., and Goodrick, S. L. (2013) Fire. In, Wear, D. N., Greis, J. G., eds. The Southern Forest Futures Project. General Technical Report SRS-GTR-178. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station Ames, G. M., Vineyard, D. L., Anderson, S. M., & Wright, J. P. (2015). Annual growth in longleaf (Pinus palustris) and pond pine (P. serotina) in the Sandhills of North Carolina is driven by interactions between fire and climate. Forest Ecology and Management, 340, 1–8. doi:10.1016/j.foreco.2014.12.020

Natural Gas Wells

Parts of the Ozark-St. Francis National Forests are underlain by the Fayetteville Shale or Basham Sandstone. These geologic layers are natural gas bearing units that are drilled by private industry for gas production. Initially, air rotary drilling techniques are used to reach the proper depth to set surface casing. During air drilling, gasses, including the greenhouse gas, Methane, is often encountered. According to 43 CFR 3160, any such gasses encountered in wells being drilled on federal lands are required to be flared if they cannot be discharged into a collection pipeline. After drilling and during completion of the well, Arkansas Oil and Gas Commission Rule D-12 states that gas can be released for up to seven days but must be flared.

Gas development operations on national forest lands are subject to all state and federal regulations designed to limit air and water pollution.

Locations are monitored by state and federal agencies (i.e. Arkansas Oil/Gas Commission, BLM, USFS) as required.

(vii) Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.

The Forest Plan Annual Monitoring Report has numerous items covering this requirement. This is the primary foundation of the Monitoring and Evaluation Report. These requirements are highlighted throughout this report.

Social and Economic Sustainability

Social, cultural, and economic sustainability is monitored by several sources such as the U.S. Census. Forests generally do not compile and analyze these items on an annual or bi-annual basis, but work with national, regional, state and local information during plan revisions.

Our Regional Office (USFS Region 8) is developing a broad-scale monitoring strategy that is expected to address social, cultural, and economic monitoring. Some potential items that could be included are:

- Economic Effects - Jobs and Income (IMPLAN, National Forest Economic Contributions)
- Employment and Specialization (U.S. Bureau of Labor Statistics, IMPLAN)
- Forest Expenditures and Employment (IMPLAN, Forest Economic Analysis Spreadsheet Tool (FEAST))
- Payments to States and Counties (USFS - Payments and Receipts Reports)
- Personal Income (U.S. Bureau of Economic Analysis)
- Population Change [U.S. Census Bureau, Economic Profile System (EPS)]

- Population Growth and Density (U.S. Census Bureau), Poverty (U.S. Census Bureau)
- Racial and Ethnic Composition [U.S. Census Bureau, Economic Profile System (EPS)]
- Social Vulnerability Index (SVI)

Existing Forest-level Monitoring That May Be Relevant to Social, Cultural, and Economic Sustainability

Forest-level monitoring on specific topics that are relevant to plan implementation may provide additional insight into the implications of social, cultural, and economic sustainability in the plan area. Many forests already monitor relevant topics as they relate to plan implementation. Examples of relevant monitoring question topics include, but are not limited to:

- Ecosystem health and sustainability
- Soil productivity
- Scenery management
- Heritage protection
- Timber production
- Recreation use
- Roads and infrastructure
- Special uses
- Energy and Minerals
- Recreational Fisheries and Wildlife Demand Species
- Land Use and Ownership
- Clear Air and Clean Water

Best Available Science Justification from Broad-Scale Monitoring Strategy Social, Cultural, and Economical Sustainability Question

Table 6 presents analysis of best available science supporting the development of broad-scale monitoring questions and associated indicators related to social, cultural, and, economic sustainability. The Region's Broad-scale Monitoring Strategy is intended to be adaptive to new issues and changing information overtime. Accordingly, it should be expected that the potential indicators identified here and the best available science supporting them will change based on the ongoing development and implementation of the Broad-scale Monitoring Strategy.

Table 6: Best Available Science Justification for Social, Cultural, and Economic Sustainability Monitoring Question.

