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Mark Twain
National Forest

September 2005

Final Environmental Impact Statement

To accompany the 2005 Land and Resource Management Plan (2005 Forest Plan)

Mark Twain
National Forest

Abstract

This final environmental impact statement (FEIS) documents analysis of ten alternatives developed for programmatic management of the 1.5 million acres administered by the Mark Twain National Forest. Alternatives 1-5 were analyzed in detail in the draft environmental impact statement (DEIS). Alternative 3 was the Preferred Alternative in the DEIS and was the foundation for the Proposed Forest Plan. Alternative 3 was modified slightly to address comments on the DEIS. This FEIS documents analysis of all alternatives and displays environmental effects at a programmatic level. Alternative 3 is referenced as the "Selected Alternative" in both the FEIS and the Record of Decision that accompanies this FEIS.

The Selected Alternative, outlined as the *Mark Twain National Forest 2005 Land and Resource Management Plan (2005 Forest Plan)*, guides all natural resource management activities on the Forest; addresses new information and concerns raised since the 1986 Plan was published; and meets objectives of federal laws, regulation, and policies. Rationale for choosing the modified Alternative 3 as the Selected Alternative is described in the Record of Decision for this FEIS.

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Photographer: Nancy Feakes, Mark Twain National Forest

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Barry, Bollinger, Boone, Butler, Callaway, Carter, Christian, Crawford, Dent, Douglas, Howell, Iron, Laclede, Madison, Oregon, Ozark, Phelps, Pulaski, Reynolds, Ripley, Saint Francois, Sainte Genevieve, Shannon, Stone, Taney, Texas, Washington, Wayne, and Wright Counties, Missouri.

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Mark Twain
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Summary

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Mark Twain
National Forest

Cover photo: Shortleaf pine woodland, USDA Forest Service

Photographer: Paul Nelson

Summary

Final Environmental Impact Statement

Introduction

This Summary provides an overview of the Final Environmental Impact Statement (FEIS) for revision of the Mark Twain National Forests' Land and Resource Management Plan (Forest Plan).

Two major sources of direction for this effort are the National Forest Management Act and the National Environmental Policy Act. Both provide guidance on the process of revision and the content for analysis. The National Forest Management Act requires an interdisciplinary approach to assure coordination of multiple-uses including outdoor recreation, range, timber, watershed, wildlife and fish, wilderness, sustained yield of products and services. The National Environmental Policy Act requires a systematic decision-making process with public involvement, issue identification, development of alternatives to address issues, and analysis of environmental impacts of alternatives.

The Mark Twain NF Forest Plan has been revised under the planning rule that was adopted in 1982. Generally, Forest Plans are to be revised every 10 to 15 years to address changed conditions and new information. The current Forest Plan for the Mark Twain National Forest was implemented in 1986.

The FEIS states the purpose and need for Plan Revision, discloses a description of the issues to be addressed, the alternatives being considered to respond to the issues, and an analysis of potential environmental effects of each alternative. The FEIS also identifies Alternative 3, with changes, as the Selected Alternative.

The companion document to the FEIS is the 2005 Forest Land and Resource Management Plan (2005 Forest Plan). Forest Plans guide all natural resource management activities and establish management goals and objectives, allocation of lands to different management emphases, and standards and guidelines for Plan implementation. Based on the Selected Alternative, the 2005 Forest Plan describes desired conditions, assigns measurable objectives, provides specific standards and guidelines as to how to achieve the desired conditions, and outlines a program for monitoring and evaluating results of implementation.

The FEIS is divided into the following five chapters:

- Chapter One (Purpose, Need, and Forest Plan Revision Issues) describes the reasons for revising the Forest Plan;
- Chapter Two (Alternatives) describes and compares alternatives for meeting revision goals on the Mark Twain National Forest. The alternatives display a reasonable range of responses to the 8 Forest Plan revision issues described in this chapter;
- Chapter Three describes the Forest's and surrounding area's physical, biological, and social environments and the effects of the alternatives on these environments;
- Chapter Four lists those who participated in preparing the FEIS; and

- Chapter Five lists distribution of FEIS copies to federal, state and local agencies, tribal governments, organizations, businesses, and individuals.

Forest Profile

The Mark Twain National Forest administers approximately 1,485,800 acres in southern Missouri. This constitutes approximately 10% of the forested land and 84% of the publicly owned forested land in Missouri (Resource Bulletin NC-139).

The Forest is composed of nine separate geographic units in 29 counties which span the state 200 miles east to west and 175 miles north to south. Private land parcels are scattered throughout the Forest boundaries. On average, Federal ownership within the boundaries of the National Forest is about 49%, and ranges from a low of 24% at Cedar Creek unit to a high of 71% at Doniphan/Eleven Point unit.

Social and Economic Condition

The relationship between the Mark Twain National Forest and local lifestyles and economies is interdependent and complex. Outdoor recreation, seven Wilderness areas, an exceptional wild and scenic river, and unique ecosystems all provide a stunning backdrop to communities that are growing at a fast pace.

Population and Demographics

Population has grown rapidly in recent decades within the 29 counties with National Forest land. Recent population growth seems to be more strongly associated with counties near metropolitan areas. Overall, the population of the Mark Twain NF area grew an average of 19% from 1990 to 2000. However, the counties that make up the analysis area continue to be the least densely populated areas of the state.

Income and Poverty

For 2001, Missouri's per capita personal income was $28,226, which places it 30th out of 50 states. Per capita income for areas in and near the Forest ranges from a low of $16,009 in Doniphan-Eleven Point area to a high of $23,802 in Cedar Creek. The average Mark Twain NF per capita income is almost $9,000 less than the state average.

The poverty rate is a commonly used indicator of the level of economic need in a community. The Economic Research Service classifies 15 non-metropolitan counties in the Forest area as having "persistent poverty" (high rates of poverty in 1960, 1970, 1980, and 1990). Nearly half of the 26 non-metropolitan counties that contain national forest lands are persistent poverty counties.

Physical and Biological Setting

The Mark Twain lies mostly within the Ozark Highlands, a region long distinguished for its extraordinary geological, hydrological and ecological diversity. Signature features include crystal-clear springs, over 5,000 caves, rocky barren glades, ancient volcanic mountains and nationally recognized streams. The Ozarks have been continuously available for plant and animal life since the late Paleozoic period, constituting perhaps the oldest continuously exposed landmass in North America (Yatskievych 1999).

In the Ozarks, eastern oak hardwood and southern pine woodlands converge with the drier western tallgrass prairie, creating a distinctive array of open grassy woodlands and savannas. This rich mixture of unique, diverse and ecologically complex natural communities provides a high level of habitat diversity. The high level of habitat diversity, influx of biota from divergent regions through thousands of years of climatic events, effects of past glaciation to the north, and extreme antiquity of the landscape have combined to support relict populations and allow for development of at least 160 endemic species.

The Mark Twain National Forest occurs in five of the seven major river basins in the Missouri portion of the Ozark Highlands. Eleven primary streams and rivers course through these basins, portions of which occur within the Mark Twain. Because of the region's karst topography, the Ozarks are home to the world's largest collection of first magnitude springs (those with over 65 million gallons of water flow daily.)

Summary of Final Environmental Impact Statement (FEIS)

Proposed Action

The Forest Service proposes to revise the 1986 Land and Resource Management Plan (1986 Forest Plan) for the Mark Twain National Forest. The revised Forest Plan would be used to guide all natural resource management activities on the Forest to meet the objectives of federal law, regulations, and policy.

Purpose and Need for Forest Plan Revision

The development of the revised Forest Plan and the accompanying environmental impact statement is intended to satisfy regulatory requirements and to address new and changing information about the Forest and its uses.

The National Forest Management Act requires that national forests revise forest plans at least every 15 years (U.S.C. 1604[f][5]). Additional indicators of the need to revise the 1986 Mark Twain Forest Plan are:

- Land conditions and public demands have changed;
- Agency policies and strategic priorities have changed;
- Results of monitoring and evaluation suggest the need for revision;
- New information is available; and
- Those interested in management of the Mark Twain National Forest have made suggestions for changes.

In April 2002, the Forest Supervisor and Regional Forester identified forest plan revision needs in the Assessment of the Need for Change for the Mark Twain National Forest Land and Resource Management Plan. The Assessment discusses the process and information used to develop proposed changes to the Forest Plan.

Revision Topics

The Notice of Intent to Revise the Forest Plan, published in the Federal Register in April 2002, described the revision topics identified by the Assessment of the Need for Change. The revision topics are the focus of this forest plan revision process. They address the central issues and public concerns to which future management of the Mark Twain National Forest must respond. The 2005 Forest Plan and the alternatives were developed to answer questions raised by these revision topics. The revision topics are listed below. They are discussed in more detail in Chapter 1 of the FEIS.

Revision Topic 1 – Vegetation and Timber Management

- Revisit suitable lands determination, revise demand estimations, and rebuild the Allowable Sale Quantity (ASQ) determination based on those changes.
- Provide for adaptive management and greater flexibility of silvicultural techniques in order to maintain oak-hickory, shortleaf pine and oak-pine communities.

Revision Topic 2 – Ecological Sustainability and Ecosystem Health

- Develop management direction for restoring and maintaining healthy forest ecosystems in response to oak decline; providing a healthier balance of shortleaf pine and white oak in what is now a predominantly black and red oak forest; and restoring some of the more open woodland habitats encountered by early settlers.
- Change management direction to allow pine and oak reforestation and stand improvement in a wider variety of situations, so as to encourage natural vegetation most suited to Missouri's natural communities.
- Provide a wide diversity of natural communities and wildlife habitat conditions based on differing landscape capabilities and advanced ecological knowledge.
- Revise list of Management Indicator Species.

Revision Topic 3 – Fire Management

- Develop management direction guiding the use prescribed fire to restore ecosystems, maintain healthy forests, provide wildlife habitat, and reduce hazardous fuels.
- Improve management direction for managing wildland fires to protect life, property, and communities.
- Develop a proactive approach to fire and fuels management so as to improve and maintain forest health and reduce the intensity of wildland fires.

Revision Topic 4 – Management Areas

- Adjust management area boundaries as needed to incorporate ecological landtypes, current social demands, and management practicalities.
- Review management direction to insure protection of Roadless, wilderness, wild, and scenic river values, and other "special areas."
- Evaluate inventoried roadless areas for their potential for Wilderness designation. Determine the most appropriate use and management for inventoried roadless areas not recommended to Congress for Wilderness designation.
- Determine eligibility and highest potential classification for any rivers identified with potential for inclusion in the Nation's wild and scenic river system.

Revision Topic 5 – Riparian Areas and Water Quality

- Provide for the restoration and maintenance of the ecological function of riparian areas, emphasizing the ecological processes that riparian areas play in supporting aquatic systems and water quality.
- Develop clearer definitions and criteria for delineating riparian areas and aquatic ecosystems, based on plant community, soil and hydrologic criteria.
- Develop management direction to protect water quality and ecological processes associated with karst terrain and karst features.

Revision Topic 6 – Threatened, Endangered, and Sensitive Species Viability

- Examine and revise management direction to protect and provide for threatened, endangered and sensitive species.

Revision Topic 7 – Access and Transportation Management

- Clarify, modify, or eliminate road density standards
- Eliminate the Forest Plan Transportation map, and clarify that changes to the road system are project level decisions.
- Clearly state the existing Forest direction for OHV and ATV use of "closed unless posted open." Clarify the relationship among the Forest Plan direction, State law, and the Forest Supervisor's closure order.

Revision Topic 8 – Monitoring and Evaluation

- Revise and improve the strategy for monitoring and evaluation to reflect ecosystem management and ecological sustainability concepts and approaches.
- Focus the monitoring strategy on information that will (1) enhance understanding of resource management issues; (2) is measurable and scientifically supported; and (3) is feasible given probable budgets.

Forest Plan Revision Issues

An issue is a point of debate, dispute, or disagreement regarding anticipated effects of implementing the proposed action. When making programmatic decisions, such as in this Forest Plan revision, issues often are framed as trade-offs between various desired conditions, amounts of products produced, or emphasis in management. For example, providing a diversity of natural communities and wildlife habitat conditions may involve tradeoffs with suitable lands determinations and ASQ. Issues stem from the topics summarized in the "Need for Change in Management Direction" section, and suggest alternative ways of responding to those topics. Public involvement, internal discussion, and analysis were used to identify the issues pertinent to Plan revision.

Response to the need for change (revision topics) and issues is tracked throughout the document by indicators that measure existing conditions and potential effects of management activities. These indicators focus our analysis and demonstrate differences between alternatives. The issues are summarized below. See Chapter 1 for a more complete discussion.

Issue 1 –Timber supply

There is disagreement about how much timber the Mark Twain National Forest can supply without adversely affecting ecosystem health, water quality, and the social and economic needs of people. Forest Plan revision will establish the acreage and location of land that is suitable for timber production. Revision will also determine the maximum level of timber that the Mark Twain NF may supply over time. The key indicators are:

- Average Annual Allowable Sale Quantity (ASQ)

Issue 2 – Ecological Sustainability and Ecosystem Health

There is concern about the effects on local timber markets from increasing the amount of white oak and shortleaf pine to provide for a healthy forest, and providing land dedicated to enhancement and restoration of natural communities. There is also debate about the effects on the forest health from passive management, and from current direction restricting certain silvicultural methods and prescriptions.

Forest Plan revision will establish what, if any, direction for increasing white oak and shortleaf pine will be provided, and how much of the Forest will be allocated to natural community restoration. The Forest Plan revision will also determine what, if any, management direction regarding timber management techniques and practices is needed to provide for forest health. The key indicators are:

- Acres of ground cover meeting desired condition for savanna, woodland and glade
- Acres treated to move towards natural community type
- Acres burned
- Acres thinned

Issue 3 – Wildlife habitat management

There is divergent views about how the Forest should be managed for the full array of wildlife species and habitats, whether rare or common, and what habitats and species should be emphasized. Forest Plan revision will establish goals for the types, amounts, distribution, spatial pattern, and function of wildlife habitats. The key indicators are:

- Acres of natural community savanna, woodland and forest meeting desired condition for old growth natural communities.
- Management Indicator Community trends

Issue 4 – Fire Management

While prescribed fire is needed to reduce hazardous fuels and restore ecosystems, there is concern that increasing the use of prescribed fire will harm forest ecosystems and air quality. Forest Plan revision will determine how, where, and to what extent prescribed fire may be used to mimic natural processes and to restore natural processes and functions to ecosystems, and to reduce fuels. The key indicators are:

- Acres treated to progress toward FRCC 1
- Acres burned to reduce fuels and restore ecosystems

Issue 5 – Economic Sustainability of Local Communities

Forest Plan decisions contribute to economic sustainability by providing for a range of uses, values, products and services. At the same time, Forest plan direction must be consistent with ecological sustainability. Forest Plan revision will determine the mix of uses, values, products, and services that the Mark Twain NF could provide over time. The key indicators are:

- Income and Employment (by Resource Program)
- Income and Employment (by major Industry and Sector)
- Payments to Counties

Resources with No Change in Management Direction

There was no change in management direction for several resource areas under any of the alternatives considered in detail in this FEIS. The 2005 Forest Plan continues the management direction from the 1986 Forest Plan for these resource areas. These resource areas and the reasons for not changing them are summarized in the Assessment of the Need for Change and Notice of Intent that was released in 2002 and in Appendix A – Public Involvement.

Of these issues, the most prominent are:

- Off-road vehicle use
- Minerals management
- Management of candidate Wild & Scenic Rivers
- Management of heritage resources, recreation, fish and aquatic resources

These topics and issues were not addressed in the formulation of alternatives, although they are discussed in the environmental analysis. In general, these topics are either not ripe for decision, have been addressed by recent (and still relevant) decisions, potential alternatives would cause unreasonable environmental harm, or adverse effects are easily limited under any alternative.

Alternative Development

As required by NEPA regulations, alternatives have been developed using an interdisciplinary process. Each alternative has been designed to respond to comments and revision topics in a different way, providing a range of possible management approaches from which to choose. Five alternatives were developed and considered in detail, each with a specific theme and set of management prescription allocations designed to match the theme. Five additional alternatives were considered but were determined to be inappropriate for further analysis. Both groups of alternatives contribute to the NEPA requirement that a reasonable range of alternatives be considered.

Changes between the Draft and Final Environmental Impact Statements

The Forest Service received 1,807 individual responses (including letters, emails, and faxes) on the DEIS and draft Revised Forest Plan. These comments, shifts in agency direction, and correction of errors led to several changes in the draft Revised Forest Plan. The changes range from minor edits and clarifications to changes in the standards and guidelines and monitoring requirements. The following summary describes the changes to standards, guidelines and other areas of the 2005 Forest Plan.

Public comments and Agency review also identified the need for several improvements to the analysis and presentation of materials in the FEIS. As a result, editorial discrepancies, minor inconsistencies, or gaps in the presentation of information in the DEIS have been corrected for the FEIS. These changes are noted in the response to comments.

We received a great deal of public and internal comments on our Draft Environmental Impact Statement (DEIS) and the Draft Revised Plan. Based on the many comments received, I have made several changes to the Draft Revised Forest Plan.

The changes range from minor edits and clarifications to changes in the standards and guidelines and monitoring requirements. The following summary describes the changes to standards, guidelines, and other areas of the Draft Revised Forest Plan.

Management Prescription 1.1 and 1.2

- Changed standards to allow for the construction of wildlife ponds if a long-term species viability concern is demonstrated and that concern cannot be addressed in another location.

- Added direction to clarify that the full range of variable conditions, from regeneration openings to areas exhibiting old growth characteristics, should be provided.

Management Prescription 2.1

- Removed a standard regarding distribution of activities in MP 2.1.

Threatened and Endangered Species

- Added requirements to survey for the presence of mussels prior to in-stream work, and to modify projects if presence confirmed.
- Added standard to prohibit vehicle or equipment use in fens, unless needed to improve Hine's emerald dragonfly habitat.
- Modified direction for Indiana bat maternity colonies. One change provides additional foraging habitat by strengthening designation criteria of maternity colony area and by specifying activities that are restricted within maternity colonies. A second change increases protection of roost trees by timing and activity restrictions around occupied roost trees.
- Added monitoring requirements for existing bat gates on caves.
- Added restrictions on prescribed burn timing near Indiana bat maternity colonies and near caves during swarming / dispersal periods.
- Prohibited core drilling in the 150-acre area designated as old growth around gray or Indiana bat caves.

Wildlife Habitat

- Revised Table 2-2 regarding stocking of trout.
- Moved direction regarding the provision for old growth and regeneration openings in MP 2.1, 6.1 and 6.2 from standards and guidelines to goals and objectives.
- Lowered the percentage of the areas that are desired as regeneration openings in management prescription 2.1 (from 11-20% to 8-15%) and 6.2 (from 3-5% to 1-5%).

Lower Rock Creek Area

- Added a standard prohibiting motorized use in most of Lower Rock Creek.

Temporary Openings

- Changed the definition of a temporary opening created by even-age timber management to specify that the stand remains an opening until the vegetation is 15 feet high (was 10 feet.)

Monitoring and Evaluation

- Changed monitoring requirements for Management Indicator Species (MIS) to focus on the effects of management activities on habitat, rather than on species population.

Editorial Corrections

- Editorial changes were made to correct misspellings, formatting, or to clarify management direction. These corrections did not change the basic intent of that direction.

Alternatives Considered in Detail

Alternatives have many things in common, sharing essential goals, concepts, and policies that all national forests are directed to follow. How they differ from one to another is in the relative emphasis given to particular issues and concerns, which is reflected in management prescription allocations for each alternative.

Alternatives 1 through 4 share forest-wide direction as established in the draft Revised Forest Plan, but do vary by acreage allocated to each management prescription. Alternative 5 is the 1986 Forest Plan, as amended (No Action alternative.) Alternative 3 is identified as the selected alternative for implementing the 2005 Forest Plan.

The five alternatives considered in detail are summarized below. A more complete description can be found in Chapter 2.

Alternative 1

This alternative was designed to respond to those who want to see passive restoration principles implemented, less active management of forest resources, semi-primitive recreation emphasized over timber production, and commercial activities reduced or eliminated.

Emphasis is on minimizing direct human influence. No commercial timber harvest would be allowed. Characteristics of the forest environment, such as vegetation structure and species, would be affected primarily by natural disturbance factors such as insects, disease, fire, and weather events. As a result, wildlife habitat would focus on mature forest, with fewer and smaller areas of early successional habitat. Existing developed recreation areas would remain, but other recreation opportunities would emphasize dispersed recreation like backpacking, hunting, and floating in a semi-primitive, motorized environment. Management is focused on visitor safety, law enforcement, and other custodial elements.

Alternative 2

This alternative was designed in response to those who want Forest management to emphasize maintaining composition, structure and dynamics of native forest ecosystems; aggressively restoring native terrestrial communities, such as glades, savannas, and shortleaf pine forests; and focus on restoration of ecosystems on large regional scales. This alternative provides emphasis and direction to encourage biodiversity and restore sustainable native ecosystems over timber sustainability.

Emphasis is on restoration of underrepresented terrestrial natural communities, while providing forest products and other multiple use benefits. Management activities, such as timber harvest and prescribed fire, would be used to influence ecological processes to attain and sustain a high diversity of habitats and species. A wide range of wildlife habitat is provided by restoring and enhancing terrestrial natural communities, and emulating their historical distribution patterns. A broad range of settings for a variety of recreational opportunities are provided, including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Alternative 3

This alternative was designed in response to those who want to see a balance between restoration of natural communities and production of traditional forest commodities.

Emphasis is on improvement of forest health conditions, production of forest products and other multiple use benefits, and enhancement of terrestrial natural communities. Restoration of terrestrial natural communities is focused in areas that are identified as biologically rich. Management activities, such as timber harvest and prescribed fire, are used to mimic ecological processes to attain and sustain a high diversity of habitats and species. A wide range of wildlife habitat is provided by restoring and enhancing terrestrial natural communities, and emulating their historical distribution patterns. A broad range of settings for a variety of recreational opportunities are provided, including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Alternative 4

This alternative was designed in response to those who want to see the use of traditional forest management and production of forest commodities emphasized over restoration of natural communities.

Emphasis is on ecosystem enhancement while providing utilization of forest resources. Multiple use management is emphasized for a majority of the Forest. Timber and mineral extraction, and other activities such as recreation are likely to influence ecological processes. A wide range of wildlife habitat is provided by emphasizing achievement of early successional and old growth habitat objectives, as well as protection of special habitats. A broad range of settings for a variety of recreational opportunities are provided including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Alternative 5 – No Action

Alternative 5, the no-action alternative, reflects current Forest-wide direction. It meets the NEPA requirement (36 CFR 219.12(f)(7)) that a no-action alternative be considered. 'No action' means that current management allocations, activities, and management direction found in the existing Forest Plan, as amended, would continue. Output levels have been recalculated for this alternative to comply with new information, in particular, new scientific and inventory data.

The 1986 Forest Plan gives strong emphasis to wildlife habitat development; particularly unique or specialized habitats such as caves, springs, seeps, fens, riparian areas, glades and fishless ponds. Timber management is the primary tool for reaching desired vegetative conditions, wildlife habitat objectives, and providing timber products for local industrial and individual needs. The Plan provides a range of settings for a variety of recreational opportunities including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Alternatives Considered but Eliminated from Detailed Study

The following alternatives were considered in the analysis, but were eliminated from further detailed study. A more complete discussion of these alternatives is included in Chapter 2.

- An alternative considering recommendation of all Inventoried Roadless Areas mapped in the Roadless Area Conservation Rule Final Environmental Statement as Wilderness Study Areas
- An Alternative(s) providing off-road, off-trail cross-country use of motorized vehicles by changing the Forest policy of "closed unless posted open."
- An alternative(s) to restrict or prohibit mineral exploration and development within the Forest or within a specific area, such as the Eleven Point River.

- An Alternative(s) where the Standards and Guidelines for resource management are different, either more or less restrictive.
- An Alternative(s) that includes each of the principles and criteria from the “Citizens’ Call for Ecological Forest Restoration: Forest Restoration Principles and Criteria” (Citizens’ Call) as standards in the revised Forest Plan

Effects of the Alternatives

The effects of each of the alternatives on the resources and programs of the Forest are summarized in the following table.

Table 1. Comparison of Alternatives by Effects on Resources or Programs

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Timber Production and Supply	No commercial timber harvest allowed. An estimated 25 MMBF would be cut and left on the ground to accomplish ecosystem restoration activities in MP 1.1 & 1.2, and to meet early successional habitat needs in 6.2. Overstocked conditions would result in stands with smaller trees and more susceptible to insect and disease.	Commercial timber harvest allowed. Has the largest allocation of land in MP 1.1 & 1.2, which would influence the amount and type of timber harvest accomplished. Most harvest would be thinning producing industrial roundwood products. Tree planting is allowed along with timber stand improvement activities to enhance conditions of natural communities.	Commercial timber harvest allowed. Most harvest would be thinning producing industrial roundwood products. Tree planting is allowed along with timber stand improvement activities to enhance conditions of natural communities.	Commercial timber harvest allowed. Has less land allocated to MP 1.1 and 1.2 than Alternatives 2 or 3. More harvests would be for regeneration producing more sawtimber products due to shorter rotation ages. Tree planting is allowed along with timber stand improvement activities to enhance conditions of natural communities.	Commercial timber harvest allowed. Most harvest would be regeneration harvest producing hardwood sawtimber products with more pine trees harvested due to shorter rotation ages. Natural regeneration of trees is emphasized. Some timber stand improvement activities would not be allowed in some portions of the Forest.
Ecological Sustainability and Ecosystem Health	Ecosystem restoration and enhancement allowed only in MP 1.1 & 1.2, and would be accomplished by using mechanical treatments and prescribed fire. An increase in shade and the buildup of leaf litter would reduce current species diversity in most of the Forest.	Timber harvest, along with the use of prescribed fire, would move areas toward more open forest and woodlands. Has the largest allocation of land in MP 1.1 & 1.2, allowing more opportunities for restoration and enhancement of ecosystems.	Timber harvest, along with the use of prescribed fire, would move areas toward more open forest and woodlands. A large variety of management activities would be available to use for restoration and enhancement of ecosystems.	Timber harvest, along with the use of prescribed fire, would move areas toward more open forest and woodlands. Land Allocations would result in smaller scale restoration of open forested natural communities with timber harvest and prescribed fire.	No lands allocated specifically for large scale restoration of natural communities; the least number of acres managed for more open forestland. The forest would look much the same as it does today with dense forested and overstocked lands. Fewer management activities could be used to restore or enhance natural communities.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wildlife Habitat Management	High chance that Bachman's sparrow would be extirpated from Missouri. More MIS, TES, RFSS and other species of concern negatively affected by lack of management and lack of early successional habitats.	High likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.	High likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.	Good likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.	Good likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.
Fire and Fuels Management	Fuels management would only be accomplished without removal of timber products, using mechanical treatments and prescribed fire. Less than five percent of the forest would be treated specifically to move from fire regime condition class 3 to 1. Without removal of fallen trees, high fuel loads would remain in the forest. More frequent catastrophic stand replacing wildland fire could occur.	Fuels management and prescribed fire are used to change fire regime condition class at the highest levels resulting in an increase in an open forest and woodlands and a reduction of fuels within the Urban Wildland Interface. Wildland fires should be easier to suppress and have less erratic behavior within treated areas.	Fuels management and prescribed fire are used to change fire regime condition class are at a high level resulting in an increase in an open forest and woodlands and a reduction of fuels within the Urban Wildland Interface. Wildland fires should be easier to suppress and have less erratic behavior within treated areas.	Fuels management and prescribed fire are used to change fire regime condition class are at a level similar to alternative 1. Though timber harvest is used to remove and reduce fuels within the Urban Wildland Interface. Wildland fires should be easier to suppress and have less erratic behavior within treated areas.	No direction to restore fire dependant natural communities or reduce fuel loading in the forest. The least amount of prescribed fire of any alternative due to current management restrictions. Fewer acres would move to a historical fire regime condition class.

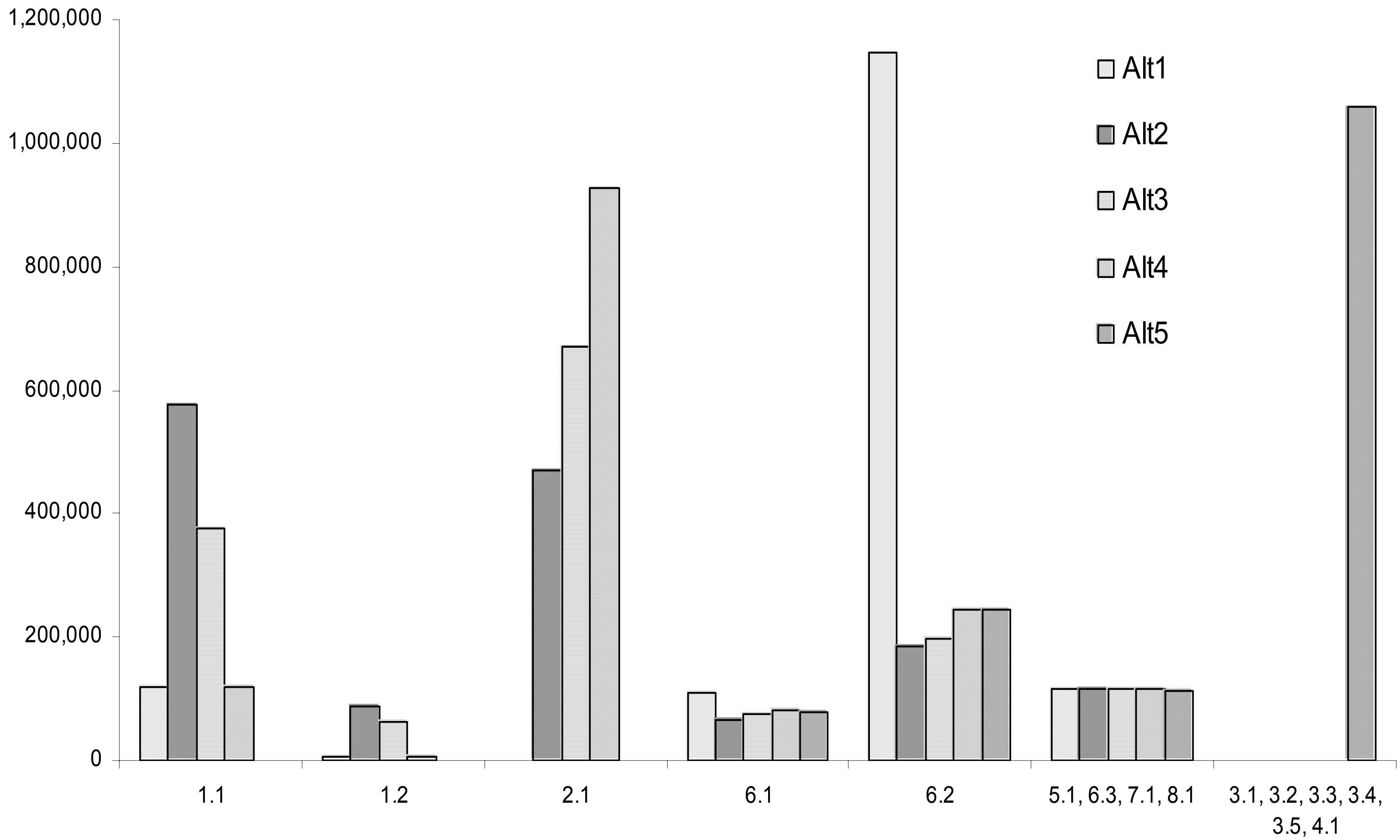
Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Economic and Social Sustainability	Jobs and income resulting from all activities are at the lowest level due to the restriction on commercial timber harvest. Lowest payments made to counties of any alternative.	Jobs and income are the lowest of all management based alternatives. Payments to counties the same for Alternatives 2 through 5.	Jobs and income slightly higher than for Alternative 2. Payments to counties the same for Alternatives 2 through 5.	Jobs and income resulting from all activities are at a level similar to Alternative 5. Payments to counties the same for Alternatives 2 through 5.	Jobs and income resulting from all activities are at the highest level due to an increase in commercial timber harvest and emphasis on sawtimber production. Payments to counties the same for Alternatives 2 through 5.
Management Area Allocations	Minimum land allocation in MP 1.1 and 1.2 considered feasible for restoration of natural communities.	Largest allocation of land in MP 1.1 for 1.2 for large scale restoration of natural communities.	Though less than in Alternative 2, allocation of land in MP 1.1 and 1.2 would allow large scale restoration of natural communities.	Majority of land is allocated to MP 2.1 where timber management is the emphasis. Land allocation in MP 1.1 and 1.2 same as for Alternative 1.	No change from current Forest Plan in management prescriptions or allocations of lands.
Riparian Areas, Water Quality and Soils	Lowest impact on soils due to the least amount of management of any alternative. Due to overall reduction in management as a result of land allocation to semi-primitive areas, the least amount of acres in riparian natural communities would be restored. Areas in riparian or watercourse protection zones are the same for Alternatives 1 through 4.	Soils impacts would be less than in alternative 5 as a result of changed standards and guidelines and differing levels of management activities. The highest amounts of activities to restore riparian communities. Areas in riparian or watercourse protection zones are the same for Alternatives 1 through 4.	Soils impacts would be the same as in Alternative 2. Activities to restore riparian communities between those in Alternatives 2 and 4. Areas in riparian or watercourse protection zones are the same for Alternatives 1 through 4.	Soils impacts would be same as in Alternative 2. The lowest amounts of activities to restore riparian communities. Areas in riparian or watercourse protection zones are the same for Alternatives 1 through 4.	Largest impacts on soils due to highest intensity of timber and other management activities resulting in greater need to temporarily access interior forest areas. No specific direction to restore riparian natural communities. Least amount of acres covered under watercourse management direction.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Recreation	Estimated 15% decrease in dispersed recreation activities, such as hunting, due to reduced access and species diversity.	Estimated 20% increase in dispersed recreation activities as a result of ecosystem restoration and species diversity.	Estimated 10% increase in dispersed recreation activities as a result of ecosystem restoration and species diversity.	No expected change due to management though could change with population demographics.	No expected change due to management though could change with population demographics.
Recreation Opportunity Spectrum	87% of the Forest would be managed for semi-primitive objectives. More solitude would be found in areas with less management.	22% of the Forest would be managed for semi-primitive objectives. More acres are allocated to roaded natural recreation objectives which would provide for more motorized use.	25% of the Forest would be managed for semi-primitive objectives. Acres allocated to roaded natural recreation objectives are similar to Alternative 2.	25% of the Forest would be managed for semi-primitive objectives. Acres are allocated to roaded natural recreation objectives similar to Alternative 2.	29% of the Forest would be managed for semi-primitive objectives. Slightly more acres are allocated to semi-primitive recreation objectives then in alternatives 2 through 4, though motorized use would be at similar levels.
Wilderness Study Areas Roadless	Thirteen areas recommended for Wilderness study.	Thirteen areas recommended for Wilderness study.	Thirteen areas recommended for Wilderness study.	Thirteen areas recommended for Wilderness study.	No areas recommended for Wilderness study.
Wild and Scenic Rivers	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	Current Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. NO additional rivers will be classified.
Heritage Resources	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	Current Forest Plan Standards and Guidelines would protect the heritage resource values.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Access and Transportation Management	In the short-term, roads would become more difficult to travel on due to limited maintenance and reconstruction. In the long-term, many local, dead-end, maintenance level 2 roads would be closed and/or decommissioned, thus limiting motorized travel to a small road network of maintenance level 3 and 4 roads.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.
Rangeland Management	Grazing would be the lowest of all alternatives.	Grazing would be the second lowest of the alternatives, since it would be phased out in MP 1.1 and 1.2 and within riparian areas in an effort to restore glade and riparian natural communities	Grazing would be reduced since it would be phased out in MP 1.1 & 1.2 and within riparian areas.	Grazing would be phased out in MP 1.1 & 1.2 and within riparian areas.	Grazing could continue affecting glade ecosystems and reducing their diversity of species.

Comparison of Alternatives

Comparison of Alternatives by Acres Allocated to Management Prescriptions



Comparison of Alternatives by Key Indicators

Table 2 – Comparison of Alternatives by Key Indicators

Key Indicator	Units	Current Condition	Alternative				
			1	2	3	4	5 No Action
Issue 1 –Timber Supply.							
Average Annual Allowable Sale Quantity (ASQ)	MMBF/year	49*	0	99	103	105	105
Sawtimber Portion (1st Decade)	MMBF/year	38*	0	38.5	43.5	47.5	50
Issue 2 – Ecosystem Sustainability and Ecosystem Health							
Ground cover meeting desired condition for savanna, woodland and glade	Ac/Decade	26,000	35,600	185,500	122,800	35,600	30,000
Acres treated to move towards natural community type	Ac/Decade	<500	17,800	93,300	61,000	17,800	13,000
Acres Burned	Ac/Decade	30,000	73,000	383,000	250,000	73,000	125,000
Acres Thinned	Ac/Decade	<3,000	26,300	143,500	94,500	27,900	<15,000
Issue 3 – Wildlife Habitat Management							
OG Natural Community Types Treated in 1st decade (MP 1.1 and 1.2 only)	Range of Acres	n/a	24,200 to 37,200	125,900 to 193,900	83,400 to 128,400	24,200 to 37,200	0
Natural Community Old Growth in 50 years (MP 1.1 and 1.2 only)	Acres	n/a	5,400	36,700	24,500	12,100	<5,000
Natural Community Old Growth in 100 years(MP 1.1 and 1.2 only)	Acres	n/a	10,800	73,500	49,000	24,200	< 10,000
Early Successional habitat (first decade)	Percent of Forest	2.5%	0.6%	7.3%	7.5%	7.8%	7.5%
Management Indicator community trends	Trends		Slight increase in MP 1.1 and 1.2; Decrease on 77% of Forest	Increase in quantity and quality	Increase in quantity and quality	Slight increase in MP 1.1 and 1.2	No significant change

Key Indicator	Units	Current Condition	Alternative 1	2	3	4	5 No Action
Issue 4 – Fire Management							
Acres treated to progress toward Condition Class 1	% of total available Acres	0.07	0.51	0.59	0.57	0.54	0.57
Area treated with Prescribed Fire	Acres/Year	<17,000	61,630	72,420	68,800	63,700	59,320
Issue 5 – Economic Sustainability of Local Communities							
Potential Jobs as result of Forest Management	Number of jobs	4,795	4,563	4,951	4,990	5,081	5,097
Potential Labor Income as result of Forest Management	Millions of dollars	168.2	160.7	174.6	175.5	177.8	178.1
Payments to counties based on 25% funds	Millions of dollars	1.4	1.0	2.2	2.3	2.3	2.4
Area in Semi-primitive management	Percent of Forest	34%	87%	25%	25%	29%	26%

**Average annual timber sold, 1986 - 2003*

Comparison of Alternatives by Resource Indicators

Table 3 - Comparison of Alternatives by Resource Indicators

Key Indicator	Units	Current Condition	Alternative 1	2	3	4	5 No Action
Watershed conditions and riparian and aquatic area functioning.							
Total allotment acres of riparian open to grazing	Acres	3,315	1,050	1,780	1,780	1,770	0
Management intensity on sensitive soils	Relativity	Low	Low	Medium	Medium	Medium	Medium-high
Acres potentially moved toward the DC for riparian	Acres	0	12,330	31,300	24,900	12,330	0
Acres in riparian or watercourse management	Acres	65,000	84,500	84,500	84,500	84,500	65,000
Range Management							
Acres of existing allotments available for continued use	Acres	52,092	7,803	10,153	10,820	11,384	20,640
Animal Unit Months supported	AUM	26,635	10,036	22,660	23,102	22,925	26,635

Chapter 1

Purpose, Need, and Forest Plan Revision Issues

Mark Twain
National Forest

Cover image: Flow from Greer Spring

Photographer: Randy Long, Mark Twain National Forest

Chapter 1

Purpose, Need, and Forest Plan Revision Issues

Introduction

This Final Environmental Impact Statement (FEIS) documents the effects of applying alternative ways of managing the Mark Twain National Forest (MTNF). The FEIS reviews the need to change the 1986 Forest Plan as presented in the Notice of Intent published in the Federal Register, (Volume 67, Number 73, Pages 18580-18583) on April 16, 2002. The FEIS presents alternatives to address the need for change, and evaluates the effects of implementing each of the alternatives. The companion document to the FEIS is the 2005 Forest Land and Resource Management Plan (2005 Forest Plan). The 2005 Forest Plan is developed in accordance with the Regional Forester's identified "selected alternative," which is based on public input, legal requirements, and resource needs. Forest Plans guide all natural resource management activities and establish management goals and objectives, allocation of lands to different management emphases, and standards and guidelines for Plan implementation.

The FEIS is divided into the following five chapters:

- Chapter One (Purpose, Need, and Forest Plan Revision Issues) describes the reasons for revising the Forest Plan;
- Chapter Two (Alternatives) describes and compares alternatives for meeting revision goals on the Mark Twain National Forest. The alternatives display a reasonable range of responses to the 8 Forest Plan revision issues described in this chapter;
- Chapter Three describes the Forest's and surrounding area's physical, biological, and social environments and the effects of the alternatives on these environments;
- Chapter Four lists those who participated in preparing the FEIS; and
- Chapter Five lists distribution of FEIS copies to federal, state and local agencies, tribal governments, organizations, businesses, and individuals.

Proposed Action

The Forest Service proposes to revise the 1986 Land and Resource Management Plan (1986 Forest Plan) for the Mark Twain National Forest to address new information and changed conditions outlined in the Purpose and need section below. Current Forest Plan management direction not needing revision will be affirmed by the revised plan. The revised Forest Plan will be used to guide all natural resource management activities on the Forest to meet the objectives of federal law, regulations, and policy.

Decisions Made in the Forest Plan

Forest Plans make six key decisions for managing a National Forest on a landscape scale in the long term. While no project-level decisions are considered during the revision process, the following are decided (36 CFR 219, 1982 regulations):

- Forest-wide multiple use goals and objectives
- Forest-wide management requirements for protecting resources (standards and guidelines)
- Management area direction
- Land suited and not suited for timber management
- Monitoring and evaluation requirements
- Recommendations to Congress, such as Wilderness designations.

In 1986, the management direction in the 1986 Forest Plan was analyzed and disclosed in the Record of Decision and Final EIS. Since that time, 31 non-significant amendments have been analyzed to update the Forest Plan. The most recent amendment was made in August, 2004, and established the Brown's Hollow area of influence for an Indiana bat maternity roost site.

While recognizing the need to change some management direction, revision will also affirm some of the existing management direction in the 1986 Plan, and may make minor editorial changes to improve the clarity of that direction.

Responsible Official

The Regional Forester is the Responsible Official for the analysis and decisions for Forest Plan Revision. Conducting analysis, developing alternatives, and preparing the Final Environmental Impact Statement (FEIS) were done at the local Forest level under the direction of the Forest Supervisor for the Mark Twain National Forest.

Based on the analysis in the DEIS, public comments, and this Final EIS, the Regional Forester has selected alternative 3 to become the 2005 Forest Plan. The Regional Forester has documented the rationale for the selection in a Record of Decision accompanying the Final EIS. The alternative selected includes the six key Forest Plan decisions.

Purpose and Need for Forest Plan Revision

The development of the revised Forest Plan and this accompanying environmental impact statement is intended to satisfy regulatory requirements and to address new and changing information about the Forest and its uses.

The Forest Plan embodies the provisions of the National Forest Management Act, the implementing regulations, and other guiding documents. Multiple-use goals, objectives, management area prescriptions, and standards and guidelines all define the Mark Twain National Forest's management direction. However, successful implementation of this direction depends on the annual budget and other factors.

The National Forest Management Act requires that national forests revise forest plans at least every 15 years (U.S.C. 1604[f][5]). Additional indicators of the need to revise the 1986 Mark Twain Forest Plan are:

- Land conditions and public demands have changed;

- Agency policies and strategic priorities have changed;
- Results of monitoring and evaluation suggest the need for revision;
- New information is available; and
- Those interested in management of the Mark Twain National Forest have made suggestions for changes.

Need for Change in Management Direction

In April 2002, the Forest Supervisor and Regional Forester identified forest plan revision needs in the Assessment of the Need for Change for the Mark Twain National Forest Land and Resource Management Plan. A Notice of Intent to Revise the Forest Plan was published in the Federal Register on April 16, 2002. The Need for Change discusses the process and information used to develop proposed changes to the Forest Plan. Following is a brief review of the revision topics that resulted from these two documents. The revision topics are the focus of this forest plan revision process. They address the central issues and public concerns to which future management of the Mark Twain National Forest must respond. The 2005 Forest Plan and the alternatives were developed to answer questions raised by these revision topics.

Revision Topic 1 – Vegetation and Timber Management

Concerns about vegetation management, especially timber management, have evolved over the last 15 years around harvest levels, cutting methods, timber sale cost efficiency and maintaining or restoring healthy ecological processes through the application of vegetation treatments. It has also been suggested that the Mark Twain NF should restrict or prohibit commercial development of natural resources.

Revision Topic 1a – Lands suited to timber production and Allowable Sale Quantity (ASQ)

The National Forest Management Act (NFMA) regulations require that Forests review lands designated as not suitable or appropriate for timber production as part of Forest Plan revision. The 1986 plan identifies 88% of Mark Twain National Forest lands as suitable and appropriate for timber production. Changes in national policy, including the Roadless Area Conservation Policy, have identified additional acres that may be inappropriate for scheduled timber production. Through implementation of the Forest Plan and better mapping techniques, we have learned that the number or acres available and appropriate for timber harvest is less than shown in the 1986 Forest Plan, due to the combined effect of mitigation factors such as filter strips for riparian areas, visual quality measures, and limits on the combined size of adjacent openings.

There have also been concerns about the Allowable Sale Quantity (ASQ) established by the 1986 Forest Plan.

There is a need to:

- Revisit suitable lands determination, revise demand estimations, and rebuild ASQ determination based on those changes.

Revision Topic 1b – Even-aged and uneven-aged management

The 1986 plan was developed with the assumption that even-aged management, including clear-cutting, would be the primary methods of perpetuating oak-hickory, shortleaf pine, and oak-pine communities that constitute the desired future condition on the majority of the Forest. Uneven-aged management was to be used “on selected areas to determine the long term feasibility of using this system…" (1986 Forest Plan, page IV-3.) The use of clearcutting has decreased from 65% of acres sold for timber harvest in 1988, to an average of 10% of acres sold for the past 10 years. In contrast, the use of uneven-aged techniques has increased from less than 1% of acres sold in 1988 to over 26% of acres sold in 2001, with an average of 31% in the last ten years. While some see this as a positive shift by the Forest, others believe that the decrease in clearcutting has contributed to the current problems of oak decline.

There is a need to:

- Provide for adaptive management and greater flexibility of silvicultural techniques in order to maintain oak-hickory, shortleaf pine and oak-pine communities.

Revision Topic 2 – Ecological Sustainability and Ecosystem Health

Sustainability consists of ecological, social, and economic components. By managing for ecological sustainability, forest ecosystems will be healthy and resilient in the long term and will provide a lasting flow of goods and services that help sustain the economy and local communities. Managing for ecological sustainability requires an integrated management approach that considers natural processes such as fire, insect and disease outbreaks, and catastrophic wind events, along with forest management activities that mimic those natural events. The USDA Forest Service Strategic Plan for FY 2004 - 2008 includes several goals focused on ecosystem health.

Revision Topic 2a – Oak decline and forest health

In the early 1900's the Missouri Ozarks were subjected to extensive logging, open-range overgrazing, over-burning, and subsequent soil erosion and loss of the grass/herbaceous ground cover component. Changes in forest vegetation brought about by these activities, along with changes in hydrological processes have led to less productive, droughtier soils, timber overstocking, and loss of healthy ecosystems. Oak decline, which occurs cyclically on the forest and appears to coincide with extended periods of drought, has been worsened by these historic changes. Long-term implications to forest health exist. The 1986 Forest Plan did not anticipate the current extended drought cycle and subsequent oak decline.

There is a need to:

- Develop management direction for restoring and maintaining healthy forest ecosystems in response to oak decline; providing a healthier balance of shortleaf pine and white oak in what is now a predominantly black and red oak forest; and restoring some of the more open woodland habitats encountered by early settlers.

Revision Topic 2b – Reforestation and Timber Stand Improvement

The 1986 Plan contains restrictions on reforestation and timber stand improvement under certain management prescriptions. These restrictions were most likely intended to insure that hardwood forests were not converted to softwood plantations. Under the 1986 Plan, we cannot plant pine in management areas that emphasize wildlife habitat diversity, even within the natural pine range. Techniques to improve areas of pine are prohibited in management areas that emphasize hardwood tree species, even within the natural pine range. Practices to improve areas of oak forests are not permitted in management areas that emphasize motorized semi-primitive recreation. However, these restrictions are preventing the Forest Service from implementing practices to encourage healthier, more resilient and sustainable oak and oak-pine forests when confronted with large-scale natural events such as fire, tornados, red oak borers and oak decline.

There is a need to:

- Change management direction to allow pine and oak reforestation and stand improvement in a wider variety of situations, so as to encourage natural vegetation most suited to Missouri's natural communities.

Revision Topic 2c – Wildlife habitat management

The 1986 Forest Plan was developed during a time of emerging ecological knowledge. Management direction and objectives for various wildlife habitat conditions were identified based on the needs of Management Indicator Species .These standards and objectives varied based on landtype association (LTA) and management prescription in order to provide a well-distributed diversity of habitats across the Forest. After seventeen years of implementing the 1986 Forest Plan, the resulting habitat conditions are very similar across all management prescriptions, resulting in a more homogenous landscape than had been envisioned. Additional information suggests that the diversity of natural communities found historically in the Ozarks is not provided for under current management direction. In addition, it has been difficult to measure accurately some habitat conditions based on data we currently collect.

There is a need to:

- Provide a wide diversity of natural communities and wildlife habitat conditions based on differing landscape capabilities and advanced ecological knowledge.

Revision Topic 2d – Management Indicator Species

The management indicator species (MIS) for the 1986 Forest Plan were selected by a committee of State and Federal biologists to represent the range of species present on the Mark Twain National Forest. MIS were selected to emphasize species of interest to the public, including species that are hunted and those that are not, and as indicators of ecological change. Information gained in the past seventeen years through monitoring population trends suggests other species would better indicate the effects of management to natural communities considered most in need of restoration.

There is a need to:

- Revise list of Management Indicator Species.

Revision Topic 3 – Fire Management

The topic of fire management focuses on the concept of using fire as a management tool. Fire management includes two aspects: 1) the use of fire to meet resource and land management goals; and 2) all activities required for protecting property and natural resources from fire.

Revision Topic 3a – Prescribed fire

Natural disturbance factors that shape vegetation in Missouri include insects, disease, floods, wind, and fire regimes. Fire has historically been a major disturbance element influencing development of Missouri's diverse ecosystems, including savannas, woodlands, prairies, forests, fens, wetlands, and glades. Plant species presence, forest structure and composition across the landscape are influenced by fire. Natural area inventories conducted by state officials throughout the Midwest have demonstrated great loss of Missouri's historic, fire-adapted ecosystems due to landscape alteration, conversion to croplands and pasture, urban/housing development, and fire suppression.

The 1986 Forest Plan has very little guidance for using prescribed fire, and it is silent regarding when, where, why, and how prescribed fire can be utilized as a tool.

There is a need to:

- Develop management direction guiding the use prescribed fire to restore ecosystems, maintain healthy forests, provide wildlife habitat, and reduce hazardous fuels.

Revision Topic 3b – Wildland fire suppression

Wildland fire suppression is necessary to protect life and property, especially considering the intermingled ownership patterns and proximity of private homes and communities to the Forest. The 1986 Forest Plan has very little guidance relating to wildland fire suppression. There are several national reports that have been developed in response to wildland fire threats to communities in recent years. These reports include: "A Collaborative Approach for Reducing Wildland Fire Risk to Communities and the Environment-10 year Comprehensive Strategy, August 2001;" "Managing Impacts of Wildfires on Communities and the Environment, September 2000;" and the National Fire Plan, September 2000. These reports outline a comprehensive approach for wildland fire management, and make recommendations for protecting communities.

There is a need to:

- Improve management direction for managing wildland fires to protect life, property, and communities.

Revision Topic 3c – Fuels management

While wildland fire suppression is essential and necessary to protect life and property, it can result in unnatural fuel buildup that leads to more intense and damaging fires than in the past. Extensive logging in the early 1900's, combined with decades of fire suppression, has resulted in forests with a high density of trees and an increase in the amount of woody debris on the forest floor. Oak decline is adding to the problem by increasing fuel loads and changing fuel types. In addition to increasing fire intensity, these accumulated fuels damage otherwise diverse, healthy ground vegetation. The Forest Plan does not address hazardous fuels that might result from natural events or management activities, or the effects on rural interface communities.

There is a need to:

- Develop a proactive approach to fire and fuels management so as to improve and maintain forest health and reduce the intensity of wildland fires.

Revision Topic 4 – Management Areas

Management areas define which management prescriptions apply to various parts of the Forest. Management area boundaries are determined by ecological characteristics, social considerations, and on-the-ground practicality of differentiating one management area from another. New ecological principles and changes in social expectations may necessitate revision of some 1986 management area boundaries.

Revision Topic 4a – Management area boundaries and land-type associations (LTA)

Current management direction, particularly for wildlife habitat, varies by landtype association (LTA), which is a subdivision of a landscape characterized by similar geological features, patterns, ecological processes and natural plant communities. Existing management area boundaries do not follow LTA boundaries, however, which have caused difficulties and complications for project level analysis. In recent years, new LTA boundaries for Missouri have been delineated through a multi-agency partnership.

There is a need to:

- Adjust management area boundaries as needed to incorporate ecological landtypes, current social demands, and management practicalities.

Revision Topic 4b – Special Area allocations

Wilderness, Natural Areas, Wild, Scenic and Recreational Rivers, and Special Management Areas are land allocations for specific purposes. A Forest roadless area inventory to identify potential wilderness areas is required during plan revision. An inventory to identify rivers with potential for inclusion in the Nation's Wild and Scenic river system is also required.

There is a need to:

- Review management direction to insure protection of Roadless, wilderness, wild, and scenic river values, and other "special areas."
- Evaluate inventoried roadless areas for their potential for Wilderness designation. Determine the most appropriate use and management for inventoried roadless areas not recommended to Congress for Wilderness designation.
- Determine eligibility and highest potential classification for any rivers identified with potential for inclusion in the Nation's wild and scenic river system.

Revision Topic 5 – Riparian Areas and Water Quality

Knowledge of the important functions of riparian areas and their effects on the biological and hydrological integrity of streams has increased since the 1986 plan was approved. A Forest Plan amendment for management of riparian areas was approved in 1991. However, the criteria used for riparian area definition and delineation were not clear or quantifiable. Inconsistent identification of riparian areas in project planning and implementation has led to inconsistent application of management direction.

Knowledge of the interconnection of surface and subsurface waters due to the karst terrain in the area has also increased. Management direction for protection of groundwater and ecological processes associated with karst hydrologic systems are generally lacking in the 1986 Forest Plan.

There is a need to:

- Provide for the restoration and maintenance of the ecological function of riparian areas, emphasizing the ecological processes that riparian areas play in supporting aquatic systems and water quality.
- Develop clearer definitions and criteria for delineating for riparian areas and aquatic ecosystems, based on plant community, soil and hydrologic criteria.
- Develop management direction to protect water quality and ecological processes associated with karst terrain and karst features.

Revision Topic 6 – Threatened, Endangered, and Sensitive Species Viability

Management for federally-listed and Regional Forester's Sensitive Species (RFSS) were originally considered an area that would not change during Forest Plan Revision. Between 2000 and 2002, we re-examined our RFSS management and updated the 1986 Forest Plan with two amendments for federally-listed species. After listening to public input and further discussions with the U.S. Fish & Wildlife Service (USF&WS), we decided additional changes were needed. There are three federally-listed species that had not previously been considered in Forest Plan management. They are Hine's emerald dragonfly, scale-shell mussel, and Ozark Hellbender. The Regional Forester updated the RFSS list. We have a better understanding of species needs and an obligation to use the best available information for management direction.

There is a need to:

- Examine and revise management direction to protect and provide for threatened, endangered and sensitive species.

Revision Topic 7 – Access and Transportation Management

Roads are needed in the Forest for recreational access, management, and access to private property. Roads and access they provide have remained controversial. Concerns exist about the effect of roads on natural resources such as water quality and wildlife habitat. Traffic volumes have increased, and recreational uses of roads have changed. Forest managers are concerned about costs of road construction and maintenance.

The Mark Twain conducted a Forest-wide road analysis in 2003 to determine and provide for the minimum forest transportation system that best serves current and anticipated management objectives and public uses, while maintaining land health and water quality. Recommendations and key findings from the roads analysis are incorporated in the following subtopics.

Revision Topic 7a – Road density standards in management area prescriptions

Current road density management direction does not include non-Forest Service roads or private lands in their calculation. A roads analysis of the Salem and Potosi Ranger Districts questioned the meaning and usefulness of these density standards in light of the extensive non-Forest Service road network on both NFS and private lands. There is a lack of scientific data and research showing a correlation between these limits and their effect on any specific wildlife species or other natural resources at the Forest Plan level.

There is a need to:

- Clarify or modify or eliminate road density standards

Revision Topic 7b – "Woods Roads"

The Mark Twain National Forest is the only National Forest with a subset of classified roads called "woods roads." These roads are generally unimproved, and are to be maintained between maintenance levels 1 and 2. This low level of maintenance, however, has not been appropriate for the level and type of use these roads have received, and in some cases has resulted in resource damage. The term "woods road" has led to confusion because the public commonly assumes it means any road in the Forest, including old roads that are not part of the Forest's road system and are to be closed after management activities are complete.

There is a need to:

- Eliminate the term "woods road" and assign standard maintenance levels to all roads.

Revision Topic 7c – Forest Plan Transportation Map

The Forest Plan Transportation Map as part of the 1986 Forest Plan proved to be useful during implementation of the plan. However, the transportation system is now largely in place and very little new road construction is occurring on the Forest, reducing the need for a Forest Plan Transportation Map. Land acquisitions, changing demographics, and development in an area can affect the need for individual roads. The Forest Plan Transportation Map essentially makes site-specific decisions, which should be made at the project level, not at the Forest Plan level. In addition, changes in national direction regarding roads management, especially the requirement to compile and maintain a Forest Transportation Atlas, make the Forest Plan Transportation Map unnecessary and redundant.

There is a need to:

- Eliminate the Forest Plan Transportation map. Clarify that changes to the road system are project level decisions.

Revision Topic 7d – OHV and ATV use on the forest

The 1986 Plan restricts off-road vehicle use to designated trails or use areas. The only designated trails on the Forest are the Sutton Bluff trail system, and the only designated use area is the Chadwick Motorcycle Special Use. The Forest Plan allows for development and designation of additional trails and use areas.

Off-road vehicles may also use Forest Service classified roads (system roads) if the vehicle complies with State law. The 1986 Forest Plan considers all unclassified roads to be closed, whether or not there is a physical closure, and therefore disallows all motorized vehicle use. The Forest Supervisor’s closure order for roads, however, seems to restrict use only on those roads that are gated, bermed, or signed closed. OHV users have expressed confusion regarding which roads they are allowed to use, as have forest managers.

There is a need to:

- Clearly state the existing Forest direction for OHV and ATV use of “closed unless posted open.” Clarify the relationship among the Forest Plan direction, State law, and the Forest Supervisor’s closure order.

Revision Topic 8 – Monitoring and Evaluation

Through implementation of monitoring and evaluation direction, we have found that some requirements can not be fully implemented, do not yield meaningful results, are not measurable or scientifically supported, or are not reasonably affordable. In addition, new information about ecosystem management and ecological sustainability concepts are not reflected in the current monitoring and evaluation requirements.

There is a need to:

- Revise and improve the strategy for monitoring and evaluation to reflect ecosystem management and ecological sustainability concepts and approaches.
- Focus the monitoring strategy on information that will (1) enhance understanding of resource management issues; (2) is measurable and scientifically supported; and (3) is feasible given probable budgets.