Question	What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?
Potential Indicator(s)	(1) Jobs and Income, Employment and Specialization, Forest Expenditures and Employment, Payments to States and Counties, Personal Income, (2) Population Change, Population Growth and Density, Poverty, Racial and Ethnic Composition, Social Vulnerability Index (SVI)
Requirement	(vii) Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.
References	Battistich, V., M. Watson, and D. Kim. 1995, Schools as Communities, Poverty Levels of Student Populations, and Students' Attitudes, Motives, and Performance: A Multilevel Analysis, American Educational Research Journal, 32, 627-658. Chung E.K., K.F. McCollum, and I.T. Elo et al. 2004. Maternal depressive symptoms and infant health practices among low-income women. Pediatrics 113(6):e523–9. Farrington, David P. 1995. The Development of Offending and Antisocial Behavior From Childhood: Key Findings from the Cambridge Study in Delinquent Development. Journal of Child Psychology and Psychiatry and Allied Disciplines. Vol. 36, No. 6, 929-964 Frentz,I.C, F.L. Farmer, J.M. Guldin, K.G. Smith. 2004. Public lands and population growth. Society and Natural Resources, 17 (1), pp. 57–68 Haan, M.N., and A.G. Kaplan. 1986. The contribution of socioeconomic position to minority health. In report of the Secretary's Task Force on Black and Minority Health, 2:69-103. Washington D.C.:U.S. Dept of Human Health Services. Hopson, L.M. and E. Lee. 2011. Mitigating the effect of poverty on academic and behavioral outcomes: The role of school climate in middle and high school. Children and Youth Services Review, 33, 2221-2229. Horne, A., & Haynes, R. 1999. Developing Measures of Socioeconomic Resiliency in the Interior Columbia Basin. USDA Forest Service General Technical Report, PNW-GTR- 453. April 1999. Hunter, L. M., Boardman, J. D. and Onge, J. M. S. 2005, The Association Between Natural Amenities, Rural Population Growth, and Long-Term Residents' Economic Weil-Being. Rural Sociology, 70: 452–469. doi: 10.1526/003601105775012714 Johnson, K. M. and C.L. Beale. 1994. The Recent Revival of Widespread Population Growth in Nonmetropolitan Areas of the United States. Rural Sociology. 4:655–67. Johnson, K. M. and C.L. Beale. 1998. The Identification of Recreational Counties in Nonmetropolitan Areas of the U.S.A. Population Research and Policy Review. 17:37–53. McGranahan, David A. 1999. Natural amenities drive rural population change. Agricultural Economic Report no. 781. Washington, DC: Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Section 6.2. Radeloff, V. C., R. B. Hammer, P. R. Voss, A. E. Hagen, D. R.Field, and D. J. Madlenoff. 2001. Human demographic trends and landscape level forest management in the northwest Wisconsin Pine Barrens. Forest Science 47:229–241. Rudzitis G. and R. Johnson 2000. The Impact of Wilderness and Other Wildlands on Local Economies and Regional Development Trends. USDA Forest Service Proceedings RMRS-P-15-VOL-2. Seesholtz, D., Wickwar, D., and Russell, J. (2004). Social Economic Profile Technical Guide.U.S. Department of Agriculture, Forest Service, Inventory Monitoring Institute. Williams, K. 1984. Economic sources of homicide: Reestimating the effects of poverty and inequality. American Sociological Review. Vol. 49, No. 2, Apr. 1984.
Indicator Rationale	The indicators selected represent those which are typically evaluated in an Environmental Impact Statement to gauge differences between alternatives with respect to the contributions of a national forest's contributions to a plan area's social, cultural, and economic sustainability.
Accurate	