Other Changes

In addition to the changes in management direction, we also made changes of an editorial nature in the 2005 Forest Plan. These include changes needed to explain or clarify direction already in the 1986 Forest Plan, removing items that do not pertain to the six Forest Plan decisions, or removing direction that can be found elsewhere, such as in the Forest Service Directives System. These changes do not represent a change in the direction, goals or objectives in the Plan, and are not discussed further in this document.

Public Involvement

Key points in the Forest Plan revision process where the public provides input include developing the need for change, identifying potential issues and possible alternatives for addressing issues, analysis of possible environmental effects, and publication of the DEIS and Proposed Forest Plan. The Mark Twain National Forest used a variety of public involvement tools and methods, including public meetings, open houses, newsletters, and news releases to engage individuals, organizations, state and local governments, and other federal agencies in the Forest Plan revision.

The Forest hosted a series of public meetings both before and after the Notice of Intent was issued to provide information about the Forest Plan revision process and gather public input on the scope of the decisions to be made, issues to be examined and possible alternatives. Subsequent Forest planning open houses, newsletters, and news releases informed the public about progress of the revision.

In February of 2005, after the release of the Proposed Revised Forest Plan and DEIS, the Forest held another series of open houses to present the Draft Environmental Impact Statement and answer questions about the analysis and the preferred alternative. These meetings were important for providing the public a forum to ask questions about the Proposed Revised Plan so that they could provide more informed comments.

The Forest Service received 1,807 responses, including letters, emails, and faxes, on the Draft Revised Forest Plan and DEIS. Those responses contained 2,430 individual comments, which were coded and attributed to 336 public concerns. Those comments are addressed in Appendix A1 of this Final EIS.

The Forest consulted and exchanged information with local county governments, State agencies, and other national forests and federal agencies throughout the plan revision process to aid in the development of revised management goals and objectives, and standards and guidelines.

See Appendix A for details on the public involvement process.

Forest Plan Revision Issues

An issue is a point of debate, dispute, or disagreement regarding anticipated effects of implementing the proposed action. Typically, an issue is described as a debate or disagreement about an effect on physical, biological, social, or economic resources. When making programmatic decisions, such as in this Forest Plan revision, issues often are framed as trade-offs between various desired conditions, amounts of products produced, or emphasis in management. For example, providing a diversity of natural communities and wildlife habitat conditions may involve tradeoffs with suitable lands determinations and ASQ. Issues stem from the topics summarized in the “Need for Change in Management Direction” section, and suggest alternative ways of responding to those topics. Public involvement, internal discussion, and analysis were used to identify the issues pertinent to Plan revision.

Response to the need for change (revision topics) and issues is tracked throughout the document by indicators that measure existing conditions and potential effects of management activities. These indicators focus our analysis and demonstrate differences between alternatives. Generally, indicators are quantitative, but some are qualitative. Descriptions of the issues below include a list of indicators that respond to each issue. These indicators are used in Chapter 3 of this document to discuss effects of alternatives, and to compare them.

The analysis for some resources in Chapter 3 may use additional indicators to show the differences between alternatives in more detail.

Depending on the topic and issue, indicators may be measured over different time periods and in different geographic locations. Indicators are analyzed at in multiple timeframes (such as 10, 50, 100 years) and multiple spatial scales (national forest, landscape ecosystem, county).

Forest Plan monitoring will document and evaluate applicable issue indicators. For more information on monitoring indicators, see Chapter 4 of the 2005 Forest Plan.

Issue 1 –Timber Supply

Forest Service Responsibility

In 1897, the Organic Act established the national forests to, among other things, furnish a continuous supply of timber. The regulations for implementing the National Forest Management Act require the Regional Forester to estimate the amount of timber that can be sold annually on a sustained-yield basis. The National Forest Management Act also requires that forest planning identify land that is not suited for timber production.

Public Concerns

Many people agree with the need to reevaluate those lands suitable and appropriate for timber production. Some suggest excluding riparian, roadless, and recreation areas from the suitable timber base. Others ask that the reevaluation of timber suitability consider the impact on local economies. People also encourage the Mark Twain NF to take intermediate and long-range projections of timber harvest levels into account in the forest plan revision. Still others suggest that there should be no commercial timber sales on the Forest

Issue Statement

There is disagreement about how much timber the Mark Twain National Forest can supply without adversely affecting ecosystem health, water quality, and the social and economic needs of people. Forest Plan revision will establish the acreage and location of land that is suitable for timber production. Revision will also determine the maximum level of timber that the Mark Twain NF may supply over time.

Key Indicators

- Average Annual Allowable Sale Quantity (ASQ)

Issue 2 – Ecological Sustainability and Ecosystem Health

Forest Service Responsibility

In forest planning the Forest Service is responsible for providing for diversity in plant and animal communities and tree species, and the agency must provide for the overall multiple-use objectives of national forests (1909.12 FSH 219.26). The Forest Service is responsible for ensuring a sustainable flow of renewable resources (recreation, timber, water, range, and wildlife) without impairment to the productivity of the land (Multiple Use/Sustained Yield Act). Forest health is essential to providing a sustainable yield of the forest’s resources.

Public Concerns

Numerous respondents assert that the Mark Twain NF should promote forest ecosystem health and sustainability. Some suggest that the Forest Service adopt techniques so that the natural integrity of the ecosystem is recovered and natural processes function unencumbered within the natural range of variability. They suggest that the best way to achieve this is through a preservation approach which prohibits all management activities in the Forest. Many encourage the Forest to use the full array of silvicultural tools to achieve forest health and ecosystem composition objectives.

Some people believe that uneven-age management is necessary to restore the forest to a healthy condition, and should be the only silvicultural system allowed on the Mark Twain NF. However, others believe that even-aged management is necessary for regenerating oak and pine forests, for mast production, and to benefit wildlife dependent upon early-successional vegetation. New information about oak regeneration and successful implementation of uneven-aged management also indicates that uneven-aged management is sometimes ineffective and has led to undesirable results on forest health on some sites where the 1986 Forest Plan requires its use.

Some respondents ask the Mark Twain NF to address native plants in the Forest Plan revision by maintaining natural forest types, aggressively restoring natural vegetation and native terrestrial communities on large regional scales (especially glades and savannas), identifying and protecting all unique plant communities, and restoring shortleaf pine communities where they would have occurred before European settlement of the area. Others are concerned that efforts to decrease the amount of black and red oak and increase white oak and shortleaf pine would adversely affect the existing timber industry in the area.

Issue Statement

There is concern about the effects on local timber markets from increasing the amount of white oak and shortleaf pine to provide for a healthy forest, and providing land dedicated to enhancement and restoration of natural communities. There is also debate about the effects on the forest health from passive management, and from current direction restricting certain silvicultural methods and prescriptions.

Forest Plan revision will establish what, if any, direction for increasing white oak and shortleaf pine will be provided, and how much of the Forest will be allocated to natural community restoration. The Forest Plan revision will also determine what, if any, management direction regarding timber management techniques and practices is needed to provide for forest health.

Key Indicators

- Acres of ground cover meeting desired condition for savanna, woodland and glade
- Acres treated to move towards natural community type
- Acres burned
- Acres thinned

Issue 3 – Wildlife Habitat Management

Forest Service Responsibility

The National Forest Management Act, Endangered Species Act, other laws, and federal regulations require the Forest Service to maintain or improve biological diversity at the genetic, species, and ecosystem levels and to maintain viable populations of existing native and desired non-native species. Federal regulations (36 CFR 219.19) require management to maintain viable populations, which are defined as those having the estimated numbers and distribution of reproductive individuals to ensure their continued existence is well distributed on national forests. Federal law also requires considering wildlife resources equally with other renewable resources in managing forests and how to manage non-native invasive species. Other federal laws assign national forests a role in managing wildlife habitat and support cooperation in such management with states and American Indian tribes.

Public Concerns

A number of people urge the Mark Twain NF to protect and restore wildlife habitat, particularly for native species and species requiring large tracts of contiguous forest. Some stress the particular need to preserve bird habitat, which they believe will result in increased bird populations. Others are specifically interested in increasing ruffed grouse populations.

Some urge the Mark Twain NF to promote aggressively early successional conditions in order to promote population growth in early successional bird species, and to comply with NFMA's requirement to maintain viable populations of all native wildlife. Others express an interest in old growth conditions, with potential old growth areas identified based on both landscape and structural characteristics. Some suggest that riparian areas are a high priority for inclusion in old growth designations.

Numerous respondents write that the Mark Twain should make a special effort to protect threatened, endangered, and sensitive species. Specific species mentioned include mountain lions, endangered reptile and amphibian populations, the Ozark hellbender, bats, eagles, and various rare butterflies.

Issue Statement

There is divergent views about how the Forest should be managed for the full array of wildlife species and habitats, whether rare or common, and what habitats and species should be emphasized. Forest Plan revision will establish goals for the types, amounts, distribution, spatial pattern, and function of wildlife habitats.

Key Indicators

- Acres of natural community savanna, woodland and forest meeting desired condition for old growth natural communities.
- Management Indicator Community trends

Issue 4 – Fire Management

Prescribed fires are intentionally set by forest managers under controlled conditions to meet specific natural resource objectives. Fuels are anything that will burn such as trees, branches, grass, and pine needles.

Forest Service Responsibility

In forest planning, the Forest Service is responsible for determining vegetation management practices for each vegetation type and circumstance (FSH 219.15). Forest Plans must also determine standards and guidelines for vegetation management. The Forest Service has embarked on a national 10-year plan (A Collaborative Approach for Reducing Wildland Fire

Risks to Communities and the Environment 10-Year Comprehensive Strategy August 2001) that emphasizes reducing hazardous fuels as one of its four main goals.

Public Concerns

The use of prescribed fire is a topic of concern to numerous respondents. People urge the MTNF to use fire to emulate historic natural disturbance regimes; restore and maintain Ozark ecosystems and large scale natural communities that benefit from periodic fire; to maintain wildlife habitat; and to reduce fuel loads. Some, however, caution the MTNF to use fire only on a limited basis, because they believe that fire is harmful, and that it is not a natural or necessary component of Ozark ecosystems. There are also concerns that increasing the amount of prescribed fire will adversely affect air quality.

Issue Statement

While prescribed fire is needed to reduce hazardous fuels and restore ecosystems, there is concern that increasing the use of prescribed fire will harm forest ecosystems and air quality. Forest Plan revision will determine how, where, and to what extent prescribed fire may be used to mimic natural processes and to restore natural processes and functions to ecosystems, and to reduce fuels.

Key Indicators

- Acres treated to progress toward FRCC 1
- Acres burned to reduce fuels and restore ecosystems

Issue 5 – Economic Sustainability of Local Communities

Forest Service Responsibility

Forest planning regulations direct that the overall goal of managing national forests is sustainability, key components of which are interdependent ecological, social, and economic factors that work together to allow goods and services to be produced without harm to the long-term productivity of the land.

Public Concerns

Many people are concerned that reducing or changing the mix of resources provided from the Forests could economically affect local communities. Similarly, they are concerned that if the Forests do not increase the amount of goods and services they provide there may be negative impacts to the economic sustainability of the local communities in terms of growth and jobs.

Other people believe that changes in resource emphasis on the National Forest would not have significant effects on economic sustainability if local communities adjusted to take advantage of the different resources that were being emphasized. Some think that a high degree of long-term ecological sustainability, including species viability, a diversity of plant and animal life, and diversity of habitats, contributes to stability of local economics. Still others believe that if the Mark Twain NF produced little to no timber, local communities would benefit from increased revenue from recreation.

Issue Statement

Forest Plan decisions contribute to economic sustainability by providing for a range of uses, values, products and services. At the same time, Forest plan direction must be consistent with ecological sustainability. Forest Plan revision will determine the mix of uses, values, products, and services that the Mark Twain NF could provide over time.

Key Indicators

- Income and Employment (by Resource Program)
- Income and Employment (by major Industry and Sector)
- Payments to Counties

Resources with No Change in Management Direction

There was no change in management direction for several resource areas under any of the alternatives considered in detail in this FEIS. The 2005 Forest Plan continues the management direction from the 1986 Forest Plan for these resource areas. These resource areas and the reasons for not changing them are summarized in the Assessment of the Need for Change and Notice of Intent that was released in 2002 and in Appendix A – Public Involvement.

Of these resource areas, the most prominent are:

- Management of off-road vehicle use
- Minerals management
- Management of candidate Wild & Scenic Rivers
- Management of heritage resources, recreation, fish and aquatic resources

These topics and issues were not addressed in the formulation of alternatives, although they are discussed in the environmental analysis. In general, these topics are either not ripe for decision, have been addressed by recent (and still relevant) decisions, potential alternatives would cause unreasonable environmental harm, or adverse effects are easily limited under any alternative.

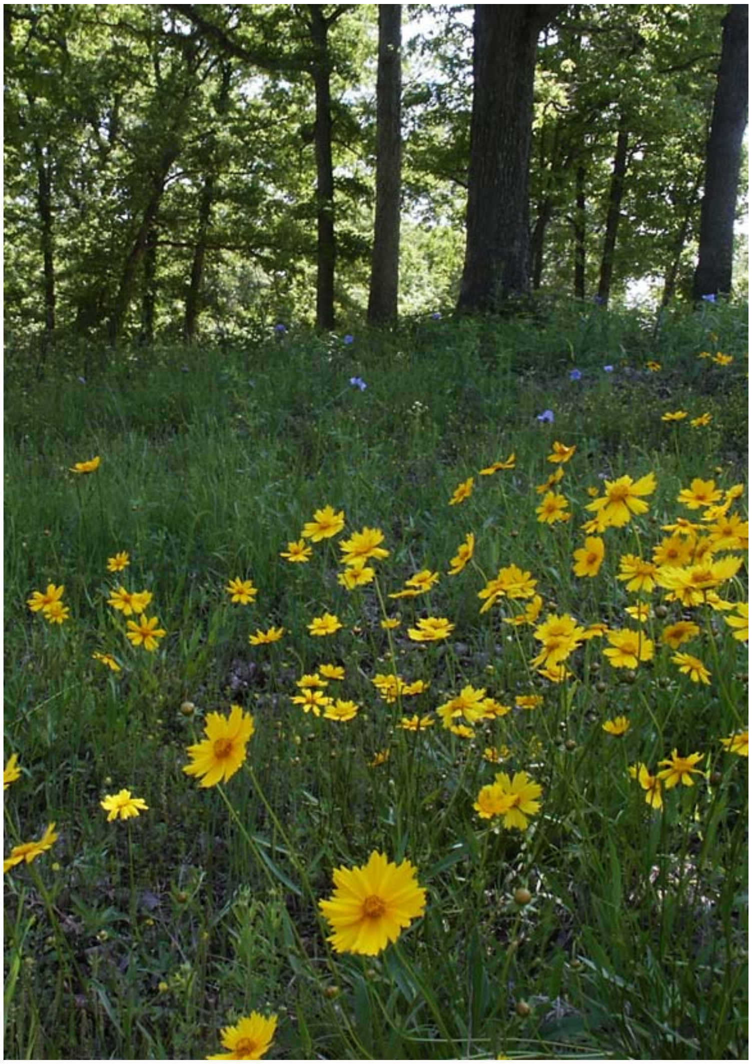
For example, in the case of off-road vehicle use, there is a strong demand for off-road and off-trail use on the Forest. However, extensive Forest Service experience with OHVs (http://www.fs.fed.us/projects/four-threats/facts/unmanaged-recreation.shtml) indicates that "open unless posted closed" policies frequently lead to environmental damage. While the demand for increased OHV opportunities on the Mark Twain could also be met by providing additional trails, potential impacts of those proposals are best assessed at a site-specific level that is outside the scope of decisions made in a Forest Plan. Such an analysis is underway (http://www.fs.fed.us/r9/marktwain/projects/ohv_study/index.htm). The general effects of OHV trails on various resources are included in the analysis in Chapter 3.

In the case of minerals management, the Forest is available for exploration and development, but effects cannot be meaningfully assessed until a site-specific proposal is made for exploration or development. Whether proposals will be submitted, and their content, are speculative. There have been no proposals submitted for development of minerals under the 1986 Forest Plan.

While there were no proposed changes to the management direction for Heritage, recreation, fish and aquatic resources, effects on these resources are discussed in Chapter 3. Each of these resources has been the subject of relatively recent decisions. Based on current information, the needs for change relate primarily to editorial clarification and removal of direction that repeats law or regulation.

Chapter 2

The Alternatives



Mark Twain
National Forest

Cover image: Coreopsis in woodland

Photographer: Paul Nelson, MTNF

Chapter 2

The Alternatives

Introduction

This environmental impact statement explores differences between a number of management alternatives for the Mark Twain National Forest. These were developed to provide a range of options for direction that forest management will take for the next 10 to 15 years. Each of these alternatives is a potential Forest Plan that could be implemented if selected.

This chapter discusses:

- How alternatives were developed;
- Features of each alternative, including the no-action alternative;
- How management areas are distributed for each alternative.
- How alternatives compare to each other;
- The Selected Alternative;
- Alternatives that were considered but eliminated from detailed study;

Development of Alternatives

As explained in Chapter 1, this Forest Plan revision process was initiated by the need to change the 1986 Forest Plan due to changes in environmental conditions, changed circumstances, and societal uses and values. The core of this process is formulation of a Revised Forest Plan and a set of forest management alternatives for implementing the plan. Alternatives provide different scenarios for applying management prescriptions across the Mark Twain National Forest. The alternatives, outside of the No Action Alternative (Alternative 5) that maintains current management direction, do not vary in proposed forest-wide direction .They do vary by acreage allocated to each management prescription (see Table 4 and maps located in the map package.) Alternative 3 is the selected alternative for implementing the 2005 Forest Plan.

The 2005 Forest Plan first defines a set of goals, objectives, standards, and guidelines that provide forest-wide direction for managing resources on the Mark Twain National Forest. Forest-wide direction combines national and regional goals with goals, objectives, standards, and guidelines specific to the Mark Twain National Forest.

Forest goals are broad statements that describe overall conditions managers will strive to achieve. They are not directly measurable and there are no time frames for achieving them. In other words, goals describe ends to be achieved rather than means to those ends; they serve as vision statements. In contrast, objectives provide these means in the form of measurable steps to be taken to accomplish goals. Objectives are generally achieved by implementing projects or activities. However, objectives are not targets, which are a measure of annual outputs dependent upon budgets. Budget allocations may or may not correspond to areas that have been emphasized by the 2005 Forest Plan. A standard is defined as a course of action that must be followed, or a level of attainment that must be reached, to achieve forest goals. Adherence to standards is mandatory. Standards are used to assure that individual projects are in compliance with the Forest Plan and other legal mandates governing the Forest Service.

They should limit project-related activities, not compel or require them. Deviations from standards must be analyzed and documented in a Forest Plan Amendment. A guideline is a preferred or advisable course of action or level of attainment. Guidelines are designed to achieve desired conditions, or goals.

The 2005 Forest Plan also establishes additional direction for management prescriptions. Management prescriptions include a desired condition statement, standards, and guidelines in addition to Forest-wide standard and guidelines necessary for resource protection.

As required by NEPA regulations, alternatives have been developed using an interdisciplinary process. Public comments received during the scoping phase were combined with concerns raised by resource specialists and monitoring results to create revision topics, or significant issues. Five alternatives were then developed, each with a specific theme and set of management prescription allocations designed to match the theme.

Each alternative has been designed to respond to comments and revision topics in a different way, providing a range of possible management approaches from which to choose. In each alternative, this approach is conveyed by the alternative’s theme, which emphasizes a particular issue or a group of compatible issues.

Each alternative stands alone as a potential Forest Plan. Alternatives do have many things in common, sharing essential goals, concepts, and policies that all national forests are directed to follow. How they differ from one to another is in the relative emphasis given to particular issues and concerns, which is reflected in management prescription allocations for each alternative.

Details of the alternatives are presented in this chapter. Alternative 3 was designated as the preferred alternative in the Draft Environmental Impact Statement. Following publication of the draft Revised Forest Plan and the Draft Environmental Impact Statement, there was a 90-day comment period. Comments received during the comment period were analyzed, and some changes were made to the goals, objectives, standards and guidelines in the Draft Revised Forest Plan. These changes have been incorporated into all the alternatives. In addition, a minor change was made to the preferred alternative regarding Recreation Opportunity Objectives for a specific area. The Regional Forester has identified Alternative 3, with changes, as the Selected Alternative.

Changes between the Draft and Final Environmental Impact Statements

The Forest Service received 1,807 individual responses (including letters, emails, and faxes) on the DEIS and draft Revised Forest Plan. These comments, shifts in agency direction, and correction of errors led to several changes in the draft Revised Forest Plan. The changes range from minor edits and clarifications to changes in the standards and guidelines and monitoring requirements. The following summary describes the changes to standards, guidelines and other areas of the 2005 Forest Plan.

Public comments and Agency review also identified the need for several improvements to the analysis and presentation of materials in the FEIS. As a result, editorial discrepancies, minor inconsistencies, or gaps in the presentation of information in the DEIS have been corrected for the FEIS. These changes are noted in the response to comments.

Management Prescription 1.1 and 1.2

Standards prohibited the construction of wildlife ponds in Management Prescriptions 1.1 and 1.2. Concerns were raised about providing habitat for amphibians in these areas. The standard was changed to allow for the construction of wildlife ponds if a long-term species viability concern is demonstrated, and that concern cannot be addressed in another location.

Questions were raised about the absence of standards or guidelines regarding designation of old growth in Management Prescriptions 1.1 and 1.2. We added direction to clarify that old growth conditions should be provided, although there is no specific percentage to be designated old growth. This change helps explain that by restoring natural communities in these management areas and achieving the desired future conditions for the land, old growth characteristics will be reflected across the landscape in patterns and distributions they would have occurred naturally.

Management Prescription 2.1

A standard requiring that activities in management prescription 2.1 be distributed to emulate historical conditions was removed. Part of the desired condition for MP 2.1 is that "natural communities are distributed similar to historical vegetation patterns." The ID team determined that the proposed standard was redundant with the desired condition, did not add any clarity to permitted or restricted activities, and therefore did not meet the basic purpose of a standard. This change will streamline and better align the standards and guidelines with the theme, goals, and desired condition for MP 2.1, and with the analysis that was conducted in the EIS.

Threatened and Endangered Species

Several changes to Forestwide standards and guidelines were made in response to comments made by the U. S. Fish and Wildlife Service. These modifications represent a strengthening and clarification of direction proposed in the Draft Revised Forest Plan, not a major shift in the management direction. The changes are:

- Added requirements to survey for the presence of mussels prior to in-stream work, and to modify projects if presence confirmed.
- Added standard to prohibit vehicle or equipment use in fens, unless needed to improve Hines Emerald Dragonfly habitat.
- Modified direction for Indiana bat maternity colonies. One change provides additional foraging habitat by strengthening designation criteria of maternity colony area and by specifying activities that are restricted within maternity colonies. A second change increases protection of roost trees by timing and activity restrictions around occupied roost trees.
- Added monitoring requirements for existing bat gates on caves.
- Added restrictions on prescribed burn timing near Indiana bat maternity colonies and near caves during swarming / dispersal periods.
- Prohibited core drilling in the 150 acre areas designated as old growth around gray or Indiana bat caves.

Wildlife Habitat

We revised Table 2-2 to exclude specific direction regarding methods used for stocking of trout in certain cold water streams. This change is being made in response to comments from the Missouri Department of Conservation (MDC) so that the 2005 Forest Plan is better aligned with MDC stocking that is currently occurring.

Direction regarding the provision for old growth and regeneration openings in management prescriptions 2.1, 6.1 and 6.2 was moved from standards and guidelines to goals and objectives. Because this direction does not describe permissions or limitations on activities, it does not function well as standards and guidelines. What is does is describe the desired future condition of these management areas. Moving this direction will ensure that it is used to help form the purpose and need for site-specific projects, and will provide more flexibility in placing these habitat conditions on the landscape to meet the needs of a variety of species.

We lowered the percentage of management areas that are desired as regeneration openings in management prescription 2.1 (from 11 – 20% to 8 – 15%) and 6.1.(from 3 - 5% to 1-5%). This change is made in response to public comment noting that the percentages were higher than those prescribed by comparable Management Prescriptions in the 1986 Forest Plan. In addition, the higher percentages did not take into account the contribution of early successional habitat from natural community restoration.

Lower Rock Creek Area

The Draft Revised Plan proposed to change the Lower Rock Creek area from a semi-primitive non-motorized area (6.1 Management Prescription) to a restoration emphasis (1.2) with a semi-primitive motorized designation. The change between draft and final 2005 Forest Plan is that for a portion of the Lower Rock Creek 1.2 area, a standard that restricts motorized use has been added.

The Lower Rock Creek Area is of great interest to groups and local residents. There is disagreement over the appropriate management prescription for this area. Based on public comments, a standard was added prohibiting motorized use in all parts of the Lower Rock Creek Area, except Wolf Hollow. This change is designed to address the concerns through compromise and still meet important restoration of natural community objectives. The 2005 Plan direction will emphasize natural community restoration in this area, which is appropriate due to the ecological conditions. The plan direction will continue to restrict motorized access in the area, except for the Wolf Hollow area where there is occasional, seasonally-restricted use of an existing road for traditional hunting purposes.

Temporary Openings

We changed the definition of a temporary opening in the forest-wide standards and guidelines for timber management to specify that the stand must be 15 feet high instead of 10 feet high. This change is in response to concerns that stands 10 feet high would still be perceived visually as an opening, and could lead to too many adjacent regeneration cuts.

Monitoring and Evaluation

We changed monitoring requirements for Management indicator Species (MIS) to focus on the effects of management activities on habitat, rather than on species populations. Monitoring forest management impacts on MIS and other species can be accomplished in a variety of ways. We believe that monitoring of habitat will be a more reliable indicator of the effects of management actions on MIS as this monitors changes that are directly affected by actions on the Mark Twain National Forest. This change is consistent with the transition language in the 2005 Planning Rule (36 CFR 21914(f)).

Editorial Corrections

Editorial changes were made to correct misspellings, formatting, or to clarify management direction. These corrections did not change the basic intent of that direction.

Description of the Alternatives

Elements shared by all alternatives

Laws, Regulations, Policies

All alternatives were designed to comply with applicable laws, regulations, and policies. All alternatives adhere to the concepts of multiple use and ecosystem management, although some alternatives achieve these concepts on varying levels.

Special Designations

A number of existing designations do not change by alternative:

- Current designated wilderness;
- Existing developed recreation sites;
- Current designated National Recreation Trails;
- Current designated Wild and Scenic Rivers; and
- Current designated Scenic Byways;
- Current designated State Natural Areas and Natural Landmarks.

Management Prescriptions

Several management prescriptions in the 2005 Forest Plan have not changed substantially from the 1986 Plan, and these prescriptions are included in all five alternatives. The allocation of lands to these management prescriptions is essentially the same as under the 1986 Forest Plan, with the exception of MP 6.2, which is greatly increased in Alternative 1. These management prescriptions are shown in Table 1 below.

Table 1 - 1986 Forest Plan Management Prescriptions used in 2005 Forest Plan

MP #	Management Emphasis
5.1	Designated Wilderness
6.1	Semi-primitive non-motorized dispersed recreation emphasis, with limited investments in management of natural vegetative communities
6.2	Semi-primitive motorized dispersed recreation experience emphasis, with limited investments in management of natural vegetative communities
6.3	Candidate areas for National River status
7.1	Developed recreation areas
8.1	Designated “special areas” other than Wilderness

Elements shared by Alternatives 1 through 4

Revision Topic 1a - Lands suited to timber production

The following areas are removed from lands suitable for timber production in alternatives 1 through 4: old growth, the Seven Sensitive Areas, Riparian Management Zones, glade complexes, recreation areas, and protection areas for karst features.

Special Designations

Roadless areas were inventoried and evaluated for their potential for Wilderness designation. Some of those areas adjacent to existing Wilderness, including Irish Wilderness-excluded lands, are recommended for study in alternatives 1 through 4.

A rivers inventory identified one additional river (Black River) with potential for inclusion in the Nation's Wild and Scenic River system.

Goals, Objectives, Standards and Guidelines

Alternatives 1 through 4 share a set of basic Forest-wide goals and objectives and a set of standards and guidelines (see accompanying 2005 Forest Plan) that ensure protection of forest resources and comply with applicable laws.

Revision topics that are addressed through goals, objectives, standards and guidelines and are the same for Alternatives 1 through 4 are:

Revision Topic 1b - Even-aged and uneven-aged management

Forest Plan standards and guidelines specifying where even-aged and uneven-aged management can be used were eliminated, thereby providing greater flexibility. Decisions regarding silvicultural system and methods to be used will be made based on project level analysis.

Revision Topic 2a – Oak decline and forest health

Vegetation standards and guidelines reference use of the local historic land survey data for purposes of project inventory, vegetation mapping, and determining treatments appropriate to meeting desired conditions. Activities are distributed across the landscape to emulate the historical vegetation patterns and quantities of natural communities based on available information. Activities are designed to mimic ecosystem dynamics, patterns and disturbance processes to achieve desired conditions except where ecological recovery is unlikely or unfeasible.

Revision Topic 2b - Reforestation and Timber Stand Improvement

Restrictions in management prescriptions on the type of reforestation and timber stand improvement were removed from the 2005 Forest Plan. This allows pine and oak reforestation and stand improvement in a wider variety of situations.

Revision Topic 2c – Wildlife habitat management

Direction for the restoration and enhancement of natural communities was developed to provide landscape scale habitat for all species. Objectives and protective measures for specialized habitats such as old growth, early successional forest, caves, glades, seeps and fens, are provided.

Revision Topic 2d - Management Indicator Species

The list of management indicator species was revised to focus on species most likely to provide an indication of the effects of management to natural communities considered most in need of restoration.

Revision Topic 3a - Prescribed fire

Standards and guidelines have been developed for use of prescribed fire for restoration and enhancement of natural communities, and for hazardous fuels reduction. Objectives have also been developed to increase from current levels the number of acres prescribed burned.

Revision Topic 3b - Wildland fire suppression

Suppression response is based on a comprehensive dynamic risk assessment which identifies values at high risk and the appropriate management response. Areas of low risk are identified where a full range of responses are available, including wildland fire use to meet the Desired Condition. Direction is provided to identify Wildland Fire Management Units.

Revision Topic 3c - Fuels management

Forest Risk Assessment identifies areas on the Forest that are at high risk for wildfire. Hazardous fuels reduction treatments focus on community protection. Fire becomes a major component of ecosystem restoration, using a variety of prescriptions including natural fire to meet management objectives.

Revision Topic 4b – Special Area allocations

Identification of special areas, including Wilderness Study areas, and management for these areas is provided.

Revision Topic 5 - Riparian Areas and Water Quality

Riparian areas and aquatic ecosystems are defined based on landform, soils, hydrologic criteria and plant communities. Riparian Management Zones and Watershed Protection Zones are established to restore and maintain ecological function and processes of riparian areas, aquatic systems and water quality. Standards and guidelines are developed to protect water quality and ecological processes associated with karst terrain and karst features.

Revision Topic 6 - Threatened, Endangered, and Sensitive Species Viability

Management direction is provided for federally-listed species not previously addressed. Management for other federal and RFSS is refined and updated.

Revision Topic 7a – Road density standards in management area prescriptions

Road density standards are eliminated. ROS objectives of each management prescription will be used during project level analysis to determine how roads will be managed.

Revision Topic 7b – “Woods Roads”

The term “woods road” is eliminated. Those roads will be assigned agency standard maintenance levels.

Revision Topic 7c - Forest Plan Transportation Map

The Forest Plan Transportation map will be eliminated. The Forest Transportation Atlas will be used to maintain an inventory of roads on the Forest. Changes to the road system will be project level decisions.

Revision Topic 7d - OHV and ATV use on the Forest

Forest direction for OHV and ATV use is stated more clearly.

Revision Topic 8 - Monitoring and Evaluation

Strategy for monitoring and evaluation is revised to reflect ecosystem management and ecological sustainability concepts and approaches. Monitoring strategy focuses on information that (1) will enhance understanding of resource management issues; (2) is measurable and scientifically supported; and (3) is feasible given probable budgets.

Management Prescriptions

An ecological approach views the landscape in the context of restoring forest health and ecological integrity for a greater portion of the MTNF rather than having separate assemblages of land allocations with different natural community or wildlife emphasis or standards. Many management prescription allocations did not take into account new information on biologically rich concentrations of globally distinct ecosystems and sensitive species.

Rather than add or augment more or different management prescriptions, the MTNF is combining seven separate management prescriptions (MP 2.1, 3.1, 3.2, 3.3, 3.4, 3.5, 4.1) into three (MP 1.1, 1.2 and 2.1) with an emphasis on ecosystem restoration (MP1.1), restoration and dispersed recreation in a semi-primitive motorized setting (MP 1.2) and enhancement of natural communities (MP 2.1).These new management prescriptions (MP) were created to reflect current practices, knowledge, and direction. These new management prescriptions are included in Alternatives 1 through 4.

Table 2 - Management Prescriptions used only in Alternatives 1 through 4

MP #	Management Emphasis
1.1	Restoration of natural communities while providing a roaded-natural recreation experience
1.2	Restoration of natural communities while providing semi-primitive, motorized, dispersed recreation experiences
2.1	General Forest - Management for multiple use resource objectives while allowing for enhancement of natural communities, improvement of forest health conditions, and roaded, natural recreation experiences

Management Prescriptions 1.1 and 1.2 are created as a strategic means of efficiently and effectively targeting the conservation of Missouri’s globally significant biodiversity (see Appendix D). The underlying concept is that a representative array of natural community/vegetation types will be restored and maintained by mimicking appropriate scales of historical natural disturbances. This should provide the range of structural habitat variations (in prairie, savanna, woodland, forest, glade and fen natural communities) in which plant and animal species have adapted and evolved.

Elements that vary by Alternative

Management Prescription Allocations

For each alternative, specific land areas of the Forest are allocated to each management prescription. Each alternative reflects a different combination of management prescription acreages. Management prescription allocations are shown on the maps of each alternative (see map package.) A listing of these acreages is provided in Table 4 of this chapter. Management prescriptions are defined in more detail in Chapter 3 of the accompanying 2005 Forest Plan.

How alternatives are described

Each alternative is presented in the same format, with the following components:

- Background –Major issues to which the alternative responds.
- Theme – The relative degree of emphasis applied to different resources and concerns.

- Responses to revision topics or issues – Only those revision topics or issues that are addressed differently are included. Describes how the alternative is different based on the revision topics or issues.

The interdisciplinary team considered 5 different alternatives in detail. Other alternatives were considered but were determined to be inappropriate for further analysis. The reasons why they were not considered in detail are presented later in this chapter. Both groups of alternatives contribute to the NEPA requirement that a reasonable range of alternatives be considered.

Alternatives were not given names to keep the comparison of alternatives more objective and impartial. Expected outcomes and effects of the alternatives were analyzed and disclosed in this Final EIS.

Alternatives Considered in Detail

Alternative 1

Background

This alternative was designed to respond to those who want to see passive restoration principles implemented, less active management of forest resources, semi-primitive recreation emphasized over timber production, and commercial activities reduced or eliminated.

Theme

Emphasis is on minimizing direct human influence. Characteristics of the forest environment, such as vegetation structure and species, would be affected primarily by natural disturbance factors such as insects, disease, fire, and weather events. As a result, wildlife habitat would focus on mature forest, with fewer and smaller areas of early successional habitat. No commercial timber harvest would be allowed. Existing developed recreation areas would remain, but other recreation opportunities would emphasize dispersed recreation like backpacking, hunting, and floating in a semi-primitive, motorized environment. Management is focused on visitor safety, law enforcement, and other custodial elements.

Response to Revision Topics or Issues

Vegetation and Timber Management

Since there would be no commercial harvest, there would be no suitable lands, and the Allowable Sale Quantity (ASQ) would be zero.

Ecological Sustainability and Ecosystem Health

Areas of Management Prescriptions 1.1 and 1.2 are included at the minimum size considered to be feasible for restoration of natural communities. Activities for restoration purposes, such as thinning, regeneration cuts, and prescribed burning, would be implemented only in the Management Prescription 1.1 and 1.2 areas. No commercial timber sales would be used. Trees would be dropped and left on the ground, unless doing so would create an unacceptable fire risk that could not be mitigated with follow-up hazardous fuels reduction treatments.

Areas of Management Prescriptions 1.1 and 1.2 account for approximately 8.5% of National Forest System (NFS) lands. Management Prescription areas for Wilderness (5.1), Semi-primitive, non-motorized recreation (6.1), candidate rivers (6.3), developed recreation areas

(7.1) and designated special areas (8.1) would remain essentially the same as under the 1986 Forest Plan. All other areas (almost 77%) would be allocated to Management Prescription 6.2, which would emphasize semi-primitive motorized dispersed recreation. The only management of vegetative communities would be to meet wildlife needs. There would be no lands allocated to Management Prescription 2.1

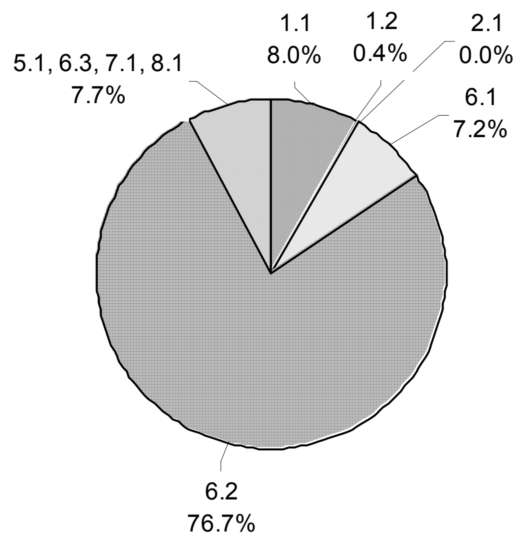


Figure 1 - Alternative 1 Management Area Allocations

Wildlife Habitat Management

Wildlife habitat management direction in management prescriptions other than 1.1 and 1.2 would include objectives for designation of old growth and minimum acreages of young forest (0-9 year age group). These would be implemented through non-commercial means, so trees would be cut and left on site.

Fire Management

Use of prescribed fire for restoration of ecosystems or providing wildlife habitat would be allowed only in Management Prescriptions 1.1 and 1.2. Prescribed fire and mechanical treatments could be used throughout the forest for purposes of hazardous fuels management.

Alternative 2

Background

This alternative was designed in response to those who want Forest management to emphasize maintaining composition, structure and dynamics of native forest ecosystems; aggressively restoring native terrestrial communities, such as glades, savannas, and shortleaf pine forests; and focus on restoration of ecosystems on large regional scales. This alternative provides emphasis and direction to encourage biodiversity and restore sustainable native ecosystems over timber sustainability.

Theme

Emphasis is on restoration of underrepresented terrestrial natural communities, while providing forest products and other multiple use benefits. Management activities, such as timber harvest and prescribed fire, would be used to influence ecological processes to attain and sustain a high diversity of habitats and species. A wide range of wildlife habitat is provided by restoring and enhancing terrestrial natural communities, and emulating their historical distribution patterns. A broad range of settings for a variety of recreational opportunities are provided, including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Response to Revision Topics or Issues

Ecological Sustainability and Ecosystem Health

Areas of Management Prescriptions 1.1 and 1.2 are increased to include all of the "portfolio" areas identified in the Ozarks Ecoregional Conservation Assessment (The Nature Conservancy 2003). "Portfolio areas" are designed to incorporate areas with high concentrations of Missouri's globally significant biodiversity.

Management Areas

Areas of Management Prescriptions 1.1 and 1.2 make up over 44% of NFS lands. Management Prescription areas for Wilderness (5.1), Semi-primitive non-motorized recreation (6.1), semi-primitive motorized recreation (6.2), candidate rivers (6.3), developed recreation areas (7.1) and designated special areas (8.1) would remain essentially the same as under the 1986 Forest Plan. All other areas, approximately 31% of NFS lands, would be allocated to Management Prescription 2.1.

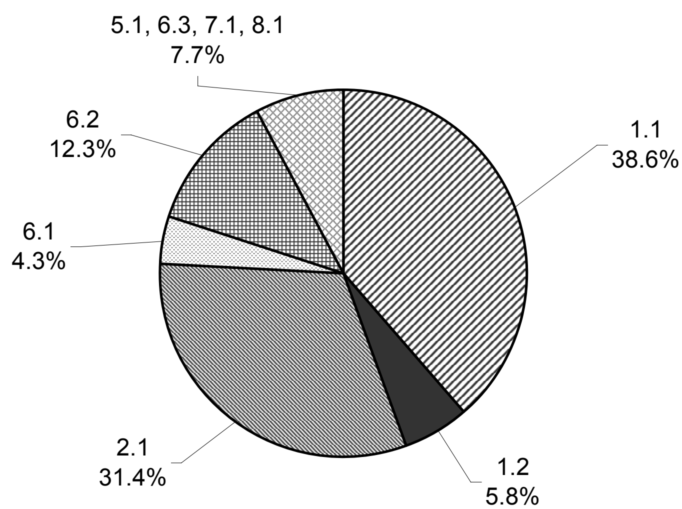


Figure 2 - Alternative 2 Management Area Allocations

Alternative 3 – Selected Alternative

Background

This alternative was designed in response to those who want to see a balance between restoration of natural communities and production of traditional forest commodities.

Theme

Emphasis is on improvement of forest health conditions, production of forest products and other multiple use benefits, and enhancement of terrestrial natural communities. Restoration of terrestrial natural communities is focused in areas that are identified as biologically rich. Management activities, such as timber harvest and prescribed fire, are used to mimic ecological processes to attain and sustain a high diversity of habitats and species. A wide range of wildlife habitat is provided by restoring and enhancing terrestrial natural communities, and emulating their historical distribution patterns. A broad range settings for a variety of recreational opportunities are provided, including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Response to Revision Topics or Issues

Ecological Sustainability and Ecosystem Health

The size of areas allocated to Management Prescriptions 1.1 and 1.2 are between those of Alternatives 2 and Alternatives 1&4.

Management Areas

Areas of Management Prescriptions 1.1 and 1.2 make up about 29% of NFS lands. Management Prescription areas for Wilderness (5.1), Semi-primitive, non-motorized recreation (6.1), semi-primitive, motorized recreation (6.2), candidate rivers (6.3), developed recreation areas (7.1) and designated special areas (8.1) would remain essentially the same as under the 1986 Forest Plan. All other areas, almost 45% of NFS lands, would be allocated to Management Prescription 2.1.

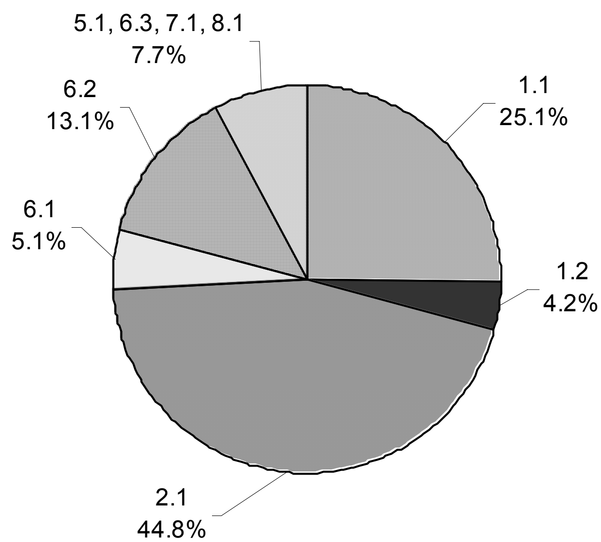


Figure 3 - Alternative 3 Management Area Allocations

Alternative 4

Background

This alternative was designed in response to those who want to see the use of traditional forest management and production of forest commodities emphasized over restoration of natural communities.

Theme

Emphasis is on ecosystem enhancement while providing utilization of forest resources. Multiple use management is emphasized for a majority of the Forest. Timber and mineral extraction, and other activities such as recreation are likely to influence ecological processes. A wide range of wildlife habitat is provided by emphasizing achievement of early successional and old growth habitat objectives, as well as protection of special habitats. A broad range of settings for a variety of recreational opportunities are provided including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Response to Revision Topics or Issues

Ecological Sustainability and Ecosystem Health

Areas of Management Prescriptions 1.1 and 1.2 are the same as in Alternative 1, which is the minimum size considered to be feasible for restoration of natural communities.

Management Areas

Areas of Management Prescriptions 1.1 and 1.2 make up 8.4% of NFS lands. Management Prescription areas for Wilderness (5.1), Semi-primitive non-motorized recreation (6.1), semi-primitive motorized recreation (6.2), candidate rivers (6.3), developed recreation areas (7.1) and designated special areas (8.1) would remain essentially the same as under the 1986 Forest Plan. All other areas, 62% of NFS lands, would be allocated to Management Prescription 2.1.

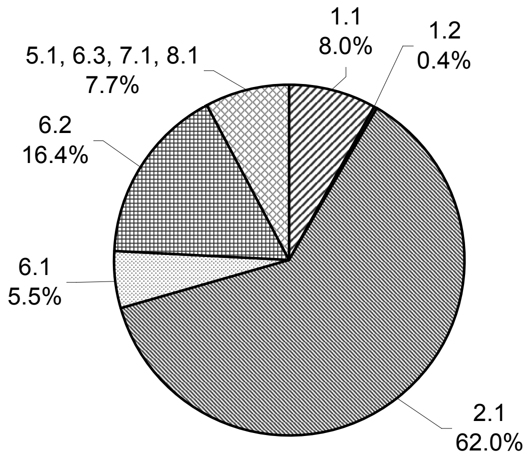


Figure 4 - Alternative 4 Management Area Allocations

Alternative 5 – No Action

Background

Alternative 5, the no-action alternative, reflects current Forest-wide direction. It meets the NEPA requirement (36 CFR 219.12(f)(7)) that a no-action alternative be considered. 'No action' means that current management allocations, activities, and management direction found in the existing Forest Plan, as amended, would continue. Output levels have been recalculated for this alternative to comply with new information, in particular, new scientific and inventory data.

Theme

The 1986 Forest Plan gives strong emphasis to wildlife habitat development; particularly unique or specialized habitats such as caves, springs, seeps, fens, riparian areas, glades and fishless ponds. Timber management is the primary tool for reaching desired vegetative conditions, wildlife habitat objectives, and providing timber products for local industrial and individual needs. The Plan provides a range of settings for a variety of recreational opportunities including both developed recreation sites and areas for dispersed recreation like backpacking, hunting, floating, and off-road vehicle use.

Response to Revision Topics or Issues

Because this alternative does not incorporate the 2005 Forest Plan, it responds to all the revision topics differently than do Alternatives 1 through 4. Therefore, each of the revision topics is discussed here, to highlight the differences between the direction in the 1986 Forest Plan and the 2005 Forest Plan.

Vegetation and Timber Management

Uneven-aged management is required on wet, mesic bottomlands (ELTs 1-6, 39, 56, 59, 61-62), on Cedar Creek Ranger District, and in the Seven Sensitive Areas; it is allowed on ELTs 7 and 18.

Ecological Sustainability and Ecosystem Health

There are no areas of Management Prescriptions 1.1 and 1.2, and no emphasis on natural community restoration. While natural communities are mentioned in the plan, there is no clear direction to consider their spatial distribution or structural components in project planning. Insect and disease problems are treated diagnostically, not proactively. Artificial reforestation (pine planting) is allowed only in MP 4.1 and 4.2. There are restrictions on release and/or pre-commercial thinning in certain management prescriptions. Wildlife habitat objectives are defined by age-class distribution; those objectives vary by management prescription and landtype association. Existing lists of management indicator species emphasizes species of interest to the public, including both species that are hunted and those that are not. Information gained through monitoring population trends suggests that many of these species do not really reflect changes in habitat composition and quality.

Fire Management

While the use of prescribed burning is not precluded, there is little direction regarding the use of prescribed fire to meet Forest Plan objectives. Risk assigned to each management area is not based on site specific risk information, and does not allow a variety of suppression responses such as wildland fire use. There is no direction to initiate wildland fire management units.

Riparian Areas and Water Quality

Little to no management activities are allowed in riparian areas. Riparian areas are delineated based on frequently flooded and occasionally flooded areas. Most protection is based on use of filter strips prescribed along steams. Riparian areas, caves and springs are protected as specialized wildlife habitats.

Management Areas

There are seven management prescriptions from the 1986 Forest Plan that are included only in Alternative 5. These prescriptions are:

Table 3 - Management Prescriptions used only in Alternative 5

MP #	Management Emphasis
3.1	Management of natural vegetative communities and their successional stages to produce moderate resource outputs from a managed forest environment.
3.2	Intensive management of hardwood species capable of yielding high value products.
3.3	Grassland management for the production of cattle
3.4	Forest management which emphasizes wildlife habitat diversity
3.5	Protection for Indiana bats and their habitat in and around hibernacula and known sites of reproductively active females
4.1	Management of shortleaf pine
4.2	Management for production of sawtimber-sized eastern redcedar

Four of these management prescriptions emphasize specific species or types of vegetation (high quality hardwoods; grasslands; shortleaf pine; and eastern redcedar.) There are no prescriptions that emphasize restoration of natural communities.

Management Prescription areas for Wilderness (5.1), Semi-primitive, non-motorized recreation (6.1), candidate rivers (6.3), developed recreation areas (7.1) and designated special areas (8.1) are essentially the same as for the other alternatives. Almost a third of NFS lands are allocated to Management Prescription 3.4, which emphasizes wildlife habitat defined by age class distributions. Another third of NFS lands are allocated to Management Prescription 4.1, which emphasizes shortleaf pine management. There would be no lands allocated to Management Prescriptions 1.1, 1.2, or 2.1.

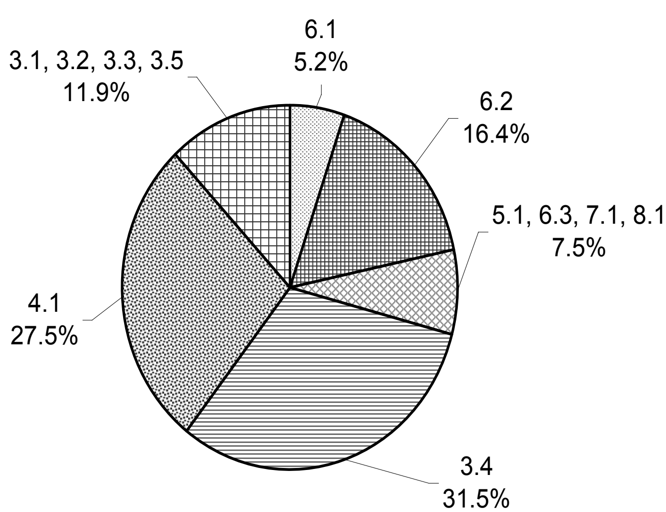


Figure 5 - Alternative 5 Management Area Allocations

Alternatives Considered but Eliminated from Detailed Study

The following alternatives were considered in the analysis, but were eliminated from further detailed study.

An alternative considering recommendation of all Inventoried Roadless Areas mapped in the Roadless Area Conservation Rule Final Environmental Statement as Wilderness Study Areas

An alternative including all five Roadless Areas mapped in the Roadless Area Conservation Rule Final Environmental Impact Statement as potential Wilderness Study Areas was considered and eliminated from detailed study.

The 2001 Roadless Rule calls for analysis of each of the RARE II areas not already designated as Wilderness during Forest Plan revision. Part of that analysis includes identification of areas that have been "substantially altered" by road construction and subsequent timber harvest.

A new Mark Twain National Forest roadless area inventory, The Forest Roadless Area Inventory and Wilderness Evaluation, was begun in 2002 and the report compiled in 2004. All five RACR inventoried areas were considered in that analysis as well as the rest of the land base in the Forest. Appendix C in this document describes the process used and displays results of the analysis.

Using the 2004 Forest Roadless Area Inventory and Wilderness Evaluation, the Forest concluded that an alternative allocating all five areas as potential Wilderness Study Areas should be eliminated from detailed study. Only one of the inventoried RACR areas, the Irish Wilderness Excluded Lands, was included as a potential Wilderness Study Area in alternatives considered in detail. When applied in 2004, the other four inventoried RACR areas did not meet minimum Roadless Inventory and Wilderness evaluation criteria, due to road management or influences from private lands. Therefore, the interdisciplinary team did not believe this to be a reasonable alternative.

The 2004 report identified eleven other potential Wilderness Study Areas in that are included in alternatives considered in detail. All of these areas are adjacent to one of five existing Wilderness areas

All the areas formerly identified as RARE II roadless areas and mapped in the Roadless Area Conservation Rule Final Environmental Statement, with the exception of the Irish Wilderness Excluded Lands, have been assigned to management areas other than potential Wilderness Study Areas in alternatives considered in detail. More detail on treatment of RACR areas in alternatives is included in Appendix C and the planning record.

An Alternative(s) providing off-road, off-trail cross-country use of motorized vehicles by changing the Forest policy of "closed unless posted open."

The current plan restricts off-road vehicle (ORV) use to designated trails or use areas. The Forest Plan allows for the development and designation of additional trails and use areas. During the comment period for the Notice of Intent a number of respondents asked that the current Forest policy be changed and allow cross-country use by ORVs.

Off-road vehicles may use Forest Service classified roads (system roads), if the vehicle complies with State law. The Forest Plan considers all unclassified roads to be closed (whether or not there is a physical closure) and therefore off-limits to all motorized vehicle use. The Forest Supervisor's closure order for roads, however, seems to restrict use only on those roads that are gated, bermed, or signed closed. OHV users have expressed confusion regarding which roads they are allowed to use, as have forest managers.

Extensive Forest Service experience with OHVs (http://www.fs.fed.us/projects/four-threats/facts/unmanaged-recreation.shtml) indicates that "open unless posted closed" policies frequently lead to environmental damage. The interdisciplinary team determined that an alternative allowing unrestricted use of OHVs would not meet the purpose and need, specifically the need to provide better protection for riparian areas and water quality. Furthermore, potential impacts of proposals for OHV use are best assessed at a site-specific level that is outside the scope of decisions made in a Forest Plan, making this alternative impractical. Such an analysis is underway. For additional information on this project, see http://www.fs.fed.us/r9/forests/marktwain/projects/projects/40401/index.htm. In the Plan revision, we have concentrated on clarifying the existing direction for OHVs.

An alternative(s) to restrict or prohibit mineral exploration and development within the Forest or within a specific area, such as the Eleven Point River.

There is a high level of interest and widely differing opinions about the mining and processing of lead in Missouri. The responsibility of the Forest Service in regards to mining is limited to the surface activities, primarily those associated with exploration for minerals. The Bureau of Land Management has responsibility and authority over federally owned minerals (including those lying under National Forest System lands).

Currently research is being conducted in Missouri by the U.S. Geological Service to determine the effects of mineral exploration and development on National Forest lands. Until this research is completed and scientific data specific to the Ozark ecosystems are available, it is impractical to consider an alternative that would drastically change management direction for the minerals program.

Under all alternatives the Forest Plan contains appropriate and adequate direction in regards to the surface activities associated with mining that occur on the Mark Twain National Forest. The goals established in the Forest Plan for minerals management are to provide for mineral prospecting and mineral development while complementing other resource management objectives. Management direction is provided to protect soil, water, wildlife, scenery and other resources.

An Alternative(s) where the Standards and Guidelines for resource management are different, either more or less restrictive.

Standards and guidelines are permissions and limitations needed to achieve the goals and objectives of the plan. They are essentially mitigation measures that minimize or negate the effects of a management action or land use. Standards and guidelines provide the baseline direction needed to protect forest resources while providing a variety of goods and services to the public. The standards and guidelines used in the alternatives were designed by the interdisciplinary team to provide needed protection and to meet the minimum management requirements established in the 1982 planning regulations. The interdisciplinary team used the best available technical and scientific information in developing the standards and guidelines.

Comparing alternatives with differing protection measures would be impractical. Therefore, it was determined that the same standards and guidelines would be used in all alternatives (with the exception of Alternative 5, No Action) to provide a baseline level of comparison. In addition, providing less restrictive standards and guidelines would not adequately protect the resources, and therefore would not meet the purpose and need for revision. Because the standards and guidelines were designed specifically to provide needed and adequate protection for the resource, more restrictive standards and guidelines would only restrict management activities without any evidence that additional protection would be provided.

An Alternative(s) that includes each of the principles and criteria from the "Citizens' Call for Ecological Forest Restoration: Forest Restoration Principles and Criteria" (Citizens' Call) as standards in the revised Forest Plan

While many of the criteria listed under the Ecological Forest Restoration Principles are aligned with the methods used to development of the Forest Plan, they are not appropriate standards. Standards and guidelines are permissions or limitations that apply specifically to on the ground implementation of management activities. As stated on page 6 of the document, the Citizen's Call "… is proposed as a national policy statement to guide sound ecological restoration policy and projects. These Restoration Principles seek to articulate a collective vision of forest restoration…." It is clear that the principles and criteria were designed for use in developing policy, programmatic direction and for guiding project planning. They were not designed to provide direction for on the ground implementation, and therefore they are not practical or effective as Forest Plan standards and guidelines.

Many of the principles and criteria identified in the Citizens' Call, modified to adapt to Midwestern ecosystems, are the same as those the Forest Service used when developing the proposed action and alternatives for the Forest Plan revision. Appendix A (Terrestrial Natural Communities) of the 2005 Forest Plan and Appendix D (Sustainability through Ecosystem Restoration) of the FEIS describe how these principles were used to develop the 2005 Forest Plan and allocate lands to the different management prescriptions.

We believe that Alternatives 1-4 embody most of the principles espoused by the Citizens' Call. Alternative 1, in particular, "was designed to respond to those who want to see passive restoration principles implemented" (Final EIS page 2-8). In this alternative, there is no commercial harvest and almost 77% of the Forest is designated as Management Prescription 6.2, emphasizing semi-primitive recreation with little to no active management activities.

Two of the Principles (Ecological Economics Core Principle and Communities and Workforce Core Principle) deal with processes that are not part of decisions made in the Forest Plan, such as agency funding mechanism, contracting, restoration on private lands, tax incentives, community development, job development and training, cooperation among communities, government and interest groups, and participation by the public in decision making processes. While the Forest Service agrees with and operates in accordance with many of the criteria listed under these Core Principles, they are not part of the six decisions made in Forest Plans. Therefore, an alternative that incorporates the principles and criteria from the Citizen's Call as standards and guidelines is impractical, does not meet the purpose and need, and was not analyzed in detail.

Comparison of Alternatives

Comparison of Alternatives by acres allocated to management prescriptions

Table 4 - Management Prescription Allocations for All Alternatives

	Management Prescription	ROS	Alt1	Alt2	Alt3	Alt4	Alt5
1.1	Restoration of natural communities	RN	120,400	576,900	376,200	120,400	N/A
1.2	Restoration of natural communities	SPM	5,400	86,900	62,200	5,400	N/A
2.1	General Forest - Management for multiple use resource objectives while allowing for enhancement of natural communities, improvement of forest health conditions	RN	0	469,500	670,100	927,800	N/A
3.1	Management of natural vegetative communities and their successional stages to produce moderate resource outputs from a managed forest environment.	RN	N/A	N/A	N/A	N/A	13,600
3.2	Intensive management of hardwood species capable of yielding high value products.	RN	N/A	N/A	N/A	N/A	74,100
3.3	Grassland management for the production of cattle	R	N/A	N/A	N/A	N/A	13,700
3.4	Forest management which emphasizes wildlife habitat diversity	RN	N/A	N/A	N/A	N/A	470,600
3.5	Protection for Indiana bats and their habitat in and around hibernacula and known sites of reproductively active females	SPM	N/A	N/A	N/A	N/A	76,400
4.1	Management of shortleaf pine	RN	N/A	N/A	N/A	N/A	411,000
4.2	Management for production of sawtimber-sized eastern redcedar	R	N/A	N/A	N/A	N/A	0
5.1	Designated Wilderness	P	64,100	64,100	64,100	64,100	64,100
6.1	Semi-primitive dispersed recreation emphasis, with limited investments in management of natural vegetative communities	SPNM	108,400	64,600	76,300	81,900	78,500
6.2	Semi-primitive dispersed recreation experience emphasis, with limited investments in management of natural vegetative communities	SPM	1,147,000	183,300	196,400	245,700	245,300
6.3	Candidate areas for National River status	SPM/RN	17,200	17,200	17,200	17,200	17,300
7.1	Developed recreation areas	R	3,000	3,000	3,000	3,000	3,000
8.1	Designated “special areas” other than Wilderness	RN	30,600	30,600	30,600	30,600	28,500
	Total		1,496,100	1,496,100	1,496,100	1,496,100	1,496,100

**Note: Acres rounded to the nearest 100*

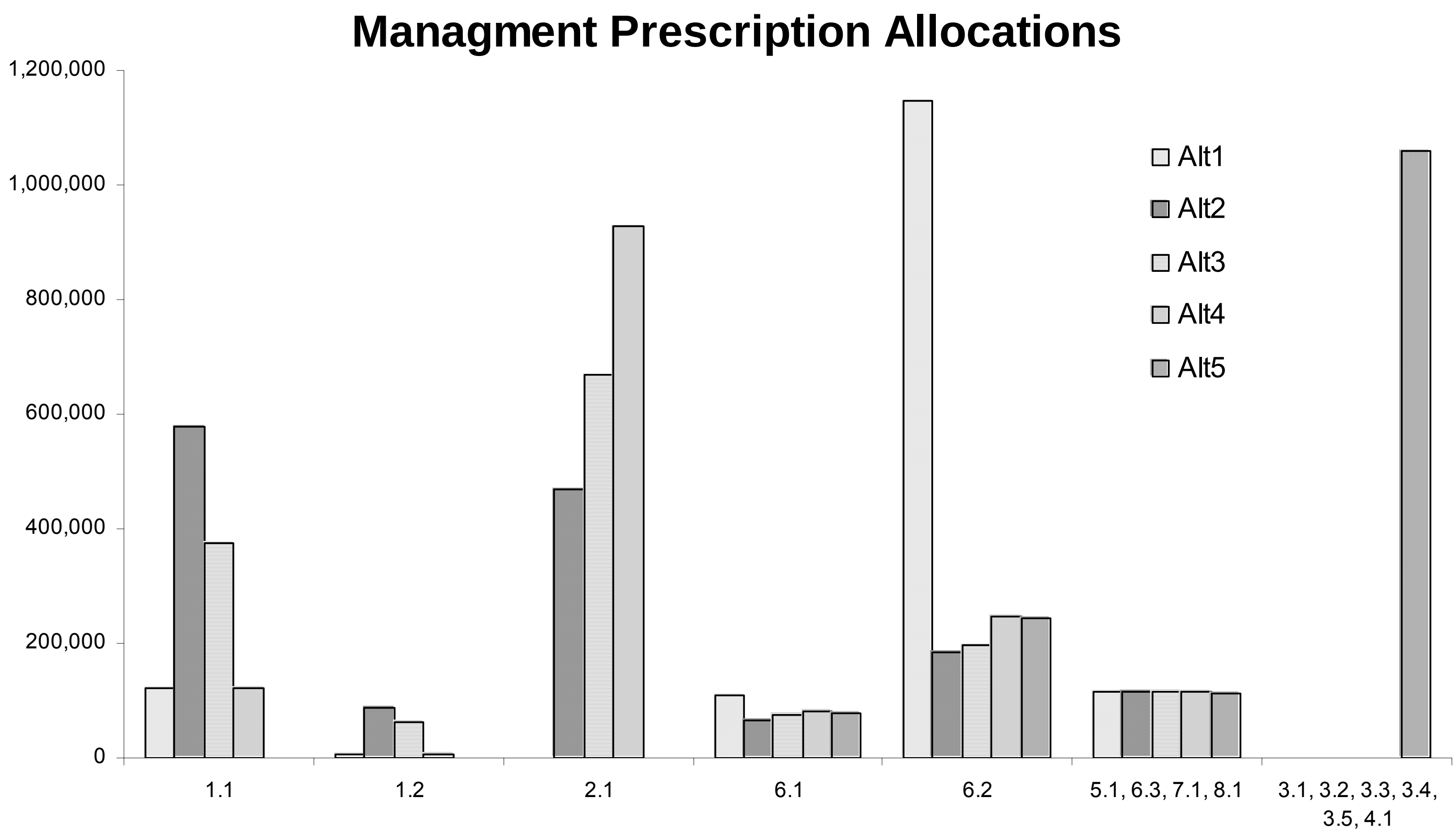


Figure 6 - Comparison of Management Prescription Allocations

Comparison of Alternatives by Key Indicators

Table 5 – Comparison of Alternatives by Key Indicators

Key Indicator	Units	Current Condition	Alternative				
			1	2	3	4	5 No Action
Issue 1 –Timber Supply.							
Average Annual Allowable Sale Quantity (ASQ)	MMBF/year	49*	0	99	103	105	105
Sawtimber Portion (1st Decade)	MMBF/year	38*	0	38.5	43.5	47.5	50
Issue 2 – Ecosystem Sustainability and Ecosystem Health							
Ground cover meeting desired condition for savanna, woodland and glade	Ac/Decade	26,000	35,600	185,500	122,800	35,600	30,000
Acres treated to move towards natural community type	Ac/Decade	<500	17,800	93,300	61,000	17,800	13,000
Acres Burned	Ac/Decade	30,000	73,000	383,000	250,000	73,000	125,000
Acres Thinned	Ac/Decade	<3,000	26,300	143,500	94,500	27,900	<15,000
Issue 3 – Wildlife Habitat Management							
OG Natural Community Types Treated in 1st decade (MP 1.1 and 1.2 only)	Range of Acres	n/a	24,200 to 37,200	125,900 to 193,900	83,400 to 128,400	24,200 to 37,200	0
Natural Community Old Growth in 50 years (MP 1.1 and 1.2 only)	Acres	n/a	5,400	36,700	24,500	12,100	<5,000
Natural Community Old Growth in 100 years(MP 1.1 and 1.2 only)	Acres	n/a	10,800	73,500	49,000	24,200	< 10,000
Early Successional habitat (first decade)	Percent of Forest	2.5%	0.6%	7.3%	7.5%	7.8%	7.5%
Management Indicator community trends	Trends		Slight increase in MP 1.1 and 1.2; Decrease on 77% of Forest	Increase in quantity and quality	Increase in quantity and quality	Slight increase in MP 1.1 and 1.2	No significant change

Key Indicator	Units	Current Condition	Alternative				
			1	2	3	4	5 No Action
Issue 4 – Fire Management							
Acres treated to progress toward Condition Class 1	% of total available Acres	0.07	0.51	0.59	0.57	0.54	0.57
Area treated with Prescribed Fire	Acres/Year	<17,000	61,630	72,420	68,800	63,700	59,320
Issue 5 – Economic Sustainability of Local Communities							
Potential Jobs as result of Forest Management	Number of jobs	4,795	4,563	4,951	4,990	5,081	5,097
Potential Labor Income as result of Forest Management	Millions of dollars	168.2	160.7	174.6	175.5	177.8	178.1
Payments to counties based on 25% funds	Millions of dollars	1.4	1.0	2.2	2.3	2.3	2.4
Area in Semi-primitive management	Percent of Forest	34%	87%	25%	25%	29%	26%

Average annual timber sold, 1986 - 2003

Comparison of Alternatives by Resource Indicators

Table 6 - Comparison of Alternatives by Resource Indicators

Key Indicator	Units	Current Condition	Alternative				
			1	2	3	4	5 No Action
Watershed conditions and riparian and aquatic area functioning.							
Total allotment acres of riparian open to grazing	Acres	3,315	1,050	1,780	1,780	1,770	0
Management intensity on sensitive soils	Relativity	Low	Low	Medium	Medium	Medium	Medium-high
Acres potentially moved toward the DC for riparian	Acres	0	12,330	31,300	24,900	12,330	0
Acres in riparian or watercourse management	Acres	65,000	84,500	84,500	84,500	84,500	65,000
Range Management							
Acres of existing allotments available for continued use	Acres	52,092	7,803	10,153	10,820	11,384	20,640
Animal Unit Months supported	AUM	26,635	10,036	22,660	23,102	22,925	26,635

Comparison of Alternatives by Effects on Resources

Table 7 - Comparison of Alternatives by Effects on Resources or Programs

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Timber Production and Supply	No commercial timber harvest allowed. An estimated 25 MMBF would be cut and left on the ground to accomplish ecosystem restoration activities in MP 1.1 & 1.2, and to meet early successional habitat needs in 6.2. Overstocked conditions would result in stands with smaller trees and more susceptible to insect and disease.	Commercial timber harvest allowed. Has the largest allocation of land in MP 1.1 & 1.2, which would influence the amount and type of timber harvest accomplished. Most harvest would be thinning producing industrial roundwood products. Tree planting is allowed along with timber stand improvement activities to enhance conditions of natural communities.	Commercial timber harvest allowed. Most harvest would be thinning producing industrial roundwood products. Tree planting is allowed along with timber stand improvement activities to enhance conditions of natural communities.	Commercial timber harvest allowed. Has less land allocated to MP 1.1 and 1.2 than Alternatives 2 or 3. More harvests would be for regeneration producing more sawtimber products due to shorter rotation ages. Tree planting is allowed along with timber stand improvement activities to enhance conditions of natural communities.	Commercial timber harvest allowed. Most harvest would be regeneration harvest producing hardwood sawtimber products with more pine trees harvested due to shorter rotation ages. Natural regeneration of trees is emphasized. Some timber stand improvement activities would not be allowed in some portions of the Forest.
Ecological Sustainability and Ecosystem Health	Ecosystem restoration and enhancement allowed only in MP 1.1 & 1.2, and would be accomplished by using mechanical treatments and prescribed fire. An increase in shade and the buildup of leaf litter would reduce current species diversity in most of the Forest.	Timber harvest, along with the use of prescribed fire, would move areas toward more open forest and woodlands. Has the largest allocation of land in MP 1.1 & 1.2, allowing more opportunities for restoration and enhancement of ecosystems.	Timber harvest, along with the use of prescribed fire, would move areas toward more open forest and woodlands. A large variety of management activities would be available to use for restoration and enhancement of ecosystems.	Timber harvest, along with the use of prescribed fire, would move areas toward more open forest and woodlands. Land Allocations would result in smaller scale restoration of open forested natural communities with timber harvest and prescribed fire.	No lands allocated specifically for large scale restoration of natural communities; the least number of acres managed for more open forestland. The forest would look much the same as it does today with dense forested and overstocked lands. Fewer management activities could be used to restore or enhance natural communities.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wildlife Habitat Management	High chance that Bachman's sparrow would be extirpated from Missouri. More MIS, TES, RFSS and other species of concern negatively affected by lack of management and lack of early successional habitats.	High likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.	High likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.	Good likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.	Good likelihood that all MIS, TES, RFSS, and other species of concern remain viable and are distributed in historical patterns.
Fire and Fuels Management	Fuels management would only be accomplished without removal of timber products, using mechanical treatments and prescribed fire. Less than five percent of the forest would be treated specifically to move from fire regime condition class 3 to 1. Without removal of fallen trees, high fuel loads would remain in the forest. More frequent catastrophic stand replacing wildland fire could occur.	Fuels management and prescribed fire are used to change fire regime condition class at the highest levels resulting in an increase in an open forest and woodlands and a reduction of fuels within the Urban Wildland Interface. Wildland fires should be easier to suppress and have less erratic behavior within treated areas.	Fuels management and prescribed fire are used to change fire regime condition class are at a high level resulting in an increase in an open forest and woodlands and a reduction of fuels within the Urban Wildland Interface. Wildland fires should be easier to suppress and have less erratic behavior within treated areas.	Fuels management and prescribed fire are used to change fire regime condition class are at a level similar to alternative 1. Though timber harvest is used to remove and reduce fuels within the Urban Wildland Interface. Wildland fires should be easier to suppress and have less erratic behavior within treated areas.	No direction to restore fire dependant natural communities or reduce fuel loading in the forest. The least amount of prescribed fire of any alternative due to current management restrictions. Fewer acres would move to a historical fire regime condition class.
Economic and Social Sustainability	Jobs and income resulting from all activities are at the lowest level due to the restriction on commercial timber harvest. Lowest payments made to counties of any alternative.	Jobs and income are the lowest of all management based alternatives. Payments to counties the same for Alternatives 2 - 5.	Jobs and income slightly higher than for Alternative 2. Payments to counties the same for Alternatives 2 - 5.	Jobs and income resulting from all activities are at a level similar to Alternative 5. Payments to counties the same for Alternatives 2 - 5.	Jobs and income resulting from all activities are at the highest level due to an increase in commercial timber harvest and emphasis on sawtimber production. Payments to counties the same for Alternatives 2 - 5.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Management Area Allocations	Minimum land allocation in MP 1.1 and 1.2 considered feasible for restoration of natural communities.	Largest allocation of land in MP 1.1 for 1.2 for large scale restoration of natural communities.	Though less than in Alternative 2, allocation of land in MP 1.1 and 1.2 would allow large scale restoration of natural communities.	Majority of land is allocated to MP 2.1 where timber management is the emphasis. Land allocation in MP 1.1 and 1.2 same as for Alternative 1.	No change from current Forest Plan in management prescriptions or allocations of lands.
Riparian Areas, Water Quality and Soils	Lowest impact on soils due to the least amount of management of any alternative. Due to overall reduction in management as a result of land allocation to semi-primitive areas, the least amount of acres in riparian natural communities would be restored. Areas in riparian or watercourse protection zones are the same for Alternatives 1 – 4.	Soils impacts less than in alternative 5 as a result of changed standards and guidelines and differing levels of management activities. The highest amounts of activities to restore riparian communities. Areas in riparian or watercourse protection zones are the same for Alternatives 1 – 4.	Soils impacts the same as in Alternative 2. Activities to restore riparian communities between those in Alternatives 2 and 4. Areas in riparian or watercourse protection zones are the same for Alternatives 1 – 4.	Soils impacts would be same as in Alternative 2. The lowest amounts of activities to restore riparian communities. Areas in riparian or watercourse protection zones are the same for Alternatives 1 – 4.	Largest impacts on soils due to highest intensity of timber and other management activities resulting in greater need to temporarily access interior forest areas. No specific direction to restore riparian natural communities. Least amount of acres covered under watercourse management direction.
Recreation	Estimated 15% decrease in dispersed recreation activities, such as hunting, due to reduced access and species diversity.	Estimated 20% increase in dispersed recreation activities as a result of ecosystem restoration and species diversity.	Estimated 10% increase in dispersed recreation activities as a result of ecosystem restoration and species diversity.	No expected change due to management though could change with population demographics.	No expected change due to management though could change with population demographics.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Recreation Opportunity Spectrum	87% of the Forest would be managed for semi-primitive objectives. More solitude would be found in areas with less management.	22% of the Forest would be managed for semi-primitive objectives. More acres are allocated to roaded natural recreation objectives which would provide for more motorized use.	25% of the Forest would be managed for semi-primitive objectives. Acres allocated to roaded natural recreation objectives are similar to Alternative 2.	25% of the Forest would be managed for semi-primitive objectives. Acres are allocated to roaded natural recreation objectives similar to Alternative 2.	29% of the Forest would be managed for semi-primitive objectives. Slightly more acres are allocated to semi-primitive recreation objectives then in alternatives 2 - 4, though motorized use would be at similar levels.
Wilderness Study Areas Roadless	Thirteen areas recommended for Wilderness study.	Thirteen areas recommended for Wilderness study.	Thirteen areas recommended for Wilderness study.	Thirteen areas recommended for Wilderness study.	No areas recommended for Wilderness study.
Wild and Scenic Rivers	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	2005 Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. Place one additional river into MP 6.3	Current Forest Plan Standards and Guidelines would protect the Outstandingly Remarkable Values of classified Rivers under MP 6.3. NO additional rivers will be classified.
Heritage Resources	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	2005 Forest Plan Standards and Guidelines would protect the heritage resource values.	Current Forest Plan Standards and Guidelines would protect the heritage resource values.

Resource	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Access and Transportation Management	In the short-term, roads would become more difficult to travel on due to limited maintenance and reconstruction. In the long-term, many local, dead-end, maintenance level 2 roads would be closed and/or decommissioned, thus limiting motorized travel to a small road network of maintenance level 3 and 4 roads.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.	No appreciable changes to the transportation system or the long-term motorized access of the Mark Twain NF.
Rangeland Management	Grazing would be the lowest of all alternatives.	Grazing would be the second lowest of the alternatives, since it would be phased out in MP 1.1 and 1.2 and within riparian areas in an effort to restore glade and riparian natural communities	Grazing would be reduced since it would be phased out in MP 1.1 & 1.2 and within riparian areas.	Grazing would be phased out in MP 1.1 & 1.2 and within riparian areas.	Grazing could continue affecting glade ecosystems and reducing their diversity of species.

Table 8 - Comparison of Effects on Management Indicator Species (5 total)

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
No significant change in habitat from current condition	2 species (Worm-eating warbler, red bat)	1 species (Worm-eating warbler)	1 species (Worm-eating warbler)	All species (Worm-eating warbler, red bat, Summer tanager, northern bobwhite, Bachman's sparrow)	All species (Worm-eating warbler, red bat, Summer tanager, northern bobwhite, Bachman's sparrow)
Short & long term negative impact on habitat quality and quantity	1 species (Summer tanager), due to continued dense canopy, impoverished ground flora & lack of early successional habitat	None	None	None	None
Long term negative impact on habitat quality and quantity	2 species (northern bobwhite, Bachman's sparrow), due to continued dense canopy, impoverished ground flora & lack of early successional habitat	None	None	None	None
Short & long term positive effects on habitat quantity & quality	None	4 species (Summer tanager, red bat, northern bobwhite, Bachman's sparrow) due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	4 species (Summer tanager, red bat, northern bobwhite, Bachman's sparrow) due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	None	None
Likelihood of viability	**High** likelihood that Bachman's sparrow would be extirpated from Missouri due to lack of open woodland and early successional habitat - indicator of decrease in all open pine woodland species	**High** likelihood that all habitats & species represented by MIS remain viable throughout MTNF and distributed in patterns approaching historical occurrence	**High** likelihood that all habitats & species represented by MIS remain viable throughout MTNF and distributed in patterns approaching historical occurrence	**Good** likelihood that all habitats & species represented by MIS remain viable throughout MTNF and distributed in patterns approaching historical occurrence	**Good** liklihood that all habitats & species represented by MIS remain viable throughout MTNF and distributed in patterns approaching historical occurrence

Table 9 - Comparison of Effects on Federally - Listed Threatened and Endangered Species (11 animals, 2 plants)

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
No significant change in habitat from current condition	11 species	8 species	8 species	11 species	11 species
Positive effect on habitat quality & availability	None	4 species	4 species	None	None
Topeka shiner habitat - Cedar Creek Unit	Long-term positive effect with protection of Watershed Protection Zones (WPZ)	Long-term positive effect with protection of WPZ	Long-term positive effect with protection of WPZ	Long-term positive effect with protection of WPZ	Long-term positive effect with protection of riparian areas
Hine's Emerald dragonfly habitat	Long-term decrease	No Change from Current	No Change from Current	No Change from Current	No Change from Current
Mead's milkweed habitat	Long-term adverse impact with potential for population to disappear with out glade management in Wilderness area	Long-term adverse impact with potential for population to disappear with out glade management in Wilderness area	Long-term adverse impact with potential for population to disappear with out glade management in Wilderness area	Long-term adverse impact with potential for population to disappear with out glade management in Wilderness area	Long-term adverse impact with potential for population to disappear with out glade management in Wilderness area
Meets or exceeds Recovery Plan objectives	All species except Mead's milkweed	All species except Mead's milkweed	All species except Mead's milkweed	All species except Mead's milkweed	All species except Mead's milkweed

Table 10 - Comparison of Effects on Regional Forester Sensitive Species (36 animals)

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
No significant change in habitat from current condition	24 species	24 species	24 species	24 species	24 species
Long term negative impact on habitat quality and quantity	3 species due to continued dense canopy, impoverished ground flora, and lack of early successional habitat	None	None	None	None

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Short & long term positive effects on habitat quantity & quality	None	1 species short term; 3 species long term, due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	1 species short term; 3 species long term, due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	None	None
Short & long term negative impact on habitat quality and quantity	None	None	None	1 species due to continued dense canopy & impoverished ground flora	1 species due to continued dense canopy & impoverished ground flora
Species trending towards listing	**High** likelihood that Bachman's sparrow would trend toward listing due to lack of management action on MTNF leading to lack of open woodland and early successional habitat.	MTNF activities do not contribute to trend toward listing any RFSS	MTNF activities do not contribute to trend toward listing any RFSS	MTNF activities do not contribute to trend toward listing any RFSS	MTNF activities do not contribute to trend toward listing any RFSS
Likelihood of viability	Possibility of decreased viability for 3 species due to continued dense canopy, impoverished ground flora and lack of early successional habitat. Good likelihood that all other habitats & species remain viable.	**High** likelihood that all habitats & species remain viable throughout MTNF and distributed in patterns approaching historical occurrence	**High** likelihood that all habitats & species remain viable throughout MTNF and distributed in patterns approaching historical occurrence	**Good** likelihood that all habitats & species remain viable throughout MTNF and distributed in patterns approaching historical occurrence	**Good** likelihood that all habitats & species remain viable throughout MTNF and distributed in patterns approaching historical occurrence

Table 11 - Comparison of Effects on Regional Forester Sensitive Species (76 plants)

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Forest habitat	Available in same or greater amount than present.	Available in at least historic amounts.	Available in at least historic amounts.	Available in at least historic amounts.	No significant change from present conditions in amount or quality
Open woodland, closed woodland, glade, savanna, wetland & fen habitats	Some increase in amount & slight increase in quality due to community restoration in MP 1.1 & 1.2, but habitat quality and quantity reduced on 77% of MTNF	Significant Increase in amount & quality due to community restoration	Significant Increase in amount & quality due to community restoration	Some increase in amount & slight increase in quality due to community restoration	No significant change from present conditions in amount or quality
Prairie habitat	Slight increase in quality, but so few acres affected that no significant effect on species viability	Slight increase in quality, but so few acres affected that no significant effect on species viability	Slight increase in quality, but so few acres affected that no significant effect on species viability	Slight increase in quality, but so few acres affected that no significant effect on species viability	No significant change from present conditions in amount or quality
Likelihood of viability	**Fair** likelihood that all habitats & plant species remain viable throughout MTNF and distributed in patterns moving toward historical occurrence; MTNF activities do not contribute to trend toward listing any RFSS plants	**High** likelihood that all habitats & plant species remain viable throughout MTNF and distributed in patterns approaching historical occurrence; MTNF activities do not contribute to trend toward listing any RFSS plants	**High** likelihood that all habitats & plant species remain viable throughout MTNF and distributed in patterns approaching historical occurrence; MTNF activities do not contribute to trend toward listing any RFSS plants	**Good** likelihood that all habitats & plant species remain viable throughout MTNF and distributed in patterns approaching historical occurrence; MTNF activities do not contribute to trend toward listing any RFSS plants	**Good** likelihood that all habitats & plant species remain viable throughout MTNF and distributed in patterns approaching historical occurrence; MTNF activities do not contribute to trend toward listing any RFSS plants

Table 12 - Comparison of Effects on State Endangered Species (30)

All State Endangered species have been analyzed under Federal, RFSS, MIS and/or SVE

Table 13 - Comparison of Effects on Other Species at Risk (66 animals)

40 animal species also included in Federal, RFSS, or MIS analysis

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
No significant short term change in habitat from current condition	46 species	41 species	41 species	51 species	51 species
No significant long term change in habitat from current condition	45 species	43 species	43 species	58 species	59 species
Long term positive effects to habitat	4 species due to positive effects to limited prairie & swamp habitat due to MP 1.1 restorations & prairie streams due to WPZ's	20 species due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	20 species due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	4 species due to positive effects to limited prairie & swamp habitat due to MP 1.1 restorations & prairie streams due to WPZ's	4 species due to positive effects to limited swamp habitat due to MP 1.1 restorations & prairie streams due to WPZ's
Short term positive effects on habitat quantity & quality		10 species due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2	10 species due to increased amount of quality open woodland, glade, savanna communities in MP 1.1 & 1.2		
Short term negative effects on habitat quantity & quality	5 species due to lack of availability of early successional & disturbance-dependent habitats, and quality of openland habitat				
Long term negative effects on habitat quantity & quality	13 species due to lack of availability of early successional & disturbance-dependent habitats, and quality of openland habitat			2 species due to negative effects on canebrakes from lack of disturbance and large open glades from continued invasion of red cedar	2 species due to negative effects on canebrakes from lack of disturbance and large open glades from continued invasion of red cedar
Long term unknown impacts		3 species	3 species		

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Species with significant concerns for long-term viability in Missouri due to MTNF activities	1 Species with significant concern for long-term viability in Missouri due to MTNF activities (Bachman's sparrow – MIS, State Endangered) due to decrease in early successional habitat & lack of open pine woodland	None	None	None	None

Table 14 - Comparison of Effects on Other Species at Risk (176 plants)

Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Forest habitat	Available in same or greater amount than present	Available in at least historic amounts	Available in at least historic amounts	Available in same or greater amount than present	No significant change from present conditions in amount or quality
Open woodland, closed woodland, glade, savanna, wetland & fen habitats	Some increase in amount & slight increase in quality due to community restoration	Significant increase in amount & quality due to community restoration	Significant increase in amount & quality due to community restoration	Some increase in amount & slight increase in quality due to community restoration	No significant change from present conditions in amount or quality
Prairie habitat	Slight increase in quality, but so few acres affected that no significant effect on species viability	Slight increase in quality, but so few acres affected that no significant effect on species viability	Slight increase in quality, but so few acres affected that no significant effect on species viability	Slight increase in quality, but so few acres affected that no significant effect on species viability	No significant change from present conditions in amount or quality
Species with significant concerns for long-term viability in Missouri due to MTNF activities	1 plant specie with significant concerns for viability due to MTNF activities (Mead's milkweed - see Federal species)	None	None	None	None

Table 15 - Comparison of Alternatives in Meeting Conservation Approaches for Species at Risk

Conservation Approach	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
A: Maintain riparian structure and function	Meets	Meets	Meets	Meets	Meets
B: Maintain free-flowing streams and rivers	Meets	Meets	Meets	Meets	Meets
C: Minimize sedimentation from National Forest lands	Meets	Meets	Meets	Meets	Meets
D: Maintain hydrologic integrity of wetland and lowland forest natural communities	Meets for lowland forest; Partially meets for wetlands	Meets	Meets	Meets for lowland forest; Partially meets for wetlands	Meets for lowland forest; Partially meets for wetlands
E: Maintain forested landscapes (with all successional stages present)	Meets	Meets	Meets	Meets	Meets
F: Restore prescribed fire regimes and manage fire-adapted natural communities	Partially meets	Meets	Meets	Partially meets	Meets least of all alternatives
G: Protect the structural and biological integrity of caves and reduce human disturbance to cave systems.	Meets	Meets	Meets	Meets	Meets
H: Protect and manage known locations of species at risk	Meets for listed species; Partially meets for non-listed SAR	Meets for listed species; Partially meets for non-listed SAR	Meets for listed species; Partially meets for non-listed SAR	Meets for listed species; Partially meets for non-listed SAR	Meets for listed species; Partially meets for non-listed SAR
I: Retain den trees and snags, downed woody material (particularly large size)	Meets	Meets	Meets	Meets	Meets for most habitat types; May or may not meet for in-stream woody
J: Control non-native invasive species	Meets	Meets	Meets	Meets	May or may not meet

Table 16 - Comparison of Alternatives in Meeting Indiana bat Habitat Needs

Resource	Habitat Needs Addressed	Alt 5 (1986 Plan) MP 3.5 Management Direction	Alts 1-4 MP 1.1 & 1.2 Management Direction	Habitat Needs Provided	Alts 1-4 MP 2.1 Management Direction	Habitat Needs Provided
Vegetation	Foraging habitat near hibernacula Roost trees near hibernacula Foraging & roost trees within maternity colony area	Vegetation management done only to improve or enhance Indiana bat habitat, to maintain or enhance natural vegetative communities on appropriate sites, or for public safety.	Restore, enhance, maintain the structure, composition & function of distinctive natural communities. Distribute activities across landscape to emulate historical vegetation patterns & quantities. Character of maternity colony areas maintained or enhanced by maintaining snags & roost trees & foraging habitat.	Same	Manage natural communities to enhance & retain their characteristic ecological elements. Distribute activities across landscape to emulate historical vegetation patterns & quantities. Character of maternity colony areas maintained or enhanced by maintaining snags & roost trees & foraging habitat.	Same
Rangeland	Foraging habitat across landscape over time Roost trees across landscape over time	Development of forage resource limited to existing allotments and allotment plans designed to protect or enhance Ibat habitat and water quality values	Grazing only on existing improved pastures. Close all areas that contain glades and natural woodlands when the current permit expires. Limitations on grazing w/in WRZ & RMZ to protect water quality. W/in allotments, retain all living shagbark & shellbark hickory, white oak, lightning struck & cavity trees >=12" dbh, unless pose safety hazard.	Better in Revised Plan	Limitations on grazing w/in WRZ & RMZ to protect water quality. W/in allotments, retain all living shagbark & shellbark hickory, white oak, lightning struck & cavity trees >=12" dbh, unless pose safety hazard.	Same or better in Revised Plan

Resource	Habitat Needs Addressed	Alt 5 (1986 Plan) MP 3.5 Management Direction	Alts 1-4 MP 1.1 & 1.2 Management Direction	Habitat Needs Provided	Alts 1-4 MP 2.1 Management Direction	Habitat Needs Provided
Recreation	Minimize physical disturbance near hibernacula entrance & maternity colony areas	Semi-primitive non-motorized in key area.	Avoid road construction above known cave passages w/in 100 feet of cave entrance. Relocate roads away from cave entrances when possible. Minimize human disturbance near maternity colonies during summer season.	Same	Avoid road construction above known cave passages w/in 100 feet of cave entrance. Relocate roads away from cave entrances when possible. Minimize human disturbance near maternity colonies during summer season.	Same
Recreation	None	Semi-primitive motorized in primary area	1.1 Roaded natural 1.2 Semi-primitive motorized	No habitat need addressed	Roaded natural	No habitat need addressed
Visual Quality	None	Visual quality objective = Modification	VQO determined based on site-specific conditions; range from Retention to Maximum Modification	No habitat need addressed	VQO determined based on site-specific conditions; range from Retention to Maximum Modification	No habitat need addressed
Recreation	Hibernation with no human disturbance	Caves closed to human visitation Sept 15 – April 30	Do not allow human entry during fall swarming, hibernation , & spring emergence	Same	Do not allow human entry during fall swarming, hibernation , & spring emergence	Same

Resource	Habitat Needs Addressed	Alt 5 (1986 Plan) MP 3.5 Management Direction	Alts 1-4 MP 1.1 & 1.2 Management Direction	Habitat Needs Provided	Alts 1-4 MP 2.1 Management Direction	Habitat Needs Provided
Timber	Foraging habitat across landscape over time Roost trees across landscape over time	Timber management only to improve or enhance Ibat habitat, to maintain or enhance natural vegetative communities on appropriate sites or for public safety	Prohibit timber harvest w/in 100 feet of cave entrance. Prohibit skid trails w/in 100 feet of cave entrance. Use silvicultural method appropriate to move toward desired conditions based on management objectives, natural community type, stand conditions, and silvical characteristics of tree species. Intermediate harvest normally leave largest &/or oldest trees to meet basal area objectives. All even-aged regeneration will leave 7-10% as reserve trees or groups. Rotation ages are: 100 SLP, 120 PO/WO; 80 RO/SO/BO	Better in Revised Plan	Prohibit timber harvest w/in 100 feet of cave entrance. Prohibit skid trails w/in 100 feet of cave entrance. Use silvicultural method appropriate to move toward desired conditions based on management objectives, natural community type, stand conditions, and silvical characteristics of tree species. Intermediate harvest normally leave largest &/or oldest trees to meet basal area objectives. All even-aged regeneration will leave 7-10% as reserve trees or groups. Rotation ages are: 70 SLP; 90 PO/WO; 70 RO/SO/BO	Same
Wildlife	Hibernation with no human disturbance	Protect hibernacula by restricting human entry Sept 15 – April 30	Do not allow human entry during fall swarming, hibernation, & spring emergence	Same	Do not allow human entry during fall swarming, hibernation, & spring emergence	Same
Wildlife	Cave microclimate maintained	Structures must permit bats to pass & must not alter airflow	Structures must permit bats to pass & must not alter airflow	Same	Structures must permit bats to pass & must not alter airflow	Same

Resource	Habitat Needs Addressed	Alt 5 (1986 Plan) MP 3.5 Management Direction	Alts 1-4 MP 1.1 & 1.2 Management Direction	Habitat Needs Provided	Alts 1-4 MP 2.1 Management Direction	Habitat Needs Provided
Wildlife	Cave microclimate maintained Roost trees near hibernacula Foraging habitat near hibernacula Minimize physical disturbance near hibernacula entrance	AOI Key area 20 acres OG & additional 130 acres mature forest	At least 20 acres OG around cave & additional 130 acres mature forest or woodland	Same	At least 20 acres OG around cave & additional 130 acres mature forest or woodland	Same
Wildlife	Roost trees near hibernacula Foraging habitat near hibernacula	AOI Primary range – up to 5 miles- 20% OG and minimum 50% oak/oak-pine >50	Range of ages including old growth throughout management areas. Designate tree groups/stands >175 years old as OG.	More dispersed through landscape than current Plan	Designate 8-12% OG for each management area. Designate tree groups/stands >175 years old as OG.	Fewer OG acres, but roost trees don't appear limiting on MTNF
Wildlife	Foraging habitat across landscape over time	AOI Primary range - Maintain minimum 50% in pole/saw with 50-70% canopy closure	Open and closed woodland natural communities desired basal area is 30-50% and 50-90% respectively. Maternity colony areas should maintain canopy gaps for foraging.	Better in Revised Plan	Open and closed woodland natural communities desired basal area is 40-70 and 70-90% respectively. Maternity colony areas should maintain canopy gaps for foraging.	Foraging distributed across landscape on appropriate sites

Resource	Habitat Needs Addressed	Alt 5 (1986 Plan) MP 3.5 Management Direction	Alts 1-4 MP 1.1 & 1.2 Management Direction	Habitat Needs Provided	Alts 1-4 MP 2.1 Management Direction	Habitat Needs Provided
Wildlife	Foraging habitat across landscape over time	AOI Primary range - Natural regeneration ok to perpetuate oak-hickory/oak-pine forest. No more than 7% in 0-9 age class at any time.	MP 1.1 & 1.2 - Desired canopy gaps in open woodland = 10 acres with 1-3 per 100 acres and in closed woodland = 3 acres with 1-5 per 100 acres. MP 1.2 - No more than 20% of each Management Area harvested during each decade	Better in Revised Plan	Regen 8-15% each management area w/1-5% in openings <=2 acres. Regen openings distributed proportionately to ELTs and natural communities present.	Same or better in Revised Plan
Wildlife	Drinking water	AOI Primary range 1-4 water sources per square mile	No new wildlife waterholes unless demonstrated viability need for TES, RFSS, species group; Construct temporary pools at end of outlet ditches when possible.	Same	Construct new waterholes only where existing water sources limited or lacking. Manage & rehabilitate existing waterholes as priority over constructing new ones. Construct temporary pools at end of outlet ditches when possible.	Same
Wildlife	Foraging habitat across landscape over time	AOI Primary range -Up to 15% can be in open or semi-open habitats	Maintain or improve artificial openlands only where they currently exist	Better in Revised Plan	Maintain or improve artificial openlands only where they currently exist	Better in Revised Plan

Resource	Habitat Needs Addressed	Alt 5 (1986 Plan) MP 3.5 Management Direction	Alts 1-4 MP 1.1 & 1.2 Management Direction	Habitat Needs Provided	Alts 1-4 MP 2.1 Management Direction	Habitat Needs Provided
Minerals	Cave microclimate maintained Minimize physical disturbance near hibernacula entrance Minimize disturbance near maternity colony areas	No drilling in key area.	Prohibit drilling or other surface disturbing mineral operations over known caves & within 150 acre hibernacula buffer. No surface disturbing mineral activity w/in 100 feet of cave entrance. Minimize human disturbance near maternity colonies during summer season.	Same	Prohibit drilling or other surface disturbing mineral operations over known caves & within 150 acre hibernacula buffer. No surface disturbing mineral activity w/in 100 feet of cave entrance. Minimize human disturbance near maternity colonies during summer season.	Same
Fire	Cave microclimate maintained Summer roosting bats Fall swarming	All Indiana bat AOI considered smoke sensitive areas	Area around Indiana bat cave is smoke sensitive area. Conduct prescribed burning within maternity colony areas only during hibernation season. Avoid prescribed burning within 150 acre buffer at Ibat hibernacula in swarming & staging periods. Prescribed burning in maternity colony areas only during hibernation season.	Same	Area around Indiana bat cave is smoke sensitive area. Conduct prescribed burning within maternity colony areas only during hibernation season. Avoid prescribed burning within 150 acre buffer at Ibat hibernacula in swarming & staging periods. Prescribed burning in maternity colony areas only during hibernation season.	Same

Chapter 3

Affected Environment and Environmental Effects

Cover image: Bluffs along Big Piney River

Photographer: Gary Schmidgall, Retired Forest Service

Chapter 3

Affected Environment and Environmental Effects

Introduction

Chapter 3 describes the existing physical, biological, and social resources of the environment that may be affected by alternatives presented in Chapter 2. It also presents the effects that alternatives may have on those resources. The discussion of affected environment and environmental effects was combined into one chapter to provide a clear picture of what resources are and what could happen to them under different alternatives. Analysis of environmental effects provides the basis for comparison of alternatives that appears at the end of Chapter 2.

Mitigation Measures

Mitigation measures, as defined by 40 CFR 1508.20 include:

- Avoiding the impact altogether by declining to take an action or part of an action;
- Minimizing impacts by limiting the degree or magnitude of an action or its implementation;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; and/or
- Compensating for the impact by replacing or providing substitute resources or environments.

At a programmatic level, Forest-wide and Management Area Standards and Guidelines provide appropriate mitigation measures for all alternatives (see the accompanying 2005 Forest Plan). While not listed specifically, this also includes administrative guidance including all laws, regulations, and Forest Service manual or other policies.

At the site-specific project level, analysis may indicate a need for additional mitigation measures to resolve site-specific issues. Monitoring efforts will determine the effectiveness of mitigation measures (See Chapter 4 of the Forest Plan for the Monitoring Strategy).

Relationship between Programmatic and Site-Specific Analysis

The 2005 Forest Plan and FEIS are programmatic documents. The FEIS discusses environmental effects on a broad scale. Over the lifetime of the 2005 Forest Plan, the Selected Alternative and accompanying Forest-wide Standards and Guidelines will set Forest management direction by establishing and affirming rules and policies for use of natural resources.

Because this document contains a Forest-wide level of analysis, it does not predict what will happen when Forest-wide Standards and Guidelines are implemented on individual, site-specific projects. Nor does it convey the long-term environmental consequences of any site-specific project. These actual effects will depend on the extent of each project, environmental conditions at the site (which vary across the Forest), site-specific mitigation measures, and their effectiveness.

In preparing this document we focus on explaining which consequences are most likely to occur and why. By combining this broad assessment with site-specific information, a reader can make a reasonable prediction about the kinds of environmental effects that would result from a specific project.

We do not describe every environmental process or condition on the Mark Twain National Forest in this document because that would be impractical, given the complexity of natural systems. The purpose of the FEIS is to provide a survey of broader environmental and social factors relevant to the programmatic planning process.

After the 2005 Forest Plan is approved, the accompanying analysis in this FEIS will be used in “tiering,” so that the broader analysis and conclusions in this document can be used as a starting point for site-specific project planning. Each project’s environmental effects analysis document will incorporate, by reference, information found in this FEIS, without the need to repeat it.

Forest Profile

The Forest profile provides the context in which alternatives are analyzed. This section has three parts:

- Social and Economic Setting – Gives a brief overview of the key social and economic components of the area.
- Physical and Biological Setting – Gives a brief overview of the key physical and biological components of the area.
- Ecosystem Management – Presents the ecosystem management framework that was used in analysis of resources and issues in Chapter 3. This section also introduces the reader to key components and concepts of the framework.

Social and Economic Condition

The relationship between the Mark Twain National Forest and local lifestyles and economies is interdependent and complex. Outdoor recreation, seven Wilderness areas, an exceptional wild and scenic river, and unique ecosystems all provide a stunning backdrop to communities that are growing at a fast pace.

Missouri has approximately 44,606,000 acres of land. The Mark Twain National Forest administers approximately 1,485,800 acres. This constitutes approximately 3.4% of the total state land base. Almost 30% of the land in Missouri is forested, making it 20th in the nation in the amount of forested land. The Forest manages 10% of the forested land and 84% of the publicly owned forested land in Missouri (Missouri’s Forest Resource 1989).

The Forest is composed of nine separate geographic units which span the state over 200 miles east to west and 175 north to south. (See Map “Mark Twain National Forest Offices”.) Private land parcels are scattered throughout the Forest boundaries. On average, Federal ownership within the boundaries of the National Forest is about 49%, and ranges from a low of 24% at Cedar Creek unit to a high of 71% at Eleven Point unit.

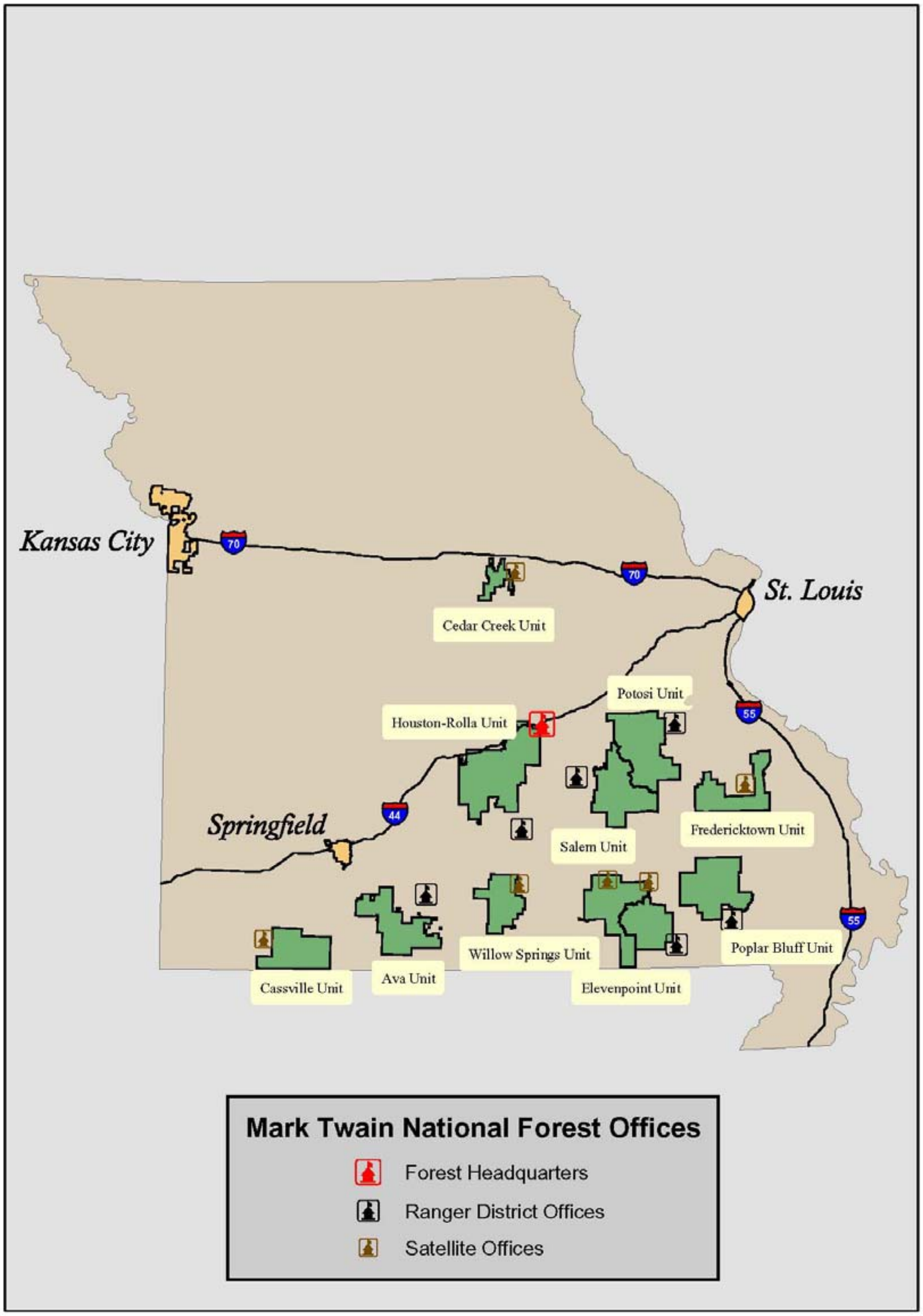

Kansas City
St. Louis
Springfield
70
70
44
55
55
Cedar Creek Unit
Houston-Rolla Unit
Potosi Unit
Fredericktown Unit
Salem Unit
Poplar Bluff Unit
Willow Springs Unit
Elevenpoint Unit
Cassville Unit
Ava Unit
Mark Twain National Forest Offices
Forest Headquarters
Ranger District Offices
Satellite Offices

Table 1 – Acres in Mark Twain NF Units

Unit/District	Net Acres	Gross Acres	Percent National Forest
Ava	143,635	288,330	50
Cassville	65,370	246,945	27
Cedar Creek	16,310	68,170	24
Eleven Point	331,725	469365	71
Fredericktown	84,010	226,200	37
Houston/Rolla	191,235	506,820	38
Poplar Bluff	156,540	335,275	47
Potosi/Salem	394,215	676,400	58
Willow Springs	102,760	194,620	53
Total	1,485,800	3,012,000	49

Source: Mark Twain National Forest, FY2002 based upon FS-383, 1/3003

There is National Forest land in 29 of Missouri's counties. The percentage of National Forest land within each county ranges from a low of 0.2% in St Francois County to a high of 28% in Carter County. On average, National Forest lands comprise about 11% of the 29 counties that contain National Forest land (USDA Forest Service 2004c). State and federal agency lands comprise about 7% of the land base.

The social environment comprises the people living in and adjacent to the Mark Twain National Forest. For the purposes of socioeconomic analysis, the study area has been divided into regions by geographic unit. Each unit has a unique configuration of socioeconomic conditions that influence its social and cultural character and contribute to the definition of and public response to natural resource issues. Table 2 shows the seven units and the counties they contain.

Table 2 - Study Regions and Counties Included

Unit	Counties	Total Acreage
Ava-Cassville-Willow Springs	Christian, Ozark, Taney, Barry, Stone, Douglas, Howell (7)	311,764
Cedar Creek	Boone, Callaway (2)	16,310
Eleven Point	Carter, Oregon, Ripley, Shannon (4)	376,639
Fredericktown	Bollinger, Iron, Madison, Saint Francois, Sainte Genevieve (5)	159,193
Houston-Rolla	Laclede, Phelps, Pulaski, Texas, Wright (5)	191,236
Poplar Bluff	Butler, Wayne(2)	136,704
Salem-Potosi	Crawford, Dent, Reynolds, Washington(4)	272,419
TOTALS	29 Counties	1,464,265

Source: www.census.gov

Historical Background

The Mark Twain National Forest has cultural resources dating back to Paleo-Indian times, prior to 10,000 B.C. The Llano, the oldest culture of the Paleo-Indian period, existed from 10,000 to 9,000 B.C. The Folsom culture follows from 9,000 to 8,000 B.C. and the Dalton culture from 8,000-7,000 B.C. These three cultures were small, family group bands that lived nomadic lifestyles.

As the Paleo-Indian culture moves toward the Archaic, social makeup of the groups became more and more complex. The Archaic Period (7,000 – 1,000 B.C.) is divided into three parts: Early, Middle, and Late. During the Early Archaic Period, reliance on vegetables and fruits increases and people begin to fish with traps and nets. Semi-nomadism begins and caves or rock shelters become semi permanent homes. Family based groups still dominated the social organization of bands. The Late Archaic Period brought warm and dry weather to the Ozarks. Tools reflect gathering and hunting. Settlements become seasonal.

The Woodland Period (1,000 B.C. – 900 A.D.) is a period of technological and social advancement. People are sedentary by the end of this period. Crops begin to be grown and the bow and arrow comes into use. Cooking and storing water brings Woodland Indians closer to the village farming life.

The Mississippi Period (900 – 1700 A.D.) brings us from the beginning of village-based culture to European contact and settlement. The social organization of this period is based on a highly stratified religious society. This period also sees the introduction of culture and people of the South into what would become Missouri.

The Mississippian culture began to decline before European contact. The Spanish expedition of Hernando de Soto (1539 - 1543) marked the first European exploration of Missouri. Desoto’s 1540 expedition into southern Missouri affected the social structure because he killed many village rulers. More disruption occurred due to diseases his men brought into the region. This social disruption led to the decline and disappearance of the Mississippian culture. French explorers and fur traders came into the region in the late 1600’s.

The primary and dominant indigenous Indian tribe in Missouri area was the Osage. By 1700, they were an organized tribe and when they encountered French explorers and settlers, the influence was great. Osage settlements were permanent villages, organized according to the political affiliation of each clan present. Hunting seemed to be the most important means of getting food for the Osage, although agriculture and farming were developed and gathering still occurred. The Osage maintained open woodlands by large-scale use of fire. Immigrant Indian groups from the East moved to and through Missouri as European settlers claimed more and more land. Eventually, the Osage and immigrant Indians ceded their Missouri lands and moved further west. The Osage left in 1923.

The people who moved into Missouri in the late 18th and early 19th centuries were attracted by opportunities to acquire timberland and by availability of free open range on unclaimed public land. Land acquisition records indicate that much of the area was settled between the 1880’s and the 1930’s.

Once the settlers arrived, the ecological structure of the area was further modified due to heavy agricultural activities that supported mining and westward expansion. Around 1870, citizens of Missouri had begun to use natural resources for profit. Timber mills flourished and vast forests of pine and oak were leveled, sawed, sold and shipped. Over fishing of streams was common, dynamite became a new fishing tool, and an almost total annihilation of game turned the land lean. By 1927, heavily harvested woodlands, bare hillsides, failing soils, eroded farmland, and streams full of gravel and sedimentation made up the Southern Missouri landscape. By the 1930’s lumber mills were gone as were forests and wildlife game. Soil erosion and water pollution had begun due to the clear-cutting, slash-burning, and continued farming and timbering of slopes. It was in this abused condition that the Mark Twain National Forest had its beginnings (Pinkerton 1981); the Forest Service began restoration in 1939.

Population and Demographics

Counties that make up the study area continue to be the least densely populated areas of the state. Table 3 shows the units ranked by growth and average population density for the area. The area has grown rapidly in recent decades and continues to do so. Recent population growth seems to be more strongly associated with counties near metropolitan areas. Overall, the population of the Mark Twain NF area grew an average of 19% from 1990 to 2000.

Table 3 - Unit Population Growth 1990 - 2000

Unit	2000 Population	1990 Population	Percent Growth	Average Population Density
Ava-Cassville-Willow Springs	216,520	156,861	38%	46
Cedar Creek	176,220	145,188	21%	122
Salem-Potosi	67,764	59,916	13%	22
Fredericktown	108,009	97,413	11%	44
Eleven Point	38,118	34,901	9%	13
Houston-Rolla	154,461	141,947	9%	44
Poplar Bluff	54,126	50,308	7%	38
MTNF TOTAL	815,218	686,534	19%	42

Source: www.census.gov
Population Density is people per square mile.

Racial Diversity and Education

Another important social indicator is racial diversity. The study area is broken down into the same race and Hispanic origin categories as those used by the U.S. Bureau of the Census during the 2000 census. Although the minority population in Mark Twain NF counties has grown from 1.9% in 1980 to almost 5% in 2000, the area has remained predominately Caucasian. Areas with the greatest diversity are more densely populated university towns of Columbia and Rolla, MO.

Educational attainment is one indicator of human resources available in a community and the level of workforce preparation generated. This has implications for community sustainability and resilience, and tends to correlate with income and poverty. Overall, education levels are relatively low. All units have a low to medium proportion of the population 25 years and younger without a high school diploma, the highest at 35% in Poplar Bluff and Salem-Potosi, and the lowest at 16% in the Cedar Creek unit.

Income and Poverty

Per capita personal income is a measure that includes trends in population and total personal income. This measure is often used as an indicator of economic wellbeing in an area. More recently per capita incomes at the state level and in St. Louis have remained stable while South Central Missouri has had slightly declining per capita income levels.

For 2001, Missouri’s per capita personal income was $28,226, which places it 30th out of 50 states. This was a 2.8% increase from 2000. This places Missouri approximately 7% below the national average. Per capita income for the study units ranges from a low of $16,009 in Eleven Point area to a high of $23,802 in Cedar Creek. The average Mark Twain NF per capita income is almost $9,000 less than the state average.

As per capita income for a unit goes up, the unemployment rate decreases. Cedar Creek unit boasts the lowest unemployment rate (2.6) as well as the highest per capita income for the study area. Poplar Bluff unit has the highest unemployment rate (8.8) and the second highest percent of persons living below the poverty level.

The poverty rate is a commonly used indicator of the level of economic need in a community. The Economic Research Service classifies 15 non-metropolitan counties in the study area as having “persistent poverty” (high rates of poverty in 1960, 1970, 1980, and 1990). Nearly half of the 26 non-metropolitan counties that contain national forest lands are persistent poverty counties.

Physical and Biological Setting

The roughly 1.5 million acres of Missouri's only national forest, the Mark Twain, lie mostly within the Ozark Highlands, a region long distinguished for its extraordinary geological, hydrological and ecological diversity. Signature features of the Ozarks Highlands include crystal-clear springs, over 5,000 caves, rocky barren glades, ancient volcanic mountains and nationally recognized streams. The Ozarks have been continuously available for plant and animal life since the late Paleozoic period some 230 million years ago, constituting perhaps the oldest continuously exposed landmass in North America (Yatskievych 1999).

In the Ozarks, eastern upland oak hardwood and southern pine woodlands converge with drier western tallgrass prairie, creating a distinctive array of open grassy woodlands and savannas. This rich mixture of unique, diverse and ecologically complex natural communities provides habitat for nearly 750 native vertebrate species and over 2,000 vascular plant species. The high level of habitat diversity, influx of biota from divergent regions through thousands of years of climatic events, effects of past glaciation to the north, and extreme antiquity of the landscape have combined to support relict populations and allow for development of at least 160 endemic species.

The Ozark Highlands are deeply dissected by clear-flowing, often spring-fed, moderate to high-gradient streams and rivers. The Mark Twain National Forest occurs in five of the seven major river basins in the Missouri portion of the Ozark Highlands. Eleven primary streams and rivers course through these basins, portions of that occur within boundaries of the Mark Twain. Because of the region's karst topography, the Ozarks are home to the world's largest collection of first magnitude springs (those with over 65 million gallons of water flow daily.) Almost 3,000 springs in the Ozark Highlands feed rivers and streams that flow year around. Greer Spring, which is managed by the Mark Twain NF, is the second largest in Missouri. Discharging an average of 250 million gallons of water daily, Greer Spring doubles the flow of the Eleven Point River.

Historical Setting

Biological systems of the Ozarks are human-influenced and fire-mediated. As far back as 12,500 years ago, Native Americans began manipulating and utilizing Missouri's vegetation. These influences likely included the use of fire, procurement of food, shelter and village construction and farming. Woodlands were kept open with frequent, low-intensity fires, and perhaps by elk and bison. The only heavily forested areas were found along major rivers and other areas not affected by the fire regime.

Beginning in the late 1800's and early 1900's, this rich ecosystem and the processes that maintained it were severely disrupted. Shortly after the Civil War, commercial timber cutting began. Timber companies purchased large acreages from the government at approximately $1.25 per acre in order to log the virgin pines. After timber was cut off, the usual practice was to let the land be sold for taxes.

Tie, stave, hub, and handle companies then logged the oak forest. Most companies selected only better quality trees for their products, most of which were cut by 1928. After logging operations were completed, areas were severely burned and many of the remaining trees were killed. Local settlers, without regard to ownership, then high graded residual stands. Frequent cuttings of pine to a small diameter eliminated the source of pine seed source in many areas, and prolific sprouting of hardwoods following fires prevented regeneration of pine on areas having a seed source.

With the forests gone, settlers attempted to farm the thin Ozark soils, and livestock were allowed to wander the open range. Initially, burning improved forage resources. However, repeated burning to maintain these conditions, coupled with intensive overgrazing, depleted the humus content and increased erosion. Consequently, the soil became less fertile and produced less forage. Prolific sprouting of hardwoods following fires reduced the amount of available forage; but livestock owners continued the traditional practice of burning the woods, even when it no longer improved forage conditions.

Throughout its early history, the entire area of the Mark Twain National Forest, and adjacent lands, experienced:

- Overexploitation of Forest resources, especially extensive logging of most of original virgin timber.
- Overgrazing by cattle, hogs, goats, horses, and sheep roaming about the state for over a century resulting in the depletion of grass and forb cover/diversity.
- Initial suppression of the original fire regime followed by annual burning to stimulate forage for free-ranging livestock.
- A severe soil erosion cycle resulting from overgrazing, livestock trampling, logging, and over-burning.
- Loss of crop and timber productivity due to topsoil erosion.
- Conversion of timberlands and ecosystems to croplands, brushland and pasture.
- Replacement of the once vast virgin stands of shortleaf pine, white oak and post oak with black, red and scarlet oak. Upon its maturity, many red oaks died during the 1980’s drought as a result of oak decline.
- Encroachment by red cedar into glades and open woodlands as a result of overgrazing.

Early Forest Service Management of the National Forest

As early as 1925, concerned citizens of Missouri recognized the unproductive condition and poor protection and management of the forest resources in the State. In 1931, the University of Missouri and influential citizens of the state requested that a National Forest be established in order to aid protection and management of a portion of the 15 million acres of wild forestland. The State passed enabling legislation under the Weeks Law, an Act of March 1911, which allowed the Federal Government to purchase lands in the state for purposes of establishing a National Forest. Prior to passage of the Weeks Law, all National Forests had been created by reservation from the public domain. The Weeks Law enabled the Federal Government to purchase suitable forest areas in the eastern and mid-western United States for establishing National Forests.

When the U.S. Forest Service moved into Missouri to establish the National Forest, there was practically unlimited open range and the Forest was open to grazing. Domestic stock, specifically cattle, goats, sheep and hogs, competed with wildlife for forage and mast. Too much grazing also interfered with tree growth, depleted rich grass and forb groundcover and caused the deterioration of soil stability. It was not until 1965 that the National Forest was closed to open range grazing under federal regulations.

As land was purchased for National Forest purposes, timber management practices and reforestation were initiated. Beginning in early 1934, the first timber management practices by the Forest Service consisted of timber stand management and some planting of shortleaf pine. Roads were constructed throughout the Forest by Civilian Conservation Corps members. At about the same time, the newly formed Missouri Department of Conservation started an ambitious program of reintroducing native animal species into their former range, including white-tailed deer and wild turkey.

In 1936, the Forest Service, unaware of the ecological role of fire, began implementing fire control and suppression measures. Prior to this, an average of 280,000 acres of the area now in government ownership burned each year. Ten years later, the average annual burned area was down to 8,000 acres. The number of fires dropped from 1,200 to 420 by 1944. However, many local landowners continued the practice of annual burning on their own properties, with some fires escaping onto National Forest lands. Arson, often used to express disapproval of government actions, became the major cause of wildfire in the Ozarks.