Reliable	The indicators selected, the data available to inform them, and the methods used to evaluate them are all based on accepted procedures and techniques based on peer reviewed science (see references).
Relevant	**Indicator(s): Population and Demographics, Racial and Ethnic Composition, Population Growth, Density, and Change, Poverty, Social Vulnerability** **R8: Southern**: Population is an important consideration in managing natural resources. In particular, population structure (size, composition, density, etc.) and population dynamics (how the structure changes over time) are essential to describing the consequences of forest management on the social environment (Seesholtz et al. 2004). Population growth can be an indicator of a region's attractiveness to live and work. The natural, cultural, and social characteristics of an area contribute to greater population growth than areas with fewer natural amenities (Rudzitis and Johansen 1991, Johnson and Beale 1994, Johnson and Beale 1998, McGranahan1999, Hunter et. al 2005, Frentz et. al 2004), and that this growth occurs increasingly at the boundaries of public lands (Radeloff et. al 2001). Population density measures the number of people living per square mile within a given area and can serve as an indicator of the socioeconomic and living conditions of a region (Horne and Haynes 1999). Poverty is an important indicator of both economic and social well-being. Low income is an indication of increased vulnerability to variety of disparities including health, cognitive development, emotional well-being, school achievement and promote socially unacceptable behavior (Williams 1984, Haan et. al 1986, Battistich et. al 1995, Farrington 1995, Chung 2004, Booth and Caan, 2005, and Hopson and Lee 2011). **Indicator(s): Jobs and Income, Personal Income, Forest Expenditures and Employment, & Payments to States and Counties** **R8: Southern**: Personal income is an indicator of the economic well-being of a county and provides a measure of all sources of income within the plan area. High personal income may be a signal of greater job opportunities, highly skilled residents, greater economic resiliency, and well-developed infrastructure; while low personal income is often a reflection of the poor economic conditions and relatively few economic opportunities available within a region. Natural amenities, often provided by public lands, have been found to influence population and employment changes in amenity rich communities (Knapp and Graves 1989, Clark and Hunter 1992, Treyz et al. 1993, Mueser and Graves 1995, McGranahan 1999, Lewis et al. 2002).

(viii) The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 U.S.C. 1604(g)(3)(C)).

The RLRMP considers productivity in several places. Page I-2 of the RLRMP has a table that lists a monitoring need of mandatory monitoring and documentation of the measured prescriptions and effects, including significant changes in productivity of the land.

Page I-7 of the RLRMP includes a table that lists the monitoring elements of annually reporting the level of BMP compliance as a percent of the number of projects investigated. It also annually tracks the acres of watershed restoration/improvement and soil and water conservation projects.

Page I-14 of the RLRMP includes the monitoring element OBJ19 which is to "Conduct watershed improvements on 20 acres per year with a performance indicator of acres treated".

The Updated Ozark-St. Francis NF Aquatic Habitat and Water Quality Inventory and Monitoring Plan includes Soil Disturbance Monitoring as part of the BMP Review Protocol on Page 15.

Soil quality monitoring is done according to guidance found in FSM 2551.6 and General Technical Report RMRS-GTR-WO-82a.

The following Forest-Wide Standards in the RLRMP are included to protect soil productivity: FW01, FW05, FW75, FW78, FW80, FW81, FW82, FW83, FW84, FW85, FW102, FW135, FW137, FW140, FW156, and MA3.J-3. These standards are evaluated during Timber Sale Administrator visits to sales, during timber audits, and during best management practice reviews.

These items show that the RLRMP is clearly in compliance with the 2012 Planning Rule.

List of Preparers

The following individuals contributed to the evaluation of the RLRMP to determine its compliance with the 2012 Planning Rule.

Preparers

Brian Barns	Database Analyst
William Carromero	Forest Botanist/Ecologist
Robert Duggan	Forest Outdoor Recreation Planner
Steve Duzan	Forest Environmental Coordinator
Connie Jankowiak	Minerals and Special Uses Program Manager
David Jurney	Forest Archaeologist
Kathy King	Writer/Editor
Rick Monk	Forest Hydrologist
Len Weeks	Forest Soil Scientist
Keith Whalen	Forest Fisheries Biologist
Teresa Williamson	Deputy Fire Management Officer
Gregg Vickers	Forest Silviculturist
Terry Krasko	Public Services/Planning Staff Officer
Craig McBroome	Technical Services Staff Officer