U.S. Forest Service managers in the southwest part of Missouri recognized that glades and open woodlands were rapidly disappearing and were being replaced by encroaching cedar trees resulting from overgrazing. In the early to mid 1970's, projects were initiated that involved cutting and burning cedar trees. U.S. Forest Service managers found out that when the glades burned there was a tremendous, unexpected response from the grasses and forbs. The glades came alive the first growing season after the burn. So convincing were the results, the Chief of the Forest Service granted permission to burn glades within the Hercules Glades Wilderness. Wildlife biologists forest-wide and from other state and federal agencies, recognizing the benefits of fire, began using fire in timbered stands to create savannas and woodlands, and to improve habitat for wildlife. Much was learned from the successes and failures of this early burning. Prescriptions were developed to insure that the duff layer and underlying soil was not burned. Fire was returned to the ecosystem in a manner that mimicked historical burning and the result was a very favorable response from the fire-adapted grasses, forbs, and trees.

Forest health problems were not restricted to Missouri. The results of removing fire from the ecosystem were evident nationwide. Fuels had built up in the western states to the extent that fires could not be controlled. Catastrophic unmanageable fires of 2000 to 2003 replaced frequent low intensity fires. The National Fire Plan, Cohesive Strategy, and the Healthy Forest Initiative all gave direction to return fire to the landscape, restore damaged ecosystems, and protect communities.

Recent Forest Service Management of the National Forest

The 1986 Forest Plan was based primarily on providing balanced age classes of trees in order to provide diverse wildlife habitats throughout the Forest. As a result of this management direction, a sustainable supply of wood products is made available, recreation opportunities are varied, and special habitats are recognized and protected where they occur.

An effort was made during the 1980's and beyond to move away from conversion of one forest type to another, simply for faster growth (i.e. shortleaf pine plantations replacing oak-hickory stands). Riparian areas were defined and recognized as areas worthy of additional management to protect water quality.

Oak decline became a management challenge in the early 1980's, and has spread throughout the Forest wherever black and scarlet oaks are reaching maturity. Salvage of dead and dying oaks has occurred through various harvest methods, including thinning and regeneration harvests.

As knowledge of ecological systems increased, it became obvious that Smokey Bear's fire message had worked too well in many fire-adapted ecosystems. Natural communities that were historically common, were now absent or severely altered by lack of fire to rejuvenate vegetation and reduce woody species invasion. While uncontrolled wildfire can severely impact the landscape, fire under the right conditions is beneficial to many of the Mark Twain National Forest's natural communities. Prescribed fire became an important tool to improve wildlife habitats, prepare sites for shortleaf pine seedbeds and reduce fuel accumulations.

Current Forest Condition

Under the care of the Forest Service, forests have been re-established, wildlife numbers have increased, and erosion control measures implemented. However, the Ozarks are very different from what it had been at the beginning of the 19th century. From roughly 1870 to 1930, a period of only 60 years, historically healthy ecosystems were completely altered.

As a result of these impacts, short-lived scarlet and black oaks now dominate where once longer-lived pine, white and post oaks were found. What was once savanna or open woodland is now thick with brush and small diameter trees. These changes, along with the suppression of fire, have resulted in lower species diversity.

Understanding ecological systems, their patterns on the landscape, and natural processes is fundamental toward understanding challenges in managing healthy natural resources. Natural processes that once shaped vegetation in Missouri include fire, insect and disease outbreaks, and catastrophic wind events. Forest management activities, like prescribed fire and mechanical treatments mimic those natural events. These are important land management tools for restoring fire-dependant systems and reducing the current fuel build-up

Future Forest Condition

The 2005 Forest Plan is an effort to move further from a homogeneous treatment of the land to recognizing unique capabilities of various parts of the Ozarks to provide goods and services, as well as recognizing and enhancing the unique qualities of different natural communities native to the Mark Twain National Forest.

In the long-term, the Mark Twain NF should reflect a full range of natural communities, from prairie to glade, savanna to open woodland and closed woodland to forest on sites where they historically occurred. Diversity of plant and animal species should be enhanced, and a variety of goods and services will be available on a sustained basis.

Ecosystem Management

Plant and animal species gradually adapted and evolved into complex arrays of natural communities (or ecosystems) subject to thousands of years of disturbance processes, climatic variations, topography and soil substrate constraints. The scale and pattern of these processes, along with a relatively stable climate for the past 3,000 to 4,000 years or more, supported a diverse assemblage of native plant and animal species (Lorimer 2001, Nigh et al 1992).

European settlement severely disrupted North American ecosystems, plant and animal populations and historic disturbance processes with unprecedented magnitude and rapidity. This Old World culture exploited, fragmented and altered the former past landscape to create a new one. Ladd (1991), Nigh et al. (1992), McCarty (1998) and Yatskievych (1999) documented these effects. These abrupt landscape alterations and disruption of historic disturbance processes have produced modern vegetation in structural, successional and compositional disequilibrium (Eirvin et al. 1998).

Ecosystem management is the work of improving the ecological quality of a given area in the context of its historical condition. Prior to European settlement, most of Missouri's ecosystems were relatively stable and highly diverse, and they possessed quantifiable characteristics in terms of vegetation structure, species composition and abundance, functional relationships, physical characteristics, and a historical range of disturbance processes. The approach to managing for diverse and sustainable natural communities is to restore their structural vegetative condition and maintain the historical disturbance processes and functions under which natural communities evolved and to which they are uniquely adapted. Conserving an adequate representation of natural communities that harbor a broad diversity of plants and animals is viewed as an efficient approach to conserving biodiversity, which may protect 85 to 90% of all species.

Why should the Mark Twain NF manage various desired conditions for natural communities that occurred prior to European settlement? The 1982 Planning Rule states with regard to plant species diversity, "Forest planning shall provide for diversity of plant and animal species and tree species consistent with the overall multiple-use objectives of the planning area."

Conservation assessments and other documents (see Appendix D-2) substantiate that the Mark Twain NF contains many globally imperiled natural communities and habitats for species of conservation concern. Many of these species are directly linked to natural communities that thrived prior to and during early European settlement. The Missouri Natural Heritage Database contain over 15,000 state element occurrence records (elements included state imperiled natural communities and rare and endangered species). Many of these record locations occur in habitats degraded by fire suppression, past overgrazing and woody invasion. Over 25 years of experience in managing ecosystems by federal, state and private non-profit organizations overwhelmingly demonstrates that emulating historic disturbance processes at these locations is perhaps the only means of assuring biodiversity conservation.

The Conceptual Framework to Ecosystem Management

The Mark Twain NF is proposing a coarse-filter, ecosystem management approach to help conserve biodiversity, address species viability and improve forest health. 2005 Forest Plan goals and Management Prescriptions incorporate conservation approaches and resource management objectives to provide a mix of natural communities across the planning area. The ecosystem management approach will place a greater emphasis on how management activities are related to historical landscape patterns, specifically described natural communities and historical disturbance processes.

The conservation approach used by the Mark Twain NF focuses on ecosystem restoration and enhancement in response to key risk factors and provides options, where available, to change those conditions in order to enhance the viability of groups of species and habitats (natural communities). The underlying concept is that a representative grouping of natural communities will include appropriate variations in habitat structure and plant species composition to accommodate most plant and animal species. The Mark Twain will continue using the traditional species-level approach for instances where needs for species of conservation concern are not met by the ecosystem approach.

Ecosystem or natural community management can be divided into separate phases relative to management activities. These phases of management include restoration, maintenance and reconstruction.

Restoration

Ecosystem restoration, sometimes called rehabilitation, needs to occur when natural vegetation exhibits the ability to achieve a given desired condition. It is the repair or re-establishment of natural community complexes. Diagnosis of ecosystem health compares current condition to the historic one using desired condition descriptions of natural communities, historic vegetation, site quality rankings and examples of high quality sites.

Reinstating historic disturbance processes should recover natural community structure, plant species composition and biological diversity that evolved in response to the physical environment. Management methods generally include thinning of undesirable woody species, prescribed burning, select treatment of non-native invasive plant species, and some reseeding – all prescribed using the effects of various disturbance regimes outlined previously. Restoration of natural communities generally takes two to three decades or more before achieving the maintenance stage of re-establishing grass/forb structure. Restoring canopy composition and structure may take a hundred years or longer!

Reconstruction

Reconstruction is the re-establishment of a natural community or elements thereof that have been nearly completely destroyed. Management methods include site preparations to remove non-native invasive species, soil preparation, burning to prevent undesirable woody or non-native species invasion, planting and seeding. This phase is very labor intensive and usually very costly. Natural communities requiring reconstruction activities may include prairie, savanna and bottomland hardwood forests.

Maintenance

Ecosystem maintenance includes the periodic prescribed application of management activities to retain structure, diversity and composition of select natural communities. This happens when the resource is nearing the desired condition; that is, once critical elements of community structure, physical processes or the environment are largely restored. Maintenance activities generally include prescribed burning to mimic historic fire, select silvicultural practices tailored to restoring woody structure, periodic checks and control of non-native, invasive species, and monitoring against risks and threats such as animal overpopulations, especially white-tailed deer, to ensure that their numbers do not exceed the balance and capacity of the natural community.

Ecosystem Management Principles

In developing the 2005 Forest Plan, the Mark Twain NF used three foundational assumptions (adopted from Manley et al.1995):

<u>Ecosystems adapted over extended time periods provide the best chance for sustainability. For biological systems, this would be systems evolved through evolutionary time.</u>

In this context, the Mark Twain NF has adopted the time period prior to European settlement (generally in the early 1800s) as a reference point from which to set desired conditions and compare historical conditions to present ones. This period chronicles evidence that points toward a landscape characterized by essentially unfragmented, high integrity natural communities (Nelson 2005). Missouri's climate has remained relatively stable for at least 4,000 years (see Wettstaed in Nelson 2005).

<u>Our best predictions of ecosystem response to management actions and anticipated disturbance represent a reasonable basis for management planning and projections.</u>

Predictive capabilities of applied management are measured in the successes and failures of respective agencies and organizations employed the past 30 years in restoring and sustaining ecosystems. The Nature Conservancy, the Missouri Natural Areas Program, the Missouri State Park System, the Missouri Prairie Foundation, the Missouri Department of Conservation, The US Fish and Wildlife Service, the Ouachita National Forest and the Mark Twain NF have pioneered ecosystem restoration efforts and their findings serve as reference benchmarks from which to monitor ecosystem restoration progress.

<u>Management designed to maintain or reproduce key ecosystem components, structures and processes is the management approach most likely to sustain ecosystem integrity and productivity.</u>

Ecosystem integrity refers to both a system's presence of appropriate environmental and biological elements and the occurrence of all processes at appropriate rates (see Angermeier and Karr (1994) and Nelson (2005) for defining high quality natural communities.) There appears to be no realistic alternative to prescribed fire that managers can use to duplicate the effects of fire for sustaining high integrity, fire-adapted natural communities. This is based on our current understanding of how natural communities function, how post-European settlement has impacted and changed them, and how deviations from the range of natural variability has affected species and ecosystem viability. Most all present indications of risk factors and threats discovered in the species viability process, through natural areas inventories and recent conservation assessments point toward loss of biodiversity caused by ecological degradation and loss of historical disturbance processes.

Hierarchy of Ecological Units

Classification hierarchies provide structure for analysis of the parts and for synthesis of ecosystems as a whole. It answers the question "How do we organize natural resources or biodiversity in a way we can compare and understand?" A hierarchical classification structure helps characterize ecosystems, and identify patterns and processes at different ecological scales. The hierarchical framework of ecological units being used by the Mark Twain NF incorporates (in part) the national framework (Cleland et al. 1997), Missouri's ecological sections and subsections (Nigh and Schroeder 2002) and terrestrial natural communities (Nelson 2005).

Domain

Domains are subcontinental areas of broad climatic similarity. All of Missouri lies within the Humid Temperate Domain.

Divisions

Divisions are determined by isolating areas of different vegetation and lifeforms, broad soil categories and regional climates. The majority of the Mark Twain NF occurs within the Hot Continental Division, with a small portion (Cedar Creek) situated in the Prairie Division.

Provinces

Divisions are further subdivided into provinces. Provinces are determined by broad vegetation regions that are controlled by length and timing of dry seasons and the duration of cold temperatures. The Ozark Broadleaf Forest Province encompasses most of the Mark Twain NF in the Ozarks while Cedar Creek occurs in the Prairie Parkland Province.

Sections

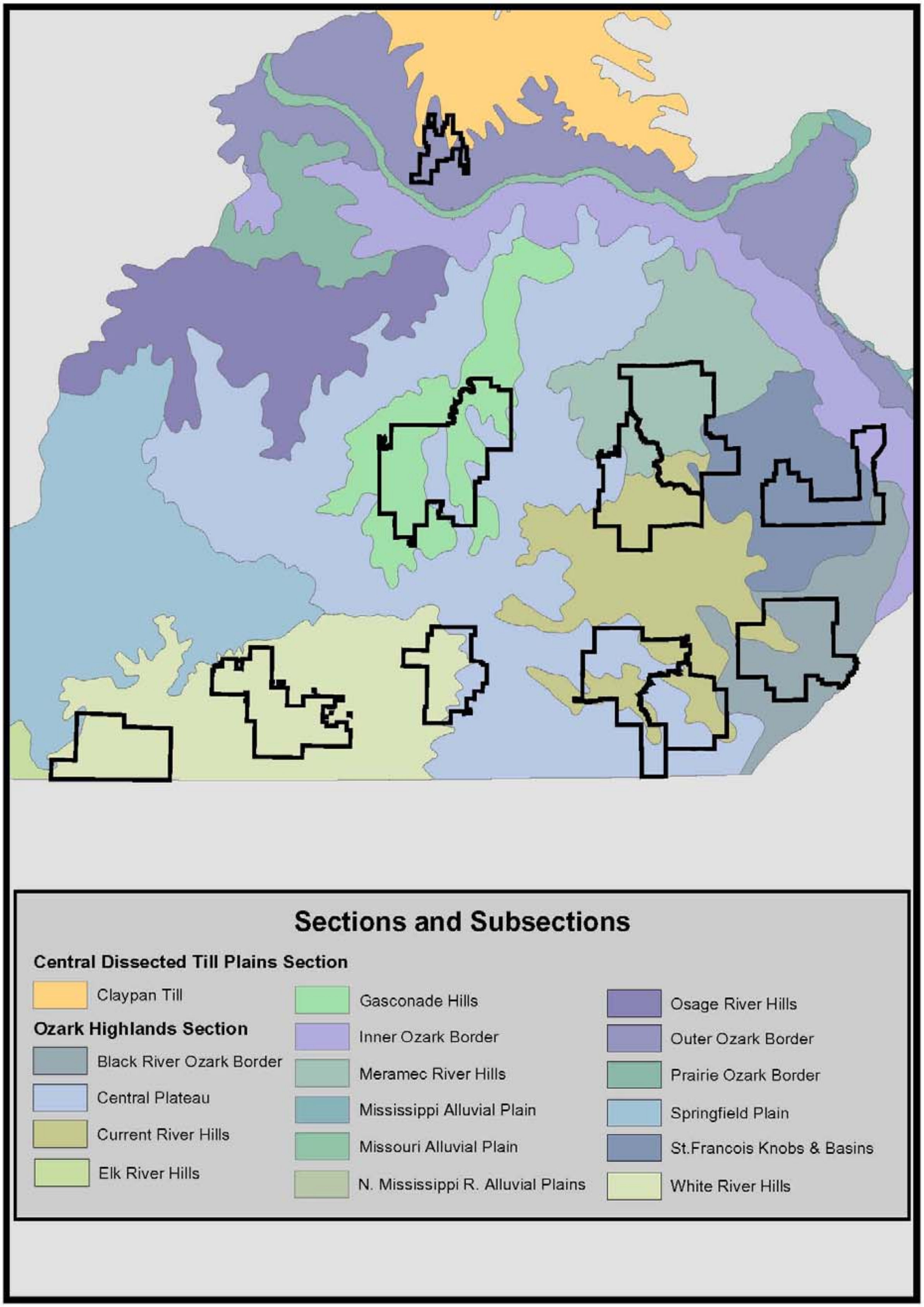
The Ozark Broadleaf Forest Province in Missouri is wholly occupied by the Ozark Highlands Section while Cedar Creek occurs in the Central Dissected Till Plains Section. Sections are intermediate areas of similar geographic origin, geomorphic process, rock formations, drainage networks, topographic similarities and climate. Sections are typically characterized by relating geographic maps of potential historical natural vegetation.

Subsections

The Ozark Highlands Section is divided into sixteen subsections. (See Map "Sections and Subsections.") Subsections are distinguished by differences in topography, relief, the relative occurrence and patterns of natural communities, geology and hydrology. These differences can often translate into characteristic plant and animal species ranges, assemblages of natural communities and social/economic land use patterns. In the 2005 Forest Plan, objectives for reaching desired condition are set at the subsection level. The 1.5 million acres of public lands embracing the Mark Twain NF are widely distributed across Missouri's ecological units with portions of the Mark Twain NF touching on or embracing 9 of the 16 subsections within the Ozark Highlands Section as shown below:

- Black River Ozark Border Subsection
- St. Francois Knobs and Basins Subsection
- Current River Hills Subsection
- Central Plateau Subsection
- White River Hills Subsection
- Gasconade River Hills Subsection
- Meramec River Hills Subsection
- Outer Ozark Border Subsection
- Inner Ozark Border Subsection

In addition, the Cedar Creek Unit, which lies north of the Missouri River, is in the Claypan Till Plains Subsection of the Central Dissected Till Plains Section.


Sections and Subsections
Central Dissected Till Plains Section
Claypan Till
Ozark Highlands Section
Black River Ozark Border
Central Plateau
Current River Hills
Elk River Hills
Gasconade Hills
Inner Ozark Border
Meramec River Hills
Mississippi Alluvial Plain
Missouri Alluvial Plain
N. Mississippi R. Alluvial Plains
Osage River Hills
Outer Ozark Border
Prairie Ozark Border
Springfield Plain
St.Francois Knobs & Basins
White River Hills

Landtype Association Groups

Landtype Associations (LTA's) are ecological landscapes based on local characteristics of topography, geography, soils, ecological processes and natural vegetation. LTA groups are groupings of similar LTA's. There are 25 for the state; 9 for the Ozark Highlands, one additional for Cedar Creek, and one that touches the Poplar Bluff Ranger District. The Mark Twain NF may apply LTA group characteristics as part of conservation planning and project evaluation/implementation.

Terrestrial Natural Communities

Approximately 60 of Missouri's 85 terrestrial natural communities occur on the Mark Twain NF. Natural communities are the foundation for analyzing potential historic vegetation and condition class for fuels. They serve as a means to describe and analyze departures between historical reference and current vegetation conditions. These natural communities (described in detail in Nelson 2005) are grouped into broad type categories based on similarities in vegetation appearance, structure and composition. Further, each major type (whether forest, woodland, savanna, prairie, glade, cliff, wetland or cave) possesses characteristic similarities in disturbance processes and the RNV, which in turn have broad management implications. It is at this level that plant and animal populations best respond to a range of similar management treatments and are differentiated on the basis of habitat variations within them.

Terrestrial Natural communities are described in terms of composition, structure, physical characteristics and function (disturbance processes, animal interactions, predation, etc). Terrestrial natural communities are used to describe ecosystem potential and to compare the range of natural variability with the current condition. For purposes of this 2005 Forest Plan and analysis, the 65 terrestrial natural communities found on the Mark Twain NF and been grouped into the following Natural Community Types:

- Forest
- Woodland
- Savanna
- Prairie
- Glade
- Cliff/Talus
- Stream Edge
- Wetland
- Cave

Range of Natural Variability (RNV)

For purposes of this plan revision, the range of natural variability (RNV) is described as those physical and biological conditions and their disturbance factors that influenced the composition, structure, distribution and dynamics of natural communities before European settlement. When the term pre-European settlement is used in the context of restoring natural communities, the primary reference is one of understanding what they were and how they functioned before the process of modern ecosystem degradation began. This allows resource managers and administrators to make more informed decisions (Sisk 1998). Their associated historical disturbance processes include fire, flooding and weather (wind, tornados, ice storms, etc) types. There is a characteristic range of frequency, intensity, duration, scale and timing for each disturbance type, with both the average and the extremes being significant in shaping the character and composition of natural communities. These conditions are further discussed in Appendix D. General Assessment of Ecosystem Sustainability.

Ecosystems, or natural communities, are described in terms of composition, structure, physical characteristics and function (disturbance processes, animal interactions, predation, etc). Ecosystems are dynamic; therefore these attributes are constantly changing. However, composition, structure and function are constrained within the limits of how historical fires, floods, animals and even indigenous people (prior to European settlement) interacted within them. The range of natural variability is a term used to reference this variation in physical and biological conditions. RNV is useful in describing and comparing the current conditions (affected environment) of the Mark Twain NF to those of the past. Sustainable management uses historical information as a reference for restoring and maintaining the patterns and processes characteristic of Missouri's historical landscape. Studying RNV gives some indication of the sustainability of ecosystems and identifies those components that may need management attention, especially fire-adapted natural communities.

Even where native species survived and the aim became sustainable use of the timber, forage, wildlife or soils, modern practices often continue altering (for better or worse) these now degraded natural communities. They still shift species presence and dominance patterns and they impose new ecological conditions. Although Missouri has large areas of surviving natural vegetation, most of it has been reduced in species richness compared to its pre-European condition. Over 20 natural features inventories conducted by the Missouri Natural Areas Program and analysis of land cover for all of Missouri's counties have revealed that much of the state's natural vegetation has undergone a major transformation in habitat and natural community integrity. Some have changed so much in composition or structure that they no longer easily classify into any category of high quality natural communities.

Historical Disturbance Regimes

Fire, wind, tornadoes, rain, snow, ice, hail, floods, drought, lightning, earthquakes and animals were among the many disturbance processes that shaped Missouri's natural communities through the centuries. Each disturbance type had its own range of variability measured in intensity, frequency, duration, scale and timing. Historic range of variability influenced the composition, structure, distribution and dynamics of natural communities before European settlement. Frequent natural fires and large grazing and browsing animals contributed to the complex mosaic patterns of oak savanna, woodland and tallgrass prairie. Catastrophic fires and tornadoes were severe enough to level forests and woodlands, setting the stage for the regeneration of young oaks, shortleaf pine, shrubs and small trees. Intense solar radiation and lack of moisture contributed to the formation of dwarf woodlands associated with bluff tops and open glades. The dynamic ever-changing patterns of vegetation along stream gravel washes and river sandbars responded directly to flooding.

Fire was a profound shaper of Missouri natural communities. Evidence is present in historical accounts, aboriginal burning, fire scars, lightning ignitions, adaptations of plants and animals, fire modeling, understanding the nature of natural fuels and the responses of applied management.

Many plant species and natural communities are adapted to or dependent upon fire. Missouri's present-day precipitation and subhumid climate, in the absence of fire, favor the advancement of woody vegetation, especially in damaged and degraded ecosystems. Without fire, woody vegetation will encroach into prairies, savannas and open woodlands.

The behavior of fire upon the landscape is likely the best explanation for why certain natural communities were historically distributed in distinctive patterns across the Ozarks in relationship to vegetation, variations in human habitation patterns, human population size and the flatness or steepness of the land (Batek et al. 1999).

Chapter Organization

The remainder of Chapter 3 is organized by resource, focusing on those resources related to the issues described in Chapter 1. Each resource section is presented in the following format:

- Issue Statement
- Issue Indicators – Used to compare the effects of alternatives on the issue.
- Analysis Area – Briefly describes the geographic area used for analysis. Analysis areas may vary depending on the resource, issue, or anticipated activities. Within a specific resource or issue, analysis areas may also differ for direct, indirect, and cumulative effects.
- Affected Environment – Describes the current conditions of resources relative to the issues and issue indicators. This section may also include history, development, past disturbances, naturally occurring events, and interaction that have helped shape the current conditions.
- Environmental Consequences

  Effects Common to All Alternatives – Describes the general type of effects that may occur to the resource from implementing alternatives.

  Direct and Indirect Effects – Describes the direct and indirect effects that each alternative could have on resources or issues. Direct effects occur at the same time and place as the action. Indirect effects occur later in time or are spatially removed from the action. Although a Forest Plan would guide management for 10 to 15 years, effects may be discussed for both the short (1 to 10 years) and long-term (greater than 10 years). Direct and indirect effects often overlap and are frequently discussed together.

  Cumulative Effects – Describes the cumulative effects by alternative for each resource or issue. Cumulative effects are the incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes the other actions. Cumulative impacts can result from individually minor but collectively significant actions that take place over time.

Timber Supply

Introduction

Proposed Changes

Several proposed changes could have an effect on timber production. They include:

- changes in the determination of suitable lands (Revision Topic 1a);
- the addition of prescriptions emphasizing restoration of natural communities(Revision Topic 2a);

Issues –Timber supply

There is disagreement about how much timber the Mark Twain National Forest can supply without adversely affecting ecosystem health, water quality, and the social and economic needs of people. Forest Plan revision will determine the acreage and characteristics of lands that are suitable for timber production. Revision will also determine the level of timber that the Mark Twain NF may supply over time.

Key Indicators

Allowable Sale Quantity (ASQ)

This indicator highlights differences between alternatives by showing what the Scheduled Timber Harvest would be on an annual basis. This Allowable Sale Quantity (ASQ) is estimated by using the Lands Suitable for Timber Management and timber yield tables. The analysis reflects land capability, current forest types and age classes and management under each of the alternatives. Acres of land suitable and appropriate for timber production are the same for all alternatives, but how the lands are managed under each management prescription changes under each alternative.

Table 4 – Key Indicators for Timber Supply

			Alternative				
Key Indicator	Units	Current Condition	1	2	3	4	5 No Action
Allowable Sale Quantity (ASQ)	MMBF/year	49*	0	99	103	105	105
Sawtimber Portion (1st Decade)	MMBF/year	38*	0	38.5	43.5	47.5	50

**Average annual timber sold, 1986 - 2003*

Scope of Analysis

The analysis area includes National Forest System Lands in the Mark Twain NF.

Affected Environment

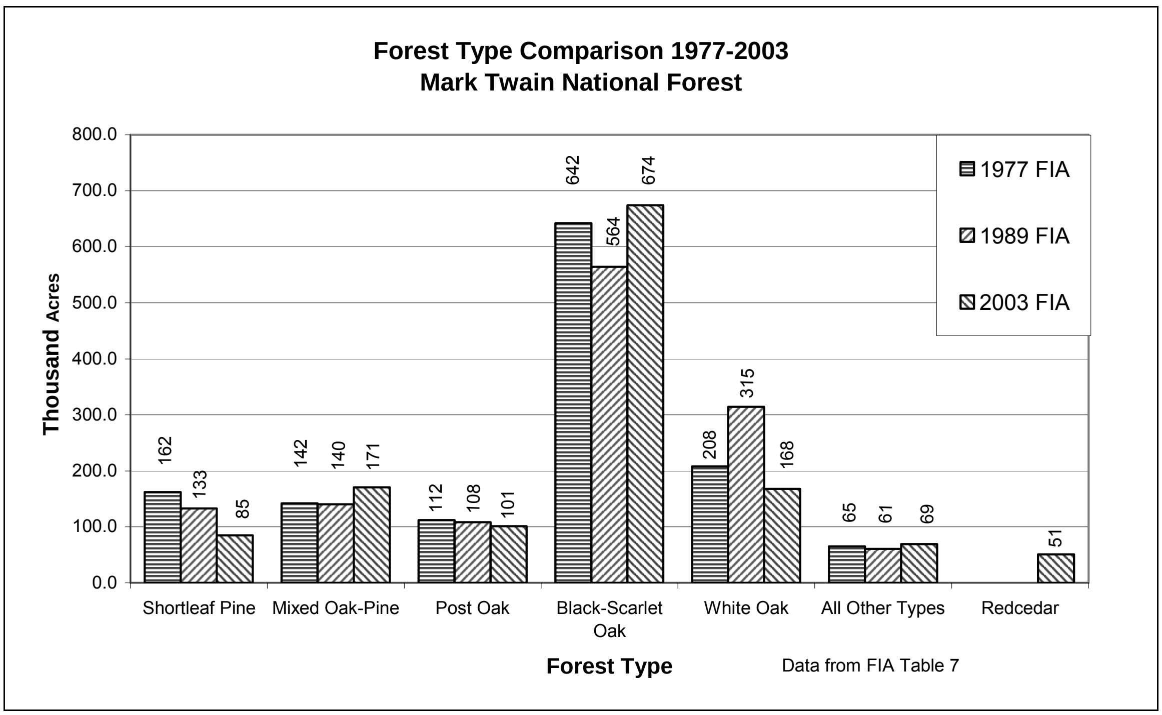
Historical Perspective

The Mark Twain lies within the Ozark Highlands Ecological Section. Historically, these lands were a rich diversity of biodiversity and ecological communities. Schoolcraft's accounts from 1818-1819 discuss grasslands, oak savannahs, mixed oak-pine woodlands and large pine woodlands and forests. By 1913, most of the virgin pine and oak-hickory forests of the Ozark region were gone. Settlers moved in and tried to farm the land but eventually gave up by the 1930s. At the time of the first Missouri forest inventory in 1947, less than 27 percent of the Mark Twain was in forests where sawtimber-sized trees predominated. Abandoned farms and large wildfires scarred much of the cutover land. The primary changes between 1819 and today are that fertile prairies have been cultivated; many of the poor prairies, barrens, and open woodlands have grown more woody and dense due to fire suppression; and most large bottomland areas have been inundated by dams or converted to pasture or croplands. A more detailed discussion of the vegetation resource of the Mark Twain lands is found in GTR-SRS-35, Ozark-Ouachita Highlands (OOHA) Assessment, Report 5, Terrestrial Vegetation and Wildlife (USDA Forest Service 1999e).

The last Forest Inventory Analysis (FIA) report for the Mark Twain was completed in 1991 (Kingsley and Law 1991). The FIA inventory for 1999-2003 has finished data processing and data is available. Data analysis for the State was published in early 2005 (Moser et.al 2005). A report for the Mark Twain will not be completed until late 2005.

The following charts show the changes in forest composition and structure over the last 26 years, using the FIA report results for 1977, 1989 and 2003 Surveys.

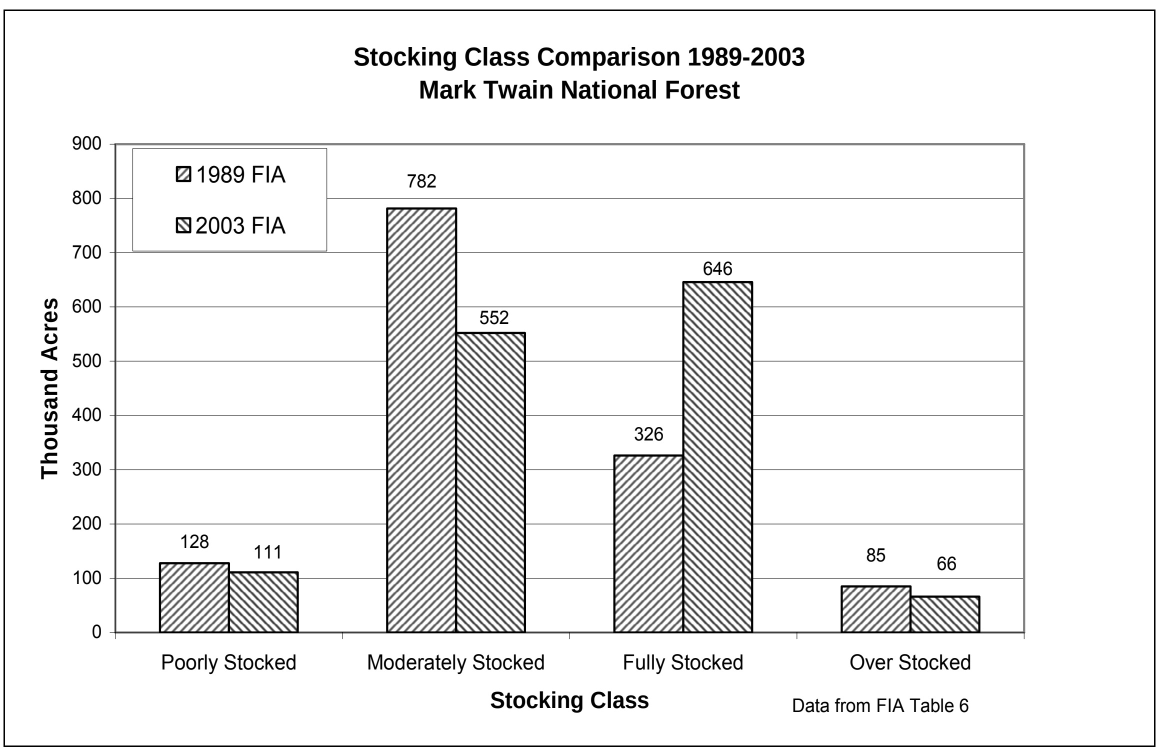
Figure 1 - Change in Forest Type 1977 - 2003



Between the 1989 and 2003 data collections, the amount of black-scarlet oak has increased 16% (110,000 acres) to 674,000 acres; white oak has declined 47 % to 147,000 acres. Shortleaf pine has declined 36% to 85,000 acres and mixed oak-pine increased 22% to 171,000 acres. At the same time, the amount of sawtimber (Figure 2) has increased 589,000 acres to 867,000 acres or 63% of the timberland of the Mark Twain.

Figure 2 - Changes in Size Class 1977 – 2003

Figure 3 - Changes in Stocking Classes 1989 – 2003



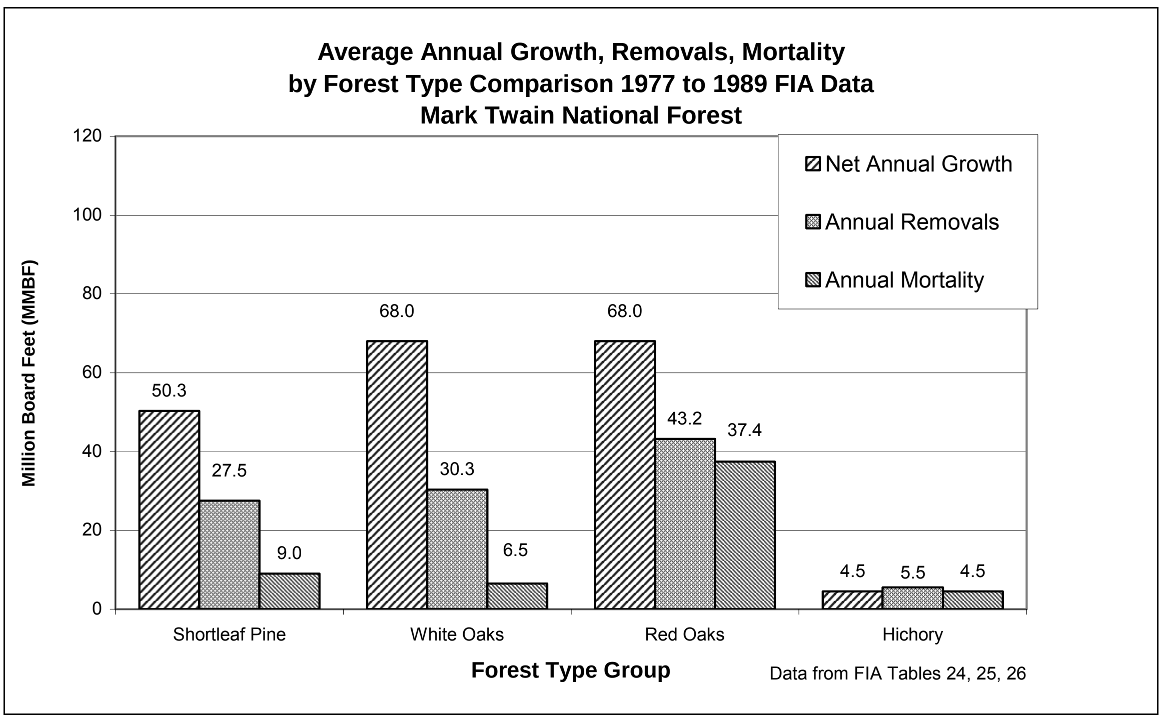
1977 FIA Data not available

Stocking classes (Figure 3), a measure of density or number of trees, have dramatically shifted from moderately stocked to fully stocked (47% of MTNF) and overstocked (5% of MTNF).

The data suggests a forest type shift to the faster-growing, shorter-lived (70 years) black-red oak group. At the same time, size is increasing from poletimber to sawtimber with 52 % of the forest being in a fully stocked to overstocked condition. Growth over the last 10 to 15 years has resulted in production of medium sized trees, 8 to 12 inches diameter at breast height (DBH) in a very dense growing condition. This condition stresses trees. If this condition persists, growth rates would slowly decrease, trees would become stressed, and mortality would increase as diseases and insects begin to affect the forest. Overstocked stands will remain about the same size and have very slow diameter growth. The pole and small sawtimber stands will not become larger sawtimber for 10 to 30 years because there is no growing space.

Nearly 58 % of the timberland in the Mark Twain is capable of growing more than 50 cubic feet of wood per acre per year. Net annual growth of growing stock averaged only 23.7 cubic feet per acre in 1988. The low growth rate reflects conditions in existing timber stands, poor sites due largely to shallow, rocky soils, dense stocking conditions and aging stands. Poor sites also contribute to the generally poor quality timber. Approximately 69 % of hardwood sawtimber in 1988 was in the ‘tie and timber’ class for butt log grade, which is the lowest quality log grade.

Figure 4 - Average Net Annual Growth, Removals and Mortality by Major Species Group 1989

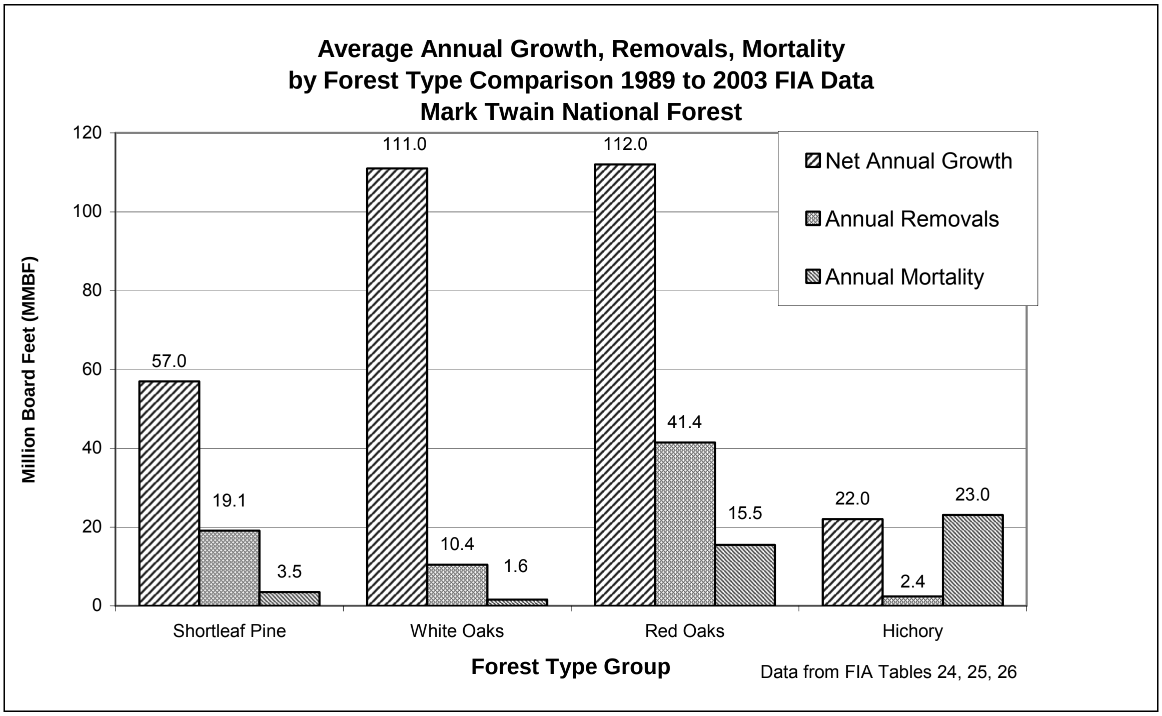


Source: NC-129

The 1991 NC-129 report discussed the data shown in Figure 4. The key point of data is that mortality for the red oak group is 59 % of all mortality, while 55% of the growth occurs in the red oak group. The reason for the high mortality is the great amount of oak decline experienced on the Mark Twain from 1980 to 1989. Removals for the red oak group reflect timber management efforts in the 1980s in trying to deal with oak decline. Mortality and removals combined represent 80.6 MMBF per year of removals compared to 68 MMBF per year of growth. Data shows that, on average, the red oak group is producing a net loss of 12.6 MMBF per year.

Data from the 2003 Survey (Figure 5) shows an increase, almost double, in net annual growth from 1989 to 2003 for the oaks and hickory classes. Removals for red oaks are similar to the 1989 data but lower for the other forest types. Mortality for the 1989 to 2003 period is about half of what it was in the period of 1977 to 1989. There is some concern that the effects of the 1998-2000 droughts and resulting mortality may not be reflected in this data.

Figure 5 - Average Annual Growth, Removals and Mortality by Major Species Group, 1989



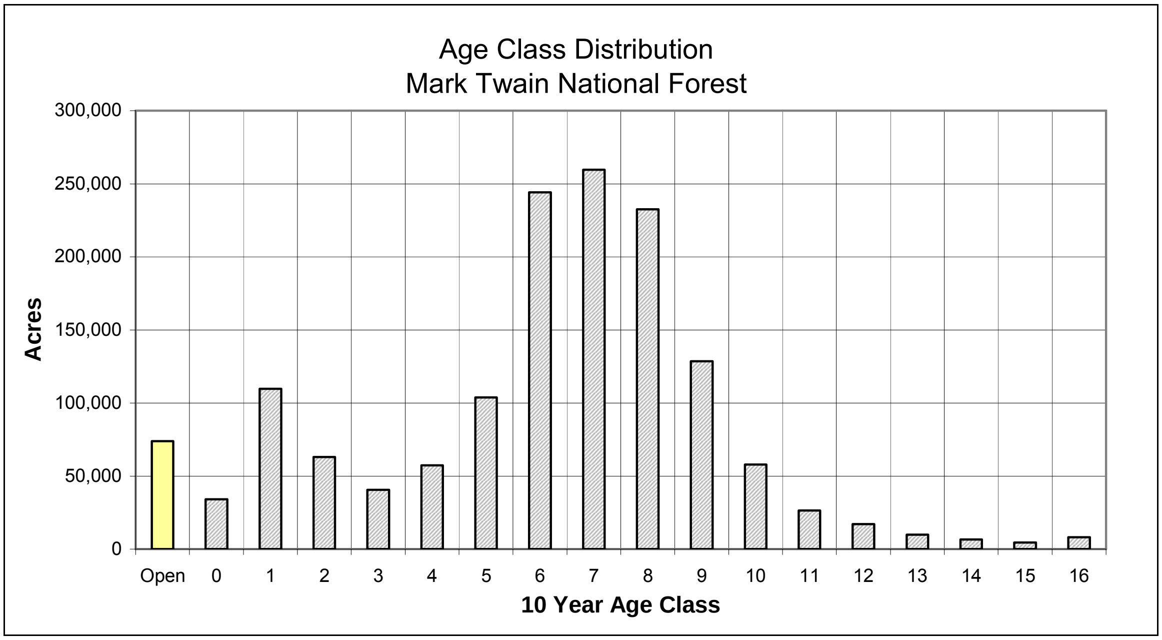
Harvest levels by method from 1994 to 2003 were 50,911 acres (5% of suited lands) of commercial thinning, 41,846 acres (4% of suited lands) of uneven-aged management, and 30,795 acres (3% of suited lands) of even-aged regeneration harvests.

Current Conditions

The Mark Twain National Forest in made up of over 1,496,100 acres found in 9 geographic units scattered among 29 counties in southern Missouri. These acres account for 3 percent of Missouri's land area, and 11 percent of the State's forested land. (Kingsley and Law 1991)

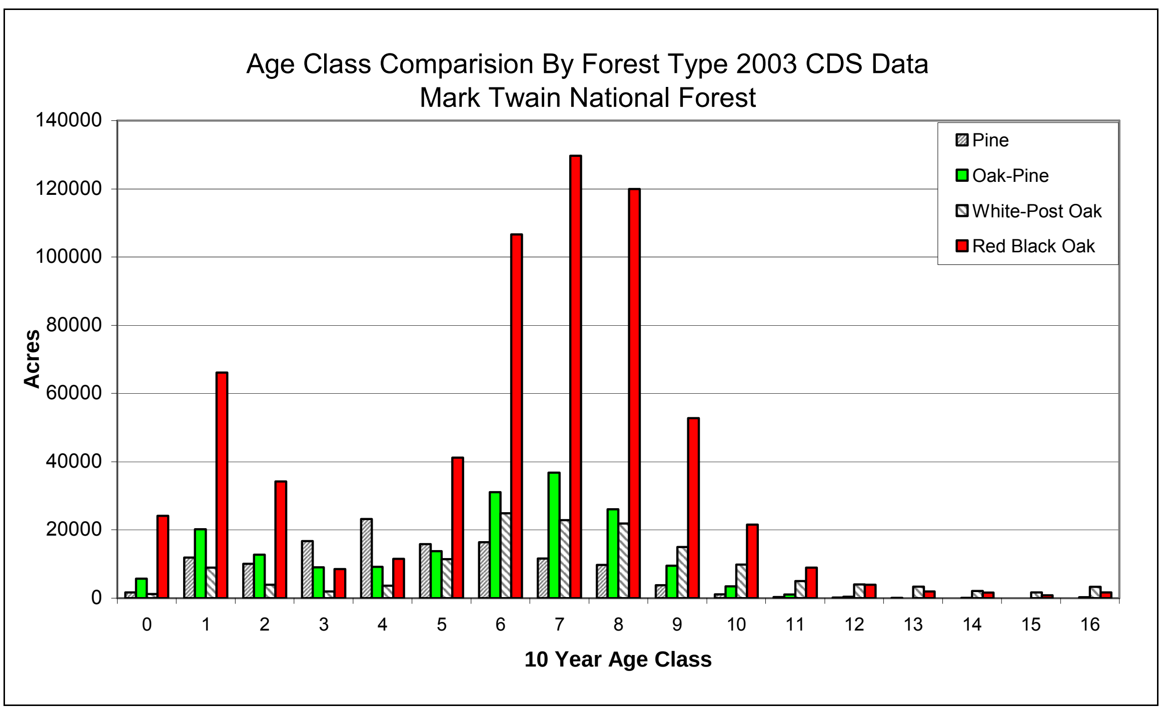
Current Mark Twain conditions as reflected in the Mark Twain's CDS data are shown in Figures 6, 7 and 8. The vast majority of the Mark Twain is over 60 years old. The largest forest type group in these age classes is the red oak group comprised of scarlet and black oaks. This may explain the effects we are seeing from the 1998-2001 droughts and resulting oak decline being experienced on the Mark Twain today. This forest type will generally grow for 70 to 90 years, and is highly sought after for sawtimber products.

Figure 6 - Age Class Distribution, 2003



Source: Mark Twain NF CDS Data

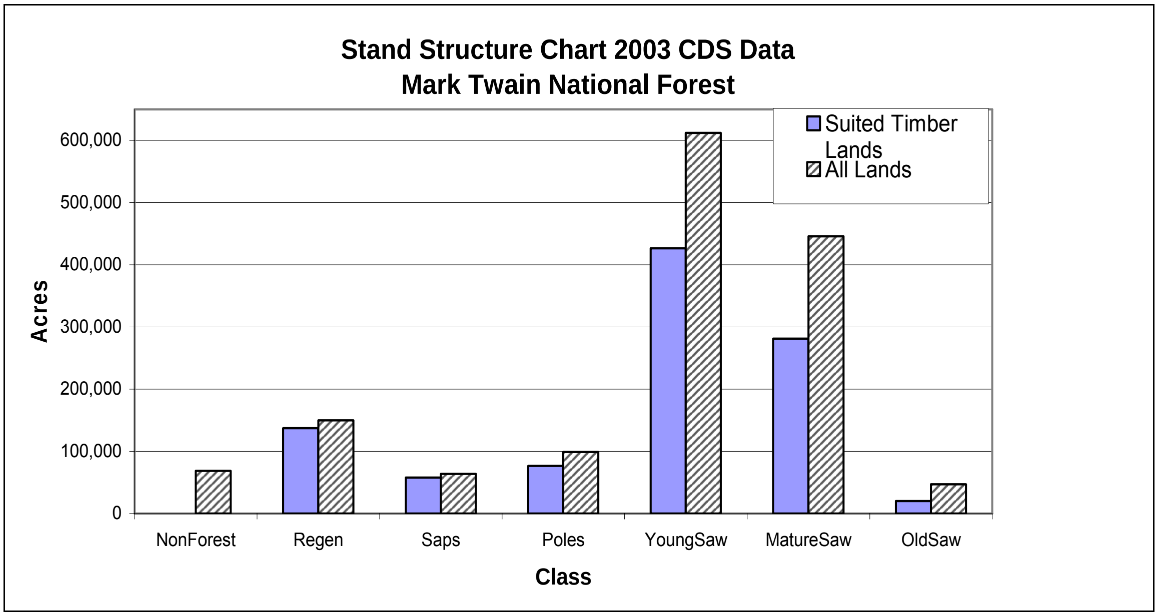
Figure 7 - Age Class Comparison by Forest Type, 2003



Source: Mark Twain NF CDS Data

As shown in Figure 8, the majority of the sawtimber is in the young sawtimber class (8-11 inches DBH) and over 60 years old.

Figure 8 - Stand Structure based on Stand Age, 2003



Source: Mark Twain NF CDS Data

Lands suited to timber production and timber supply

Suitable timber lands are lands where timber harvesting is a scheduled management practice over a long period of time. Suitable lands can change for many reasons. For example, a newly identified threatened or endangered species could require more old growth be removed from the suitable base to meet habitat requirements; or if industry begins using helicopter logging for lands with steep slopes, these lands may be returned to the suitable base and scheduled for harvest.

The 1986 Plan lists lands suitable for timber management in Table 4-2, IV-6. This table shows that, in 1986, the Mark Twain determined the suitable timber base to be 1,282,500 acres, 88 % of the Mark Twain, for scheduled timber management activities. An assumption of the 1986 Plan was that wildlife habitats, such as old growth, would be managed for timber products as well as old growth values so these lands were included in the suitable lands.

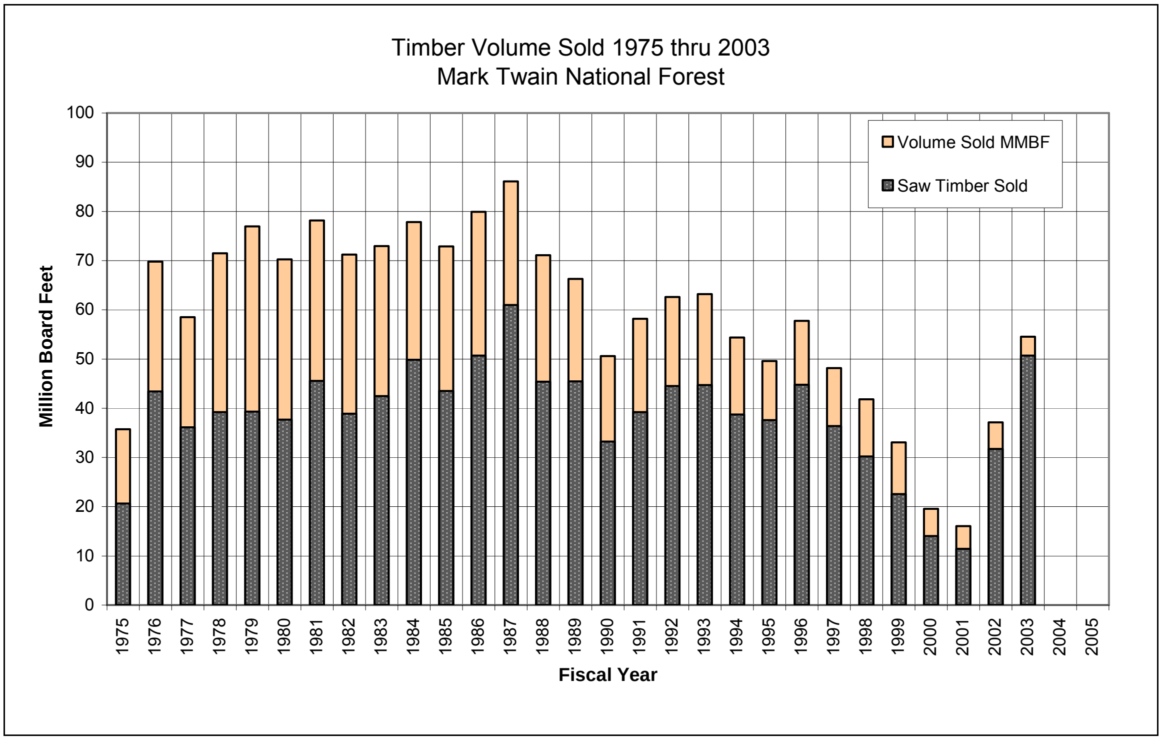
In response to several national issues and lawsuits, the Mark Twain conducted an analysis of suitable lands in late 1994 and early 1995. It was determined that 948,100 acres were suitable timber lands. The acres were reduced due to steep slopes, removal of designated old growth areas, riparian areas and areas allocated to management prescriptions 6.1 (Sensitive Areas), 6.3, 8.1 and 9.1 (2430/1930 Letter to Regional Forester, March 3, 1995). The ASQ was not recalculated on the new acres base. It was determined that this analysis would be done when the Plan was to be revised in 1996. Project work recognized and used the new suitable lands. In 1997, the data from the Mark Twain's Vegetation database (CDS) was summarized using the Land Suitability Class attribute. The results were very similar to the 1995 numbers.

The acres of suitable land are used in the calculation of the allowable sale quantity (ASQ). Any large change in the suitable land base can affect the ASQ set in the Forest Plan. The

1986 Plan calls for an average allowable sale quantity of 105 million board feet (MMBF) per year.

Many question the Mark Twain's capability to produce this volume and historically the Mark Twain has not achieved this level of volume output with the budgets it has received. See Figure 9 for the actual sold history.

Figure 9 - Timber Volumes Sold by Fiscal Year 1975 - 2003



Source: Mark Twain NF CDS Data

The 1986 Plan estimated 25 MMBF of firewood, 60 MMBF of sawtimber and 20 MMBF of roundwood in calculation of ASQ. As shown, little fuelwood was sold, sawtimber ranges from 15 to 55 MMBF, and roundwood ranges from 5 to 25 MMBF. In the last 4 years, the sawtimber portion of the sold volume has exceeded 90%. The amount of roundwood volume sold since 1990 has continued to decline. Some of this decline may be attributed to a change in definition of a sawtimber tree from 11inches diameter breast height (DBH) and larger to 9 inches DBH and larger.

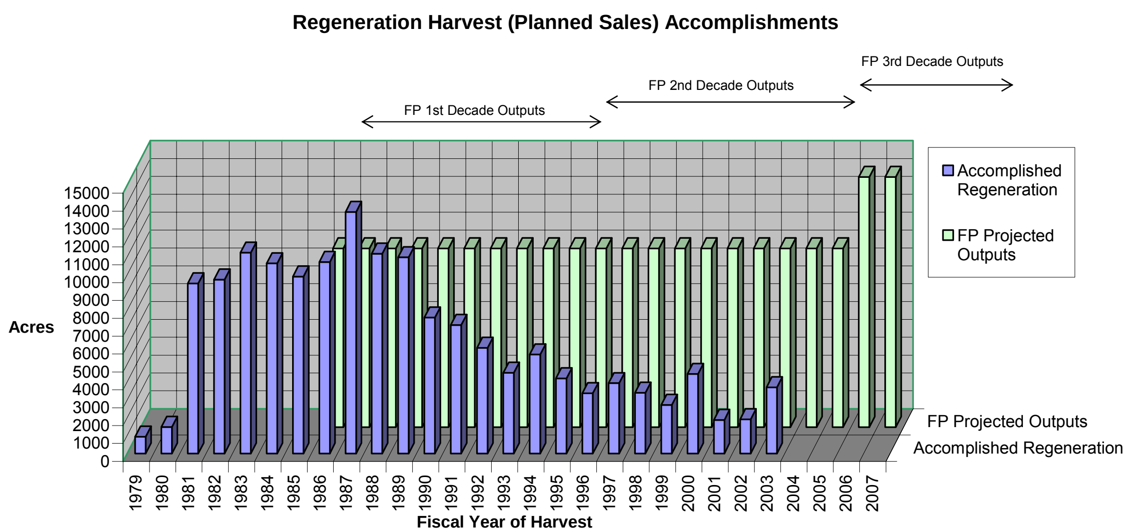
In the period 1978 through 1988, the Mark Twain averaged 75 MMBF per year with a high of 80.1 MMBF in 1987. If markets had been available for the firewood and more roundwood capacity, the Mark Twain conceivable could have reached a 95 to 105 MMBF harvest level.

Figure 10 shows the amount of regeneration harvesting accomplished verses the projection of acres to be regenerated by the 1986 Plan. During the 1980's, regeneration harvests were on track with what the plan projected. Starting in the early 1990's, the amount of regeneration harvesting started to fall to its current level. The 1986 Plan's projection of 11,200 acres is virtually the same as Alternative 3's projection of 11,270 acres.

Throughout the 1990's, timber markets, appeals of project decisions, lawsuits, reduced budgets and national policy changes (New Perspectives, Ecosystem Management, reduce clear cutting, Roadless Area Review, etc.) all played a role in the Mark Twain's declining timber sales program. The capability of the land to produce timber products under the 1986

Plan did not change. The circumstances and rules on how the Plan would be implemented did change. These changes reduced the amount of volume sold, but did not change the biological capability of the land to grow trees.

Figure 10 - Regeneration Harvests Accomplished versus Planned, Fiscal Year 1979 - 2003



Forest Plan Average Annual Outputs for Regeneration cuts = 11.2 M acres (Table 4-1 IV-5). Minimum Regeneration objectives = 10 M acres first 2 decades (Table 4-4, IV-8).
1989 J.Law analysis summarized Step 2 OA showed 10,988 acre annual average for Regeneration needs.

Source: Mark Twain NF CDS Data

Environmental Consequences

Direct and Indirect Effects

Lands suitable for timber production

All alternatives

As part of the planning process, lands not suited for timber production were identified as required in the National Forest Management Act, Sec.6 e(2) and g(2)(a). Results of this analysis identified 1,316,900 acres as tentatively suited forestland (Stage 1 suitable lands). Table 5 summarizes analysis results and compares them to the 1986 Forest Plan.

Appendix B explains in detail the process used for determining suitable lands. This analysis uses GIS to compute acres; the results would vary slightly if other information sources, such as CDS of FIA data were used.

Table 5 - Summary of Stage 1 Lands Suited for Timber Production

Classification	1986 Forest Plan [1]	Revision (2004 Analysis Acres)
Net National Forest System Land	1,461,600	1,496,100
Water	-3,500	-2,800
Non-Forest Land (Open Lands, Road and Utility Rights-of-Ways, glades, etc.) [2]	-23,200	-104,400
Sub-Total Non Forest Lands	-26,700	-107,200
Forest Land	1,434,900	1,388,900
Not Available – Wilderness[3]	-64,200	-57,000
Not Available --list any other areas withdrawn by Congress, the Sec., or the Chief ... (Eleven Point NS River, Greer Special Area, Irish Excluded Lands)	0	-13,000
Not Capable of Producing Industrial Wood	0	0
Potential for Irreversible Soil/Watershed Damage	0	0
Restocking in Five Years not Assured	0	0
Inadequate Response Information	-34,700	-2000
Sub-Total Forest Land Withdrawn	-98,900	-72,000
Sub-Total Non Forest and Forest Land Withdrawn	-125,600	-179,200
Tentatively Suitable Lands (Stage1)	1,336,000	1,316,900

Note: Numbers are rounded to the nearest 100 acres
1 Data from the 1986 Forest Plan Table 4-2, IV-6
2 Current open lands now include 44,000 acres of open glades.
3 Some Wilderness acres are withdrawn under Open Lands designation

The tentatively suited timber base (Stage 1 Lands) is 1,316,900 acres or 88 % of the Mark Twain, a decrease of 19,100 acres (-1 % of the Mark Twain) from the 1986 tentatively suited acres.

The Mark Twain has acquired an additional 34,100 acres of land since 1986. Much of the land is in the Greer Spring Special area and other Land and Water Conservation lands acquired along rivers and riparian areas. Approximately 44,000 acres of open and semi-open glades were removed from the timber base and re-classified as non-forest open lands. Road and utility right-of-ways are accounted for and classified as non-forest lands. The analysis increases non-forest lands by 80,500 acres or 5 % of the Mark Twain.

Lands withdrawn by Congress and others decreased 26,955 acres (-2 % of the Mark Twain) due to re-classification of land thought to have inadequate resource information and how the Wilderness acres are accounted for. In the 1986 analysis, Wilderness was removed as Wilderness. This analysis removed the open lands within the Wilderness in the first step to show the true open land verses forested lands. Much of the Hercules Glades Wilderness lands are open and semi open glades and sites with low productivity so they are re-classified as non- forest open lands.

Assumptions for this analysis are that Standards and Guidelines would be the same for all alternatives. Management Prescriptions and Standards and Guidelines would direct management activities. Many areas will allow timber harvest to reach specific resource objectives, such as thinning an old growth stand to create specific habitat conditions. The area and volume will not be counted towards ASQ because those lands are managed for other resource needs and not for scheduled timber production.

All Management Prescriptions, with the exception of 5.1, Wilderness management, are included as suitable lands. Alternatives 1-4 use the same standards and guidelines to minimize adverse effects of timber harvests on soil, water, air, wildlife, recreation, and visual resources. Alternative 5 has some standards and guidelines different from Alternatives 1-4. The Land Suitability Analysis for the 1986 Plan was re-analyzed in 1995 and 1997. Results of those analyses produced a very similar suitable land base to the 2004 analysis; therefore the same suitable land base is used for all alternatives. Lands removed from the suitable timber base would protect other resources and provide specialized habitat and forested habitats needed for wildlife. Based on the proposed standards for soil, water and other resources, and specialized habitat needs for wildlife, the analysis mapped each resource need, and identified forest land not appropriate for timber production as required by the NFMA. The results are shown in Table 6 as Stage 2 Suitable lands; approximately 997,100 acres.

Table 6 - Summary of Stage 2 Lands Suited for Timber Production

Classification	1986 Forest Plan [1]	Revision (2004 Analysis Acres)
Not Suitable due to Minimum Management Requirements and for other Resources (such as: Riparian Areas, Experimental Forest, Habitat for Threatened, Endangered, or Sensitive Species, Administrative and Developed Recreation Sites, Designated Old Growth, etc.) [1]	-53,500	-319,800
Lands Suitable and Appropriate for Timber Production (Stage2)	1,282,500	997,100

Note: Numbers are rounded to the nearest 100 acres
1 The 1986 Plan did not remove old growth areas from the suitable base.

The largest change in suitable lands comes from minimum management requirements for other resources such as: riparian areas, Sinkin Experimental Forest, habitat for Threatened, Endangered, or Sensitive species, administrative and developed recreation sites, designated old growth, etc. Many of these areas were identified and mapped for the first time and many overlap, such as old growth, a cave and riparian area in the same stand. Updated Standards and Guidelines were applied to these areas and a spatial map was produced. Lands for other resources total 319,800 acres or 21 % of the Mark Twain. This is an increase of 266,300 acres over the 1986 analysis. Much of this area is designated old growth, riparian areas and the Sinkin Experimental Forest. The 1986 Plan included these acres as suitable and fully expected to harvest timber from these lands and therefore counted the projected volumes in ASQ calculations.

Result of the analysis provides 997,100 acres or 67 % of the Mark Twain as Land Suited for Timber production. This is a 285,400-acre decrease (or -19 %) from the 1986 Forest Plan. These acres are the suitable timber based used by all alternatives to calculate the Allowable Sale Quantity.

Allowable Sale Quantity (ASQ)

Timber Scheduling Analysis

The National Forest Management Act (NFMA) gives guidance on the amount of harvesting that should occur on national forests. Section 13 of the Act limits the amount of harvest to a quantity that is equal to or less than that which could be removed annually in perpetuity on a sustained-yield basis. The ASQ is a maximum capacity of suitable land to grow timber volume on a long-term sustained yield basis under a given management scenario (Forest Plan). ASQ is not a target. ASQ can be analyzed and recalculated at any time and applied through a Forest Plan Amendment or Revision.

A description of the timber harvest scheduling analysis is found in Appendix B. As part of the analysis, all NFMA requirements are met by use of software constraints, in model construction, and in the resulting analysis. Demand for timber products is expected to increase in the Ozarks according to the Ozark-Ouachita Highlands Assessment (USDA Forest Service 1999b). The timber scheduling analysis recognizes that demand may increase or decrease based on market condition, but the historic trend is that demand for timber products from all sources and ownership will continue to increase. For the 1986 Plan analysis, a demand projection was estimated and applied to the ASQ determination and shown in Table 2-1, Demand vs. Supply Potentials By Resource By Decade, (page II-4) and figure 4-1 (page IV-10). The table shows the Mark Twain harvest projection of 79.8 million board feet per year (MMBF) of sawtimber/products in decade 1, increasing to 198.4 MMBF per year in decade 5. The projected ASQ in decade 1 is 105 MMBF and increases to a projected total of 261 MMBF. These increases are derived by putting estimated demand increase into the models and projecting outputs. The current analysis does not use demand in the models. The results are based on the amount of suitable lands, revised yield tables and how the forest would be managed through management prescription assignment.

The timber scheduling analysis did not model natural disturbances such as tornados or oak decline. The oak decline situation cannot be modeled due to a lack of credible information such as managed yield tables for affected oak decline stands. Information about the differences in the growth and yield for declining stands left to die; stands that are thinned; and stands that are regenerated is not available.

Information about when and how much oak decline will occur does not exist. While some information on short-term affects of oak decline exists, no information on long-term effects is available. The results of trying to schedule oak decline into model predictions over a 150 year period would be to extrapolate data that has already been extrapolated in another model. We believe the results would be too speculative to be informative. Tornados and other natural events are random and predictions cannot be as to how many will occur and what damage level would result.

The analysis includes creating new timber yield tables and the use of SPECTRUM software to model the alternatives. The analysis only deals with suitable timber base acres and only addresses the timber scheduling analysis needs. Details are explained in Appendix B.

All Alternatives

Table 7 displays the proposed average annual maximum sell volumes by alternative that could be sold from lands classified as suitable for timber production. The numbers are based on the SPECTRUM model's projected outputs by decade and displayed as average annual volume in millions of board feet for all commercial wood products. Model outputs are estimates based on a series of modeling runs that simulate implementation of the 2005 Forest Plan. Actual sell volumes will likely fluctuate somewhat between decades from those displayed, but would not exceed the maximum sell volumes displayed and would be very similar in outputs and effects across the planning horizon (150 years). Alternative 1 volume would not be sold, but cut and left on the ground, resulting in 0 or no ASQ.

Table 7 - Estimated Average Annual ASQ in Million Board Feet

SPECTRUM Model Projected Outputs	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Average Annual Allowable Sale Quantity (MMBF)	0	99	103	105	105
1^{st} Decade Sawtimber Portion	0	38.5	43.5	47.5	50

Note: Alt 1 volume (25MMBF) is cut but not removed from the forest, therefore the ASQ is 0.

Less than 6 MMBF separate Alternatives 2 through 5. An estimated 99 MMBF per year would be cut and sold in Alternative 2 followed by Alternative 3, 4 then 5 with 105 MMBF.

Mix of Forest Products

Alternative 1

Alternative 1 would limit timber cutting to ecosystem restoration activities in the MP 1.1 and 1.2 areas, and regeneration harvest for wildlife needs of 5% in MP 6.2 and 1-5% in MP 6.1 areas. An estimated 25 MMBF per year would be cut and left in the woods. There would be no ASQ since timber cannot be sold and removed. Figure 11 shows no ASQ and no products. It is used to compare to the other alternatives.

Alternatives 2 through 5

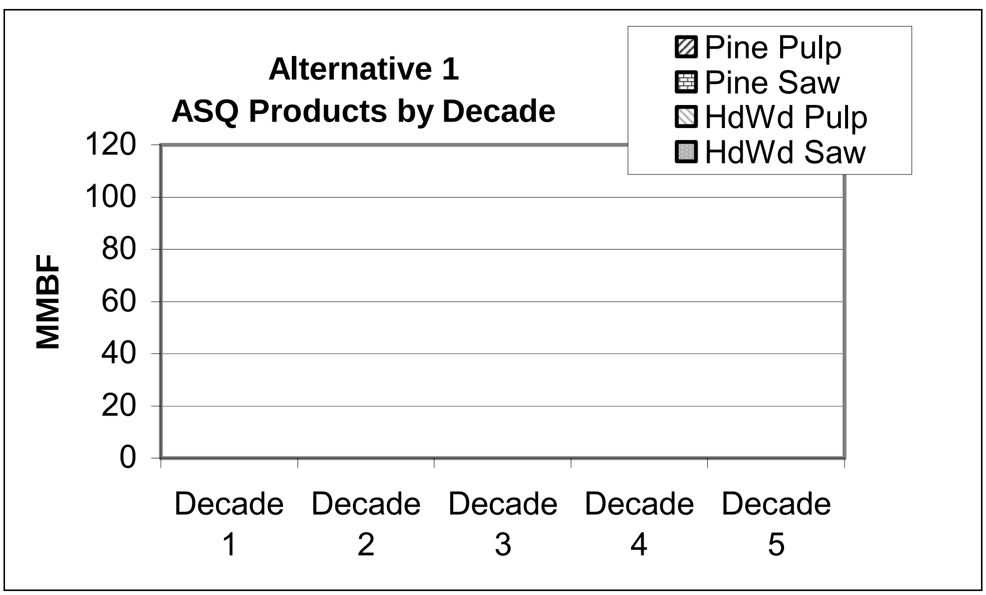
For Decade 1, Alternatives 2 and 3 have more thinning and roundwood products compared to Alternatives 4 and 5 which have more regeneration harvests and sawtimber products. Estimated product outputs are shown in Figures 12 through 15. In all alternatives, sawtimber is less than 50% of the product outputs in Decades 1-5.

For alternatives 2 and 3, hardwood sawtimber and products are dominant during the first 2 decades. Only in decade 3 does shortleaf pine products become a substantial part of the forest product outputs. Much of this shows the existing pine areas reaching an age where they need harvesting, and that many of the oak stands are managed for longer rotations.

For alternatives 4 and 5, shortleaf pine products are a large part of the first decade harvest, and a substantial part of the harvest for decades 3, 4 and 5. Much of this can be attributed to the large number of acres managed under a 70 year rotation.

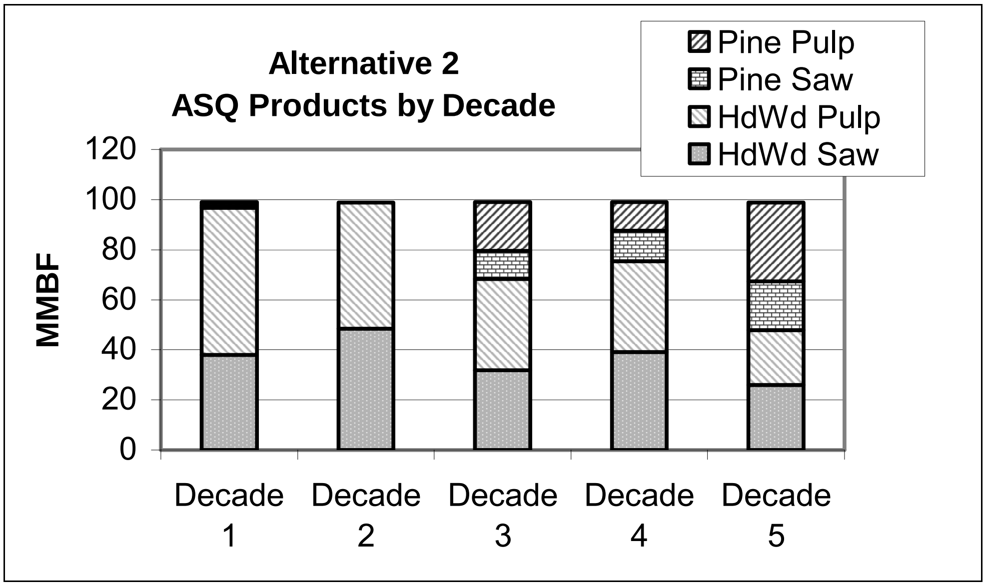
The graphs reflect current inventory species groups and ages. No conversions are modeled.

Figure 11- Alternative 1 Timber Products from All Suitable Lands



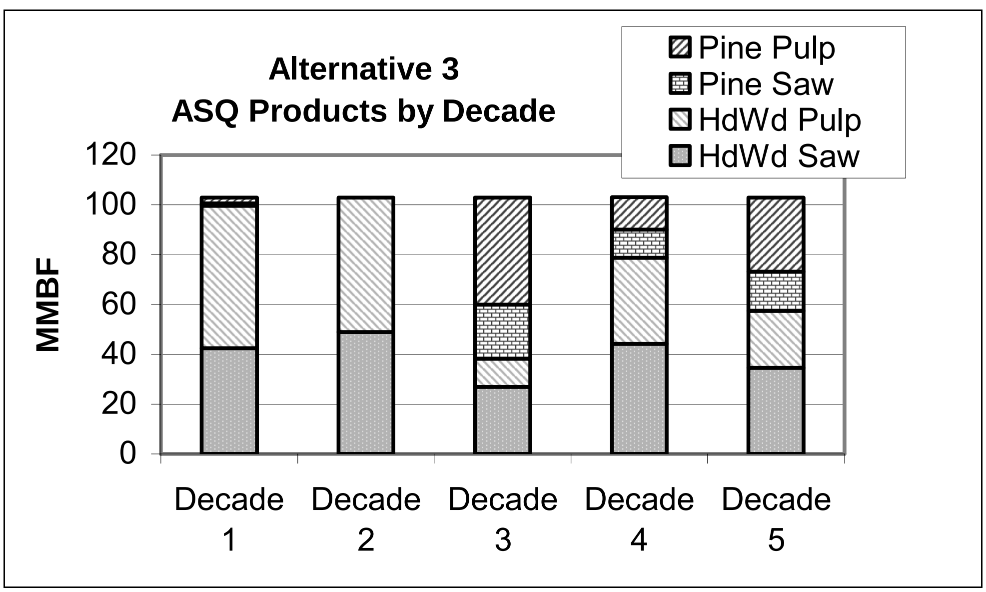
Source: SPECTRUM Model runs, Mark Twain NF 2004

Figure 12 - Alternative 2 Timber Products from All Suitable Lands



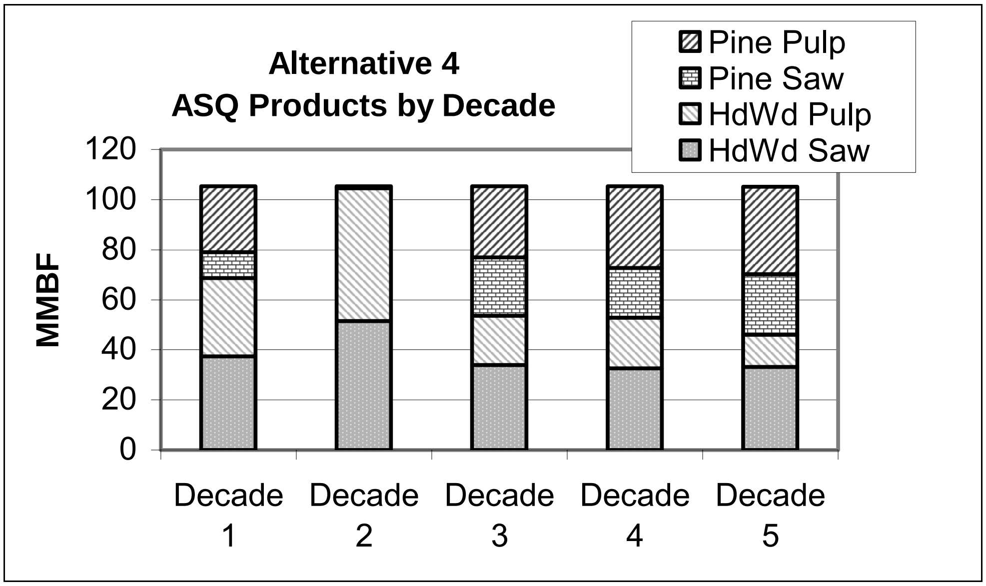
Source: SPECTRUM Model runs, Mark Twain NF 2004

Figure 13 - Alternative 3 Timber Products from All Suitable Lands



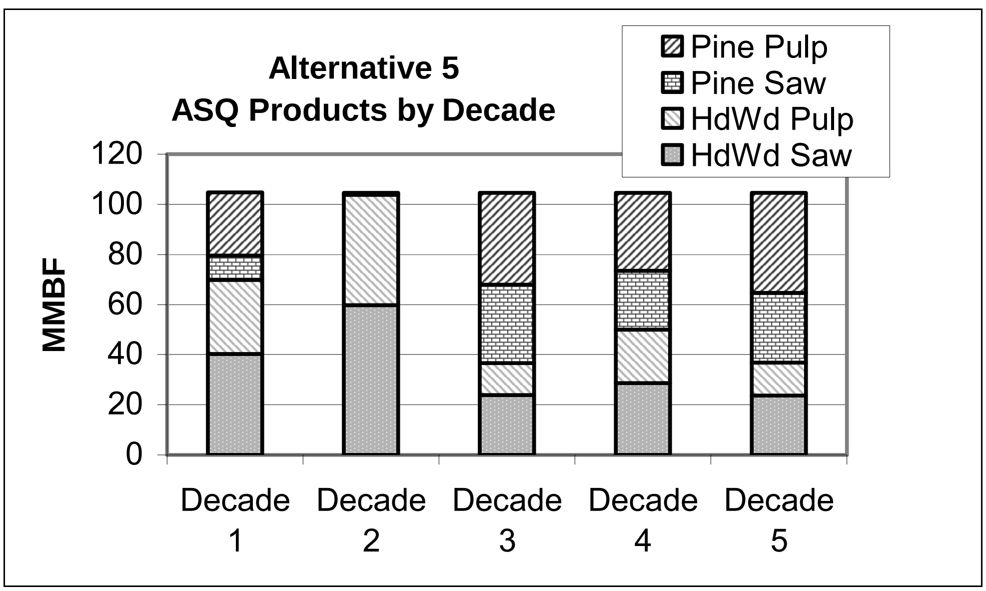
Source: SPECTRUM Model runs, Mark Twain NF 2004

Figure 14 - Alternative 4 Timber Products from All Suitable Lands



Source: SPECTRUM Model runs, Mark Twain NF 2004

Figure 15 - Alternative 5 Timber Products from All Suitable Lands



Source: SPECTRUM Model runs, Mark Twain NF 2004

Conclusions

The direct and indirect effects discuss the differences of the 5 alternatives. The effects of the proposed Mark Twain Plan are related to the determination of suitable lands for timber management and how much timber can be harvested (ASQ) from those lands. The mix of timber products based on species mix and whether the product is sawtimber or roundwood, is also discussed.

The full implementation of standards and guidelines in the 2005 Plan, are directly reflected in process to determine the suitable lands. Unsuitable areas are lands that are often described by a standard or guideline such as a 100 foot buffer around springs. The analysis shows that the Mark Twain can supply timber products without adversely affecting ecosystem health, water quality, and the social and economic needs of the people because the standards and guidelines would be fully implemented and protected as unsuitable lands.

The suitable lands determined for this plan revision are similar to past analyses but 285,400 acres less than the 1986 Plan analysis. The main difference being that old growth and glades are now assigned as unsuitable. This analysis is better documented and mapped. Result of the analysis provides 997,100 acres or 67 % of the Mark Twain NF as Land Suited for Timber production.

The ASQ for Alternative 1 is 0. The ASQ for the alternatives 2-5 range from 99 to 105 MMBF, a difference of less than 6 MMBF; yet each alternative manages a different amount of ecosystem lands. Alternative 3 estimates an ASQ of 103 MMBF, about 2% less than the 105 MMBF ASQ of Alternative 5, the current Forest Plan.

Except for Alternative 1, the product mix will remain mostly mixed oak species for the next 20 years. Shortleaf pine products will increase in decade 3-5 due to aging of the forest. There will be less than 50% sawtimber due to the smaller sized trees in a fully/over stocked condition. The reduced estimate of sawtimber could affect the timber sale program and habitat goals if markets are not found for the smaller products. If the smaller products cannot be sold, then the annual amount of sold volume will be lower and habitat goals may not be fully achieved.

Cumulative Effects

Cumulative Effects Question

What are the incremental effects to forest vegetation from harvesting timber on the forest lands in Missouri?

- In terms of sale quantity on lands available for timber harvest.
- In terms of the mix of forest products.

Cumulative Effects Area

The area used to discuss cumulative effects for forest vegetation will start with the State of Missouri. The 29 county area in which the Mark Twain National Forest will then be looked at in more detail. The Forest Inventory and Analysis (FIA) data will be used as it is the most extensive and available data source regarding forest vegetation for all land ownerships. The 1993 Land Use Land Cover dataset from the Missouri Resources Assessment Partnership (MoRAP) will be used to show the spatial extent of forest vegetation derived from 1991-1993 satellite imagery.

Temporal Scale

FIA data will be used to look at the forest vegetation from 1947 to 2003. Early FIA data (prior to 1989 survey) is not in an electronic format so it cannot be analyzed in detail. Most discussion will look at the 1989 and 2003 surveys covering the period from the early 1970’s to 2003. This period covers the time when public agencies started active management of their timber resources. Actions that may take place in the foreseeable future are 10 to 15 years into the future.

MoRAP Vegetation change analysis for 1996 through 2000 using Landsat satellite imagery is used to provide a spatial look at changes on other ownerships. This data is currently available only for this time period.

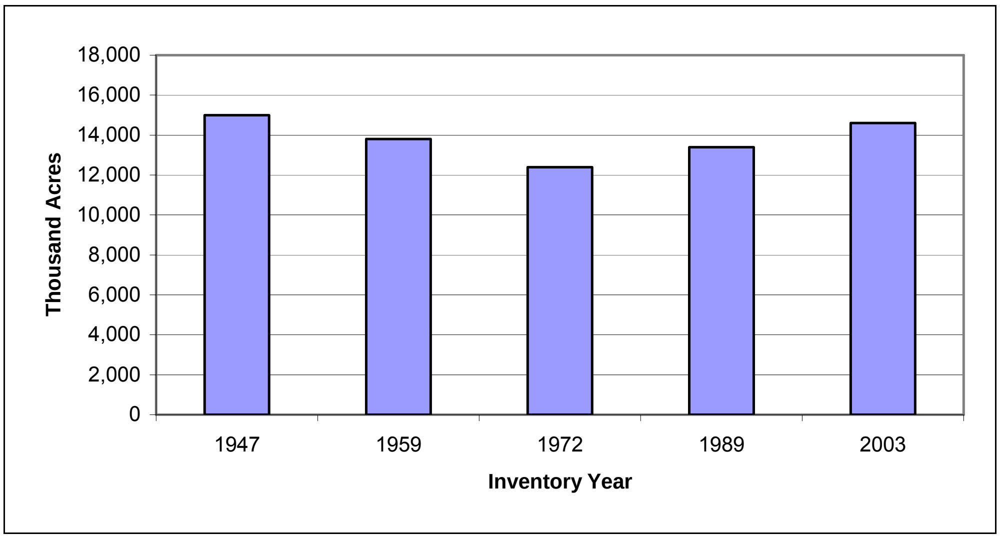
Affected Environment

The affected environment for Mark Twain lands has been described and discussed in previous pages.

The State of Missouri had a total forest land area of 14.6 million acres (Figure 16) in 2003. Forested lands include marginal lands not counted in the timberland class; therefore the timberland class will show fewer acres. Eighty two percent (82%) is owned by private landowners and 18% is owned by public agencies. The Mark Twain National Forest owns 9.4% of Missouri's forests in 2003, a 1.6% drop due to private-other ownership increases since the 1989 survey.

The amount of timberland was estimated at 15 million acres in 1947. The 1972 FIA survey reported a loss of 1,453,600 acres (-10.5%) of timberland between 1959 and 1972 (Essex 1974). The largest losses were in the Prairie and Southwestern Ozarks. Much of the loss of timberland was attributed to forest to pasture conversion, highway construction and transmission and pipeline rights-of-way through timbered areas. Since 1972, the area of timberlands has risen with each survey.

Figure 16 - Area of Timberland in Missouri by Inventory Year, 1947 - 2003



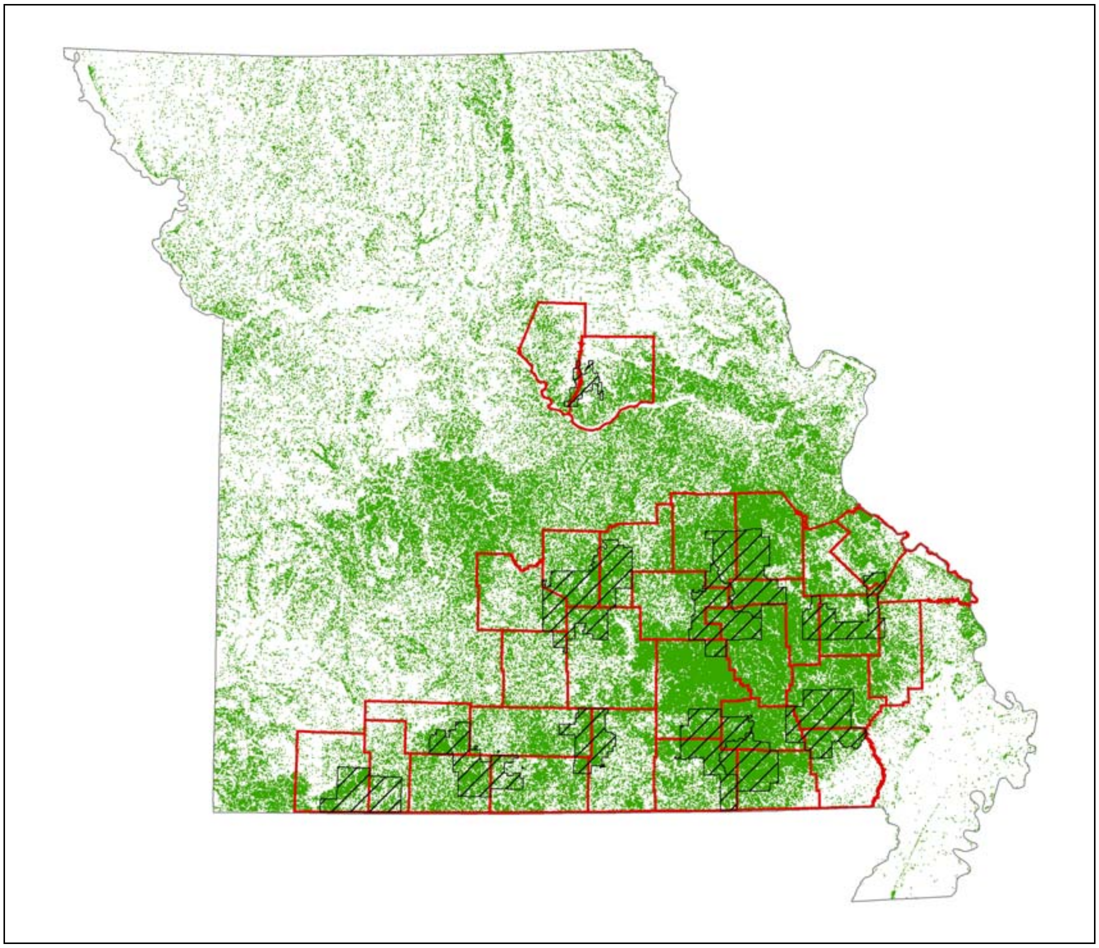
Source: Missouri's Forest Resources in 2003; Resource Bulletin NC-243(Spring 2005)

Currently, ninety six percent (96%) of the forest is hardwoods of which 82 percent is oak-hickory forest. The 1947 data shows oak-pine, oak-hickory and white oak forest type groups constituting 77.6 percent of the total forest while the 1999-2003 data has the oak-pine and oak-hickory groups making up 86 percent. The forested land cover for Missouri is shown in Figure 17. Note the Mark Twain National Forest Boundaries and the 29 counties in which the forest occurs. A general comparison of forest cover in Missouri from the early to mid 1970's (USGS Land Use Land Cover Map) to the 1993 MoRAP map shows that forested areas are still forested. Some areas have been removed from forest to agricultural or urban uses while other areas are re-growing into forest. Overall, there are more forest lands in 2003 than the 1970's.

Private landowners own 11,747,366 acres (83.4%) of timberland in Missouri. The Mark Twain NF follows with 1,379,816 acres (9.8%), then State agencies with 636,298 acres (4.5%)

The 29 county area is 13,145,829 acres or 29.4% of the land in the state of Missouri. The accessible forested land area, 7,726,235 acres, in the 29 counties represents 17% of the State lands; but 53% of the State's forested lands. The timberland in the 29 counties is 7,408,579 acres or 56% of the 29 county land area. Private landowners own 73.8 % of the timberland followed by the Mark Twain NF with 18.6 % and state agencies with 5.7%.

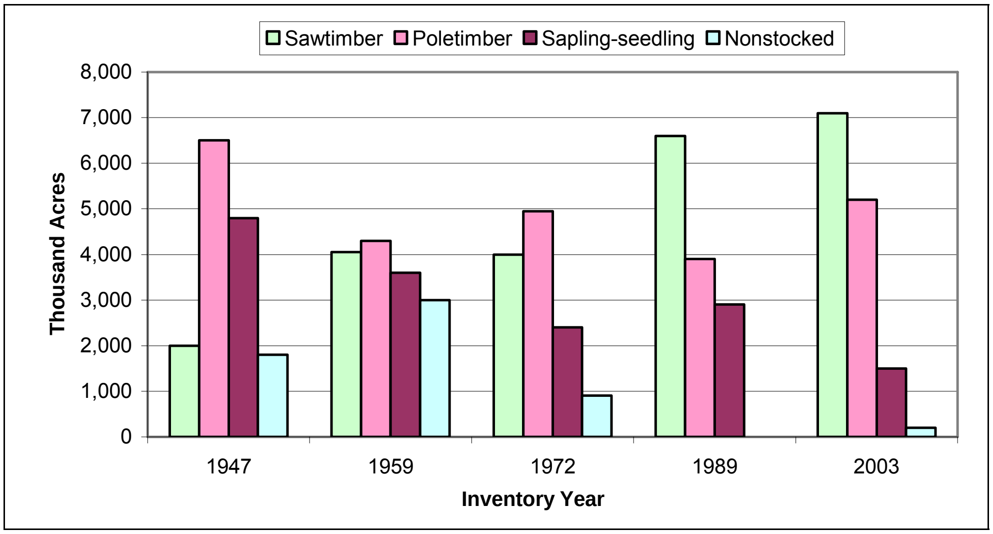
Figure 17 - Forest Lands Derived from Landsat Satellite Data 1993 Classification and the 29 County Area where National Forest Lands occur (Green is forestland, crosshatch is National Forest Boundaries



Source: MoRAP Landcover, 1993

Figure 18 shows the area of timberland by size class from each of the FIA surveys since 1947. This chart shows the progression of size class growth over the last 50 years. What was once a cut over area in the early 1900's, has now recovered into a majority of sawtimber sized stands.

Figure 18 - Area of Timberland in Missouri by Stand-Size Class, 1947 - 2003

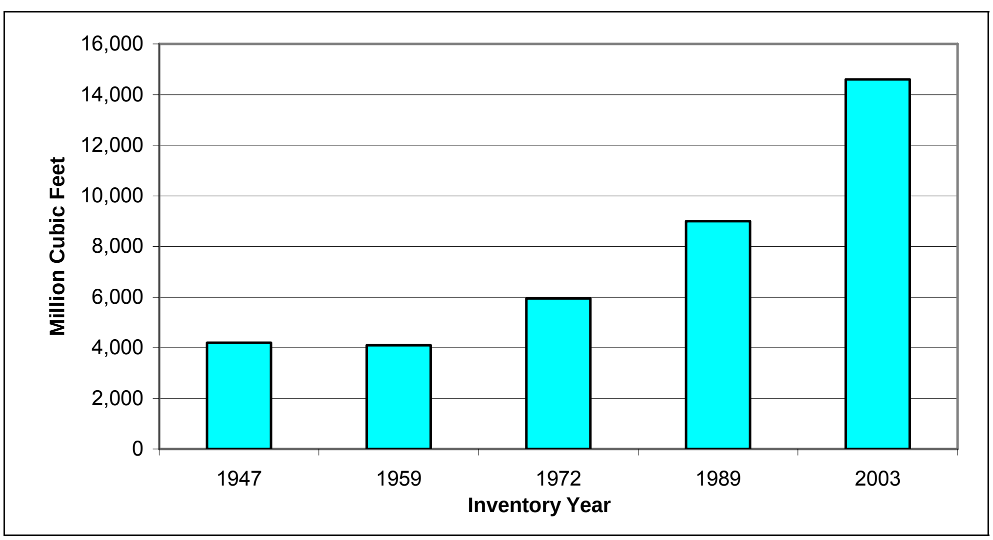


Source: Missouri's Forest Resources in 2003; Resource Bulletin NC-243(Spring 2005)

Figure 19 shows the amount of growing stock volume on timberland, by FIA survey, since 1947. The 2003 data, 14.6 billion cubic feet, shows a large increase over the 1989 data. The total live, above ground biomass on timberland in Missouri totaled 554.3 million dry tons. The net annual growth of growing stock increased, on average, 629.4 million cubic feet per year from 1989 to 1999-2003. Average annual removals totaled 118.6 million cubic feet per year during the same time period. Average annual mortality was 81.8 million cubic feet per year. The total of both removals and mortality are well below the net annual growth.

All analyses of the data show Missouri timberlands continuing to recover from turn of the century harvesting and land use changes. These lands are growing larger sized trees; net annual growth is increasing; volume of wood and biomass is increasing and the amount of forest area increased.

Figure 19 - Growing Stock Volume on Timberland in Missouri, 1947 - 2003

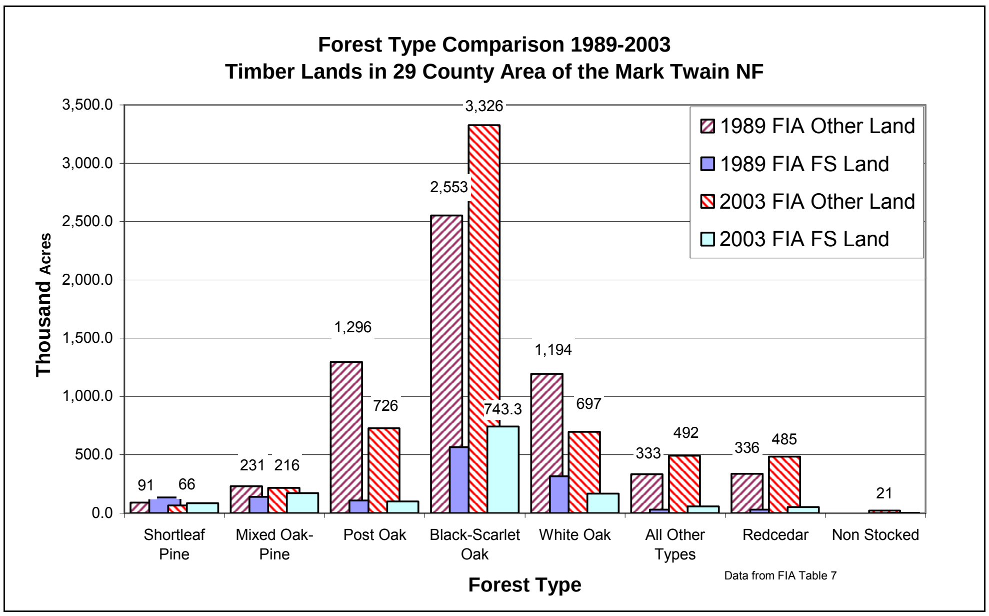


Source: Missouri's Forest Resources in 2003; Resource Bulletin NC-243(Spring 2005)

Of the 29 county area, private and other public agencies own 82% of the timberlands with 18.6% in Mark Twain NF lands. Between 1989 and 2003, the Mark Twain gained 50,816 acres of timberlands, while private lands lost 14,037 acres of timberland. The Mark Twain NF lands were mainly acquired lands such as the Greer Springs Area, other land exchanges and some open area re-growth to forest. There is limited information available to help explain the loss of timberlands on private lands. The best estimate, based on review of satellite data, is that some private lands are being converted to open pasture.

The forest type groups for the 29 county area are shown in Figure 20. The trends and changes for the private and other landowners are similar to the trends on Mark Twain lands. The black-scarlet oak group is increasing on both ownerships while the white oak and shortleaf pine groups are decreasing. The post oak group is decreasing on private-other ownerships, but stable on Mark Twain lands. Overall, changes on Mark Twain lands are similar to private-other lands in the 29 county area with the amount of change being larger on private-other lands. The biggest change is the large increase in the black-scarlet oak group and decrease in the white oak and post oak groups.

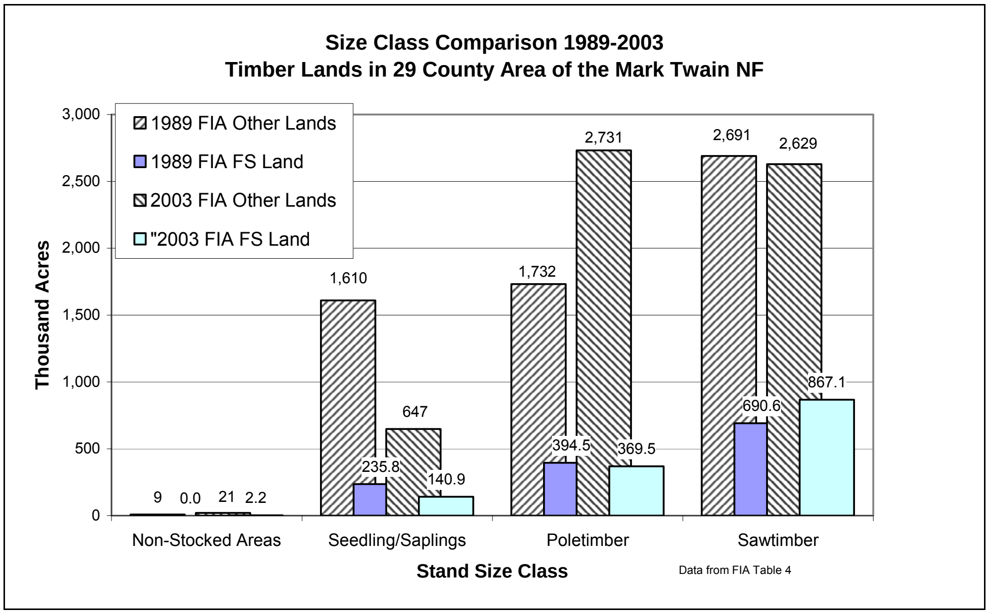
Figure 20 - Forest Type Comparison, 1989 - 2003



Source: FIA Database (May 2005)

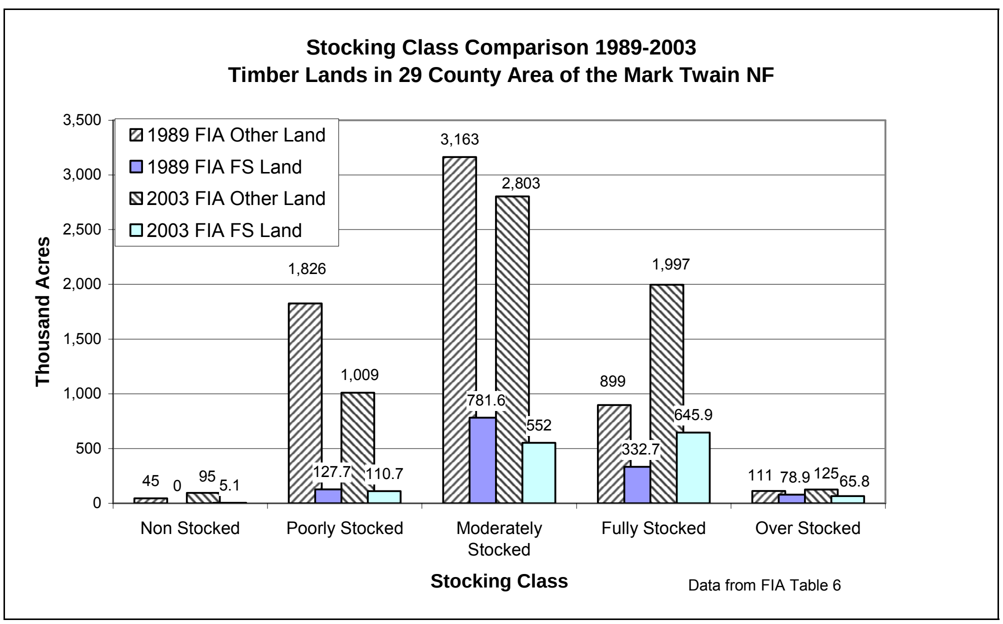
Figure 21 shows the size class comparison for the 29 county area. The small increase in non-stocked areas is the result of regenerating the forest where a FIA plot is located. The decrease in the seedling-sapling class is shared by all owners but a much larger drop on private-other lands. The poletimber class is stable on Mark Twain NF but a large increase on private-other lands, most likely an in growth from the seedling-sapling class. The sawtimber class is stable on private-other lands, with a 176,500 acres increase on Mark Twain NF lands.

Figure 21 - Size Class Comparison, 1989 - 2003



Source: FIA Database (May 2005)

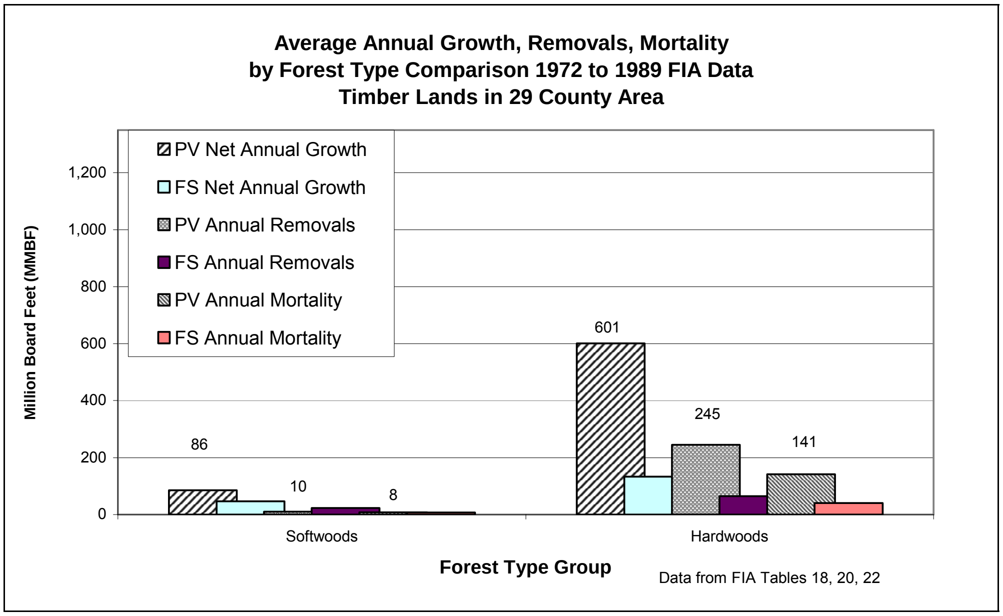
Figure 22 - Stocking Class Comparison, 1989 - 2003



Source: FIA Database (May 2005)

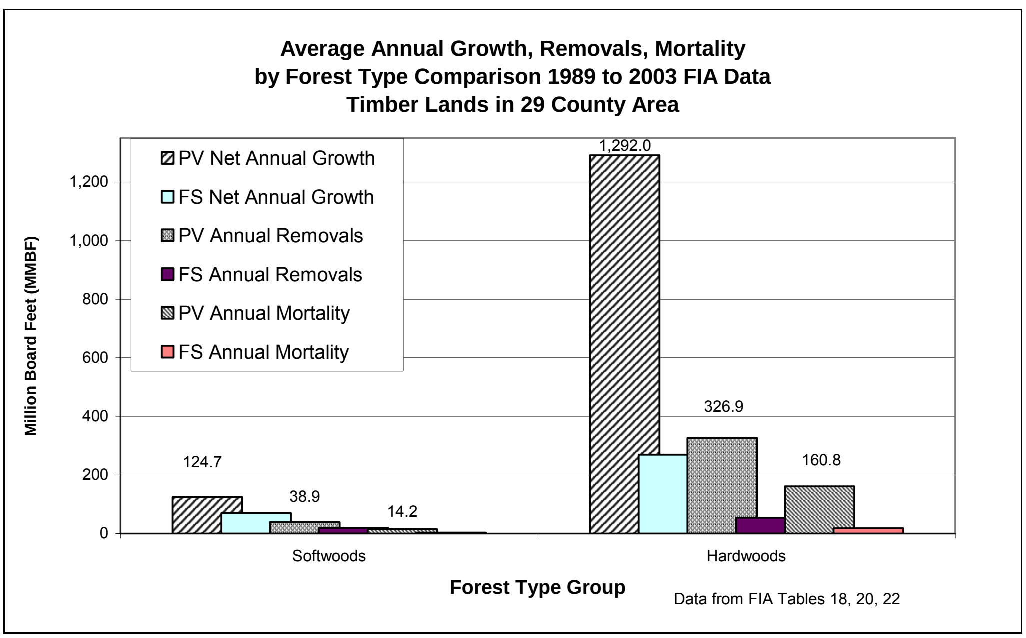
Stocking class comparison, Figure 22, shows decreases in the poorly and moderately stocked class for private-other and Mark Twain lands. There is a large increase in the fully stocked class for both ownerships. Figures 23 and 24 compare the net annual growth, annual removals and annual mortality between private-other lands and Mark Twain lands.

Figure 23 - Average Annual Growth, Removals and Mortality Comparison, 1972 - 1989



Source: FIA Database (May 2005)

Figure 24 - Average Annual Growth, Removals and Mortality Comparison, 1989-2003



Source: FIA Database (May 2005)

Trends in each chart are similar for private-other lands and Mark Twain lands. The largest change is not among ownership classes, but between survey years. The data for the 2003 survey shows a doubling of net annual growth and only moderate increases in removals and mortality from the 1989 survey data.

Comparing lands suitable for timber management across all ownerships is difficult. Only the Mark Twain lands are required to follow the requirements of the National Forest

Management Act, and all Federal agencies must follow National Environmental Policy Act, Endangered Species Act, etc. Private, Industrial Forests and State lands have no such requirements in Missouri. We assume that the State agencies, Pioneer Forest and other Industrial landowners would manage their lands following Best Management Practices (BMPs) to minimize environmental impacts and have some plan on how their lands would be managed. BMP's are very similar to the Forest Plan's standards and guidelines. Private lands have no State law mandate for forest management and therefore no restrictions on what they do on their land. Private land owners can and do work with the Missouri Department of Conservation to develop management plans, which include BMPs, for their property.

Table 8 compares FIA forest lands and timberlands, used here as suitable lands, with average annual removals as an estimate of 'sale quantity'. This comparison shows that private lands have 85.7 % of the suitable timberlands and provide 68.9 % of the timber volume removed. Mark Twain lands are 7.3 % of the suitable timberlands and provide 10.3 % of the timber volume removed.

Table 8 - Suitable Acres and Removals by Ownership Class Comparison, 1989 - 2003 FIA

Ownership Class	Acres Forest Lands	Acres Timberlands (Suitable Lands)[1]	Percentage of Total Timberlands	Total Growing Stock (MMBF)	Average Annual Removals (MMBF)[3]	Percentage of Total Removals
National Forest	1,496,100[2]	997,1002	7.3 %	10,525	74	10.3 %
Other Federal	343,001	256,258	1.8 %	1,495	14	1.9 %
State and Local	798,003	700,728	5.1 %	4,853	133	18.6 %
Private[4]	11,966,690	11,747,366	85.7 %	70,957	491	68.9 %
Totals	14,603,794	13,701,452		87,830	712	

Source: FIA Database (May 2005)
1 FIA Timberland Acres are considered available for management.
2Uses Mark Twain Suitable land. All other data from FIA.
3 Removals are for all species and an estimated annual average. Numbers may not equal other sources of harvest volume. Removals are used here as an estimated "Allowable Sale Quantity" for comparison purposes.
4 Industrial Forest lands can no longer be separated out from the Private land group due to privacy issues.

Conclusions

Private lands make up 85.7% of Missouri's suitable lands and provide 68.9 % of the timber removals. Mark Twain lands are 7.3 % of the suitable timberlands and provide 10.3 % of the timber volume removed. All land owners combined are harvesting less than 0.8 % of the growing stock available. Over 90% of the removals are oak-hickory products. Sawtimber makes up 51 to 67 % of the removals with Other Federal and State-Local Governments having the highest amount of roundwood products (49 and 43 %) removed. Based on the available data, Missouri's forest is underutilized and more planned management could be applied.

All analyses of the data show the timber lands of the 29 county area and the Mark Twain follow similar trends as Missouri timberlands. Overall, timber lands at all 3 levels of this analysis show continuing recovery from turn of the century harvesting. These lands are growing larger sized trees; net annual growth is increasing; volume of wood and biomass is increasing and the amount of forest area increased. Removals and mortality are roughly 30% of growth, so timber harvesting does not have a negative effect to Missouri's forest. Oak decline is likely to continue with the large amount of red oak on all land ownerships. These trends are most likely to continue into the next 10 to 20 years.

Environmental Impacts

The most extensive past actions that have affected Missouri's forest lands were the harvesting of virtually all forest lands between 1880 and 1930. Of the 15 million acres of forest land, an estimated 6.6 million acres of shortleaf pine forest (4.2 million acres) and mixed pine-oak forest (2.4 million acres) were estimated to exist prior to 1880 (Liming 1946).

Using the 1947 FIA forest land estimation, shortleaf pine and mixed oak-pine would have represented approximately 3.3 million acres. This represents about 50% of the pre 1880 estimate, the other 3.3 million acres was harvested during a 50 year period of 1880 to 1930. By 1959, the estimated area of shortleaf pine (277,890 acres) and mixed oak-pine (569,790 acres) was 847,680 acres, only13% of the pre 1880 estimate. By 1972, FIA inventory showed 116,000 acres of shortleaf pine and 281,000 acres of mixed oak-pine (Spencer and Essex 1976). The 2003 FIA Survey estimates 154,095 acres of shortleaf pine, 391,834 acres of mixed oak-pine for a total of 545,929 acres or 8% of the pre 1880 estimate.

This represents a huge change in forest composition in 120 years. Shortleaf pine and mixed oak-pine forests historically made up approximately 44% of Missouri's forest; but now make up less than 8%. In the 29 county area where the Mark Twain lands occur, shortleaf pine and mixed oak-pine forest is estimated to have been 60 to 75% of the forest lands; it now makes up 7% of the forest. The 29 county area now accounts for 98% of the shortleaf pine and mixed oak-pine forest in the entire State.

Most of the areas experiencing oak decline today are on sites where shortleaf and mixed oak-pine existed historically. Oak decline will likely last through most of the first decade. Sawtimber stands of the Red oak group will be hit hardest. Red oak borer infestations will likely increase the first decade, causing the need for salvage operations to continue. Continuing to maintain large acreages of the red oak group on the Mark Twain will greatly increase the risk of future oak decline.

Timber harvesting has continued since the 1940's but at a much reduced rate compared to the 1880-1930 period. Each year, stands are regenerated and other stands are thinned. As the timber has grown to sawtimber size, more harvesting has and will continue to occur. National Forests are required to calculate an allowable sale quantity which limits the amount of harvesting to a long-term sustainable level.

The timber harvest scheduling model estimates that more than 50% of the ASQ is in roundwood products. This is a big change in product projections from what was estimated in the 1986 Plan. The amount of roundwood has increased and sawtimber has decreased. While projected total volumes are similar to 1986 results, the proportion of sawtimber drops from around 60% of ASQ to 45-50% of ASQ depending on the model run. The mix of poletimber and sawtimber in a stand is changing to a larger proportion of poletimber.

During the last 15 years, the Mark Twain NF has had difficulty selling roundwood products. If this situation continues, achieving the 2005 Forest Plan objectives that require vegetation management for the first two decades would be very difficult. This situation will be similar to the shortfall experienced by the 1986 Plan and would limit future growth of the Mark Twain NF and long-term outputs as well. Desired future conditions could be reduced and delayed by several decades. Harvesting only sawtimber-sized stands would allow overstocked pole sized stands to slowly stagnate, and a loss of long-term volume could result. Depending on the rate of sawtimber harvest, this product could be used up resulting in fewer sales offered from the Mark Twain NF.

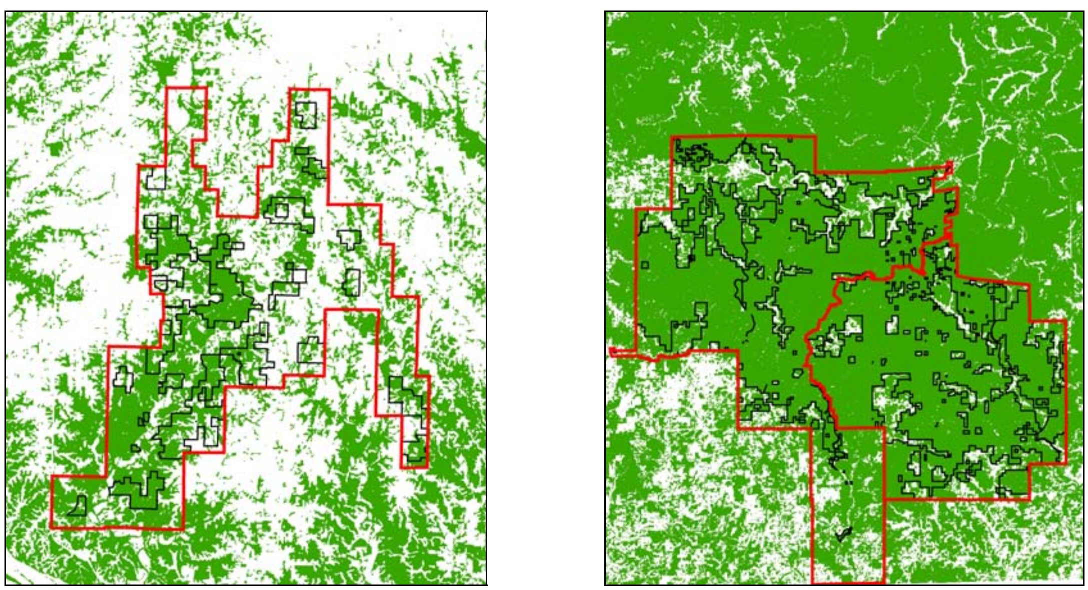
The Mark Twain NF proposed harvest rate for the 1986 plan was 105 MMBF, 11,200 acres of regeneration and 18,000 acres of thinning each year. The proposed action for the Plan

Revision is nearly identical to the 1986 plan volumes and acres harvested. Private and other lands have no restrictions for harvest amounts or timing; but generally when the forest reaches a sawtimber size, some areas are harvested. The average annual timber removal (Figures 23 and 24) from private-other lands is 254 MMBF/year from 1972-1989; and 326 MMBF/year from 1989 to 2003. Average net annual growth far exceeds the removal rates for both Mark Twain and private-other lands. Harvest levels on the Mark Twain and private-other lands are not expected to change substantially in the foreseeable future. The rate of future harvest, on all ownerships, will likely continue at the same level at shown in the 2003 FIA data and could increase as oak decline and other situations occur.

Fragmentation of forest by agricultural or urban areas can be a concern depending on the area being looked at. Figure 25 shows the Cedar Creek unit (left) and the Eleven Point unit (right) of the Mark Twain (map scales are not equal). Cedar Creek is one of the most fragmented units due to its ownership pattern (24% National Forest) and the amount of lands managed in an open grass condition (51% open lands). This situation has been in place since the land was acquired. In contrast, the Eleven Point unit is the most forested unit (89%) with over 71% National Forest ownership. Areas to the north, Jack's Fork and Current River valleys, are also mostly forested; while areas to the south have a mix of open and forest. This is due to public ownership and topological differences of the landscape. Most urban encroachment into forested areas is occurring from the existing cities of Springfield-Branson, St. Louis, Jefferson City-Columbia, Rolla and Poplar Bluff. To date, only Cedar Creek, Ava, Poplar Bluff and Cassville units have had effects from urban encroachment. Each of the 9 geographic units has some level of fragmented forest caused by agriculture or urban areas. As shown on the Cedar Creek area, the ownership patterns of the Mark Twain NF are themselves a cause of fragmentation.

The 2005 forest plan would manage the current Mark Twain NF land base (forest verses non-forest) in a way that minimizes fragmentation. Over the next 10-15 years, some urban encroachment will likely take place around each of the Mark Twain NF units but none of this is can be controlled by the Forest Service.

Figure 25 – Forest Vegetation on Mark Twain Lands from MoRAP Landcover, 1993



Cedar Creek Unit *Eleven Point Unit*

A vegetation change study was conducted by the Missouri Resources Assessment Partnership (MoRAP) using satellite data (Landsat TM and Landsat ETM) with image dates of 1996 to 2000. Image analysis shows that disturbed forests such as clear-cut harvests, tornado damage, etc., in the Ozarks region, generally appear fully regenerated to young forests within 5 years.

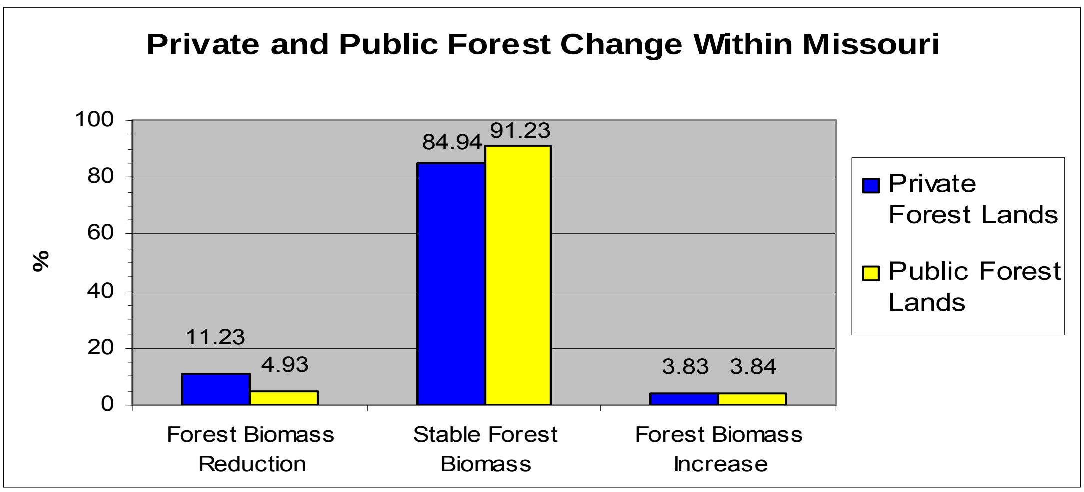
The study also found that forest biomass reduction on private forestlands is twice that of public forestlands. Forest biomass increase is proportionately less on private than public forest lands. This suggests that some of the forest biomass reduction on private lands may be permanent clearing for pasture or other uses, while public forest lands remain in a forested condition. See Table 9 and Figures 26, 27 and 28.

Table 9 - Annual Rate of Biomass Change in Missouri, 1996 - 2000

	Private Forest Land		Public Forest Land	
	Percent	**Acres**	**Percent**	**Acres**
Biomass Reduction	2.24%	328,867	0.99%	21,722
Biomass Increase	0.77%	112,160	0.77%	16,919

Source: MoRAP Vegetation Change Analysis 1996-2000

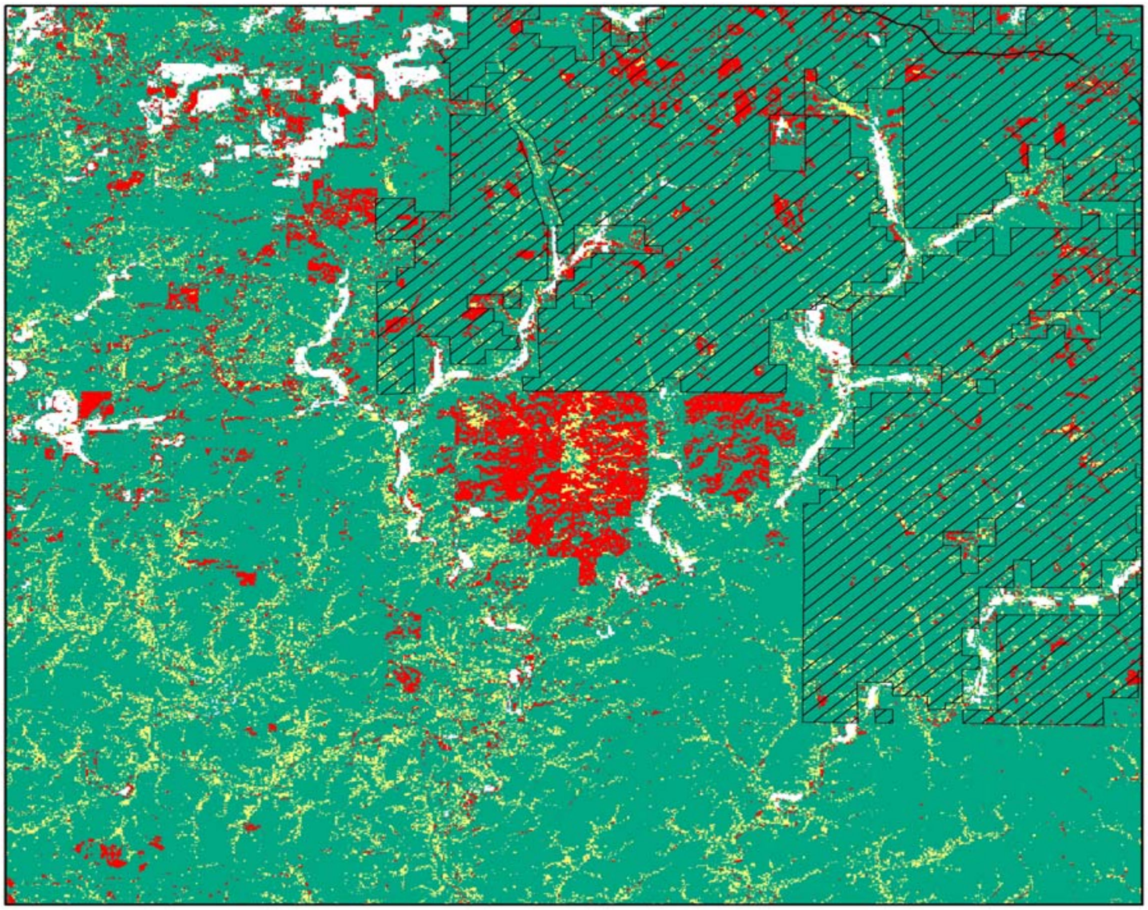
Figure 26 - Vegetation Change Analysis for Missouri, 1996 - 2000



Source: MoRAP Vegetation Change Analysis 1996-2000

Figure 27 shows an area south of Salem Missouri; red areas are biomass decrease, yellow areas are biomass increases, green areas are stable or no change and white areas are open lands (not forest). Cross hatched areas are Mark Twain land. An assumption is made that the areas of biomass change are directly related to timber harvesting (95% correlation on Mark Twain lands). As shown, most change areas on all ownerships have scattered patterns of harvesting and re-growth with the vast majority of the area being in stable or no change class. What is different is the larger and more concentrated harvesting on private lands in some areas. Another pattern that appears is the square or rectangular shape of many of the change areas. This is attributed to ownership boundaries of the property being harvested.

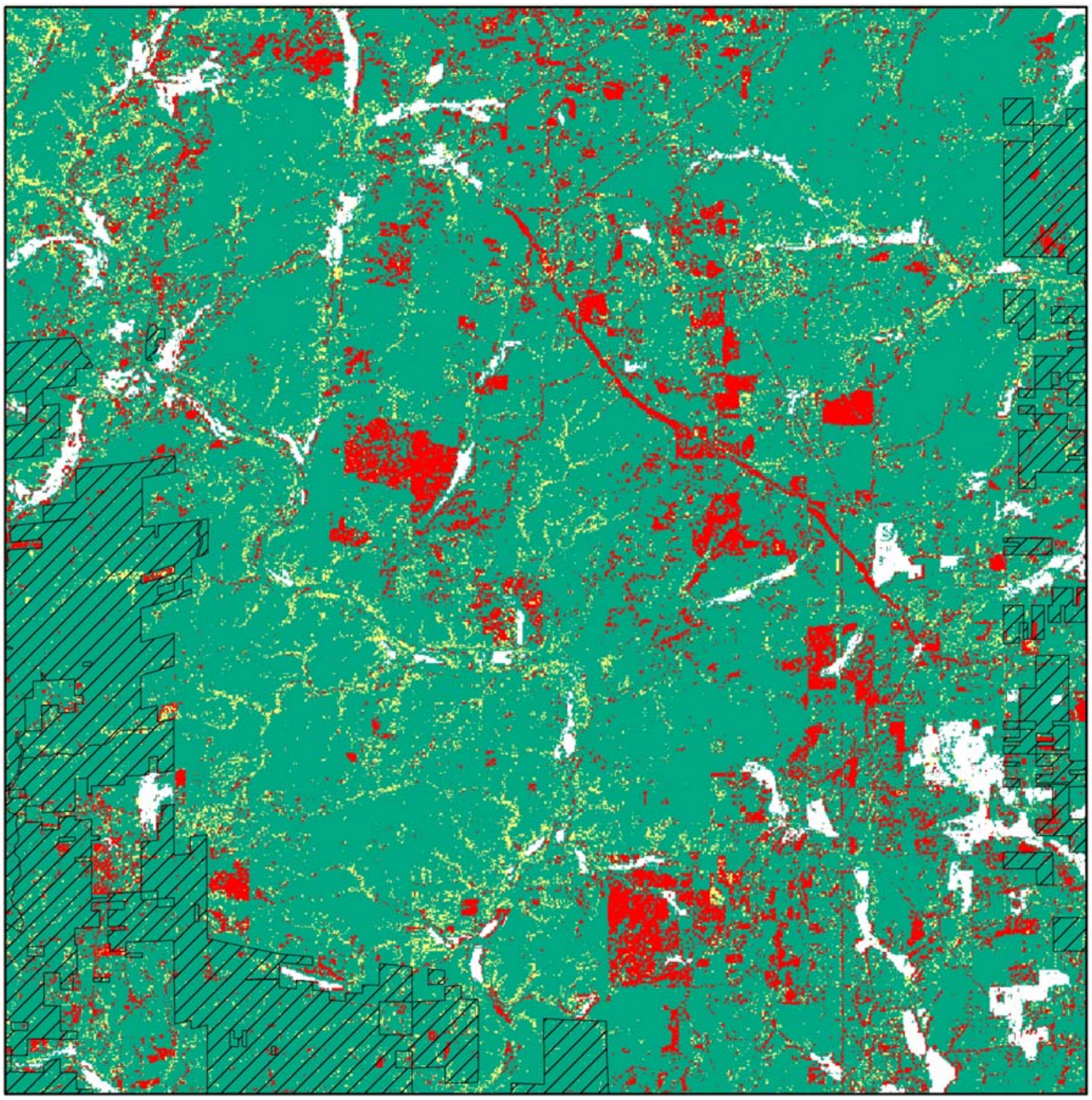
Figure 27 - Vegetation Change Analysis for Missouri 1996 – 2000, South of Salem, MO



Source: MoRAP Vegetation Change Analysis 1996-2000; crosshatch is National Forest land.

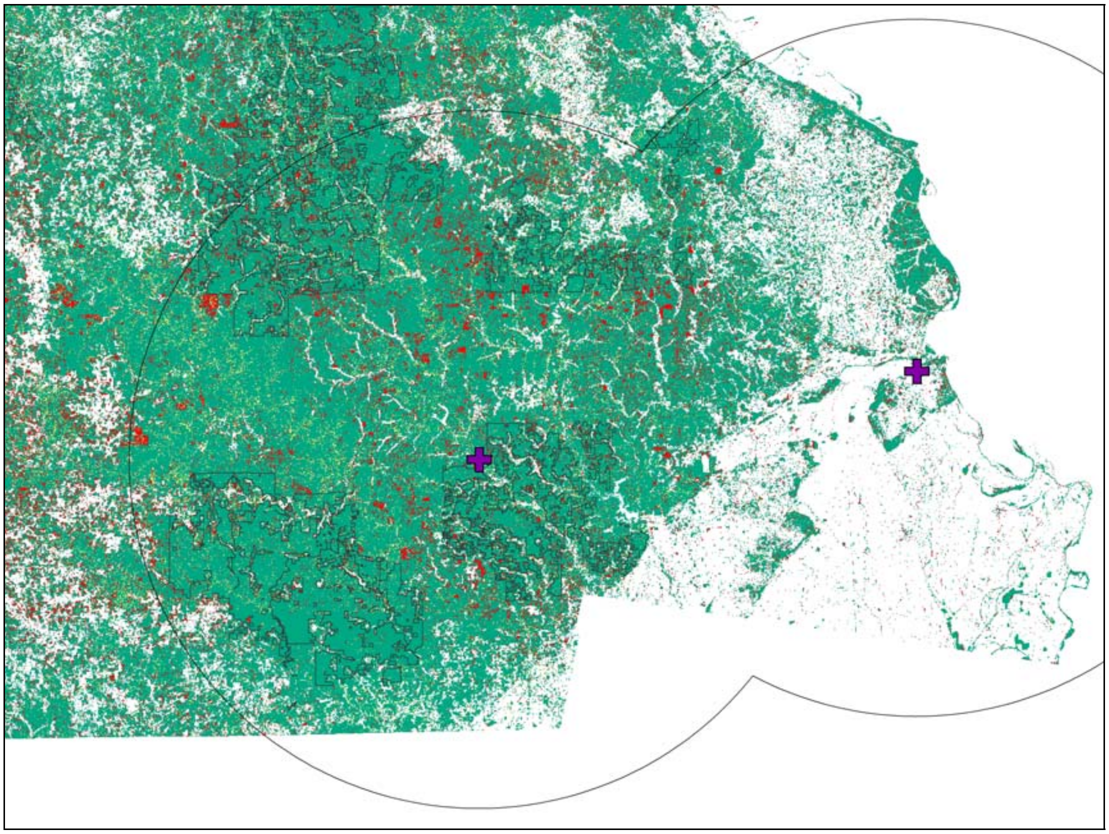
Figure 28 shows an area east of Van Buren, Missouri. The linear patterns are large existing utility right-of-ways that have been maintained by cutting or clearing unwanted vegetation. The largest and most pronounced linear pattern is the relocation of US Highway 60 right-of-way clearing. Like Figure 26, this area also shows biomass reduction on private lands having several larger, more concentrated areas. In reviewing this data for much of southern Missouri, the pattern of large biomass reductions on private land is not as pronounced or large as the areas shown in Figures 26 and 27. It is likely that this type of pattern will be repeated to some extent in the future 10 to 15 years. Open lands are concentrated in 2 areas; around small towns and larger urban areas, and along stream course bottoms. Both of these areas are clearly seen in Figures 27, 28 and 29.

Figure 28 - Vegetation Change Analysis East of Van Buren, Missouri, 1996 - 2000



Source: MoRAP Vegetation Change Analysis 1996-2000; crosshatch is National Forest land.

Figure 29 - Vegetation Change Analysis for Area around known Chip Mills in Missouri. 1996 - 2000



Source: MoRAP Vegetation Change Analysis 1996-2000.

Currently, there are two chip mills operating in Missouri, each with an estimated capacity of 100 MMBF per year at high production output. Chip production from roundwood is market driven. One mill had been closed, but was reported to have resumed operation in the spring of 2004; the second mill has been operating well below capacity. One mill is within the 29 county area of the Mark Twain and would be expected to use roundwood products from the Mark Twain. Figure 29 shows the chip mill locations, a 50 mile radius from the mills, Mark Twain lands and the vegetation change data. While hard to see details at this scale, one can see that the area is mostly stable forest (84% of the forest). 9.7% of the area shows as a decrease in biomass; with 8.3% being on private lands; and 5.9% of the area shows an increase in biomass. Operations of the chip mills have not made a major impact or changes in the forest vegetation from 1999 to 2000. The Mark Twain could sell more volume, up to the ASQ, but the sale program is not tied to the chip mills, or any other mill's needs or production goals. Timber sales are sold to the highest bidder and the Mark Twain has no control over what the purchaser does with the timber once it is cut and removed from National Forest Lands.

If the chip markets improve, then demand for roundwood would increase and chances for selling roundwood from the Mark Twain would increase. In the short term, the mills have little to no effects on the timber sold from the Mark Twain. At full operating capacity, the mills would likely utilize some amount of the roundwood products from the Mark Twain. The Mark Twain has a large supply of roundwood products that are currently not being utilized. Since sawtimber prices are 10 to 20 times more than pulp prices, it is not likely that sawtimber products from the Mark Twain would be sent to chip mills now or in the foreseeable future.

The long-term supply of growing stock volume from Missouri timberland (all ownerships) was estimated at 14.6 billion cubic feet in the 2003 Missouri FIA inventory (Moser et al. 2005). Fifty-eight percent of this volume is in sawtimber. Annual growing stock removals for 1989 to 1999-2003 were 118.6 million cubic feet, well below the 629.4 million cubic feet of net annual growth.

Much of the roundwood product is not currently utilized. Full production of the two chip mills would likely utilize a large amount of these products and help reduce stocking of the forest as well as aid in tree species management. The long-term cumulative effects of having the two chip mills operating would be a healthier forest that is less stocked and more of a mixed species forest due to the roundwood products being utilized. Without these mills, roundwood products will have a much smaller market and fewer products utilized. The long-term results would be an overstocked forest and more likely in an unhealthy condition.

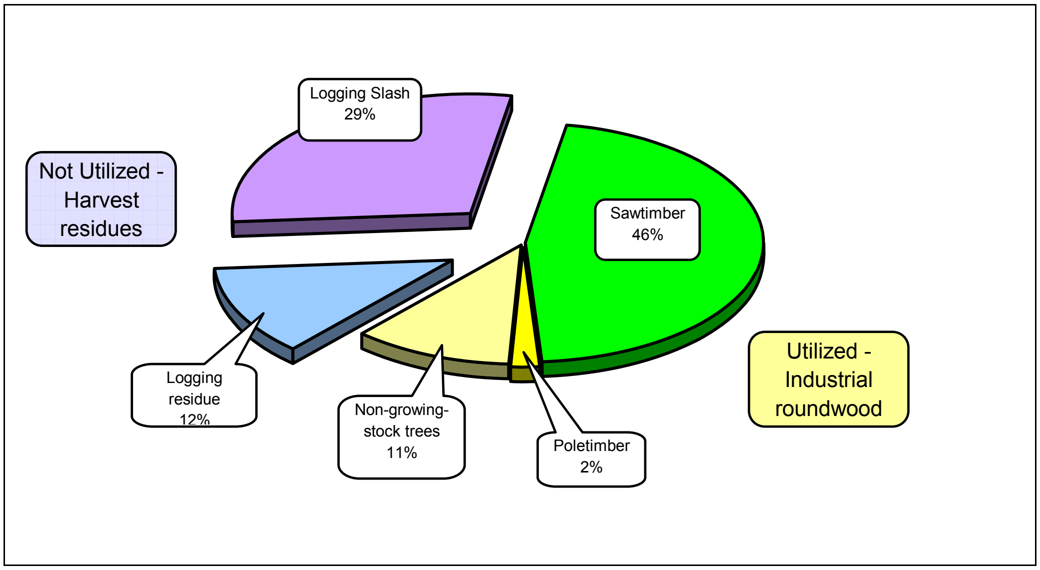
Table 10 shows a historical view of the primary wood-using mills in Missouri. Changes since 1946 are evident. The number of mills in all categories has been decreasing except for the medium and large sized sawmills. This table reflects the changes in the forest vegetation since 1946, a general consolidation of the industry and improvements in mill technology. The Missouri Department of Conservation conducted a mill survey in 2000 (Missouri Forest Industries 2000 Directory of Primary Wood Processors). Based on this survey there 298 mills in the 29 county area. These mills have an estimated low capacity of 389 MMBF to a high capacity of 629 MMBF. Based on Figure 23, an average net annual growth in the 29 county area is estimated at 1,736 MMBF. The area is currently growing 2 times more volume than the mill capacity with average annual removals at 406 MMBF. Growth is still exceeding current harvests and mortality and more than mill capacity. This situation will likely continue for the next 10 to 15 years assuming current market prices and demand. If prices and demand move higher, the removals would likely move higher; but even a doubling of removals will still be less than current growth.

Table 10 - Active Primary Wood-Using Mills, Missouri, 1946, 1969, 1980, 1987, 1991, 1994. 1997, 2000

Kind and size of mill	1946	1958	1969	1980	1987	1991	1994	1997	2000
Sawmills									
Large[1]	2	5	7	8	13	17	32	35	31
Medium[2]	43	103	117	163	169	172	189	212	185
Small[3]	2548	882	425	315	228	206	191	170	187
Total Sawmills	2593	990	549	486	410	395	412	417	403
Cooperage mills	85	36	36	30	20	20	12	8	8
Veneer mills	6	3	4	4	5	4	1	1	1
Pulp mills	-	2	2	2	1	1	1	1	1
Charcoal[4]	3	60	52	36	15	14	14	10	6
Handle mills	19	12	7	10	6	6	5	6	4
Posts	6	14	22	28	23	17	9	9	8
Other Products[5]	94	44	9	3	11	14	7	6	9
Total Other Mills	213	171	132	113	81	76	49	41	37
Total All Mills	2806	1161	681	599	491	471	461	458	440

1 Annual lumber production in excess of 5 million board feet.
2 Annual lumber production from 1 million to 5 million board feet.
3 Annual lumber production less than 1 million board feet.
4 Includes only those charcoal operations using roundwood.
5 Includes plants producing shavings, chips, cabin logs, rails, poles, etc.
Source: Table 1, Missouri Timber Industry – An Assessment of Timber Product Output and Use, 2000; Piva and Treiman, Resource Bulletin NC-223

Figure 30 - Distribution of Timber Removals for Industrial Roundwood by Source of Material, Missouri, 2000

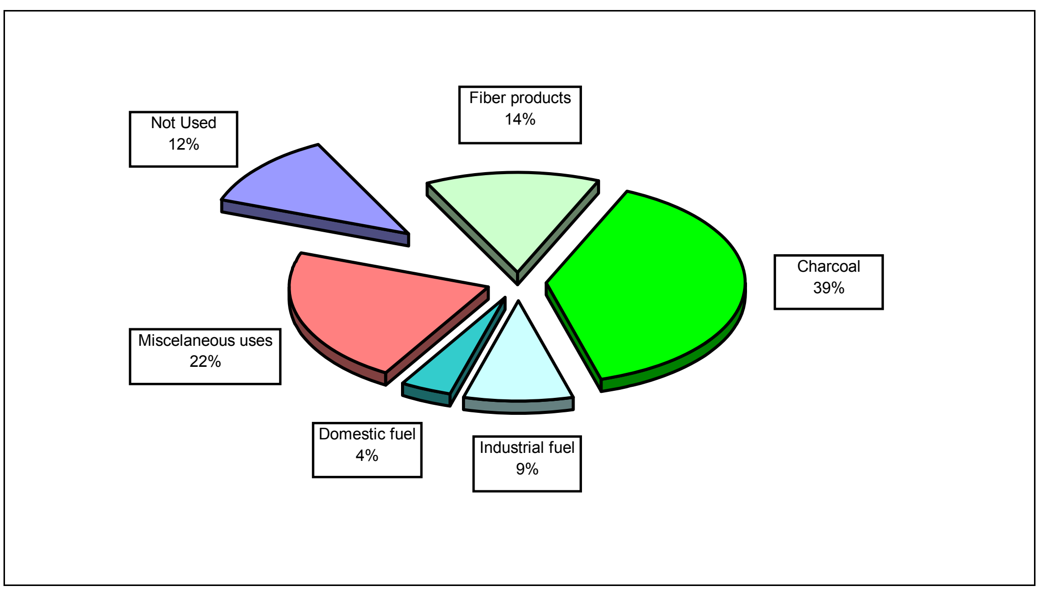


Source: Figure 5, Missouri Timber Industry – An Assessment of Timber Product Output and Use, 2000; Piva and Treiman, Resource Bulletin NC-223

Figure 30 shows the distribution of the forest biomass when timber removals take place. Forty one percent of the biomass remains in the forest to be recycled through natural processes. This shows that not all the biomass is removed and that recycling of the forest does occur. This will likely continue into the future.

Figure 31, shows that less than 12% of the residues generated by the primary wood-using mills are not used. This is a large improvement since1969 where 60% of mill residues went unused (Spencer and Essex 1976). The industry keeps improving the utilization as technology improves. This will likely continue into the future.

Figure 31 - Distribution of Residues Generated by Primary Wood-Using Mills, by Method of Disposal, Missouri, 2000



Source: Figure 7, Missouri Timber Industry – An Assessment of Timber Product Output and Use, 2000; Piva and Treiman, Resource Bulletin NC-223

The EPA and MoRAP have developed models to look at significant ecosystems (Development of Critical Ecosystem Models for EPA Region 7; Regional Geographic Initiative (RGI) Report, September 2004). The model and resulting analysis look at ecological significance, aquatic classification and species models, human stresses, forest change, aquatic conservation focus areas and conservation opportunity areas. The Mark Twain has reviewed the data and report. The main threats to forest vegetation come from agricultural land conversion (forest to crop or pasture), and land demand from urban sprawl; both of which are beyond the control of the Mark Twain. These threats are likely to continue into the future with some impact on the forest lands near these areas.

Conclusions

The analysis of past, present, and likely future actions have been discussed. Effects from current forest management practices of all ownerships on Mark Twain lands and private-other ownerships produce minimal to moderate changes to forest vegetation age classes and species composition in any given 10 year period. The average annual removals and mortality from all land ownership is less than 1% of the net annual growth.

During the 50 year period of 1880 to 1930, we may assume that 80% (some 11.68 million acres) of Missouri's forest were harvested. This would average out to 233,600 acres of harvest each year. Using MoRAP's biomass change data, approximately 70,118 acres may have been harvested annually from 1996 to 2000. This is about 30% of the scale and at much less intensity of harvesting that took place from 1880 to 1930. Today's forest management is much different from the 1900's. In the past, entire watersheds and landscapes were harvested in a matter of months with little regard for wildlife, soils or water effects. Today's forest management is guided by Best Management Practices and Forest Plan Standards and Guidelines with harvest areas mostly spread out across an area.

The Mark Twain NF has about 7 % of the State's suitable timber lands and about 10% of the 'sale quantity' (Table 7) based on current average annual removals of timber. The data shows that all ownerships are harvesting less than 1 % of the forest's growth. One must consider the history of Missouri's forests and the past 30 years of forest management. The Mark Twain's range of alternative ASQ's of 99 to 105 MMBF per year on 997,110 acres of suitable land would have minimal impacts due to the small scale of operations on Mark Twain lands. Alternative 1 would cut some trees but the sale quantity would be 0, with most affects being on local mills and related jobs. Comparing the effects of forest management on all ownerships shows that private lands have the largest amount of suitable lands with the largest amount of growing stock and the largest amount of timber removals.

Timber Management

Introduction

Proposed Changes

Several proposed changes could have an effect on timber management. They include:

- changes to standards and guidelines relating to even-aged and uneven-aged management (Revision Topic 1b);
- the addition of prescriptions emphasizing restoration of natural communities(Revision Topic 2a);
- changes to standards and guidelines regarding reforestation and timber stand improvement (Revision Topic 2b); and
- increases in the amount of prescribed burning and fuels management (Revision Topics 3a and 3c).

Scope of Analysis

The analysis area includes land tentatively suitable for timber management on the Mark Twain National Forest Refer to the previous section for discussion on and definitions of suitable and tentatively suitable timberland. The discussion of direct and indirect effects considers only National Forest land, while the discussion of cumulative effects includes land in southern Missouri.

Affected Environment

See discussion under Timber Supply section.

Environmental Consequences

Even-aged and Uneven-aged management

General Effects

Where uneven-aged (UAM) silviculture is ecologically appropriate, it offers an opportunity to simulate late-successional forest dynamics, the maintenance of certain types of wildlife habitats, and aesthetic values (Guldin 1996). However, “Selection silviculture is the least economically efficient of all the silvicultural systems. This largely results from the relatively small amount of timber removed per acre per harvest. Timber marking, administrative and road construction costs per unit of volume removed per harvest are also high.” (The Ecology and Silviculture of Oaks, Johnson, Shifley, and Rodgers 2002). The number of entries required for UAM would magnify environmental effects from road construction and maintenance, and temporary roads and skid trails.

Direct and Indirect Effects

Alternative 1

Timber management in the traditional sense would not be practiced under this alternative. No commercial harvest would be allowed. Regeneration is projected to be 53,600 acres per decade. The purpose of regeneration is restoration in MP 1.1 and 1.2, and to meet wildlife needs in MP 6.1 and 6.2.

Alternatives 2, 3, and 4

There are no restrictions or requirements on the type of regeneration method that must be used. In areas with high risk of oak decline, high site index, frequent burning regimes, or under acreage restrictions, UAM may be an inappropriate method. Decisions on the type of management will be made at the project level, and will be based on a site specific evaluation of stand conditions, management objectives, natural community type, and desired condition. Consequently, it is difficult to accurately predict the amounts of each type of management at this time. However, emphases on ecosystem restoration and prescribed burning would limit opportunities for uneven-aged management in MP 1.1. The percentage of uneven-aged management in MP 2.1 would be expected to be slightly higher than in MP 1.1and 1.2. The amount of uneven-aged management in Alternatives 2, 3, and 4 would differ according to acres allocated to MP 2.1, with Alternative 2 having the least, Alternative 4 the most, and Alternative 3 between the two.

Alternative 5 (Current Management)

Lands suitable for timber management within the seven sensitive areas will be managed under the UAM silvicultural system, including: Smith Creek, Van East Mountain, Lower Rock Creek, Swan Creek, Spring Creek, North Fork, and Big Springs Addition. In addition, wet mesic bottomlands (ELT's 1-6, 39, 56, 59, 61, and 62), specialized wildlife habitats identified in the 1986 Forest Plan, and lands suitable for timber management on the Cedar Creek District will be managed under the UAM system.

The use of UAM on some sites where required by this alternative is ineffective and may have undesirable results, as illustrated by the following:

- Oak mortality related to oak decline may be accelerated by UAM, especially where species in the red oak group predominate (Starkey and Oak 1989). Implementation of UAM entry cycles in stands at risk for oak decline would carry parts of the stand well beyond pathological age, and partial cutting often accelerates problems with Armillaria, spreading it throughout the stand (Kessler 1992, Loewenstein and Guldin 2002).
- UAM is difficult in mesic oak forests with high site indexes. Strong competition on mesic sites from shade tolerant species may prevent the development of adequate oak reproduction (Vegetation Management Review Report, Johnson and others 1994). Experience with UAM of shade-intolerant southern pines indicates that intensive competition control treatments may be required, especially on the more mesic sites (Graney and Murphy 1997).
- Effective UAM requires a regeneration harvest with successful regeneration in each 15 to 20 year entry cycle. It is difficult to obtain successful recruitment of regeneration into the overstory each cycle where regular and frequent landscape scale burns are prescribed (Melick 1989).
- UAM can be a problem in areas with acreage restrictions, because it requires an entry cycle of every 15 to 20 years. MP 6.1 and 6.2 have limitations of 10% and 20% respectively of the acreage with timber harvest per decade. If 20% of MP 6.2 was managed by UAM the first decade, and 20% the second decade, the remaining 60% of the area could never be managed (during the third decade it would be time for the entry cycle of the 20% that was entered the first decade).

Reforestation and timber stand improvement

Reforestation is the re-establishment of tree cover by either natural regeneration (natural seeding or coppice), or by artificial regeneration (direct seeding or planting). Artificial regeneration can be used to obtain sufficient regeneration, obtain desired species composition, and to increase genetic diversity and quality.

Timber stand improvement includes pre-commercial thinning (PCT) and release treatments. Pre-commercial thinning is thinning trees that are too small to be of commercial value. The trees are cut and left on-site. PCT is used to obtain desired stocking levels for forest health and increased growth, and to maintain or improve species composition by favoring desired species. PCT treatments are made between 10 to 30 years of age in shortleaf pine, and between 15 to 35 years of age in hardwood and hardwood-pine stands.

Release is a treatment to free young trees from undesirable competition, usually over-topping. Larger trees and or other overtopping vegetation are cut and left on-site. Release can be used to improve the composition, structure, condition, health and growth of a stand. Release treatments are done no later than 10 years of age in shortleaf pine stands, and 15 years of age in hardwood and hardwood-pine stands

Direct and Indirect Effects

Alternative 1

<u>Reforestation</u>

Reforestation is projected to be 53,600 acres over the first decade. No artificial regeneration is scheduled. With natural regeneration, historic oak-pine and pine types could not be regenerated in areas where those types do not presently exist. An unhealthy condition would exist in large areas of the Forest. Insect and disease attacks would be common and widespread, and a moderate to severe risk of oak decline would persist on a large part of the Forest.

Since there is no commercial harvest, larger trees in the regeneration areas would be cut and left on-site. Funding would be required for cutting timber, an estimated 25 to 100 million board feet of timber each year. This timber would be unavailable for use as forest products, and would create potential hazardous fuel problems.

<u>Timber Stand Improvement</u>

Pre-commercial thinning and release for the decade is projected to be 2,200 acres. These activities would be limited to MP 1.1 and 1.2, and would help to restore natural communities and improve forest health and species diversity. Acres in MP 6.1 and 6.2 total 1,255,400 acres in this alternative; they would have no timber stand improvement treatments. As a result, many overstocked stands would grow slowly and stagnate, and in this unhealthy condition, they would be susceptible to insect and disease attacks. An increase in shade and buildup of leaf litter would cause groundcover vegetation to weaken and die, reducing species diversity.

Alternatives 2, 3, and 4

<u>Reforestation</u>

There are no restrictions by management prescription on the use of artificial regeneration. Decisions made on planting or seeding of shortleaf pine or other species would be made at the project level. Artificial regeneration would be an appropriate treatment on all suitable acres if site-specific evaluation determines that it would move the Forest toward the desired condition. Reforestation to historic timber types would enhance the condition of terrestrial natural communities, help restore degraded ecosystems, and move the Forest toward a healthier desired condition. The greatest amount of reforestation over the decade is projected for Alternative 4 (116,000 acres), with lesser amounts projected for Alternative 3 (112,700 acres), and Alternative 2 (109,600 acres).

Timber Stand Improvement

There are no restrictions by management prescription on the use of timber stand improvement treatments, providing the treatments help to move the Forest towards the desired condition. As a result, stands could be thinned if necessary to promote growth, forest health, and species diversity; and release treatments could be used to free young trees from competition and to improve health, growth and composition of forest stands. The projected acres are higher in Alternative 4 primarily due to more acres in MP 2.1, with shorter rotation ages and more regeneration which brings more opportunity and need for these treatments. Projected acres are less in Alternative 2 because of more acres in MP 1.1, which relies more on prescribed burning to move the Forest towards the desired condition. The projected acres in Alternative 3 fall in the middle.

Alternative 5 (Current Management)

Reforestation

This alternative is projected to have 112,000 acres of reforestation over the first decade. Most of the reforestation would be by natural regeneration of the species presently growing on the site. Standards and guidelines restricting artificial regeneration are included in management area prescriptions. No artificial regeneration is allowed in MP 3.1, 3.3, 3.4, 6.1, and 6.2 (821,400 total acres), and artificial regeneration is allowed in MP 3.2 (74,100 total acres) only to meet high value hardwood stocking objectives, even though 3.2 is part of the historic pine range. Reforestation to historic oak-pine or pine forest types by planting or seeding shortleaf pine would be allowed only in MP 4.1 (411,000 total acres). An overabundance of black and scarlet oak susceptible to oak decline would continue to exist on large areas of the Forest.

Timber Stand Improvement

Standards and guidelines restricting pre-commercial thinning and release are included in some management area prescriptions. No pre-commercial thinning is allowed in MP 3.1 or 3.3 (27,300 total acres). No release is allowed in MP 3.1, 3.2, 3.3, 6.1, and 6.2 (424,900 total acres).

Alternative 5 projects a large amount of pre-commercial thinning and release in areas where it is allowed. A small amount of movement towards historic timber types would be possible by using timber stand improvement treatments to favor desired species, in stands where they exist. However, where pre-commercial thinning or release treatments are prohibited the following effects would occur:

- many overstocked stands would grow slowly and stagnate, and in this unhealthy condition they would be susceptible to insect and disease attacks
- an increase in shade and buildup of leaf litter would cause groundcover vegetation to weaken and die, reducing species diversity
- desirable trees in young stands overtopped by competing vegetation would grow slowly and have poor survival rates.

Intermediate Thinning

Intermediate thinning is a treatment that reduces the basal area by cutting and removing trees. In this type of thinning trees usually have commercial value, and treatments are accomplished with a commercial timber sale. Intermediate thinning may improve growth, enhance forest health, obtain advanced regeneration, or to move the stand towards its natural community type (see Appendix D for a description of thinning methods).

Direct and Indirect Effects

Alternative 1

No commercial timber harvest is allowed. Intermediate thinning would be accomplished by cutting the trees and leaving them on site; funding for the cost of felling trees would be required. A small amount of intermediate thinning for restoration is projected (2,400 acres) in MP 1.1 and 1.2. Stands in the rest of the Forest would become overstocked and would stagnate. Forest health and species diversity would decline.

Alternatives 2, 3, and 4

There are two types of intermediate thinning in these alternatives. The first is the conventional practice, which reduces basal area (BA) to the desired stocking level to enhance forest health, maximize growth and increase timber volumes. This is approximately 60% stocking or B level on Gingrich stocking charts, which would be 60 to 70 BA. This type of thinning would normally be practiced in MP 2.1. The second type would be thinning to reach a desired basal area or “restoration thinning.” This type of thinning would reduce basal areas to levels necessary to restore the natural community type, which could be as low as 30 to 40 BA. It would be practiced primarily in 1.1 and 1.2, and would help to restore natural community type, historic natural ground cover vegetation, and species diversity. The projected amount of each type of thinning varies by acres allotted to the management prescriptions in each alternative. Volumes from restoration thinning may be higher than from conventional thinning, as basal areas may be reduced below the fully stocked level. However, volumes for the final regeneration cut would be reduced due to less basal area carried to rotation age. Alternative 2 would have more restoration thinning, while Alternative 4 would have more conventional thinning. Alternative 3 is projected to have the same amount of each type of thinning.

Alternative 5

A large amount of intermediate thinning is projected for this alternative. Treatments would reduce stocking to increase growth and enhance forest health. However, basal areas would not be reduced enough to restore natural community types in most areas; no restoration thinning is planned for this alternative.

Prescribed burning, wildland fire management, and fuels management

Significant increases in the amount of prescribed burning are projected for all alternatives. Factors influencing these increases include: the need to reduce hazardous fuels as shown by the Forestwide Risk Assessment, increasing awareness of the role of fire in the natural history of the area, and the importance of landscape type burning to promote health and restoration of ecosystems.

Effects Common to All Alternatives

- The quality of timber may be reduced by regular and frequent burning, especially in some species, such as the red oak group.

- Prescribed burning will help restore historic ground cover vegetation, which will improve the soil conditions, enhance water regime, and increase growth of timber.
- Regeneration may be reduced or eliminated by regular and frequent burning, especially in areas under UAM.
- Prescribed burning may act as a release or thinning to improve the composition, health, and growth of a stand.
- Prescribed burning may act as site preparation by reducing ground cover and leaf litter, which will increase natural regeneration—especially of shortleaf pine.

Direct and Indirect Effects

There is less than a 20 percent difference in the projected amount of acres of prescribed burning in the alternative which has the least (Alternative 5), and the alternative which has the most (Alternative 2).

Management Areas and Management Prescriptions

Direct and Indirect Effects

Alternative 1

In Alternative 1 no commercial timber harvest is allowed, and except for fuels management, very little prescribed burning will occur outside of MP 1.1 and 1.2. Thinning and timber stand improvement would be limited to restoration treatments in MP 1.1 and 1.2. Regeneration would be limited to restoration in MP 1.1 and 1.2, and to meet wildlife needs in MP 6.1 and 6.2. The Forest would exist in an increasingly overstocked, unhealthy condition. The risk of catastrophic insect and disease attacks and wildfires would increase.

Alternatives 2, 3 and 4

Alternatives 2, 3, and 4 in the 2005 Forest Plan reduce the number of management prescriptions and draw boundaries to reflect the latest ecological principles and social considerations. Alternatives 2, 3, and 4 do not vary in standards and guidelines, but they do vary in the amount of acreage allocated to management prescriptions. The major influence on management practices in these alternatives is desired condition, rather than restrictions in management prescriptions. As a result, the Forest would move towards the desired condition, ecosystems would be restored or enhanced, and commodities would be produced under all these alternatives. Acres allocated to each management prescription, as shown in Chapter 2 Table 4, illustrate the emphasis of each of these alternatives.

Alternative 5

In Alternative 5 the Management Area boundaries of the 1986 Forest Plan reflect the knowledge of ecological characteristics, and social and political considerations that existed when it was drafted. The Forest was divided into management areas with emphasis on providing areas for various interests and social considerations. Goals and Objectives, and Standards and Guidelines emphasize the priorities for each area, such as wildlife, intensive hardwood management, pine management, natural vegetation communities, grazing, red cedar management, wilderness, and recreation. However, the management area boundaries and priorities as established in the 1986 Forest Plan don't always match ecological reality on the ground. Some management prescriptions prohibit treatments to restore historic timber types and natural community types, obtain desired stocking levels for forest health and increased growth, and free young trees from undesirable competition.

Oak Decline and Forest Health

The 1986 Forest Plan did not anticipate problems with oak decline. However, oak decline has long-term implications to forest health. In the late 1800's and early 1900's the Missouri Ozarks were subjected to extensive logging, open-range overgrazing, over-burning, and subsequent soil erosion and loss of the grass/herbaceous ground cover component. These activities moved timber from predominately shortleaf pine/white oak to a predominately black and red oak forest. Many black and red oak stands are on poor sites, overstocked, and reaching the end of their life span. An estimated 400,000 acres of the Mark Twain National Forest are at moderate to severe risk of oak decline.

Direct and Indirect Effects

Alternative 1

In Alternative 1 no commercial timber harvest is allowed. The forest environment would be affected primarily by natural disturbance factors such as insects, disease, fire, and weather events. Management to mitigate effects of oak decline or to restore the forest to a healthy condition would be limited to cutting hazard trees, reduction of hazardous fuels, and the restoration treatments in MP 1.1 and 1.2. Problems with oak decline could create large areas of dead and dying oaks.

Alternatives 2, 3, and 4

Alternatives 2, 3, and 4 strive to restore and maintain healthy forest ecosystems and provide a healthier balance of shortleaf pine and white oak. Decisions on oak decline and forest health management actions will be made after site specific evaluation. Standards and guidelines and management prescriptions have the flexibility to allow the use of appropriate management activities. These activities include:

- regeneration to historic forest type
- intermediate thinning to desired basal area in MP 1.1 and 1.2 (Restoration Thinning)
- intermediate thinning to favor desired species and obtain desired stocking levels (conventional commercial thinning)
- pre-commercial thinning and release
- salvage and sanitation treatments

There would not be large differences between Alternatives 2, 3, and 4 on oak decline and forest health. Emphasis on ecosystem restoration and enhancement in each of these alternatives would have both short-term and long-term beneficial effects on oak decline and forest health.

Alternative 5

In Alternative 5 problems with oak decline and forest health would be treated diagnostically and not proactively. Restrictions in management prescriptions limit management practices that would have long-term beneficial effects for oak decline and forest health on a large part of the Forest. Artificial regeneration of shortleaf pine to help restore a healthier balance of pine and white oak is prohibited on approximately 60 percent of the suitable land (everywhere except MP 4.1). There would be no restoration thinning. Pre-commercial thinning would be prohibited in MP 3.1, 3.3, and 4.2. Release would be prohibited in MP 3.1, 3.2, 3.3, 6.1, and 6.2. Long-term problems with oak decline and forest health would continue to exist.

Cumulative effects

This discussion of cumulative effects includes land in southern Missouri, where most of the state's timberland exists. Biological systems of the Ozarks are human-influenced and fire-mediated. Woodlands were kept open through the use of frequent, low-intensity fires, and perhaps by elk and bison. The intentional and unintentional burning by Native Americans probably occurred sufficiently long enough (thousands of years) that effects were thoroughly incorporated into natural communities (Swanson et al. 1994; Nowacki 2002). The only heavily forested areas would have been found along major rivers and other areas not affected by the fire regime.

Beginning in the late 1800's and early 1900's, this rich ecosystem and the processes that maintained it were severely disrupted. Oak and pine forests that covered the Ozarks for unbroken miles were harvested in support of mining and westward expansion. Fortunes boomed with early lead and silver mining. With forests gone, settlers attempted to farm the thin Ozark soils, and livestock were allowed to wander the open range. Land clearing, farming and grazing caused soil erosion that clogged streams with silt and gravel.

As a result of these impacts, short-lived scarlet and black oaks now dominate where once longer-lived pine, white and post oaks were found. What was once savanna and open woodlands are now thick with undesirable brush and small diameter trees. These changes, along with the suppression of fire, have resulted in lower plant and animal species diversity.

Non-industrial private owners hold 83 percent of the State's timberland. Conversion of private land to agriculture, urban expansion, and overgrazing of woodlands continues to reduce natural communities and historic natural vegetation present in southern Missouri. Less than 20% of the forested land in private ownership is under active forest management. In 1989, the majority of the growing stock volume in Missouri was in oak species. Hardwoods dominate with more than 90 percent of the total growing stock volume. The black/scarlet oak forest type was the predominant type on almost 5 million acres (37 percent of the timberland area), though many of these black/scarlet oak sites were occupied by shortleaf pine prior to 1900.

Cumulative effects of the implementation of vegetation and timber management in the Forest Plan revision involve uneven-aged versus even-aged management, reforestation and timber stand improvement, intermediate thinning, oak decline and forest health activities, and allocations to management prescriptions. These effects are dependent on how these silvicultural tools, including prescribed burning, are used during the planning period (approximately 10 to 15 years).

In Alternative 1 vegetation and timber management would not be practiced in the traditional sense. Tools are limited to restoration treatments (thinning, regeneration and prescribed burning) in MP 1.1 and 1.2, and regeneration in MP 6.1 and 6.2 for wildlife needs. Large areas of black and scarlet oak at high risk of oak decline would continue to exist and add to the total amount present in the state. Many overstocked stands would grow slowly and stagnate, creating an unhealthy condition ripe for insect and disease attacks that could spread off the Forest. Areas that were historically open or closed woodlands would remain overstocked, closed canopy forests. An increase in shade and buildup of leaf litter would cause ground cover vegetation to weaken and die, reducing species diversity on the Forest—further reducing the numbers of some species at risk statewide, and even jeopardizing others.

In Alternatives 2, 3, and 4 a full complement of silvicultural tools is available to manage the Forest. Management decisions would be made on a site specific basis at the project level. Within the standards and guidelines, and management prescriptions, desired condition would drive determination of the appropriate treatment. Work to restore natural communities would add to the amount of these communities and mixture of species they contain. Restoration to historic timber types will move the Forest, and the State, towards forest types that existed in pre-settlement days. A move toward a healthier balance of shortleaf pine/white oak will reduce long-term effects of oak decline that the Forest and the State now suffers from due to an overabundance of black and scarlet oak. Intermediate thinning, timber stand improvement treatments, and appropriate decisions regarding use of UAM or EAM would improve species composition and forest health. Plant species adapted to historically open conditions of the forest floor would have a greater chance of persisting for decades with these silvicultural treatments. The addition of prescribed burning would also expand the abundance and diversity of these plant species, which would reduce the statewide risk to these species. A healthier and more resilient Forest would help reduce the possibility of insect and disease epidemics on the Forest and statewide.

In Alternative 5 management prescriptions limit management options. Artificial regeneration of shortleaf pine is prohibited in much of the natural range of shortleaf pine. Timber stand improvement treatments such as pre-commercial thinning and release are prohibited in some areas. UAM is required in some areas, though it may not be the most appropriate method. Due to these restrictions, restoration to historic timber types would be difficult on the majority of the Forest. Work to restore natural communities would be very limited on the forest and statewide. The amount of historic timber types would increase only slightly, and natural communities in the state would continue to decrease. Forest health and species diversity would suffer. Treatments for oak decline would continue to be reactive and not proactive, and potential problems with oak decline would not decrease.

Ecological Sustainability and Ecosystem Health

Introduction

Biological diversity refers to the full variety of life in an area, including the ecosystem, plant and animal communities, species and genetic diversity and the processes through which individual organisms interact with one another and with the environment Nigh et al. 1992). The Forest Service is charged with providing for the diversity of plant and animal species (36 CFR 219.26).

The Mark Twain National Forest is using a coarse filter and fine filter approach to conserving biodiversity and addressing species viability. Estimates of the range of natural variability in composition, structure and processes created by historical disturbance patterns prior to extensive human alteration of the landscape provide reference conditions from which to define desired ecological conditions. We assume that most, if not all, indigenous plant and animal species that occurred prior to settlement were byproducts of healthy historical ecosystems, and that today's list of Regional Forester Sensitive Species, Federally –Listed Threatened and Endangered Species, State Endangered Species and other species of conservation concern are symptomatic of ecosystem dysfunction, habitat destruction and other risk factors.

The ecosystem approach to management, the coarse filter approach, is a strategy for protecting biodiversity and maintaining species viability on the Mark Twain National Forest. The approach to managing for diverse and sustainable natural communities is: **to restore their structural vegetative condition and maintain historical disturbance processes and functions under which natural communities evolved, and to which they are uniquely adapted**. The underlying concept is that a representative array of natural communities will include appropriate variations in habitat structure and plant species composition to accommodate most plant and animal species. Conserving an adequate representation of natural communities that harbor a broad diversity of plants and animals is an efficient approach to conserving biodiversity, which may protect 85 to 90% (Groves 2003) of all species and thus improve the possibilities of conserving biological diversity (Nigh et al. 1992, Hunter et al. 1991, Manley et al.1995, Baydack et al. 1999, TNC 2003).

Ecosystem management is a proactive approach to prevent creation and listing of threatened species rather than expend resources attempting to recover them. The approach concentrates more intense management efforts toward restoring high quality natural communities in regions where the best concentrations of sensitive species and restorable ecosystems remain. This approach is supplemented by Forestwide standards and guidelines, and management prescriptions intended to provide other desired conditions for a variety of habitats important to wildlife and plants. The 1982 Planning regulations require that conditions be provided to support species in a "well-distributed" pattern throughout the species range within the plan area (36 CFR 219.19.) The remaining Forestwide management prescriptions and their associated management activities are intended to provide widely distributed habitat for generalist species as well as for those associated with special or critical habitats not found in Management Prescriptions 1.1 and 1.2.

Fine filter conservation approaches are needed to address viability of some species because the causes for concern are not related to habitat, or because coarse filter approaches do not adequately address certain fine scale habitat components. Fine-scale features such as fens, caves, seeps, spawning sites and raptor nest sites are often essential for viability. Standards and guidelines were developed to address identified habitat needs, non-habitat factors, or to supplement broad-scale management as necessary.

Proposed Changes

Proposed changes that could have an effect on ecological sustainability and ecosystem health include:

- changes in standards and guidelines relating to even-aged and uneven-aged management (Revision Topic 1b);
- the addition of prescriptions emphasizing restoration of natural communities (Revision Topic 2a);
- changes to standards and guidelines regarding reforestation and timber stand improvement (Revision Topic 2b);
- prescribed burning, wildland fire management, and fuels management (Revision Topics 3a, 3b, and 3c); and
- changes in management for riparian areas (Revision Topic 5).

Delineating Opportunity Areas for the Ecosystem Restoration Approach: Management Prescriptions 1.1 and 1.2.

Selection of new project management areas for purposes of restoring significant ecosystems should be based on conservation assessments (Groves 2003, Baydack et al. 1999). Significant ecosystems are those distinctive, biologically intact landscapes that have a high probability (with management) of retaining their conservation targets (species and natural communities) over time. The Mark Twain NF relied on conservation assessments and data to identify areas of the Forest with the highest opportunity to conserve the best, most viable arrays of ecosystems, plants and animals. Management prescriptions 1.1 and 1.2 were developed in response to the identification of opportunity areas. Spatial elements (maps targeting distinctive areas that provide species and natural community targets) become the conservation planning framework from which to meet Management Prescription 1.1 and 1.2 objectives. Opportunity areas were delineated using information from the following sources:

- Ozarks Ecoregional Conservation Assessment (TNC 2003)
- Atlas of Missouri Ecoregions (Nigh and Schroeder 2002)
- The Terrestrial Natural Communities of Missouri (Nelson 2005)
- The Missouri Biodiversity Report (Nigh et al. 1992)
- The Missouri Natural Areas Program
- The Conservation Wildlife Strategy
- Partners In Flight; Ozark-Ouachita Physiographic Region
- Ozark-Ouachita Highlands Assessment (USDA Forest Service 1999a-e)
- Missouri Resource Assessment Partnership

The Mark Twain NF found that the approach used by The Nature Conservancy best fit the ecosystem sustainability approach and intent of the 1982 Planning Rule because of the natural community complexes, target species, viability determinations and consideration of lands owned by the Forest. Most, if not all, of the spatial elements provided by the other sources listed were found to fit well within the ability and opportunity for the Forest to develop project opportunities. Specific project analysis will further permit use of spatial data coupled with project conservation design work to identify the best sites from which to commence ecosystem management activities.

The Mark Twain National Forest met with the Missouri Chapter of The Nature Conservancy to gather information on conservation areas, among other sources, and discuss the results of the Ozarks Ecoregional Conservation Assessment. The analysis is strongly linked to this effort in two ways: first, it allows the Mark Twain to focus conservation planning and management efforts on specific opportunity areas on Forest lands, also known as “portfolio sites,” through development of Management Prescriptions 1.1 and 1.2. The amount of allocated acreage, corresponding conservation targets and projected management activities vary by alternative based on the suggestions provided by The Nature Conservancy. Second, specific outcomes were formulated by identifying minimum/maximum viability targets for natural community complexes in MP 1.1 and 1.2. This allowed us to set management activity objectives to move critical ecosystems toward desired conditions.

The Nature Conservancy’s Ozarks Ecoregional Conservation Assessment (OECA) serves as a regional conservation blueprint, identifying those elements of a region’s biological features that are of conservation significance from a biodiversity perspective. It is an efficient conservation design in that portfolio areas encompass some 70% of primary species targets. The Mark Twain NF touches upon or fully embraces 11 of the Ozarks 22 total Terrestrial Landscape Areas. The OECA, along with other information provided by Partners in Flight, the Missouri Resources Assessment Partnership and the Missouri Natural Areas System, provides information to determine what is the least area of landscape needed to ensure sustainable conservation of this biodiversity (TNC 2003). These dynamic landscapes have desired conditions specifically described in The Terrestrial Natural Communities of Missouri (Nelson 2005). Desired conditions are land or resource conditions that are expected to result if planning goals and objectives are achieved. For purposes of restoring ecosystems, desired conditions are described as key natural community elements or outcomes in Appendix A, Terrestrial Natural Communities in the 2005 Forest Plan.

To varying degrees, Alternatives 1 through 4 focus on managing landscapes across Missouri's ecological subsections as a means of representing target natural communities and addressing minimum species viability needs. Alternatives in the 2005 Forest Plan generally use different measures of ecosystem management direction based on themes of each alternative, allocations of management prescription acres and projected activities. Some alternatives may rely more heavily on protected areas, while others put greater emphasis on management that may restore resources to conditions approaching the range of natural variability (RNV).

Species Viability, Threatened and Endangered Species, Management Indicators and Regional Forester Sensitive Species addressed through Ecosystem Sustainability

In the Species Viability Evaluation (SVE) process, over 1600 plant and animal species and communities were evaluated for viability concerns on the Mark Twain NF. Of these, 66 animal and 176 plant species were identified as species needing further consideration (Species at Risk or SAR).

Information was gathered on life history and habitat needs for these species. Animal species were grouped by threats, and plant and animal species were grouped by general habitats. Species were evaluated using a wide variety of quantitative and qualitative information. Information was gathered from currently accepted and applicable scientific literature, other scientific sources, databases, and from species experts, along with professional judgment of Forest Service biologists. This information was used to develop Conservation Approaches (ecosystem level or coarse filter) that would guide management and protection of large landscapes and assemblages of terrestrial and aquatic biological communities. These Conservation Approaches were then used to develop the Alternatives, Forest-wide Goals and Objectives, Forest-wide standards and guidelines, and Management Prescriptions 1.1 and 1.2 for the 2005 Forest Plan.

Using this approach, all the communities that are present or should be present on Mark Twain NF have been addressed. In addition, all but 5 of the animal species and all but one of the plant species would have habitat distributed across MTNF in appropriate ecological locations. For those species that have needs outside of the Conservation Approaches, or coarse filter, (bald eagle, Indiana bat, Hine's emerald dragonfly, gray bat and federally listed mussels), specific standards and guidelines were developed to encompass their particular habitat needs or to address specific threats to the species. In addition, standards and guidelines were developed for one fine filter habitat component (snags, den trees, and downed woody vegetation) to ensure its availability across the landscape for a number of different animal species.

Issue – Ecological Sustainability and Ecosystem Health

There is much disagreement about whether it is necessary to increase the amount of white oak and shortleaf pine to provide for a healthy forest; the amount of land dedicated to enhancement and restoration of natural communities; and the effects on local timber markets. There is also debate about whether passive or active management is necessary to restore a healthy forest, and what direction is needed to guide or restrict certain silvicultural methods and prescriptions.

Forest Plan revision will establish what, if any, direction for increasing white oak and shortleaf pine will be provided, and how much of the Forest will be allocated to natural community restoration. Forest Plan revision will also determine what, if any, management direction regarding timber management techniques and practices are needed to provide for forest health.

Key Indicators

Indicators are identified and displayed to show how alternatives provide for the diversity of habitats and ecosystems. These indicators include Management Indicators that serve as surrogates for ecosystem health and recovery. The following indicators reflect the knowledge, monitoring and experience of state and federal land and resource managing agencies who have been involved in ecosystem restoration efforts. These programs include the Missouri Natural Areas Program, the Missouri State Park System Ecosystem Management Program, The Nature Conservancy Stewardship Program and select ecosystem restoration projects on the Mark Twain NF.

Acres of ground cover meeting desired condition (DC) for savanna, woodland and glade

This indicator highlights the differences between alternatives because improved ground cover diversity is among the first components of natural communities to respond to treatment.

Acres treated to move towards natural community type

This indicator highlights the differences between alternatives because twenty-five years of effort restoring fire-adapted communities strongly correlates applied management prescriptions with regenerated structural components of desired natural communities.

Acres Burned Each Year

This indicator highlights the differences between alternatives because burning helps move vegetation (species richness) and glade, woodland and savanna natural communities toward desired conditions. Acres burned are intended to mimic historical disturbances that should restore and sustain natural communities.

Acres Thinned

This indicator highlights the differences between alternatives because thinning helps move vegetation and glade, woodland and savanna natural communities toward desired conditions. Acres thinned in various ways in response to current vegetation conditions will aid restoration of structural aspects of the desired condition.

Table 11 - Key Indicators for Ecosystem Sustainability

			Alternative				
Key Indicator	Units	Current Condition	1	2	3	4	5 No Action
Ground cover meeting DC for savanna, woodland and glade	Ac/Decade	26,000	35,600	185,500	122,800	35,600	30,000
Acres treated to move towards natural community type	Ac/Decade	<500	17,800	93,300	61,000	17,800	13,000
Acres Burned	Ac/Decade	30,000*	73,000	383,000	250,000	73,000	125,000
Acres Thinned	Ac/Decade	<3,000**	26,300	143,500	94,500	27,900	<15,000

Figures do not include other management activities that may enhance natural community diversity or wildlife outputs.
**Estimate of total acres burned that move portions of Forest toward restored ecosystems meeting desired conditions outlined in 2005 Forest Plan, Appendix A.*
***Estimate includes 1,500 acres red cedar reduction and other thinning to restore glades, woodlands and small savanna sites during plan period.*

Affected Environment

Historic Conditions (Range of Natural Variability)

Terrestrial Natural Communities

Natural communities are the foundation for analyzing potential historic vegetation and condition class for fuels. They serve as a means to describe and analyze departures between historical reference and current Forest conditions. These natural communities (Nelson 2005) are grouped into broad type categories based on similarities in vegetation appearance, structure and composition. Further, each major type possesses characteristic similarities in response to disturbance processes and the range of natural variability (RNV.) It is at this level that plant and animal populations best respond to a range of similar management treatments and are differentiated by habitat variations within them. The relative amounts of each type that occurred on the Mark Twain NF were estimated using the Historic Vegetation Project data from the Geographic Information Center, University of Missouri (see Appendix D on Historic Vegetation).

Forests

Fifteen percent (224,400 acres) of MTNF ownership was forested although analysis shows that a much greater portion of the vegetation on MTNF lands is forested today. However, much of this forest cover is the result of land use changes occurring after European settlement, and actually represents artifact of now degraded woodland and savanna. Forests are multistoried with a canopy, subcanopy of small trees, shrubs, saplings, vines and ground flora adapted to shade and essentially permanent leaf litter. There are 14 forest natural communities. Little light penetrates except in gaps created by wind, tornados, ice and snowstorms, and, especially during drought, fire. Because most forests generally occur on north and east-facing slopes or under mesic to wet soil conditions, fires are infrequent and generally of low intensity. Worm-eating warbler, ovenbird, Swainson’s warbler, Acadian flycatcher and gray bat are associated with forests.

Woodlands

The majority of MTNF lands (77% or 1,191,000 acres) consisted of complexes of mostly fire-adapted open and closed woodland types. There are 15 individual woodland natural communities. Woodlands consist of mosaic patches of even-age oak and/or pine shrubs, saplings and mature trees occurring at irregular intervals as determined by fire behavior characteristics and effects across a varied landform. Because frequent fire was so important to the maintenance of woodlands historically, as much as 25% if not more of woodland natural communities would have fallen under the shrublands and barrens descriptions in the historic vegetation survey. Other portions of the understory or midstory are generally sparse with a dense ground flora rich in forbs, grasses and sedges. Cooper’s hawk, whip-poor-will, summer tanager, Bachman’s sparrow, Indiana bat and northern long-eared bat are some of the species of conservation concern associated with woodland natural communities. Oaks dominate most woodlands but oak-hickory, oak-pine and pine mixtures also occur.

Savannas

Eight percent (119,700 acres) of Forest lands were once fire-mediated savanna (grouped into shrublands and barrens). Only local isolated remnants occur in portions of the MTNF, particularly on the Ava Ranger District. Savannas are grasslands with open-grown, scattered, orchard-like trees or groupings of trees; there are four savanna natural communities. These are distinguished from woodlands in that they are strongly associated with large prairies or woodlands on broad plains. Historically savannas were maintained by frequent fires and grazing by large herbivores, like elk and bison. Savanna wildlife includes the great crested flycatcher, eastern bluebird, blue-winged warbler and indigo bunting. Indiana bats are believed to be highly associated with savannas.

Prairies

Only about 1,500 acres of MTNF lands contained fire-dependent native prairie, of which a few remnants remain. Prairies are natural communities dominated by perennial grasses and forbs with scattered shrubs and very few trees. Historically prairies were maintained by frequent fires and grazing by large herbivores, like elk and bison. Distinctive prairie animals include the northern harrier, field sparrow, Henslow's sparrow, northern crawfish frog and dickcissel. Most prairies are degraded or destroyed except a few acre patches on the Cedar Creek unit.

Glades

Glades cover approximately 86,000 acres on and adjacent to the Mark Twain National Forest. Of this, approximately 37,000 acres occur on the Mark Twain. Glades are open areas of exposed bedrock or shallow soil over rock dominated by drought-adapted herbaceous vegetation. Tree growth is absent or stunted, but shrubs are present. Glades often contain seeps and are associated with bordering open woodlands. Their size ranges from those creating canopy gaps in woodlands to complexes that are up to 1,000 acres. The largest occur mostly on dolomite in the White River Hills Subsection and on igneous substrates in the St. Francois Knobs and Basins Subsection. Small glades, generally less than 10 acres, occur on limestone and sandstone rock. Fire and historical native ungulate grazing played an important role in maintaining their character. Missouri glades contain several endemic and disjunct species, many of which are listed as species of concern including the greater roadrunner, eastern collared lizard, Bachman's sparrow, Bush's poppy mallow, Trelease's larkspur and wavy-leaf purple coneflower . Most glades are threatened by eastern redcedar invasion and non-native invasive species.

Bottomland natural communities

Of the forest, woodland and savanna acres above, 65,000 acres presently consists of some type of bottomland natural community. However, much of this type was cleared for purposes of farming and pasturage throughout the MTNF. Only a few small acre relict examples of good integrity bottomland natural communities remain. Bottomland natural communities occupy floodplains along loosing and intermittent drainages, permanent streams and rivers on the Mark Twain NF. Bottomland natural communities include five bottomland forest types, three woodlands, three stream edge, fens and seeps, marshes, springs and spring branches. Bottomland communities are important for the ecological function of riparian areas for protecting water quality.

Fens and Acid Seeps

These natural communities are wetland types associated with a constant supply of groundwater seepage creating conditions that form peaty, mucky shallow to deep marly soils. The Natural Heritage Database identifies 42 significant fens and seeps, totaling 3,905 acres, occurring on the Mark Twain National Forest. These include Ozark fens, forested fens and acid seeps. A host of distinctive and often restricted plant and animal species characterize this bog-like natural feature including the federally-listed Hine's emerald dragonfly, four-toed salamander, social sedge, tussock sedge and large-leaved grass of Parnassus. Early settlers and present landowners have attempted to drain and alter the hydrology of fens and seeps. Many have been overgrazed and invaded by undesirable woody species or non-native invasives.

Early successional habitat (as a structural stage of savanna, woodland and forest natural communities)

In the context of meeting many wildlife habitat objectives, distinctions are drawn between open lands (artificial, native or intermixed) that provide habitat for many generalist plant and animal species, and early successional habitats that are structural stages of savanna, woodland and forest natural communities. Many species of conservation concern (for example neotropical migrant birds) were adapted to the extensive spatial patterns, patches and distributions of early successional stages that were characteristic of the natural communities above (see historical vegetation section of Appendix D. Thus, the primary distinction is the presence of dominant and characteristic plant species associated with respective natural communities intermixed within moderate to good integrity natural vegetation (see desired condition chart in Appendix A of 2005 Forest Plan). Early successional habitat is especially important among open and closed woodland, savanna and forest natural communities. Other open lands often contain low diversity mixtures of non-native species, weedy herbaceous plants, thorny shrubs, some more generalist pioneering natives and non-characteristic trees mostly indicative of old fields and overgrazed lands.

Special habitats

Other natural communities are grouped into special habitats because they provide environmental conditions favorable for species of conservation concern, concentrations of breeding animals, and distinctive microhabitats for ferns, mosses and lichens or unique geologic features. These include caves, sinkholes, sinkhole ponds, cliffs, rock outcrops and other wetland types. Many of them remain close to their historical condition.

Table 12 - Historic Vegetation by Subsection (on National Forest System Lands Only)

Ozarks Highlands Section	Prairie		Savanna (shrub/barren) <20% cover		Open Woodland 20- 50% cover		Closed Woodland 50-80% Cover		Forest >80% cover		TOTAL ACRES
	Acres	% of NFS Acres	Acres	% of NFS Acres	Acres	% of NFS Acres	Acres	% of NFS Acres	Acres	% of NFS Acres	
Black River Ozark Border	0		15,200	11%	38,700	29%	50,800	38%	28,700	22%	133,400
St. Francois Knobs and Basins	0		3,000	3%	25,800	27%	39,200	40%	29,200	30%	97,200
Current River Hills	200	<0.1%	19,900	4%	169,700	34%	249,600	50%	62,700	12%	502,100
Central Plateau	100	0.1%	10,800	15%	28,300	40%	26,100	36%	6,900	9%	72,200
White River Hills	500	0.3%	29,100	9%	123,300	40%	110,100	36%	46,500	15%	309,500
Gasconade River Hills	500	0.03%	26,400	15%	80,500	47%	55,600	32%	9,300	5%	172,300
Meramec River Hills	100	<0.1%	15,400	9%	63,100	36%	63,300	36%	34,900	20%	176,800
Outer Ozark Border	0	0%	500	3%	4,600	35%	5,400	41%	2,800	21%	13,300
Inner Ozark Border	0	0%	300	4%	3,200	38%	3,500	42%	1,400	16%	8,400
Central Dissected Till Plains Section											
Claypan Till Plains	100	3%	100	3%	1,300	42%	1,300	42%	300	10%	3,100
TOTAL ACRES	1,500	1%	120,700	8%	538,500	36%	612,900	41%	222,700	15%	1,488,300

Source: Geographic Information Center, University of Missouri, Columbia 2004.

Native Grazers

Before European settlement, American bison, elk and white-tailed deer roamed freely throughout Missouri. Coronado, believed to have reached the southwestern portion of Missouri in 1541, noted rolling grassland with Osage Indians hunting among vast herds of buffalo (Bielmann and Brenner 1951). Houck (1908), Beilmann and Brenner (1951), and Schoolcraft (1821) provide many eloquent historical accounts of wildlife abundance in Missouri. Father Membre (Houck 1908), in 1681, writes that “The fields (native prairies and savannas) are full of all kinds of game, wild cattle (bison), stags (elk), does, deer, bears, turkey, partridges, parrots, quails, woodcock, wild pigeons, and ringdoves.”

The most obvious influences on the grazing distribution of native Missouri herbivores prior to European settlement included food and feeding adaptations, water, minerals, topography, vegetation structure, weather changes, predators, hunting by Native Americans, insects and migratory behaviors. Native herbivores often migrated to areas of rich resources, productive natural communities and palatable species, in that order (Senft et al. 1987). Social behaviors of herding and congregating around water sources might have led to local grazing pressure, but the sheer magnitude of continental scale for richly distributed natural vegetation buffered any lasting negative effects. Prior to the introduction of modern era exotic plant species, only native plant species would have re-colonized areas impacted by local grazing pressure.

Several primary factors likely protected even the most conservative plant species from becoming rare due to the grazing disturbance process:

- the magnitude and scale of plant populations covering thousands of square miles;
- plant adaptations to grazing; and
- the fact that native herbivores rarely revisited and browsed the same plant populations (except local areas) more than once as they migrated or moved about the landscape.

Current Condition

Terrestrial Natural Communities

None of our remnant natural communities, even those now designated as Missouri Natural Areas, passed undiminished through the last 150 years or more of modern human land use. The historical mosaic patterns, structure and composition of savanna, open woodland, glade and forest natural communities are today fragmented, reduced in species richness and extensively converted or destroyed by complete cutovers, overgrazing, fencing, road building, urbanization and fire suppression.

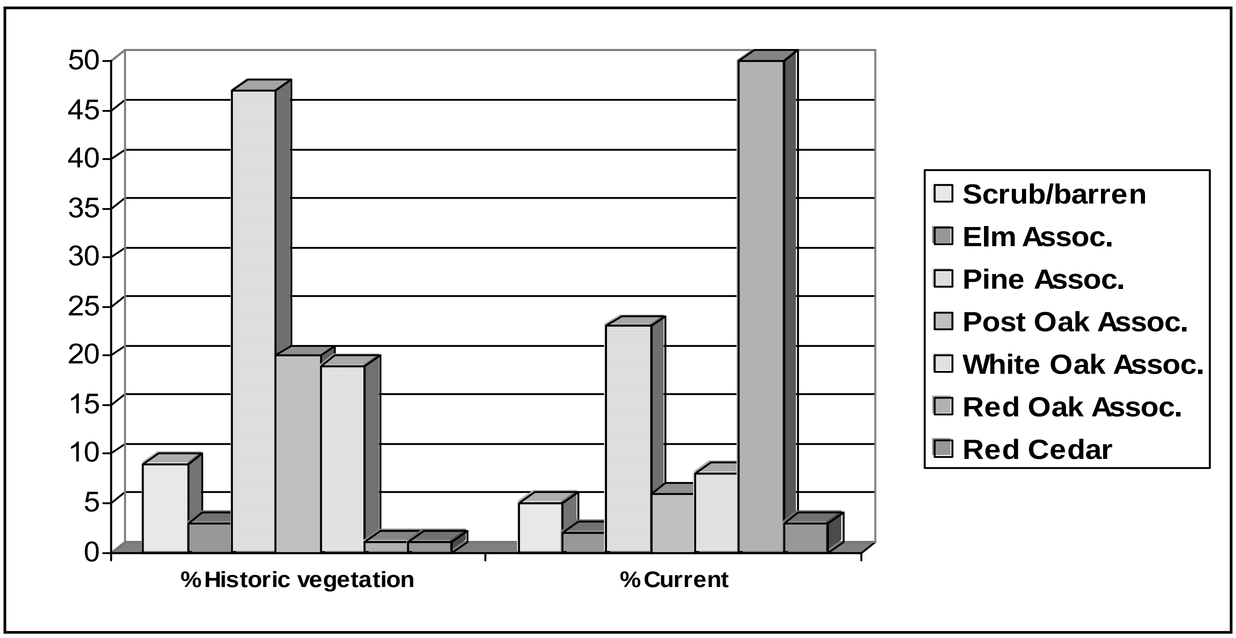
The vegetative composition for many upland forest types is still close to their RNV, but dramatically altered for most bottomland forests, with few high quality examples surviving. The RNV for woodlands has changed dramatically with major losses in shortleaf pine, post oak and white oak dominance and loss of grass and forb groundcover in all woodland communities. For savannas, the RNV is nearly 100% altered on the Mark Twain NF, with major losses of original tree structure and grass/forb groundcover. Most prairies are degraded or destroyed except a few acre patches on the Cedar Creek unit. Most glades are threatened by invasion of eastern redcedar and non-native invasive species. Early settlers and present landowners have attempted to drain and alter the hydrology of groundwater seepage (fens and acid seeps). Many have been overgrazed and invaded by undesirable woody species or non-native invasives. Many caves, sinkholes, sinkhole ponds, cliffs, rock outcrops and other wetland types remain close to their historical condition.

Because natural communities have been so altered, and because we do not have the type of inventory information needed, we are not able to map existing occurrences of natural communities in order to compare with historic amounts and distributions. We can, however, map the distribution and amount of historic timber types and compare that to the existing condition. This information, shown in Table 13, illustrates the magnitude of change in forest type and composition. For example, 39% of what was historically scrub/barren is now dominated by red or black oak.

Table 13 - Change in Timber Species Type

	Current Condition					
Historic Vegetation Group	**Open lands**	**Pine**	**Post oak**	**White oak**	**Red or black oak**	**Red cedar**
Scrub/Barren and Prairie	8%	23%	15%	8%	39%	6%
Elm Associations	18%	7%	3%	13%	39%	4%
Pine Associations	1%	33%	2%	8%	60%	<1%
Post oak Associations	7%	15%	13%	8%	50%	1%
White oak Associations	6%	10%	7%	9%	57%	7%
Red oak Associations	13%	4%	10%	14%	38%	16%
Red cedar Associations	0%	0%	0%	0%	0%	100%

Figure 32 - Percent Change between Historic and Present Vegetation Association Cover



Native Grazers

Emerging ecological knowledge shows that wildlife abundance, species richness and diversity, plant pollinators linked to ground flora, the presence of native herbivores and primary predators were historically elements of high integrity, healthy ecosystems (Nelson 2005).

Since European settlement, humans have greatly altered or eliminated historical animal groups through direct harvesting or habitat destruction. Habitat fragmentation, roads, fences and competition with exotic species, including domestic livestock, have altered or eliminated the once historic free-roaming migrations of abundant wildlife. Missouri's free-roaming elk and bison are gone. The present-day condition of the Ozark's vegetation attests to many decades of open range grazing. Great numbers of free-ranging hogs, goats, sheep, cattle and horses stripped the Ozark woodlands, savannas, glades and forests of their rich and abundant grasslands and wildflowers.

While the Mark Twain National Forest is out of the RNV for native grazers, American bison and elk, it is beyond the scope of this FEIS to address restoration and recovery of native grazers and primary predators due to social and practical management issues.

Current Condition compared to Range of Natural Variability

The Ozarks Ecoregional Conservation Assessment (TNC 2003), Ozark-Ouachita Highlands Assessment (USDA Forest Service 1999a-e), the Missouri Biodiversity Report (Nigh et al. 1992), Atlas of Missouri Ecoregions (Nigh and Schroeder 2002), Development of Critical Ecosystem Models for EPA Region 7; Regional Geographic Initiative Report (September 2004), and the Terrestrial Natural Communities of Missouri (Nelson 2005) all point to risk factors that have changed the range of natural variability. These documents further clarify the importance that historical disturbance processes had in influencing the distribution and character of Missouri's vegetation at the time of European settlement. Main conclusions drawn from these and other sources include:

Human Uses

- The historical biological landscape of the Ozark Highlands and Central Dissected Till Plains sections reflects the effects of frequent, low intensity fires set by Native Americans and lightning.
- Modern settlement, which began in the early 1800s, significantly changed many ecosystems on what would be Mark Twain NF.
- Mining, land clearing, wide scale deforestation, over a century of open-range domestic livestock grazing and intentional fires collectively contributed to changed vegetation patterns beginning in the mid to late 1800s.

Forest Vegetation/Natural Communities

- Most historical natural communities and vegetation patterns have changed significantly in the past 100 years or so, with significant loss of grass/forb dominated woodlands, glades, and savannas and their diverse structural openness.
- Former woodlands, savannas, glades, fens, prairies and certain forest natural community types may not recover without imitating historical fires or reinstating native grazers.
- The current distribution and coverage of shortleaf pine, white oak, post oak and bur oak, among other species, is much lower than its historic RNV (Table 13 and Figure 32; see also Timber Supply analysis). For example, shortleaf pine occupies only about 500,000 acres of the estimated 6.6 million acres that occurred at the time of European settlement; a net loss of 6.1 million acres (Stambaugh 2001).
- Red cedar has increased dramatically from its historic RNV resulting from overgrazing and fire suppression, especially on glades and in formerly open woodlands.
- The percent canopy cover has increased dramatically from its historic RNV. The RNV in vegetation patch openness has shifted from a variable mix of shrub barrens,

open and closed woodlands and essentially treeless glades to closed, densely wooded canopies over most of the Mark Twain.

- Red and black oak species have increased in distribution and coverage, and are rather homogeneous in age primarily due to initial removal of desirable shortleaf pine and white oak concurrent with the era of open range grazing and fire suppression.
- Much of the present-day Forest is overstocked with high basal area densities and relatively even-aged, 50 to 70 year old stands of timber. An estimated 35 to 75% of the natural communities in Management Prescriptions 1.1 and 1.2 acres, and elsewhere, are in excess of desired basal areas, which exceed the RNV for corresponding historic vegetation.
- Vegetation composition and structure remains close to the RNV for a limited amount of mesic and dry-mesic forests, cliffs and rock outcrops although species richness is modified.
- Vegetation structure for forests and woodlands are younger on average, and densely overstocked thereby lacking structural age/class diversity, shrub/barrens, regeneration sites, cavities and coarse woody debris compared to the historic RNV for similar natural communities.
- Large, old trees are relatively rare today, especially for large-canopy shortleaf pine and white oak on uplands, and mixed oak/hickory and bur oak-giant cane in bottomlands.
- Altered vegetation composition and structure, non-native invasive species, habitat destruction, land fragmentation, urban development, more than 70 years of fire suppression and keystone species extinctions have altered ecosystem functions from the latter half of the 20th century to the present.

Non-forested vegetation

- An estimated 1,500 acres of prairie, 30,000 acres of treeless glades, 120,700 acres of shrub barrens (savanna) have changed significantly across the Forest compared to their historic RNV. Many of these acres are in poor ecological health due to land development and conversion, non-native invasive species, past domestic livestock overgrazing and fire suppression.
- Unregulated domestic livestock grazing from the early 1800’s through the mid 1960s led to a significant reduction in species richness and dominance of historic grass/forb-dominated ground cover associated with glades, savannas, barrens and open woodlands.
- Except on some glades, historic grass/forb dominated natural communities have all but disappeared on private lands adjacent to and within the Mark Twain NF due to overgrazing and conversion to cool season, rapidly spreading non-native invasive grasses.
- Most open pasturelands and old fields, especially in riparian and water protection zones, occurring on the Mark Twain NF are not within the historic RNV, primarily either dominated by non-native invasive grasses or a mixture of annual weeds, grasses and early successional soft-mast shrubs/trees typical of overgrazed pastures and abandoned croplands.

Climate and Fire

- Precipitation, humidity, weather patterns and temperatures appear essentially unchanged over the past 3,000 years and are within the RNV.

- The historical fire regime is outside the RNV (low intensity, frequent ground fires; infrequent, high intensity, stand-replacing fires. Surface fires were common, especially on gently dissected plains and hills dominated by shortleaf pine, white oak and post oak, and on glades.
- Alternative applied management methods and strategies are ineffective and inefficient at mimicking historical effects of fire to restore the ecological health of fire adapted natural communities.
- In many stands, the accumulation of leaf litter, woody debris and dense young brush/timber is outside the historic RNV. Fuel types have shifted from the once grass/forb dominated ground cover of woodlands, savannas and some forest natural community types to shaded, deep leaf litter.

Air Resources

- The Forest is outside of the historic RNV in terms of modern emissions from burning fossil fuels for heating, transportation, electricity and industry. These emissions, except the burning of natural fuels (wood, grass, etc), did not exist prior to European settlement.
- The concentration of smoke on the Mark Twain NF is presumed to be lower than the historic RNV due to fire suppression.

Biological Threats

- An estimated 400,000 acres of the MTNF is at moderate to severe risk of oak decline.
- Oak woodborers and root armillaria are likely trending outside of the historic RNV due to changes in vegetation composition, past timber harvest and fire suppression.
- Non-native invasive plant species (NNIS GIS data) including mutiflora rose, autumn olive, garlic mustard, sericea lespedeza, kudzu, japanese honeysuckle, tall fescue and crown vetch (among others) are present across the MTNF and seriously threaten forest health in many places.

Wildlife

- Wolves, mountain lions, elk and American bison no longer freely roam or successfully reproduce on the Mark Twain NF.
- At least 21 of 90 bird species breeding in the Ozark-Ouachita Highlands have declined in abundance. Some of these species inhabited open grasslands, savannas, pine woodlands, interior forests and shrub/sapling structural stages of woodlands that have declined.
- Non-native feral hogs occur on portions of the Forest and are causing ecological damage, especially in wet-mesic to wet bottomland forests, small springs, fens and acid seeps.

Aquatic Resources

- Most cold water, spring fed Ozark streams are outside their historic RNV for native fish and perhaps other aquatic organisms due to the introduction of non-native fish species, fishing pressure, watershed alterations and non-native plant introductions.
- Hydrological alterations, sedimentation, nutrient loading and habitat destruction on non-Forestlands impact many aquatic/stream resources on the MTNF according to available watershed assessments.

- Population levels for Ozark hellbenders and other aquatic organisms are declining for unknown reasons although watershed assessments point to land clearing, recreation and domestic livestock grazing as potential causes.
- Subsurface habitat disturbance, sedimentation, pollution and destruction of surface lands stress karst sites across the Ozark Highlands.
- Many fens and seeps are threatened by historical alterations of hydrological flows, woody and non-native species invasion, and fire suppression.

Oak decline and forest health

Oak decline is a major cause of tree mortality in the Ozarks. The first effects were noticed in 1980-1981 in the south central part of the Forest near Winona and Van Buren. There was a severe drought in the summer of 1980 that seems to have been one of the causes of the decline. The decline increased in 1983-1986, and then slowly decreased through the early 1990s. Nearly 50% of the sawtimber was scarlet and black oak, and age 60 to 80 years old. The effect of oak decline to this area was substantial. A new wave of oak decline started in 1999-2000 on the Salem and Potosi Ranger Districts after 3 years of severe drought. Other areas of the Forest have also been affected by this drought. An ongoing study by the North Central Research station is comparing 1989 FIA data with 1999-2001 FIA data and re-measurements of the 1999-2001 data in 2003. Some early results indicate that mortality in the red oak group could reach 5%.

Environmental Consequences

Effects common to all alternatives

General Effects of Management Activities

Whether vegetation and biodiversity moves toward the Range of Natural Variability for natural communities, or away from it in a new direction depends on how vegetation is managed and affected by disturbances beyond the control of the Mark Twain NF. The Forest can choose to apply management activities in four general ways. Each will have different effects, other than ones they share like direct and cumulative effects of unpredictable weather extremes, insect and disease outbreaks, oak decline and wildfire:

- Apply specified management prescriptions to achieve the desired condition for natural communities, thereby moving vegetation back toward RNV. This is the ecosystem approach to management based on mimicking RNV for disturbances, and is the primary focus of MP 1.1, 1.2 and portions of 8.1.
- Apply management treatments to achieve other desired results that target timber, range, recreation, wildlife, game and other species outputs. Current Plan management prescriptions emphasize a variety of or combinations of these objectives.
- Apply management treatments that, while not restoring ecosystems to their historic desired condition as described in Appendix A of the 2005 Forest Plan, may enhance biodiversity. New standards and guidelines are proposed that move in this direction in MP 2.1.
- Not applying treatments. This has the effect of allowing vegetation to follow a variety of alternate successional pathways. Many of these unmanaged pathways are not in the RNV on the Mark Twain, nor would many achieve RNV in the foreseeable future.

Range of Natural Variability for natural communities has shifted on most of the Mark Twain due to past land abuse and changes in disturbance processes. On portions of the Forest where active timber management and prescribed burning occurs, changes in vegetation will occur. Projected management activities should shift natural communities toward RNV under all five alternatives to some degree. However, such activities will not re-establish the RNV for vegetation patterns and components of certain ecosystems across all alternatives. Likewise, lack of management that would otherwise mimic historic disturbance patterns prior to European settlement will affect the recovery of degraded natural communities.

The total amount and proportions of natural community types will differ between alternatives and are directly dependent on the amount of land allocated to various management prescriptions, specifically for ecosystem restoration and other uses. Ecosystem restoration is emphasized in Management Prescriptions 1.1 and 1.2. MP 1.1 and 1.2 was intended to capture natural community and species of conservation concern, thus moving toward restoration of the RNV for target natural communities.

Effects of No Management

All Forest land is subject to some degree to management inaction due to decision delays, budgetary constraints, social issues, appeals and inoperable or inaccessible lands. Inaction or the inability to effectively manage resources has the following effects on restoring and maintaining high quality natural communities:

- Spread of non-native invasive species
- Allows unnatural, undesirable changes in vegetation away from RNV
- Increase in fuel buildup
- Loss of species richness and abundance
- Decreased habitat for early successional wildlife species
- Structural and age class diversity of natural communities appear very similar and moves away from RNV

Likewise, management inaction can have positive effects in the following ways:

- Allows for natural succession or effects for some natural community types
- Decreases fuel buildup through modified, limited investment in wildfire suppression.
- Limits the spread of non-native invasive species for some activities
- Reduces temporary sedimentation and soil impacts to water resources for some activities
- Increases habitat for late successional wildlife species

Special management guidelines for certain management prescriptions, such as MP 5.1 for wilderness, must ensure wilderness objectives are met. While their special designations are socially and economically important, consequences of inherent inactions or management constraints can result in positive and negative effects on forest health.

Vegetation characteristics in most wilderness areas are within the Range of Natural Variability for wind and tornado damage, ice and snowstorms, and insects and diseases. However, most wilderness acreage is out of RNV for fire and the distribution/patterns of natural communities. Approved fire management plans may allow lightning-caused fires to burn in wilderness. Currently, the Hercules Glades Wilderness has an approved fire management plan. Rockpile Mountain, Irish Wilderness, Bell Mountain and Paddy Creek wilderness areas are all in The Nature Conservancy’s portfolio conservation areas identified in the Ozarks Ecoregional Conservation Assessment (TNC 2003). Only one, Rockpile Mountain, is considered the critical core for the lower St. Francois Mountains portfolio area. Prescribed burning may be needed for Rockpile Mountain and Bell Mountain wilderness areas to manage glades, woodlands and Mead's milkweed. The Regional Forester must approve the use of prescribed burning in wilderness areas.

Human-caused wildfires do occur in wilderness areas, but are often suppressed at a relatively small scale and perhaps create 1-2 percent tree regeneration per year. It is impossible to predict the amount of change that will occur due to natural events, other than fire. Vegetation and natural communities are expected to continue moving away from RNV due to processes including:

- invasion of woody species into glades,
- non-native invasive species everywhere,
- continued aging of second growth densely stocked trees,
- closure of former open and closed woodlands, and
- continued decrease in density of grasses and forbs with corresponding shifts in animal population structure associated with maturing, even-aged timber stands

Natural Areas may be managed to move toward the Range of Natural Variability according to specific management guidelines for all alternatives. These same effects as described for wilderness apply to thousands of other acres across the MTNF, which may not receive management treatments during the 2005 plan period.

Effects of Fire Management

All alternatives significantly increase the total acres treated by prescribed fire over the Plan period. Prescribed fire will be used to achieve fuels management, ecosystem restoration, and wildlife and silvicultural goals in all alternatives. Impacts from prescribed fire to the Range of Natural Variability should influence ecosystems that have evolved with frequent, low to moderate intensity fires such as savannas, open and closed woodlands, glades and fens. The application of fire should increase coverage of grasses and forbs, and species diversity where fire is applied more than once in the same area. Shortleaf pine, white oak and post oak may move toward their RNV with corresponding decreases in red cedar, black oak, scarlet oak, red oak and some red maple. These shifts should gradually occur in areas where prescribed burning is applied, perhaps taking 80 years or more where the historical dominant tree association is currently converted to another type.

Growing season fires as specified in Objective 2.2a of Goal 2.2 will be used primarily as a restoration tool, especially for grass or grass/forb fuels in open woodlands, savannas, prairies and glades as a means of reducing woody species cover for the first decade. However, other evidence does exist for the occasional occurrence of summer growing season fires, which the Mark Twain NF may want to emulate. The Mark Twain NF recognizes that growing season fires do not occur at the same given point or area of the landscape on a repeated growing season basis. Also, adaptive management implies that Forest staff will evaluate and monitor management action results, then adjust management frequencies in lieu of more rigid applications of one fire frequency interval.

Because many fire-adapted natural communities depended on historical wildfires to maintain them, a modified approach to controlling wildland fire would move portions of the Forest toward RNV. When risk is low, standards and guidelines allow for suppression activities that are the least affecting while still achieving objectives, such as allowing the fire to burn to a natural or manmade fuel break. This may increase the acres treated for purposes of restoring or enhancing natural communities while reducing fuel loads. Personnel safety may be improved by reducing human exposure to direct methods of fire suppression.

Effects of Timber Management

Timber management activities are among the tools necessary to move the Forest toward the Range of Natural Variability. Timber management activities effectively accomplish two things in moving toward desired conditions for RNV: first, they manipulate vegetation structure in terms of age class and spatial patterns to simulate RNV. Secondly, they help shift species composition to the RNV. Forestwide standards and guidelines (2-27 of the Forest Plan) state "use silvicultural systems, harvest methods and intermediate treatments to move the forest towards the desired condition." Silvicultural systems can be used in to mimic ecosystem dynamics, patterns and disturbance processes to achieve desired conditions where feasible. Which type of systems, methods and treatments are used on a particular site will be determined at the project-specific level for management objectives, natural community type, stand conditions, and the silvical characteristics of the specifies present or desired.

One of the silvicultural tools needed to move the current condition back toward the RNV is regeneration, which re-establishes characteristic natural community tree cover either by natural regeneration (natural seeding or coppice) or by artificial regeneration (direct seeding and planting). Much of the historical range for shortleaf pine, white oak, and post oak has shifted toward red oak, black oak, and red cedar.

The Mark Twain NF projects approximately 34,400 acres of regeneration cuts in Alternative 3 during the first decade for purposes of treating a variety of natural community types in MP 1.1 and 1.2. These regeneration acres were estimated using the rotation ages of the various forest types. During site-specific project analysis, the desired condition descriptions (see Table A-1, Appendix A of the Forest Plan) and standards and guidelines under Vegetation Management (pages 3-3, 3-4, 3-6 and 3-7) of the Forest Plan will provide guidance in how regeneration is used. The total regeneration acres will be applied to move current altered vegetation patterns toward more desirable conditions, particularly for woodlands and savannas. Regeneration cuts also establish the full range of habitat structure for shrubs, oak regeneration, young forests and establishment of grass/forb groundcover.

According to the Dictionary of Forestry published by the Society of American Foresters, even-aged management as practiced on the Mark Twain is actually two-aged management because of the amount of reserves. At least 7%-10% of the each regeneration harvest unit is retained in reserve trees and/or reserve tree groups (see page 2-28 of Forest Plan standards and guidelines). While the Mark Twain NF will continue to refer to clearcutting, seed tree, and shelterwood "with reserves" as even-aged management to avoid confusion, the resulting stand may be two-aged or trend towards an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes. Reserve trees include combinations of the largest, long-lived specifies (pine, white oak, post oak, etc), standing dead trees and cavity or den trees to achieve desired condition. Reserve trees may be selected to mimic age-class patterns, canopy openness and basal areas as specified for the respective natural community type. Even-age regeneration cuts may be as large as 40 acres, or even 500 acres within the Ava, Cassville, Houston, Rolla and Willow Springs units to mimic spatial patterns of characteristic natural community types as determined during project analysis.

Pre-commercial thinning and commercial thinning reduce dense stocking to achieve desired conditions for basal area and percent canopy for woodlands and savannas.

Effects of rangeland management

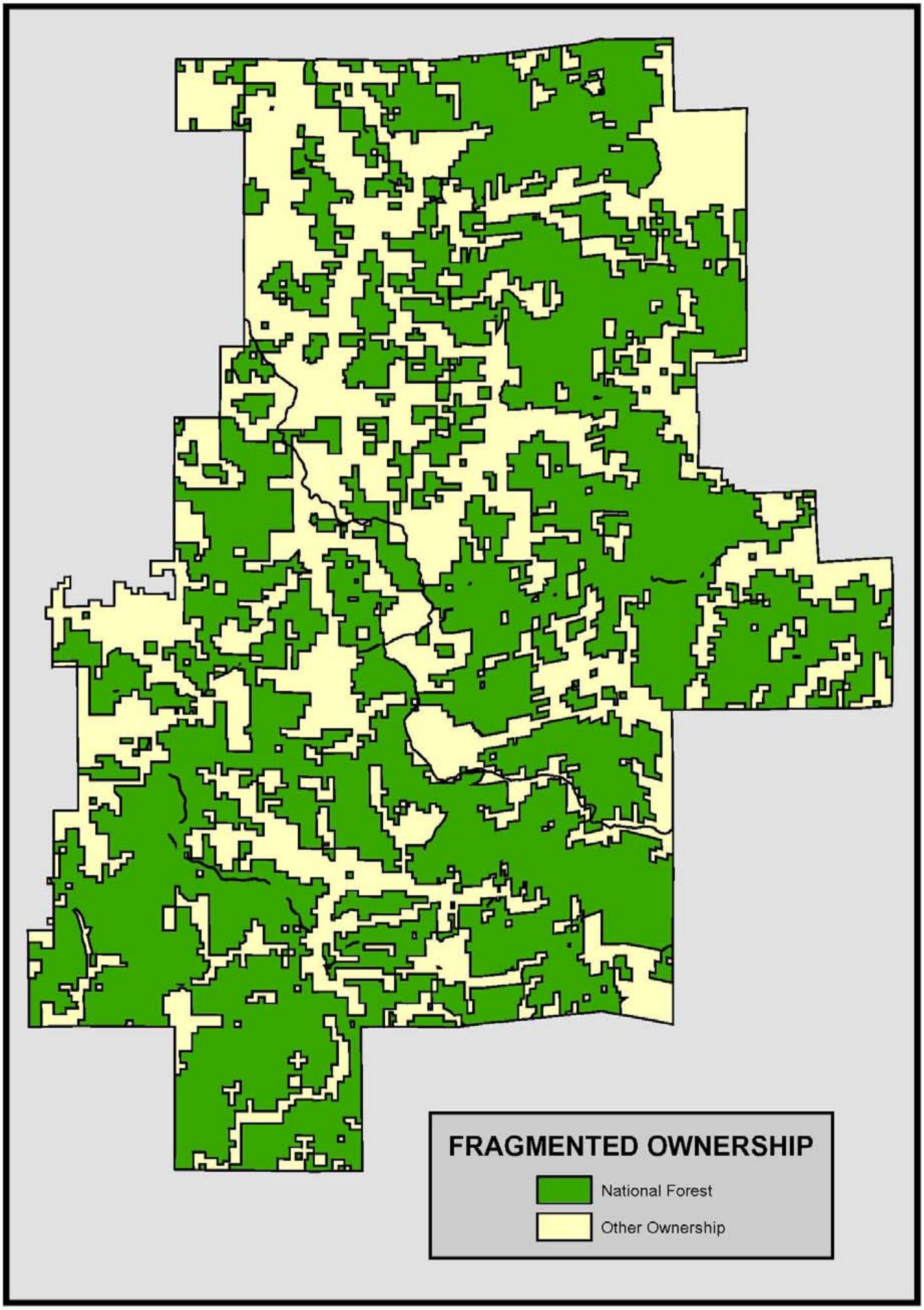
The precise original patterns for grazing generally remain undetermined. Researchers have studied the role of bison, elk and other animals in creating patch variability on savanna, grassland and woodland natural communities, particularly in conjunction with applied burning (Hartnett et al. 1996; Coppedge and Shaw 1998). Studies suggest that reintroduction of native grazers into high quality natural landscapes favors increased natural community biodiversity (Fuhlendorf and Engle 2001). However, few Missouri natural areas or other landscape areas are of sufficient natural integrity to reintroduce grazing in a way that mimics pre-settlement grazing patterns while also benefiting recovery of respective natural communities.

The single greatest problem facing the Mark Twain NF with respect to range management for natural communities is their generally poor ecological condition, despite perceptions that the appearances and presence of glades and open woodlands provides sufficient habitat for viable plant and animal populations.

The Forest has permitted domestic livestock grazing for many decades. Most glades and adjacent woodlands on the Mark Twain reflect more than a century of overgrazing pressure and range depletion. The effects from livestock grazing include soil erosion and compaction, reduction or removal of sensitive plant species, increases in non-native invasive plant species and poor water quality. Past grazing practices were thought to provide range conditions to minimize soil erosion and water quality impacts. In particular, it was thought that livestock grazing on glades would help maintain them and prevent red cedar encroachment. However, natural feature inventories and vegetation monitoring indicate that the past history of open-land overgrazing resulted in the loss of sensitive glade soils and no recovery of glade plant and animal diversity to the point that even limited domestic livestock grazing is affecting their recovery.

Effects of Ecosystem Restoration on Fragmentation

Fragmentation is the disruption and break up of natural communities into smaller areas when the former, higher quality natural community is degraded, altered or destroyed. Much of the ownership on the Mark Twain NF is fragmented in two ways. First, all of the 1.5 million acres is divided among 9 separate ranger district units, each separated by as much as 30 miles. Second, within each ranger district, Forest ownership is incomplete with many units broken and fragmented into checkerboard patterns of mixed Forest Service and private lands. (See Map “Fragmented Ownership.”)


FRAGMENTED OWNERSHIP
National Forest
Other Ownership

This fragmented condition challenges the Mark Twain NF to provide for species and natural community viability across the entire planning area in several ways. The effects, including disruption of plant and animal population dispersals, re-colonization, reduction in suitable habitat, minimum home range, and increases in edge effect (Nigh et al. 1992). In these cases, the consequences to ecosystem function and species viability for small units of land are beyond the control of the Mark Twain. Activities occurring on private lands within the Forest boundaries are generally outside of the RNV for natural communities. Two forms of fragmentation affect the historic distribution and present-day quality of natural communities:

- Fragmentation of natural communities by complete habitat conversion
- Fragmentation of natural communities by unnatural succession

The first is the actual disruption or destruction of natural communities caused by land clearing and conversion to pasture, home and building construction, roads and highways, utility corridors and large areas of non-native species invasion. This type of fragmentation is considered unnatural in that it severely impacts or destroys biodiversity and is typically outside the historic RNV.

Private land between and among the nine units of the Forest is highly altered and diverted to monocultures of cool season pasture, towns, homes, buildings, croplands, powerlines, road developments, impoundments, heavily grazed woodland and degraded forests. These privately developed lands are increasingly inhospitable to certain animal species migrations, plant species dispersals and native plant seed/fruit productivity, especially in non-native pastures. Land between these units marginally, depending upon species, serve as corridors for animal migration and plant species dispersal, except in the more naturally vegetated Current River Hills, Black River Ozark Border, St. Francois Knobs and Basins and Meramec River Hills subsections.

The second form of natural community fragmentation occurs within the Mark Twain, and is less obvious. The rather uniform, even-aged, closed canopy of a red cedar or red/black oak stand that has disrupted the former, variably open structure of woodlands and glades greatly reduces the biodiversity of both. The understory cover of grasses, forbs, shrubs and variably aged tree growth provided diverse habitat structure, cover and an abundance of forage/seeds for many plants and animals. Within the Range of Natural Variability, natural disturbance events maintained a constant, stable array of vegetation gaps and open travel corridors. Some natural gaps occurred along gradual ecological gradients, such as the effects of a fire moving over a ridge or burning late into the evening, to those that are abrupt and creating edge effect transitions such as tornado blowdowns or hot fires running on an upslope hill.

This form of habitat fragmentation, may also contribute to the erosion of genetic variation for species that once were able to move across shifting patterns of constantly changing open land natural communities, and were adapted to richer grass and forb groundcover. This isolation of populations can result in restriction of gene flow and loss of genetic variation with increased risk of inbreeding depression and genetic drift, which may increase risk of extinction. We do not know, however, how much and what type of genetic variation is most important to preserve, and efforts to date to incorporate genetics in population viability assessments completed for land-management decisions have not been fruitful. We do know that this type of habitat fragmentation across the Forest limits and isolates certain species populations. For example genetic studies linked to reduction in once widespread, fire-dependent glades, savannas and open woodlands include lichen grasshoppers, tarantulas, eastern collared lizards (Templeton et al. 2001) and Mead’s milkweed (Bowles et al. 1995). These studies compared trends in areas in which habitats were isolated by uniform vegetation structure and lack of fire to those, which are restored and managed with fire.

The creation of variable-sized age class stands resulting from silvicultural and other methods is sometimes considered another form of fragmentation. The Missouri Department of Conservation initiated a long-term forest management study in the mid 1990's to study effects of typical forest management strategies on a variety of biological resources. Preliminary results of these studies indicate that neither nest predation rates nor next parasitism rates for forest interior birds increased following silvicultural treatments. Until better information is available, the Missouri Forest Ecosystem Project studies are the most appropriate for analyzing effects of forest management in Missouri. We know that Ozark Highland natural communities historically were distributed in variable size patterns and patches of heterogeneous structure and composition (Nelson 2005). These vegetation patterns represent transitional changes between more closed forests to the east, savannas and woodlands in the Midwest (Nuzzo 1986) and the prairies of the Great Plains immediately to the west and north of the Ozark Highlands. Many wildlife species known to inhabit the early successional openings of open land natural communities (glade, savanna, open woodland, foret gaps) were likely adapted to the constantly shifting patterns of these Midwestern natural communities for hundreds of years. We attempt to maintain these patterns through timber harvest and prescribed fire on the Forest. The habitat needs of many species are provided when there is a variety of age-classes and successional stages distributed across the landscape through time. Future studies should examine how silvicultural methods, wildfire, prescribed fire and other activities mimic the historical range of disturbance events that create such openings.

Effects of Natural community restoration on non-native invasive species

Over 700 non-native plant species successfully reproduce and thrive in Missouri. Many occur on the Mark Twain NF with over a dozen posing immediate serious threats to forest health. Current non-native invasive species inventories (Non Native Invasive Species GIS maps) show that non-native plant species infestations are increasing across the Forest. Such infestations are expected to continue in all alternatives, affecting the Range of Natural Variability. Restoring RNV for natural communities should help reduce these infestations by increasing competition by native groundcovers. The amounts of projected management treatments for restoring ecosystems in MP 1.1 and 1.2 that vary by alternative should also reduce infestations in proportion to acres treated. In general, direct treatments to reduce non-native species will occur across all alternatives.

Direct and Indirect Effects

Alternative 1

Domestic livestock grazing on glades in MP 1.1 and 1.2 would be discontinued upon expiration of allotment permits. There would be three primary effects as a result of closing these allotments. First, the probable vectors for spreading serious non-native invasive plant species such as crown vetch, sericea lespedeza and knapweed would be removed. Second the likelihood of plant diversity recovery, especially sensitive species, would be improved by reducing the chance that few remaining sensitive plant populations are either trampled or browsed. Finally, the restoration of the former extremely shallow organic soil layer would enhance recovery of more mesic plant species.

In Alternative 1, prescribed burning to restore ecosystems is limited to MP 1.1, 1.2 and some portions of 8.1. Prescribed burning for purposes of treating moderate to high-risk fuel risks can be used elsewhere in Alternative 1.

No commercial timber harvests are allowed in Alternative 1. Other agencies have used non-commercial methods, like volunteer labor, prison inmate labor, court-appointed labor, contract felling and appropriated stewardship funding, for nearly 20 years to remove undesirable species and restore vegetation structure. Such methods are effective for small-scale projects, but become increasingly ineffective as areas needing treatment increase into the hundreds of acres. Cost estimates for acres treated non-commercially range from $155 to $5,500 per acre.

Alternative 1 would also employ large-scale prescribed burn units; however, limitations on silvicultural treatments and temporary road construction would result in less structural diversity and a low to moderate response by ground cover vegetation.

Slight increases in plant cover and diversity are anticipated in Alternative 1 for areas treated by prescribed burning alone. However, Alternative 1 will do little to restore desired characteristics of canopy openness, reduced basal area and habitat structure for savannas, open woodlands and glades that are presently modified by woody species invasion. Ecosystem recovery is much slower for overstocked, densely wooded stands. Ground flora recovery takes several decades compared to 5-10 years for stands in which basal areas are reduced to desired conditions through harvest, or woody species removal. This affects recovery of invertebrate and vertebrate populations, and sensitive plant species.

While projected acres treated for ecosystem restoration in MP 1.1 and 1.2 are the same in Alternatives 1 and 4, they differ in that the Forest would have to use non-commercial methods to accomplish the projected thinning, red cedar reduction and regeneration in Alternative 1 to achieve objectives. Costs would likely extend timelines for achieving the total target acres needing treatment. In the meantime, many overstocked stands would remain and delay restoration of variable stand structure and groundcover flora. Achieving the desired condition for respective natural communities would likely take more than 30 years instead of 10 years with thinning and prescribed burning treatments. This alternative would increase the trend of ecological degradation resulting from unnatural succession. Stand vegetation would increase in basal area, high canopy closure and deep fuel litter; grass/forb cover would slightly increase inside prescribed burns, or decrease in unburned areas.

No artificial regeneration is planned for Alternative 1; thus, red, scarlet and black oak would continue dominating natural communities that were once characterized by shortleaf pine and/or white, post and black oak. Moderate to severe levels of oak decline would continue. Prescribed burning alone, given the relative uniform age class structure of the MTNF, may not restore needed amounts of diverse seral stages of savanna, woodland and forest natural communities serving as early successional habitat (McCarty 1998).

Alternative 1 would prioritize ecosystem restoration within the 1.1 and 1.2 areas. If only the MPs 1.1 and 1.2 are treated, there would be an increase in oak mortality in the red oak group on the rest of the Forest. Not cutting the declining tree would likely result in a reduction of oak regeneration. Overall stocking density of the Forest would increase, growth would decrease, and stands would stagnate. Stands would grow older, but tree size would not increase for several decades until mortality opened up more growing space.

Timber would be cut only for specific ecosystem restoration objectives. Trees would be cut and left in the woods. Leaving such a large amount of timber on the ground would likely increase some insect populations, possible to epidemic proportions with unknown consequences.

Reforestation is projected to be 10,000 acres over the first decade. No artificial regeneration is planned. With natural regeneration, historic oak-pine and pine types could not be regenerated in areas where those types do not presently exist. Insect and disease attacks would be common and widespread, and a moderate to severe risk of oak decline would persist on a large part of the Forest.

Timber stand improvement treatments would be limited. No Knutson-Vandenburgh funds would be generated by commercial timber harvest. Management activities to improve forest health and species diversity with pre-commercial thinning and release would be limited to funds appropriated by Congress. The total pre-commercial thinning and release for the decade is only projected to be 2,200 acres. As a result, many overstocked stands would grow slowly and stagnate, and in this unhealthy condition, they would be susceptible to insect and disease attacks. An increase in shade and buildup of leaf litter would cause groundcover vegetation to weaken and die, reducing species diversity.

No commercial timber harvest is allowed. Intermediate thinning would require funding for the cost of felling trees. As a result, only a small amount of intermediate thinning is projected; 2,400 acres over the first decade. Stands would become overstocked and would stagnate. Forest health and species diversity would decline.

Overall, the amount of glade habitat would either remain steady (depending on fire effects) or decline due to continued red cedar invasion. Key indicator ground flora would respond marginally where existing canopy gaps occur, but would be slow to recover elsewhere. The amounts of structural/seral stages of natural community old growth and early successional stages for fire-adapted savanna, woodland and forest natural communities would be limited to only those areas where some intense fire might create them.

Alternatives 2, 3 and 4

As in Alternative 1, domestic livestock grazing on glades in MP 1.1 and 1.2 would be discontinued upon expiration of allotment permits. Alternative 2 would have the least impact on natural communities from grazing given the amount of acreage in MP 1.1 and 1.2.

While artificial regeneration, pre-commercial thinning, or release by management prescription can be used in Alternatives 2, 3 and 4 to move natural communities toward the desired future condition, there are new standards that would guide project planning and harvest stipulations to move toward the Range of Natural Variability patterns and composition for communities in MP 1.1 and 1.2.

Alternatives 2, 3 and 4 would encourage large landscape-scale ecosystem restoration projects with expanded prescribed burning units encompassing several compartments. This design would reduce natural community/habitat fragmentation by encouraging restoration of continuous, healthier groundcover flora in lieu of smaller, isolated islands of natural community habitat.

Alternatives 2, 3 and 4 allow the Mark Twain to move greater quantities of underrepresented natural communities toward the RNV desired condition for structural age-class variations, species richness and abundance, and animal communities or animal species of concern.

Indirect effects of reducing non-native invasives through ecosystem restoration are best achieved in Alternatives 2 and 3, primarily because ecosystem treatments stimulate competitive groundcover flora to occupy otherwise a barren, leaf-covered ground. Timber management activities and mechanical fireline construction may increase the spread of non-native invasives, especially sericea lespedeza, knapweed and tall fescue.

Alternative 2 expands the amount of projected management activities in MP. 1.1 and 1.2 by nearly 50% compared to Alternative 3. Commercial thinning, regeneration cuts and cedar reduction are increased in response to achieving desired condition, especially for open woodlands, savannas and glades. Alternative 4 reduces the size of MP 1.1 and 1.2 by nearly 75%.

Alternative 2, 3 and 4 would allow artificial reforestation to move vegetation toward the desired condition for natural communities. Projected regeneration activities in MP 1.1 and 1.2 are proportional to the acreage allocated to MP 1.1 and 1.2 by these alternatives.

There are no restrictions by management prescription on the use of artificial regeneration. Decisions made on planting or seeding of shortleaf pine or other species would be made on the project level. Artificial regeneration would be an appropriate treatment if site-specific evaluation determines that it would move the Forest towards the desired condition. Reforestation to historic timber types would enhance the condition of terrestrial natural communities, help restore degraded ecosystems, and move the Forest towards a healthier desired condition. The greatest amount of reforestation is projected for Alternative 4 (116,000 acres), with lesser amounts projected for Alternative 3 (112,700 acres), and Alternative 2 (109,600 acres) in the first decade.

There are no restrictions on the use of timber stand improvement, providing they help to move the Forest towards the desired condition. As a result, stands could be thinned if necessary to promote growth, forest health, and species diversity. Release treatments could free young trees from competition, and improve the health, growth and composition of forest stands. Projected acres of pre-commercial thinning and release vary by alternative. The projected acres are higher in Alternative 4 primarily due to more acres in MP 2.1, with shorter rotation ages and more regeneration, which generates more opportunity for treatments. Projected acres are less in Alternative 2 because of more acres in MP 1.1, which relies more on prescribed burning to move the Forest towards the desired condition. The projected acres in Alternative 3 fall in the middle.

Overall, an adequate amount of glade habitat and other fire-adapted natural communities in need of restoration would be provided by Alternatives 2 and 3 with the lowest amount in Alternative 4. Habitat for species requiring early successional stages within savanna, woodland and forest natural communities will increase in all these alternatives

Alternative 5

Because grazing on glades would be continued, Alternative 5 would have the greatest impact on ecosystem recovery of glades.

While Alternative 5 gives discretion for managing natural vegetative communities, it provides no direction or specific objectives to assure that such restoration activity will occur. Alternative 5 does not identify natural communities by their type for specific management, other than glades, but neither does it prevent such identification. The approach for providing wildlife habitat and vegetation diversity is addressed through silvicultural methods expressed as a percentage of timber age classes, open lands and wildlife ponds. As with the 1986 Forest Plan, there is no obligation to follow through with ecosystem restoration management activities. Using timber management to provide wildlife habitat, specific high quality areas of opportunity may be missed. Much of the current condition of the Forest reflects upon the past 18 years of action under the 1986 Plan. . Additionally, restrictions as described in the Silvicultural Treatments section under Timber Stand Improvement would constrain the Mark Twain from achieving desired condition for natural communities in those management prescriptions. Alternative 5 allows for continued expansion of food plots and wildlife ponds. Construction activities associated with building new food plots and wildlife ponds could encourage expansion of non-native invasive species. Likewise, lack of maintenance or abandonment of food plots could also cause increases in non-native invasive species.

The acreage treated varies somewhat by alternative, with the least amount of acres burned in Alternative 5.

A primary difference from the 1986 Plan is that artificial reforestation could be used to restore naturally- occurring trees and other vegetation.

Alternative 5 would restrict moving toward RNV for - natural communities dominated by shortleaf pine and other vegetation patterns as described in the silvicultural treatment section.

Alternative 5 currently encourages stand or compartment treatments on a scale ranging from several to 1,500 acres.

Management constraints or limitations in the 1986 Forest Plan include:

- No timber management activity in MP. 5.1.
- No pre-commercial thinning in MP 3.1, 3.3 or 4.2 (87,600 acres)
- No release treatments in MP 3.1, 3.2, 3.3, 6.1 and 6.2 (425,000 acres)
- No pre-commercial thinning and release treatment on 512,700 acres.
- No artificial regeneration allowed in MP 3.1, 3.3, 3.4, 6.1 and 6.2 (821,700 acres)
- Artificial regeneration in MP 3.2 for hardwood stocking only.
- Artificial regeneration of shortleaf pine prohibited everywhere except MP 4.1, or prohibited on 80% of suitable lands.
- Use of uneven-aged management in seven sensitive areas, wet-mesic bottomland forests, specialized wildlife habitats and lands suitable for timber management on the Cedar Creek District.

Alternative 5, which emphasizes eight wildlife habitat conditions, favors a more restricted number of wildlife species but does not necessarily favor recovery of ground flora abundance and populations of sensitive plant species.

Standards and guidelines restricting artificial reforestation would continue in Alternative 5 for MP 3.1, 3.3, 3.4, 6.1 and 6.2, especially for historical occurrences of shortleaf pine, white and post oak-dominated natural communities. This alternative would likely perpetuate oak decline across much of the Mark Twain National Forest.

Standards and guidelines restricting artificial regeneration are included in management area prescriptions. No artificial regeneration is allowed in MP 3.1, 3.3, 3.4, 6.1, and 6.2. Artificial regeneration is allowed in MP 3.2 only to meet high value hardwood stocking objectives, even though 3.2 is part of the historic pine range.

Standards and guidelines restricting pre-commercial thinning and release are included in some management area prescriptions. There is no pre-commercial thinning in MP 3.1, 3.3, or 4.2. No release is allowed in MP 3.1, 3.2, 3.3, 6.1, and 6.2.

This alternative would have 112,000 acres of reforestation. Most would be by natural regeneration of species presently growing on site. Reforestation to historic oak-pine by planting or seeding shortleaf pine would be prohibited on over 80 percent of suitable lands. A small amount of movement towards historic timber types would be possible by using timber stand improvement treatments and commercial thinning to favor desired species, in stands where they exist. However, an overabundance of black and scarlet oak susceptible to oak decline would continue to exist on large areas of the Forest.

Alternative 5 has a large amount of pre-commercial thinning and release in the areas where allowed. On land where pre-commercial thinning or release treatments are prohibited the following effects would occur:

- many overstocked stands would grow slowly and stagnate, and in an unhealthy condition they would be susceptible to insect and disease attacks
- an increase in shade and buildup of leaf litter would cause groundcover vegetation to weaken and die, reducing species diversity
- desirable trees in young stands overtopped by competing vegetation would grow slowly and have poor survival rates.

A large amount of intermediate thinning is planned for this alternative. Treatments would reduce stocking to increase growth and enhance forest health. However, basal areas would not be reduced enough to restore natural community types in most areas; no "restoration" thinning is planned for this alternative.

Cumulative Effects

Cumulative Effects Question

What are the incremental effects to the ecological integrity of natural communities in the context of Range of Natural Variability?

Cumulative Effects Area and Timeframe

The analysis area for cumulative effects for natural communities includes forest lands distributed across Management Prescriptions 1.1 and 1.2, and all activities on other federal, state, industrial and private lands within the Forest boundary and lands between all nine units of the Mark Twain National Forest. This analysis area encompassing these 9 units, inclusive of MP 1.1 and 1.2 stretches over 200 miles from west to east, and over 150 miles from north to south. This area roughly covers the Ozark Highlands ecological section, and a portion of the Central Dissected Till Plains section. Several ecological and biological assessments point to continued concerns regarding loss of biodiversity that is distinct to this ecoregion (Nigh 1992, Nigh 2002, Pell et al. 1999, Yatskievych 1999, Pflieger 1997, Ozarks Ecoregional Assessment Team 2003).

For purposes of analyzing the effects to biodiversity and natural communities, the timeframe selected is two decades. This timeframe is sufficient to evaluate whether projected activities are moving affected environmental elements (currently degraded natural communities) toward desired conditions assuming that aggressive management treatments commence shortly after plan approval. Further, this timeframe is consistent with monitoring and evaluation studies conducted by other state conservation agencies and non-profit conservation organizations that have examined management effects on restoring ecosystems since the early 1980's (McCarty 1998, Packard and Mutel 1997, Nelson 2005). Finally, various conservation agencies and private conservation organizations can generally assess trends in sensitive populations and threatened natural communities within this timeframe.

Past, Present and Reasonably Foreseeable Future Actions

The FEIS (Appendix D and Chapter 3, Affected Environment under Ecosystem Sustainability) explains how much of the present-day altered ecological condition resulted from a chronology of exploitation events stemming from post-European settlement. Recognizing that the ecological integrity of the Midwest was at risk and threatened with further loss, state and federal agencies formed the Missouri Natural Areas Program in 1977. Its purpose is to inventory, classify, designate and manage lands to protect elements of

Missouri's natural diversity. The program established the Missouri Natural Heritage Database in 1981. The database houses over 15,000 element occurrence records for species and natural communities of conservation concern, protected areas, semi-protected public and private lands. Twenty five comprehensive natural features inventories provided the data for the Program. Experts trained in natural features inventory methods and techniques systematically assessed the ecological integrity of respective counties, including all of the 29 counties encompassing the Mark Twain National Forest. In the context of sustaining healthy, high integrity natural communities, these programs assess the present landscape condition in context of the RNV for historic natural communities, biodiversity, natural processes and the status of plant/animal species of conservation concern. As explained in the FEIS, it was not until recent years that scientists and natural resource managers understood how their management actions affected ecological integrity in context of pre-European conditions. Thus, natural feature inventories serve as the basis from which to determine and compare the present-day status of ecological integrity as compared to the higher quality conditions that occurred at the time of European settlement. Ecosystem restoration efforts ongoing for the past 25 years help benchmark desired conditions.

The Missouri Resource Assessment Partnership (MoRAP) provided Landsat satellite imagery from which to analyze vegetation patterns across ecological subsections. These land cover images and natural features inventories show that RNV for a large part of the Ozark Highlands is significantly altered on private lands. Private ownership patterns on the Mark Twain National Forest vary significantly by individual ranger district. Significant impacts have occurred more on private lands adjacent to the Mark Twain than on the Forest itself. There is a higher occurrence of restorable, sizeable underrepresented natural communities on the Forest than on most private lands, except private lands and other public lands on portions of the Current River Hills, St. Francois Knobs and Basins, and Meramec River Hills. Because the historical disturbance processes are out of RNV on private lands adjacent to the Mark Twain, most remaining remnants will continue to degrade in quality or disappear altogether. Habitat destruction, conversion to cool season pasture, unnatural succession, deterioration of sensitive native species (due to domestic grazing, fire suppression and dense woody growth), and development are factors affecting the environment on private lands in and around the Mark Twain National Forest. Population and demographics trends provided in Table 71 and 68 further substantiate land use and development trends across the Ozarks. The number of housing units increased by 23% between 1990 and 2000 on the Mark Twain National Forest. Further medium to high changes are expected between 2000 and 2030 (Forests on the Edge, Stein et al. 2005).

The EPA and MoRAP have developed models to look at significant ecosystems (Development of Critical Ecosystem Models for EPA Region 7; Regional Geographic Initiative Report, September 2004). Relevant to assessing and evaluating the relative status and trends in ecosystem integrity, general inferences are made from the combined spatial maps of agricultural threats, land demand, conservation opportunity areas and no-conversion patches. However, these spatial datasets are limited in their ability to convey specific information on vegetation integrity otherwise assessed by on-the-ground ecologists and botanists.

The Affected Environment section of the Ecosystem Sustainability chapter outlines the effects of past land use following European settlement in the early 1800s. Various conservation assessments (see Chapter 3-63 of the FEIS) explain the present-day status of ecosystem integrity resulting from this history of land change. This chronology of change is further outlined in Nelson (2005). The most extensive past actions include over 100 years of overgrazing, fire suppression, extensive deforestation, urbanization/housing development, road building and land conversion to other uses. For example, nearly 40% of the Ozark Highlands are now covered in non-native cool season grasses, over 4% in row crops and 1% urban (Missouri Resource Assessment Partnership 1998). The Missouri Agricultural Statistics Services website shows that farming and livestock grazing remain as pressing impacts on private lands surrounding the Forest.

Whether portions of the Mark Twain move toward or away from the Range of Natural Variability for various natural communities depends on the current condition, threats by non-native invasive species and loss of species richness, recoverability and planned treatments. The general effects of various management actions (and whether the Forest actively moves lands toward desired healthier conditions) are explained on pages 3-75 through 3-79 of the FEIS. If the purpose is ecosystem restoration (MP 1.1 and 1.2), treatments are most intense and are directed at emulating historical disturbance processes. These activities move portions of the Forest toward the desired condition most rapidly and over the largest areas as proposed in Alternatives 2 and 3. Such activities may offset the negative, long-term consequences of continued ecological degradation on adjacent private lands and best meet the natural community viability criteria given in the Ozarks Ecoregional Conservation Assessment. Activities projected in MP 2.1 may favor moving natural communities toward the desired condition over the short term, but may eventually result in some loss of more sensitive species in 20 to 50 years. Areas receiving no treatment, especially in historical woodlands, savannas, glades and fens, will deviate the quickest from RNV with consequences for loss of viability for species of conservation concern and general biodiversity. The 1986 Forest Plan does not provide much proactive direction for ecosystem management, nor do the management prescription purposes match actual ecological conditions and needs. Additionally, any activity or threat spanning decades that does not recover natural community health will likely favor disease, non-native invasive species and eventually irreversible loss of species diversity.

The relative amounts of projected management activities, directed at restoring RNV for terrestrial natural communities, must be to mimic disturbance regimes for many decades beyond the Plan period. Desired RNV conditions for natural communities will take 10-30 years to restore groundcover and more than 100 years to restore the structural, mixed age class composition of trees and shrubs. Budget constraints may restrict how much is achieved during the Plan period, and require that large-scale ecosystem restoration efforts take up to 30 years to initiate in stages. Gains in species diversity and recovery of plant and animal populations of conservation concern may occur as natural communities are recovered on a scale sufficient to meet species needs. In contrast, losses in species richness may reach critical thresholds for those lands yet to be treated or due to factors beyond the control of the Forest.

Other conservation initiatives are in place from which to strategically plan and execute similar ecosystem restoration efforts. The Comprehensive Wildlife Strategy (CWS) is a federal/state-coordinated wildlife grant program that targets species and natural communities of greatest conservation need. The Missouri Department of Conservation is coordinating a statewide effort for agencies, organizations and conservation individuals to meet and develop local conservation plans focused on concentrated opportunity areas where constellations of species of concern and natural communities still occur. Management Prescriptions 1.1 and 1.2 are integral opportunity areas in this process. The Mark Twain National Forest does not know yet to what extent actions resulting from these planning initiatives will contribute toward restoring natural communities. These conservation opportunity areas for the most part occur on other state and federal lands, but do include some private lands. Examples of present actions include restoration of pine woodlands on Peck Ranch Conservation Area near Eleven

Point Ranger District, glades on Caney Mountain near the Ava Ranger District, Restoration of glades at Roaring River State Park adjacent to Cassville Ranger District and igneous glade/woodland restoration at Taum Sauk Mountain State Park near Potosi Ranger District. However, most of these restoration projects fall outside of the otherwise distinctive conservation portfolio areas identified by The Nature Conservancy. In many cases, only the Mark Twain National Forest exclusively contains opportunities for ecosystem restoration in select portfolio areas.

Conclusions

In summary, the Ozarks Ecological Conservation Assessment (OECA) has identified 5.26 million acres across the Missouri Ozark Highlands with the purpose of maximizing the aggregate viability of distinctive natural communities and target plant and animal species in 25 terrestrial portfolio sites (12 of which cross the MTNF). Of this acreage, a low of 125,745 to a high of 663,810 acres (438,393 acres for Alternative 3) in Management Prescriptions 1.1 and 1.2 encompass these portfolio sites. This OECA assessment, along with information provided by the Missouri Resource Assessment Partnership (MoRAP) and through the Missouri Department of Conservation’s Comprehensive Wildlife Strategy (CWS), are developing conservation approaches that would most efficiently conserve viable examples of globally significant biodiversity features.

Additionally, the Missouri Department of Conservation is completing 18 Conservation Opportunity Area (as part of CWS) profiles for the Ozark Highlands with an additional 18 planned in the future. Each COA profile includes goals, objectives, active and projected ecosystem/habitat restoration projects, funding sources and timeframes for project implementation. This initiative includes the portfolio and the Mark Twain NF’s Management Prescriptions 1.1 and 1.2 boundaries.

Appendix E (Representations of Terrestrial Natural Communities in the Missouri Natural Heritage Database and Missouri Natural Areas System; Nelson 2005) provides statistical report totals for occurrences of high quality managed natural communities statewide occurring on public, non-government organization and private lands. While the numbers are statewide, most of the acres likely occur in the Ozark Highlands given the regions relative degree of naturalness. The report summary indicates 1,923 Heritage occurrences with 28,127 acres in Natural Areas, 86,593 acres on public lands and 44,367 acres on private lands. This represents less than 0.3% of the state’s acreage. Each area occurrence ranges from less than one acre to a high of 7,028 acres. Many areas are relatively small (less than several hundred acres) and widely dispersed across highly fragmented ecoregions.

Appendix E shows that 9,557 acres within Natural Areas, 17,930 acres on public/non-governmental and 4,249 acres on private lands count toward protection of Missouri woodland types; only 571 acres of savanna types; and 11,620 acres of glade complexes statewide. The summary indicates that adequate representation is not close to being accomplished. The Appendix E summary from the Natural Heritage Database may not count all present acreages being actively restored. These include stewardship sites on Missouri state parks, conservation areas and private lands. No summation of projected or planned ecosystem restoration activities currently exists although CWS may provide the means of summarizing overall objectives for the Ozark Highlands. A range of 97,411 to 149,189 acres of various natural community types are projected for treatments on the MTNF during decade one in Management Prescriptions 1.1 and 1.2. The Missouri Department of Conservation, Missouri Department of Natural Resources and The Nature Conservancy are actively restoring underrepresented, fire-adapted woodlands and glades throughout the Ozarks. Desired conditions are at the early preliminary restoration stages, and acreages likely total less than

100,000 scattered in smaller sites throughout the Ozarks. This acreage figure may double in the next decade, depending on the success of implementing CWS Opportunity Area projects. In the meantime, public and private lands not actively managed to restore ecosystems will continue moving away from the range of natural variability, subject to continued population growth, agricultural/deforestation fragmentation, exotic species invasion, overgrazing and loss of species diversity.

Wildlife Habitat Management

Introduction

Proposed Changes

Natural community restoration: moving toward range of natural variability

The Mark Twain National Forest is combining seven formerly separate management prescriptions (MP 2.1, 3.1, 3.2, 3.3, 3.4, 3.5, 4.1) into three (MP 1.1, 1.2 and 2.1) with an emphasis on ecosystem restoration (MP 1.1), ecosystem restoration and dispersed recreation in a semi-primitive motorized setting (MP 1.2) and enhancement of natural communities (MP2.1). This ecological approach is intended to view the landscape in the context of restoring forest health and ecological integrity for a greater portion of the Mark Twain rather than having separate groups of land allocations with different natural community or wildlife emphases or standards. Standards and guidelines for these management prescriptions provide for management to mimic key ecosystem components, structures and processes appropriate to the historic range of natural variability known for respective natural communities.

The assumption behind range of natural variability is that restoring and maintaining landscape conditions within distributions that organisms have adapted over time is the management approach most likely to produce sustainable ecosystems (Manley et al. 1995, Baydack et al. 1999). With respect to wildlife, the earlier discussion regarding range of natural variability for ecosystems provides insights into the broad range of natural communities (Nelson 2005), their historical patterns and wildlife and plant habitat requirements. There is a need to examine our traditional tools—such as timber harvest, exotic species control, brush removal, and prescribed burning—for their usefulness in restoring or enhancing ecosystems to accomplish wildlife management objectives. There is much new information on the classification, characterization, location, ecological condition, and specific management prescriptions needed to restore and maintain natural communities.

A significant change includes the creation of Management Prescriptions 1.1 and 1.2 as a means of efficiently targeting conservation of Missouri’s globally significant biodiversity as identified in the Ozarks Ecoregional Conservation Assessment (TNC 2003). These prescriptions provide direction for determining a range of acres by ecological subsection in which to start ecosystem restoration activities over the Plan period. Ecosystem restoration activities are guided by desired conditions for various natural community types and specified descriptions of natural communities associated with various subsections (Appendix A of the 2005 Forest Plan). The 2005 Forest Plan allows for a wide range of management activities to meet these desired conditions, especially for underrepresented natural communities. The Mark Twain may use modeling of ecological landtypes, natural communities and landtype association groups for purposes of conservation planning and project implementation

Eliminate age-class wildlife management objectives

A significant change proposed will continue providing the habitat variations currently based on creating various age class and open land stands, but in different ways. Major changes include setting desired conditions for managing a range of variability in structure, composition, basal area and ground cover characteristics for natural communities in Management Prescriptions 1.1 and 1.2.

Native grasslands and artificial openlands

Natural grasslands are glades, native prairies, and seeded/planted native grass on appropriate sites where the historic range of natural variability was former grassland. Artificial openlands are old fields, abandoned non-native and highly degraded pastures, cool-season pastures, food plots and warm season plantings outside the range of natural variability for the historic vegetation. Artificial openlands maintained or improved would not exceed the current amount within the Forest boundaries, unless future acquisitions would include these types of habitats.

Since the definition of natural grasslands and artificial openlands is somewhat different from the 1986 Plan definition of open and semi-open habitat, that amount of acreage between Alternatives 1-4 and Alternative 5 will be quite different.

Native grasslands and artificial openlands are important to wildlife species, especially early successional and select game species. The Mark Twain will manage within the limits of what artificial lands that already occur on the Forest, or any additional open lands acquired through purchase with emphasis on maintaining or restoring native grasslands.

Regeneration

According to the 1986 Plan, stands could be regenerated based on growth of select tree species without considering the desired conditions for site appropriate natural community types. The maximum amount of suitable land to be regenerated was set as that necessary to meet wildlife habitat objectives. Under the 2005 Forest Plan, regeneration cuts would consider natural community characteristics including retention of 7-10% of the harvest unit in reserve trees, including combinations of the largest, long-lived tree species appropriate to the local site, standing dead trees and living cavity or den trees.

Standards and guidelines would also place increased emphasis on moving the Forest toward desired conditions for natural communities through restoration of spatial patterns of vegetation patches and age classes (Appendix A of the 2005 Forest Plan). For example, the size of restoration cuts may range as large as 500 acres in the Ava/Cassville/Willow Springs Ranger District to mimic the historical range of large patch glade/open woodland complexes known to occur in the White River Hills Subsection. Ecosystem restoration should encourage well-distributed habitat, ecosystem function (mimicking disturbances), and greater connectivity between associated ecosystems, especially in MP 1.1 and 1.2.

Early successional habitat criteria

Early successional habitat is any stand of trees less than 10 years old, created by natural or human-related disturbances. It is generally a natural structural stage of a savanna, woodland or forest natural community containing dominant or characteristic herbaceous plants (see glossary).

All even-aged regeneration harvests shall retain a minimum of 7%-10% of the harvest unit in reserve trees and reserve tree groups, which should include a combination of:

- The largest, long-lived species occurring on the site (pine, white oak, post oak, hickory, black gum),

- standing dead trees,
- cavity or den trees

Reserve trees and reserve tree groups should be spaced to mimic natural community structure and composition.

Reserve tree groups should include a combination of at least 5 trees. Where opportunities permit, locate some reserve tree groups within drainages.

Downed woody material should be left on site whenever possible.

Old Growth

One of the key habitat components to support the range of native terrestrial wildlife species is old growth habitat, which includes large, old trees, downed material, snags, varying structure. Few areas in Missouri have trees older than 50-75 years and most virgin forests were cut in the early 1900’s (MDC 1986). Some old stands greater than 2 acres with groupings of trees surviving major logging since European settlement (over 175 years old) still exist on the Forest.

Old growth incorporates the range of natural variability of forest, woodland and savanna natural communities. The desired condition characteristics are based on canopy, presence or absence of midstory and understory, ground layer, age-class distribution, presence or absence of snags and/or down or decaying woody debris and fire effects (Appendix A of the 2005 Forest Plan). The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to natural community type, local site conditions and the ecological disturbance factors (wind, fire, insects, ice storms).

Regardless of the natural community type and its structural variation, stand age is a critical element in moving toward old growth conditions. Tree species longevity applies to those late stages of a tree’s lifespan in which certain desirable structural characteristics appear long after a tree’s economic rotation age (i.e., crown structure is stabilized, heart rot increases creating hollow bole and limbs, limbs lost due to weather events and lightning, large size). These characteristics begin appearing at or after rotation ages for select tree species. Old growth forests, woodlands and savannas are stands of mature trees that are 100 years old or more. Efforts should be made to designate permanent old growth on sites currently exhibiting characteristics of desired natural communities and within the range of natural variability.

Certain forest and some closed woodland natural communities historically developed relatively free of stand or understory replacement disturbances over a long period of time. In the absence of moderately intense, frequent fires or other major disturbances, these natural communities contained a high number of snags, downed decaying logs of various sizes and shapes, multiple canopy layers and a diverse herbaceous layer on deep organic litter. Some of these forest and woodland natural communities were subject to more frequent stand replacing disturbances. Events including storm downbursts, long interval stand replacement fires, tornado damage, ice and snowstorms and insect damage change the understory, subcanopy or canopy.

Savannas, open woodlands and some closed woodland natural communities exhibit different old growth characteristics resulting from the effects of moderate to high frequency, but low intensity fires. Long-lived trees are still present, but vary in age class distribution and canopy openness. Shrubs, regenerating tree species, grasses and forbs dominate the ground layer replacing the deep leaf/organic layer typical of other types of old growth. Snags and some downed woody material occur but are not as prevalent as in the other types. Old growth in fire-dependent forest types may not differ from younger forests in the number of canopy layers or accumulation of down woody material.

As described in the Physical and Biological Setting section, the chronological sequence of land use changes resulting from post-European settlement created conditions falling outside the range of natural variability for old growth natural communities. Most natural communities, following exploitation of timber and grassland/forage resources, were allowed to undergo succession regardless of their past or present condition. Portions of the Forest formerly occupied by savanna, prairie, open and closed woodland and glades unnaturally moved outside their RNV without restoration and management. This type of old growth often results in decreased diversity of those species once characteristic of the historic natural community, and an increase in generalist species adapted to disturbance-free old growth characteristics. Old growth at the limits of or outside of RNV occurs across much of the Forest in stands that currently meet the age class definition of old growth and which differ in composition and structure from the historic range of natural variability.

Management direction in the 2005 Forest Plan provides for representation of various old growth stand types as outlined in Appendix A of the 2005 Forest Plan for MP 1.1 and 1.2. Further, management activities may be distributed across the landscape to mimic historical vegetation patterns and provide for quantities of old growth natural communities. Emphasis is given to treating under-represented natural communities as described in Appendix A of the 2005 Forest Plan for each individual Management Prescription 1.1 and 1.2 areas. Additionally, the plan directs the Mark Twain NF to inventory Forestlands for stands in excess of 175 years old (i.e. those essentially missing any logging activities since European settlement). Several stands in excess of two acres or more do occur.

The determination of a stands' status as old growth will be based on age of large trees, past disturbance (including fire), basal area, tree size or DBH of large trees, stand density and number of standing snags and down logs per acre (USDA Forest Service 1997).

For a stand to be considered old growth, only minimal evidence of past human disturbance which conflicts with the old growth characteristics of the area should be evident. Recent vegetative management, which maintains or moves the stand toward old growth characteristics, including thinning and prescribed fire, would be allowed. Nowacki (1993) indicates that fire and its frequency are important in the disturbance regime for most old growth forest community types in southern Missouri. Field inventories to identify stands with old growth characteristics are needed.

Healthy Forest Initiative (HFI) and Healthy Forest Restoration Act (HFRA) for Old Growth

The Healthy Forest Restoration Act (HFRA) requires that when the Forest Service uses HFRA authority, they will "fully maintain, or contribute toward the restoration of the structure and composition of old-growth stands according to the pre-fire suppression old-growth conditions characteristic of the forest type, taking into account the contribution of the stand to landscape fire adaptation and watershed health, and retaining the large trees contributing to old-growth structure." (USDA and USDI 2004)

The direction identified in the 2005 Forest Plan for identifying desirable old growth sites, designating permanent old growth stands, and retaining old growth characteristics, including structure and composition, complies with the HFRA.

Issue - Wildlife Habitat Management

There are different views about how the Forest should be managed for the full array of wildlife species and habitats, whether rare or common, and what habitats and species should be emphasized. Forest Plan revision will establish goals for the types, amounts, distribution, spatial pattern, and function of wildlife habitats.

Key Indicators

Acres of natural community savanna, woodland and forest meeting desired condition for old growth natural communities.

This indicator highlights the differences between alternatives because the changes in acres of savanna, woodland and forest natural communities (MP 1.1 and 1.2) treated. This gives an indication of old growth natural communities acres, thus providing support for viability for those species requiring old growth habitats. Acres treated in various ways could help restore structural aspects of old growth natural communities.

Table 14 - Key Indicators for Old Growth Habitat

Key Indicator	Units	Current Condition	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5*
OG Natural Communities Types Treated in 1st decade	Range of Acres	n/a	24,200 to 37,200	125,900 to 193,900	83,400 to 128,400	24,200 to 37,200	0
Natural Community Old Growth in 50 years	Acres	n/a	5,400	36,700	24,500	12,100	<5,000
Natural Community Old Growth in 100 years	Acres	n/a	10,800	73,500	49,000	24,200	< 10,000

** Acres for Alternative 5 are based on reforestation to historic oak-pine, limited to less than 20% of the suitable land and minimal treatment for restoring stands and creating natural community old growth.*

Affected Environment

The Ozarks Ecoregional Conservation Assessment, Missouri Biodiversity Report, Ozark/Ouachita's PIF Bird Conservation Plan, Terrestrial Natural Communities of Missouri and Ozark/Ouachita Highlands Assessment—all point to the problem of declining plant and animal populations resulting from habitat loss and current vegetation conditions existing outside the range of natural variability. The consequences of change resulting from post-European settlement (Ecosystem Sustainability-Affected Environment), is a chronic Forest-wide problem for many species, especially those associated with grass/forb dominated woodlands, savanna and glade complexes, and forest interiors.

Historic Condition (Range of Natural Variability)

Habitats are areas within natural communities where physical and biological elements provide a suitable environment for the food, water, cover, breeding, roosting shelter, wintering and space resources needed for plant and animal livelihood. Prior to European settlement, natural communities were characterized by species richness, abundance, diversity, the presence of native herbivores, large predators and relatively intact soils. Interactions and functions of plants and animals were bound by an abundance of flowering forbs and grasses, hard mast-producing oaks and hickories interspersed in patterns and sizes ranging in the tens of thousands of square miles. The expansive cover of flowering and seeding herbs provided abundant food and cover for thousands of invertebrate species, many which were uniquely adapted and confined to one or several of the hundreds of plant species. Beilmann and Brenner (1951) credit the abundance of wildlife at the time of European settlement to highly productive open woodlands covered in seed and fruit-bearing grasses, wildflowers, open-grown oaks and shrubs—all linked to the replenishing influence of fire. Likewise, this insect abundance provided forage for huge numbers of birds, small mammals, reptiles and amphibians.

Current Condition Compared to Range of Natural Variability

Over 700 wildlife species (birds, mammals, amphibians, reptiles and fishes) occur in Missouri. About 670 species occur within counties containing Mark Twain National Forest lands. However, the presence, abundance, distribution patterns and viability of many species in the Ozark Highlands have changed since the time of European settlement as follows:

- Historical exploitation of animal populations by trapping, hunting and habitat destruction has extirpated the passenger pigeon, Carolina parakeet, red-cockaded woodpecker and ivory-billed woodpecker from Missouri.
- While still present elsewhere, viable reproducing, free-roaming populations of golden eagle, red-cockaded woodpecker, gray wolf, mountain lion, bison and elk are now absent in the Missouri Ozark Highlands.
- Game species including white-tailed deer, beaver, river otter, wild turkey and black bear were exploited during settlement for food, sport and fur, with their numbers initially reduced to critically low levels.
- Systematic clearing and logging of forests and woodlands from the late 1800's to the early 1900's led to initial expansion of open shrublands and barrens thereby increasing bobwhite quail and eastern cottontail rabbit populations. Subsequently, these numbers have declined below historical levels due to more intensive land use, especially conversion to cropland, exotic pastures and dense second growth, overstocked woodland.
- Subsequent conservation measures have resulted in population expansion of generalist species perhaps beyond the capacity of historical ecosystems including white-tailed deer (Rooney et al. 2003) and wild turkey (except in select Missouri counties).
- The Missouri Department of Conservation is directly responsible for managing and regulating wildlife population numbers for many mammal, bird, fish, reptile, and amphibian vertebrates with varying success. Current wildlife numbers may not coincide with historical numbers due to social issues, like poaching, anti hunting and trapping, impractical controls in urban areas, irreversible habitat loss, etc.
- The black bear is successfully breeding and expanding its range across the Ozark Highlands, but is below its historical population numbers and area range.
- Limited sightings and road kills have verified the presence of a few mountain lions in Missouri, but they are not known to be successfully breeding anywhere in the state.
- The abundance of invertebrate and vertebrate species associated with the former high biomass and species richness of woodland, savanna, prairie and glade groundcover is reduced due to widespread overgrazing and fire suppression. The list of invertebrate species of conservation concern continues to grow as additional research continues (Ballard and Greenlee 1996).

- Non-native feral hogs occur on portions of the Forest and are causing ecological damage, especially in wet-mesic to wet bottomland forests, small springs, fens and acid seeps.
- Native fish and aquatic vertebrate/invertebrate population structure, abundance and diversity is modified for many streams and rivers, especially those with competing populations of non-native trout or other stocked native fish species. We do not know what specific effects or impacts non-native fish species might have on native vertebrate or invertebrate populations.
- The current patterns, amounts and distributions of remaining damaged natural communities do not mimic their historical patterns; therefore, the abundance and distribution of wildlife species have shifted as a result. Many wildlife species associated with open land and early successional habitats have decreased while those adapted to late successional forest have increased.

Early Successional Habitat

Early successional or seral habitats are created by both natural and human-related disturbances, creating diversity across the landscape, providing habitat for numerous species (Thompson and Dessecker 1997). Foraging and nesting activities are directly affected by the distribution and abundance of early successional forests (Trani et al. 2001). Early successional species such as Bachman's sparrow, northern bobwhite, prairie warbler, bobcat and woodcock are declining in population, paralleling declines in early successional habitat (Trani et al. 2001). Ninety-five of the 187 neotropical migrant birds which breed in the Midwestern United States use shrub-sapling or young forest habitats. Approximately 1/3 of those species are declining in population (Thompson and Dessecker 1997). Early seral habitats are especially important to indigo bunting, eastern towhee, yellow-breasted chat and ruffed grouse.

Currently, the minimum viability standards and Desired Future Conditions (DFC) for the 1986 Plan are not being met for early successional habitat. There are approximately 37,000 acres or 2.5% of the Forest in early successional habitat. However, in 1999 and 1989, there were an estimated 65,100 acres (4.3%) and 97,000 acres (7.3%), respectively, of early successional habitat on the Mark Twain NF (USDA Forest Service 1999f). This represents a 42% to 66% reduction of early successional habitat on the Mark Twain in the last 15 years.

Native Grassland and Artificial Openland Habitat

Grasslands with native species and artificial openlands cover about 3 percent of the Forest. Grass and grass-like species commonly found in many of the converted artificial grasslands include both warm-season and cool-season forbs. An estimated 1,500 acres of prairie historically occurred on the Forest, maintained primarily by fire and grazing. Today, only a few acres remain on the Cedar Creek unit. Most other former prairie sites recorded in the land surveyor notes are highly degraded and would require high dollar investments to reconstruct. Native grasslands on Mark Twain NF include native warm-season grass fields and glades. Artificial openlands include non-native cool-season grass fields. Using the 1986 Forest Plan definition, there are approximately 151,000 acres of open and semi-open habitat.

Some of these open, grassy areas are extremely small in size (i.e., 0.05 acres), and do not provide habitat for the Henslow's sparrow or other sensitive species, which benefit from patches greater than 5 acres. Some species, such as the hooded warbler are found primarily in patches < 1 acre (Thompson and Dessecker 1997). Existing grassland areas on the Forest vary in size from less than 1 acre to over 200 acres in size. Artificial openlands range from less than 1 acre to over 150 acres in size. There are over 290 species in Missouri that use grasslands and openlands (MDC 2004a).

Many of these grasslands and openlands were originally private pastures or croplands, and may not be ecologically suitable sites. Approximately 35% of artificial openlands are currently within Riparian Management Zones (RMZ) or Watercourse Protection Zones (WPZ); approximately 15% of natural grasslands are within the RMZ or WPZ.

Old Growth Habitat

Old-growth forests provide important habitat conditions and serve as source areas for certain plant and animal species. They also help maintain stable, productive soils and high quality water; provide unique sites and opportunities for research studies; and serve as reference sites for monitoring the effects of forest management practices, air pollution, and other environmental change factors. Native Americans, as well as other members of the public, also attach spiritual and aesthetic values to old growth. In addition to providing a wide array of wood resources, they provide a setting for many Missourians to pursue their recreational interests, whether they involve sporting ventures like camping, hunting and fishing, or more ‘non-consumptive’ activities such as hiking, bird watching, or enjoying forested settings.

Within the Mark Twain National Forest’s land base, about 13,600 acres of trees are older than 150 years, and only 3,300 acres older than 175 years (CDS database). Currently, limited management is occurring to achieve old growth characteristics. The larger the area, the more likely that species requiring interior habitat rather than edge habitat will be present. Additionally, an area should not be isolated from National Forest System Land nor in areas known to be old pine plantations in order to be permanently designated old growth.

The existence of old growth on the Mark Twain NF has not been confirmed through field inventories across the Forest, although some stands do meet the age criterion. The Forest did not manage any areas specifically for old growth conditions under the 1986 Plan. However, stands were designated as future old growth. Future old growth consists of any area managed in such a way that old growth characteristics will tend to prevail in the future and across a large spatial scale. These areas may include natural areas, wilderness areas, Wild and Scenic River corridors, Table Rock and Lake Wappapello buffer zones, and bat cave areas.

In these locations, few improvements exist or are planned, and vegetation management is limited primarily to benefit habitat or to improve the condition for which the area was established. Manipulation in these areas is limited. Stands of trees will likely not be harvested, a wide range of tree sizes may exist, snags and logs often remain, interior-dependent species may use the area, and other characteristics of old growth will be evident.

It can require 100-250 years for stands within different natural communities to develop old growth characteristics in Missouri under natural conditions (MDC 1986).

The current characteristics and amount of old growth on the Mark Twain is difficult to estimate because of the changed old growth criteria between 1986 and the present. The Forest does not have an inventory of old growth habitat based on stand structure and tree characteristics. However, existing stand data can be used to provide an evaluation of existing old growth and effects to old growth based on stand age and size density.

Late successional forest stands have some of the characteristics of old growth and provide many of the functions of old growth. Late successional forest can be considered to be represented by stand condition 4 (mature), animal habitat type (AHT) 23-31 (mature and old growth pine, oak-pine, and mixed hardwoods), stand density of 8 and 9 (sawtimber at 40-69% and 70+% stocking levels, respectively).

Many forest types will be evaluated for late successional/old growth potential using data from the CDS database.

In Missouri, approximately 270 wildlife species use old growth and over 80 of these species are heavily dependant on old growth and its environment (MDC 1986). Old growth attributes important to wildlife include large diameter trees, dens and cavities in trees, standing snags, multi-layered vegetation structure, dead and down woody material, herbaceous vegetation and tall canopy.

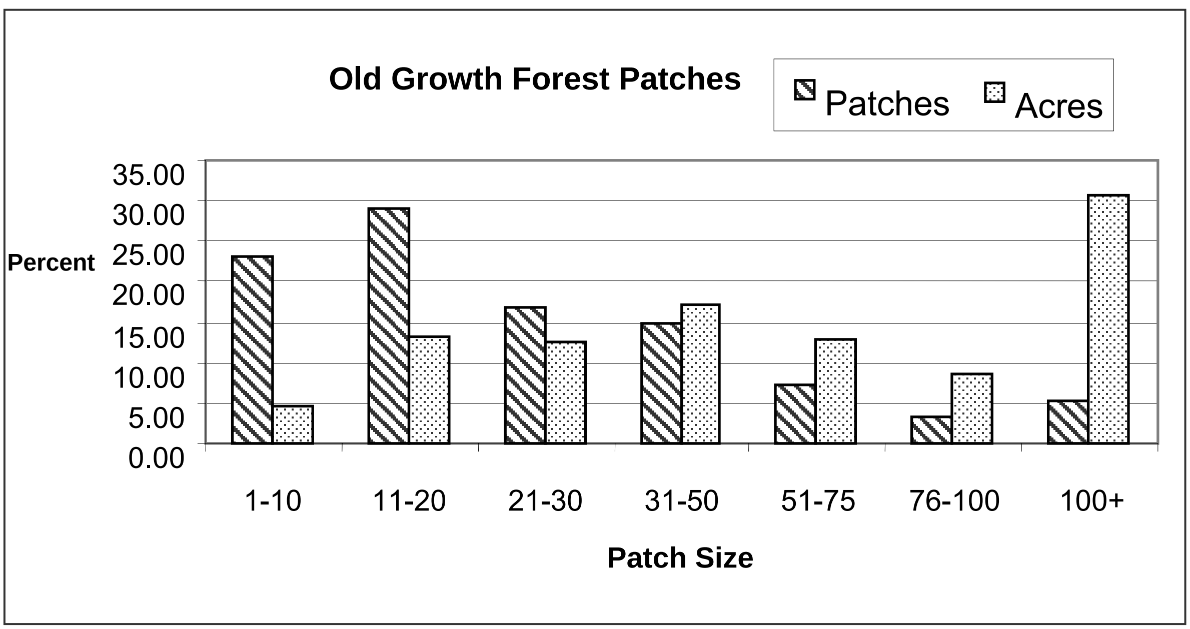
Large downed logs provide essential habitat for many species and contribute to attributes and functional features of most later successional and old growth habitats. Species including tiger salamander, slimy salamander, skinks, gray tree frog, ovenbird and Louisiana water thrush require dead and down woody material for part or all of their life requirements. Large old trees and snags in open woodlands and savannas provide nesting and roosting habitat for bluebirds, red-bellied woodpecker, fox squirrel and broad-winged hawk.

About 33% of the forested acres on the Mark Twain National Forest, are late successional forests. These are composed of forests 80 years and older. It will change in the future as younger forests mature and move into the late successional structural stages and as natural and human-caused disturbances move some of these late successional forests into younger structural stages.

Approximately 8% of the forested portion of the Mark Twain is at old growth age; distribution is also an important consideration. Late successional and old growth forest are well distributed across the landscape.

Old growth patch size was analyzed using GIS. Old growth patches are defined as connected old growth stands of all cover types. Results of this analysis are displayed in Figure 33.

Figure 33 - Old Growth Forest Patches



Source: ARC/Info, GIS

The data shows that there are many more small patches than large patches. Over thirty percent of old growth acreage is in large patches (>100 acres), whereas, over 50% of the old growth polygons are 20 acres in size or less.

Environmental Consequences

Effects Common to all Alternatives

Continued existence

All alternatives are intended to meet the minimum viability needs of wildlife and plants. Each alternative allows management to maintain viable and well-distributed populations and habitats by ensuring that environmental conditions are present in quality, quantity, distributions and spatial patterns that adequately represent the range of natural variability for appropriate natural communities. The 2005 Forest Plan acknowledges that well distributed populations and habitats cannot always exist for some rare, disjunct, localized species or species that depend on a narrow habitat or niche, or species in which the existing population status is tenuous and beyond the ability of the Mark Twain to affect. It is not possible to determine a single, fixed population size above which a species is viable and below which may be extirpated from an area. Habitats and sensitive population numbers in many areas may already be low, stable or increasing. Consequently, any future viability estimates may be expressed as likelihood, with associated measures of uncertainty.

Well distributed

The term “well distributed” must be applied differently depending on the historic population structure of the species being considered. For some species, a well-distributed pattern is one which a species is evenly distributed across the landscape. Examples may include the gray squirrel, raccoon, white-tailed deer and wild turkey. However, many Ozark species are local endemics, globally rare, declining or highly isolated. For these species, the concept of well distributed must be based on the species natural history, present status, habitat conditions, external threats and historical distribution. For these species, it is often not possible, practical nor desirable to manage for broadly or evenly distributed habitat. Examples include Mead’s milkweed, wood frog and Bachman’s sparrow.

Important desired conditions for natural communities should improve habitats for many plant and animal species. Each alternative varies in the amounts, quality and distributions of natural community or habitat types. All alternatives include key objectives for diverse natural community variations that provide for the minimum range of natural variability. Emphasis is placed on restoring a wide range of distinct natural communities that are currently damaged or reduced in size and distribution across the Forest.

Management activities complimenting the ecosystem restoration approach would create a wide diversity of structural habitats and plant species abundance in MP 1.1, 1.2 and portions of 8.1. The Forest Service both directly and indirectly affects wildlife population numbers, diversity and species viability through the active or passive management of habitat.

Certain management practices would remain the same, including maintenance and some new construction of food plots, wildlife ponds, artificial open lands and select silvicultural practices. Their effects on most wildlife species are expected to remain as they have for existing wildlife. Food plots tend to increase or attract generalist wildlife game species. Maintenance of existing wildlife ponds should continue providing watering needs of migratory waterfowl, breeding sites for aquatic invertebrates and vertebrates including ringed and tiger salamanders.

New Forest-wide standards and guidelines would place a greater emphasis on managing for desired conditions for site-specific natural communities. If prescribed burning is expanded, regardless of alternatives selected, then wildlife associated with fire-mediated natural communities would be expected to increase at the expense of wildlife that now inhabit fire-suppressed conditions.

Management constraints, especially inaction, will tend to decrease species diversity for damaged savannas, open woodlands, fens and glades. Shifts in wildlife associated with early successional habitat to late successional habitat will continue. Populations of invertebrate species associated with open, grass/forb-dominated natural communities will remain low or decline.

The total amount and proportions of natural community types will differ between alternatives and are dependent on the amount of land allocated to various management prescriptions, specifically for ecosystem restoration and other uses. Ecosystem restoration is emphasized in Management Prescriptions 1.1 and 1.2, but varies by amount across each alternative, except Alternative 5, which does not include MP 1.1 and 1.2.

There is a need for development of management techniques that mimic historic disturbances, taking into consideration spatial scales, relationships to landform, historic vegetation, and variability for structure and composition for distinct natural communities.

Oak Decline and Early Successional Habitat

About 400,000 acres of MTNF are at severe to moderate risk of oak decline. In all alternatives, it is likely that at least some portion of these areas would be affected to some degree by oak decline, and result in small to large areas of dead and dying trees. It is impossible to predict how much area would actually be affected and to what degree.

Response to catastrophic disturbance is allowed in all alternatives, and all management prescriptions with the exception of Wilderness (Management Prescription 5.1). In areas where salvage regeneration cuts are made, additional early successional habitat would be made available. In areas of oak decline where intermediate salvage harvests occurred, there would be small gaps in the canopy suitable for species such as hooded warbler. In areas of light to moderate oak decline, some areas may not be salvaged, but would be allowed to naturally succeed. In these areas, some early successional habitat would be present in the canopy gaps where trees naturally died. The amount of all these areas that would contribute toward early successional habitat objectives would be determined during site-specific project analysis.

Direct, Indirect and Cumulative Effects

Early Successional Habitat

Effects Common to all Alternatives

Creation of early successional habitat either by natural or human disturbances may result in species being killed, harmed, displaced, or temporarily disturbed, depending on the timing of the activity. In addition, this activity may destroy sites for rare wildlife species that do not readily reestablish elsewhere. Other effects include creation of early successional habitat required by some species at risk, brood parasitism, increase in predation and creation of edges.

Natural disturbances, such as tornados and windthrow, could occur at anytime of the day. This could result in an increase in number of species killed or harmed if the event occurred at night when most species are at rest. Human disturbances, such as timber harvest, would have increased compact to soil, which would have a greater impact on burrowing species. Activities, such as logging, have noise associated with them, which provides some increased time for mobile species to move from the area. Natural disturbances, even those occurring during daylight hours, are usually sudden and provide wildlife very little lead time to move from the area. This could result in more loss of species from natural disturbances than from human disturbances.

As with effects of timber harvest and prescribed fire, the direct effects of forest regeneration, whether natural or human caused, are expected to be localized and relatively short-term (1-10 years). Effects may, however, be long-term (>10 years) if wildlife sites are not re-established.

Management direction for all alternatives is established to prevent or mitigate harm, mortality, or destruction of rare species and key habitats. Therefore, direct effects from forest regeneration are expected to be within an acceptable limit under all alternatives.

Currently, approximately 2.5% of the Mark Twain NF is in early successional habitat. Alternatives 1-5 would vary in the amounts of early successional habitat after the 1st decade; from 3.5% in Alternative 1 to greater than 7% in Alternatives 2-5.

Prairie warblers require early seral habitat. No minimum acreage requirement has been established for this species. Thompson and Dessecker (1997), state that songbirds benefit most from patches of regenerating forest greater than 5 acres, preferably 10 to 40 acres. Early seral habitats provided by uneven-aged methods, such as selection with groups, are in patches less than 2 acres. Therefore, these patches are too small to benefit prairie warbler and other similar Neotropical birds. However, some songbirds, such as the hooded warbler, require the smaller openings created by uneven aged management (Thompson and Dessecker 1997).

Studies show that clearcutting enhances the quality, quantity, and availability of food and cover for white-tailed deer, rabbit, most game birds, all early successional songbirds, and several rodents. Snags and logging slash left after clearcutting benefits cavity nesting birds, raptors, and many amphibians and reptiles. Stand regeneration has a negative effect on amphibians because clearcutting results in a warmer, drier, less stable environment that seems inhospitable to them and may cause reproductive problems. While most studies show that area-sensitive or edge-avoiding species of birds are reduced in number near clearcuts, in most cases these species are not eliminated. Nest predation and parasitism were not shown to be higher in or near clearcuts unless the stands already were small due to the encroachment of roads, farms, and human habitation (Harlow et al. 1997).

The benefits of clearcutting for early successional species generally declined in the sapling and poletimber stages of succession as the canopy begins to close (Harlow et al. 1997). Cook and O'Laughlin (2000) state that an important aspect between wildlife and timber harvesting is how much vegetation remains on site for food and cover for species inhabiting the area. By retaining 7-10% of the harvest area in reserve trees consisting of the largest, long-lived species, standing dead trees, and cavity and den trees, negative impacts to wildlife species will be minimized and positive impacts could occur to some species. Leaving downed woody material on-site would also improve habitat for small, less mobile species such as amphibian, reptiles and small mammals.

Alternative 1

This alternative would increase habitat for the scarlet tanager, but decrease prairie warbler habitat as forest succession occurs due to the limited number of acres treated. Of the existing 0-9 age class habitat, marginal areas would grow out of this habitat type within the next few years. Alternative 1 would have long-term negative impacts on species requiring early successional forest or shrub/brush habitat since the stands creating the 0-9 age habitat would result in the ground covered by downed logs from the lack of removal of cut trees. This timber activity would increase habitat for some species such as salamanders, which require down logs and leaf material.

This alternative would only minimally increase the amount of 0-9 age class from the current amount unless an event such as a stand replacement fire, tornado or other natural event occurs. This alternative would allow young and mature forest to progress toward old growth stands, which would improve conditions for salamanders.

Alternative 1 would provide a minimal amount of early successional habitat across the Forest required by numerous species using this habitat. This limited amount could also negatively affect some species associated with this habitat due to the increase in downed timber remaining in the area after harvest.

Alternatives 2 through 5

Alternatives 2, 3, 4 and 5 generally increase the representation of younger age classes in both the short and long-term and would provide highly favorable habitat conditions for species associated with young forest on the Mark Twain NF. Though establishment of young forest habitat is a short-term effect timber harvests generally would continually re-establish new young forest. The amount available would vary in each decade. These alternatives would provide abundant amounts of young forest in woodland habitats. The amount of young forest habitat produced under Alternatives 2-5 would be within the amounts expected under the range of natural variability.

Alternatives 2-5 provide for early successional species, whereas Alternative 1 would have limited amount of early successional habitat, with natural events contributing sporadically throughout the majority of the forest under all the alternatives.

Assuming a direct correlation between habitat availability and species populations, overall conditions in early successional woodlands and forest would generally result in population levels close to those expected under the range of natural variability on National Forest land. Similarly, in Decade 2 of Alternatives 2-5, the amount of early successional habitat would be within the RNV. Habitat quality would be highest in Alternatives 2 and 3 due to restoration and enhancement of natural communities in MP 1.1 and 1.2.

Regeneration activities would benefit early successional and shrub bird species that seem to be experiencing some of the largest population declines in the Ozarks; i.e. Bachman's sparrow, prairie warbler, blue-winged warbler, Bell's vireo (Fitzgerald and Pashley 2000, Sauer et al. 2004).

Timber harvest methods such as over-story removal, clear cutting, seedtree and shelterwood would decrease habitat for the scarlet tanager and other species requiring more mature habitat. These cuts would increase inclusions of early seral habitat in forested patches. Species requiring early seral habitat would benefit from clearcut and seed tree harvests. These activities would be expected to occur across the Forest.

Alternatives 2-5 would have greater than 7% in early seral stage, but the surrounding area on private lands, both within and outside the proclamation boundary, have large pastures and open fields, which increase potential for parasitism by cowbirds. However, this increase in early seral habitat on Mark Twain NF would not significantly increase cowbird populations in the project area, and effects from cowbirds would remain similar to existing conditions (Sauer et..al. 2004, Fitzgerald and Pashley 2000).

Habitat suitability for salamanders would be reduced in stands that have prescriptions for over-story removal, clearcutting, seedtree and shelterwood (Herbeck and Larson 1999).

Timber harvest methods such as selection with groups, improvement cuts, individual tree selection, red oak salvage and various thinnings would retain enough canopy cover to continue to be suitable for salamanders. However, it is likely that salamanders and other species associated with accumulated leaf litter and forest old growth conditions have increased from their historic range of natural variability because of the expansion of this habitat type following post-European settlement overgrazing, fire suppression and expansion of woody canopy cover.

These alternatives would maintain more of early seral habitats and open canopy forest than Alternative 1 due to the amount of area treated. As a result, beneficial effects within the silviculture treated and burn areas would be sustained for white-tailed deer, eastern wild turkey, indigo bunting, ruffed grouse, raccoon, and bobcat.

Cumulative Effects

Cumulative Effects Question

What are the effects to early successional habitat and early seral dependent species from land management practices?

Cumulative Effects Spatial Boundary

The area used to discuss cumulative effects for early successional habitat and early seral dependent species is the 29 county area in which the Mark Twain NF lies. This area roughly covers the Ozark Highlands ecological section, and a portion of the Central Dissected Till Plains section (see map in Timber Supply cumulative effects section displaying national forest and 29 county area as it relates to Missouri). Timberland in the 29 county area is 7,408,579 acres or 56% of the land area. Private landowners own 73.8% of the timberland followed by the Mark Twain with 18.6% and state agencies with 5.7%

Cumulative Effects Temporal Boundary

For analyzing the effects to early successional habitats, the timeframe selected is from 1986 (original Forest Plan) to a period 1 decade out. This timeframe is sufficient enough from which to evaluate whether the forest is moving toward viable populations of early seral stage dependant species.

Past, Present and Reasonably Foreseeable Future Actions

The incremental effects of other federal, non-federal, or private actions would not change, regardless of alternative. Any difference in cumulative effects would be reflected in the variation of an alternative's direct and indirect effects. The Forest Service has no direct control over effects on wildlife from sub-dividing and developing private lands.

Approximately ½ of the land within the Mark Twain NF proclamation boundary is privately-owned. These private lands continue to be developed, reducing the amount of forested lands and resulting in cover type conversions from native vegetation to pasture, agriculture and industrial sites. Forest Service management activities will continue to maintain the current forest cover throughout the Forest.

Forest Inventory and Analysis (FIA) data (Miles 2005) shows that between 1989 and 2003 the amount of early successional habitat within the 29 county area decreased by approximately 25%, with the Mark Twain NF has showing an approximate 50% decrease in the amount of early successional forest habitat.

Cumulative Effects Analysis

Events on private lands are somewhat unpredictable, along with the relative amount of early successional habitat. Therefore, available early successional habitat off Forest is unpredictable. Trends show that some pasture and cropland is reverting to forest, thus creating early successional habitat needed by many species. Selection of any alternative that would result in a decrease in management/restoration of natural communities (savanna, open woodland, closed woodland, and some forests) would decrease early successional habitat and plants/animals associated with them.

Concern over status of some early successional habitat species could be attributed to the reduction of amount of early successional habitat throughout the eastern United States (Thompson and DeGraaf 2001). By providing a full range of age classes throughout the savanna, woodland and forest natural communities, Mark Twain NF would provide early successional habitat needed for early seral species showing declines across the Ozarks. An increase in early successional habitat on Mark Twain NF should help negate some of the adverse impacts on other ownerships, therefore increasing the viability of species

Grassland Habitat

Effects Common to all Alternatives

Effects to species associated with grasslands (northern harrier, short-eared owl, eastern bluebird, loggerhead shrike, grasshopper sparrow, scissor-tailed flycatcher, eastern kingbird, field sparrow, eastern tiger salamander, northern crawfish frog, speckled kingsnake, etc.) are largely tied to livestock grazing and recreation. These species are to some degree, tolerant of invasive non-native grasses and forbs with expected population declines where non-native invasive species dominate. Recreation activity does not vary by alternative, and grazing management is different only in Alternative 5; therefore, the effects to these species would be similar among alternatives. Application of standards and guidelines for grasslands and rangeland vegetation would continue to provide habitat for these species, with potential improvements over time. Continued inventory and monitoring of grassland species would occur. The Forest provides less of this type of habitat than the surrounding private lands. Grassland habitat would continue to be stable to decreasing on the Forest due to the emphasis on natural community restoration.

Throughout the Forest, potential for recreational activities to introduce non-native invasive species would likely remain high in all alternatives. Treatment for noxious weeds would continue similarly in all alternatives, and the current threat to sensitive plant populations from noxious weeds is unknown. Most plant populations are in remote locations due to unique habitat associations and, as such, are largely protected from potential management activities. Livestock grazing has the potential to impact grassland habitats, and these same habitat types are the most likely areas for noxious weed expansion. Continued inventory and monitoring would occur for these species as outlined in the Monitoring Plan. Condition of grassland habitat would be maintained or improved across all alternatives as long as the spread of noxious weeds is curtailed.

The effects to grassland avian species (Swainson’s hawk) would be similar to those described for the sensitive grassland avian species (northern harrier, short-eared owl). Swainson’s hawk is highly migratory and there have been cumulative effects on its winter range.

Grassland habitat is the habitat least available naturally on Mark Twain NF. Existing grasslands would be maintained in all alternatives, dependant on location in management areas, benefiting species such as migrant loggerhead shrike and field sparrow.

Because so little of the Forest is natural grasslands and artificial openlands, management activities in general will have little impact on those species requiring grassland habitat. Management of known sites of grassland species-at-risk (SAR), including the loggerhead shrike, and restoring natural grassland communities should maintain their current viability on the Mark Twain.

All alternatives have standards and guidelines for grasslands. Grasslands are primarily wildlife habitat or range forage objectives in Alternative 5. Emphasis in Alternatives 1-4 is on management of natural grasslands as part of the natural range of variability of the landscape. Artificial grasslands in Alternatives 1-4 would be limited to the approximate acres that currently exist. The amount of area in grasslands would not increase, but the proportion of native warm-season grasslands to non-native cool-season grass would likely increase, creating habitat more suitable for the majority of grassland species, including northern harrier and field sparrow.

Openland habitat types identified as important to endangered, threatened and sensitive species would be managed to protect, conserve and restore those species. Management activities would be restricted or emphasized based on the needs of the species under consideration. These activities would be site specific and do not vary among alternatives.

Numerous acres on the Mark Twain NF are currently infested with noxious weeds, particularly the openlands and grasslands. Although noxious weeds are commonly found in areas of ground disturbance, they are also known to invade otherwise healthy, undisturbed plant communities. Once established, noxious weeds reduce biodiversity and crowd out native plants, displacing wildlife that depend on these native plants and disrupting watershed function, soil chemistry, nutrient and energy flow. Left unchecked noxious weeds can pose a significant threat to ecosystem health. The risks of noxious weed infestations vary by alternative; those alternatives with the most ground disturbance have the greatest risk. If these ground-disturbing activities occur adjacent to or within natural grasslands, loss of native grassland species could occur. This in turn could have a negative effect on wildlife species using the grassland habitat.

For Alternatives 1-4, several small areas of remnant prairie (totaling about 100 acres) are the core of MP1.1 on the Cedar Creek Unit. Alternative 5 has no specific direction for restoring prairies, but prairies are listed as natural vegetation communities to manage (1986 FP page IV-14-17). There are standards and guidelines for providing open/semi-open habitat across the Forest.

The occurrence of fire changes the seral stage of grassland plant communities from a mid- and late- to an early seral stage. Generally, after disturbances, grasslands progress from bare ground to a forb-dominated community, then to a forb/grass mix, then to a grass-dominated climax community. This is determined by the tolerance of the occurring species to fire and the presence of noxious weeds. Noxious weeds after fire can out-compete native vegetation and slow or stop restoration of high diversity grassland natural communities

In the short term, fire removes vegetation, exposes soils to potential erosion, and releases nutrients previously tied up in woody material in poor quality, degraded grassland natural communities. However, soil erosion appears not to be a major problem in most grassland and openland sites. Through time the increase in available sunlight and nutrients results in an increase in herbaceous vegetation and reduction in soil erosion. Some nutrients are lost through volatilization. Depending on preburn species composition, there may be a positive or negative impact on the uses of the vegetation. In areas in which noxious weeds or undesirable native species exist prior to the burn, there may be a net loss in desirable species, especially in sites invaded by sericea lespedeza and tall fescue.

Alternatives vary by the number of acres to be treated with fire, with Alternative 2 burning the most acres in the first decade, followed by Alternatives 3, 4, 1, and 5.

Alternative 1

Habitat for northern bobwhite, northern harrier, short-eared owl, loggerhead shrike, grasshopper sparrow and red bat would decrease as woody vegetation invades old fields and glades due to lack of management. Prescribed burning would focus on meeting individual resource objectives, and not on restoration of early successional and grassland habitats.

Approximately 25% of artificial openlands and native grasslands are within riparian management zones, a majority of which are not naturally occurring. Only maintenance of naturally occurring openlands and grasslands would be allowed within riparian management zones and watercourse protection zones. This would result in further loss of grassland habitat as woody vegetation begins to invade these sites.

Alternatives 2 and 3

With emphasis on restoration (Alternative 2) and enhancement (Alternative 3) of natural communities, these alternatives have the most opportunity to increase prairie, grassland, savanna and glade habitat quantity and quality. As these habitats regain their characteristic structure, species composition, and range of variability, more habitat will be available for grassland species, including the striped skunk, white-footed mouse, loggerhead shrike and red bat. Grassland habitats are limited to the amount currently available. Existing grasslands may or may not be maintained depending on their location in various management prescriptions and opportunities to achieve resource objectives. In the short term, some grasslands would have characteristics suitable for northern bobwhite and loggerhead shrike habitat, but others would either be too overgrown, or too intensively managed to provide suitable habitat. Overall, these alternatives should result in the greatest increase in suitable grassland habitat of all alternatives.

Approximately 25% of the artificial openlands and native grasslands are within the RMZ; a majority of these not naturally occurring. Only maintenance of naturally occurring openlands and grasslands is allowed within the RMZ and WPZ. This would result in further loss of grassland habitat as woody vegetation begins to invade these sites.

Alternative 4

Grassland habitats are limited to the amount currently available. Existing grasslands may or may not be maintained depending on their location in various management prescriptions and opportunities to achieve resource objectives. In the short term, some grasslands would have characteristics suitable for northern bobwhite and loggerhead shrike habitat, but others would either be too overgrown, or too intensively managed to provide suitable habitat. This alternative would provide less suitable grassland and openland habitat than Alternatives 2 and 3, but should result in more habitat than Alternatives 1 and 5.

Approximately 25% of the artificial openlands and native grasslands are within the RMZ, with the majority of these not naturally occurring. Only maintenance of naturally occurring openlands and grasslands is allowed within the RMZ and WPZ. This would result in further loss of grassland habitat as woody vegetation begins to invade these sites.

Alternative 5

Current management of glades is guided by glade special habitat standards and guidelines (1986 Forest Plan page IV-56) which have minimum percentages of glade habitat in the White River subsection to be managed as open and semi-open glades. In addition, there are specific standards and guidelines for large openlands, including large and small glades (1986 Forest Plan page IV-64). In the past 15 years, about 1500 acres of glade have been treated to reduce woody vegetation. This alternative would result in less suitable grassland habitat than Alternatives 2, 3and 4.

Cumulative Effects

Cumulative Effects Question

What are the effects to grassland habitat and grassland dependent species from land management practices?

Cumulative Effects Spatial Boundary

The area used to discuss cumulative effects for grassland habitat and grassland dependent species is the 29 county area in which the Mark Twain NF lies. This area roughly covers the Ozark Highlands ecological section, and a portion of the Central Dissected Till Plains section (see map in Timber Supply cumulative effects section displaying national forest and 29 county area as it relates to Missouri).

Cumulative Effects Temporal Boundary

For analyzing the effects to grassland habitats, the timeframe selected is from 1986 (original Forest Plan) to a period 1 decade out. This timeframe is sufficient enough from which to evaluate whether the forest is moving toward viable populations of early seral stage dependant species.

Past, Present and Reasonably Foreseeable Future Actions

Many acres within the proclamation boundary on private lands are currently openland. Many of these acres are open hay/pasture land, most likely fescue. Fescue is a non-native, cool season grass managed almost exclusively for maximum forage production. Much private land now in fescue used to be wooded drainages and slopes.

The Forest Service has no direct control over effects on wildlife from sub-dividing and developing private lands. Approximately ½ of the land within the Mark Twain NF proclamation boundary is privately owned. These private lands continue to be developed, increasing the amount of openland and resulting in cover type conversions from native vegetation to pasture, agriculture and industrial sites

Cumulative Effects Analysis

Fescue that is hayed and/or grazed annually provides low-quality short-grass habitat that is used by species such as killdeer, voles, red-tailed hawks and some reptiles. Bats, nighthawks, purple martins, chimney swifts and swallows might use these areas when foraging for insects. The forage value of fescue is questionable since the majority contains the fescue fungus.

Cumulative effects to wildlife species off Forest on adjacent lands are likely more important than any effects on the Forest. Conversion of idle lands to intensive agriculture and urbanization will decrease available habitat on private lands.

Conversion of forested land to non-forest uses continues on private ownerships in variable amounts throughout the Ozarks. Urban/rural development is particularly strong in the Table Rock Lake/Branson area (Cassville and Ava units), and in the Howell County area (Willow Springs unit), although it occurs in and around all units of the Mark Twain NF. Conversion of upland and riparian forest to agricultural uses, particularly pastures, continues on private ownerships across the Forest. These changes may or may not make habitat unsuitable for red bats and other grassland species.

Alternatives 2 and 3 would result in more native grasslands, including prairies and glades, while alternatives 1, 4 and 5 will have the least emphasis on natural community restoration. With the Mark Twain NF emphasis on natural community restoration including prairies and glades, our contribution to the cumulative effects within the 29 county area would be positive.

Old Growth Habitat

Effects Common to all Alternatives

Land purchases for establishment of the Mark Twain began about 65 years ago. The government purchased many tracts that had been logged by their former owners in the 1930s or earlier. Other tracts were purchased over the last 65 years, but the former owners first harvested timber from them. Most remaining stands were logged after being acquired by the Forest Service. Some stands have been identified as possible old growth, even if they are second growth. None have been field-inventoried to confirm that they are in fact old growth. Over time, all stands can meet old growth criteria.

Under all alternatives, approximately 8% of the Forest acreage will remain in wilderness or in other management allocations in which active management is restricted. Forest-wide standards and guidelines provide protection of these areas to assure continued development and enhancement of old growth characteristics and habitat conditions for old growth dependent species. Currently, approximately 50% of the wilderness areas are over 70 years of age, with less than 10% being over 100 years of age (USDA Forest Service 2004a). Most of these acres, although not designated old growth, will continue to mature and develop old growth characteristics. Over time, this would increase the old growth component and provide additional large patch old growth areas needed by interior forest species and species with large home ranges, such as pileated woodpecker, barred owl, turkey and spotted skunk. However, as discussed in the ecosystem sustainability effects section, areas that were within the historic range of natural variability for former savannas, open woodlands and glades that would not be restored or enhanced, especially with the use of prescribed burning and select silvicultural methods, will experience declines in plant and animal species associated with them.

Old growth would be managed much the same in all alternatives. The amount of forest cover would not change significantly from the current percentage. However, Alternatives 1, 4 and 5 would have more closed canopy, densely stocked immature and mature forest and less open or closed woodland than Alternatives 2 and 3, due to the emphasis on natural community restoration in the latter. Old growth designation and development of old growth characteristics within the natural range of variability for natural communities would particularly benefit cavity nesters but decrease habitat for plant and animal species associated with former open, fire-dependent natural communities.

In Alternatives 1-4, old growth would be designated on a percentage of MP 2.1, but in MP 1.1 and 1.2, old growth would develop naturally as part of the restoration and enhancement of natural communities. Since Alternative 5 does not have MP's 1.1, 1.2 or 2.1, old growth would be designated on a portion of the Forest based on MP and Land Type Association.

Old growth would be managed to maintain desired composition and structure and to reduce risks or loss. Activities, such as vegetative treatments and prescribed burning, can be conducted to avoid creation of fragments of insufficient area or inappropriate spatial pattern to serve the habitat needs of species and communities at risk. Management to provide for some old growth characteristics such as large diameter trees, cavities, standing snags, tall canopy, dead and down woody material and herbaceous vegetation within old growth stands would provide better quality habitat for pileated and red-headed woodpeckers, tufted titmouse, pine warbler, worm-eating warbler, ovenbird, wood thrush, whip-poor-will, Kentucky warbler, tiger salamander, and numerous other species. Habitat conditions needed by some old growth dependant species would not necessarily be provided by just setting aside stands as old growth.

Prescribed burning within old growth stands would benefit old growth dependant species by providing canopy gaps, snags, dead and downed woody material, den trees, and herbaceous understory. In addition, silvicultural activities leaving the largest trees, snags and cavity trees, also benefit old growth species.

The designation of old growth forest buffers around cave entrances would maintain cave entrance microclimates.

Effects common to Alternatives 1-4

Natural vegetative communities, including old growth open pine savannas, woodlands and forests, would be reestablished on appropriate sites to reach plant and animal diversity objectives and would provide, specialized habitat requirements for species native to these communities such as red-cockaded woodpecker, white-breasted nuthatch, broad-winged hawk, barred owl, pine warbler, pileated woodpecker, gray and fox squirrel and others.

In addition, oak, hickory, mixed oak and other old growth natural communities will be designated. Species benefiting from oak-hickory old growth include Indiana bat, great horned owl, wood thrush, yellow-throated vireo, Cerulean warbler, pileated woodpecker and others. Once these areas reach the old growth stage, they will continually provide for habitat conditions required by old growth-dependant species, such as large diameter trees, den and cavity trees, standing snags, multi-layered vegetation structure, dead and down woody material, herbaceous cover and tall canopy.

Permanent old growth would be designated in all alternatives, and would be present as part of the range of natural variability in MP’s 1.1 and 1.2. Designation of permanent old growth within MP 2.1, 6.1 and 6.2 would allow areas to move rapidly toward a combination of all old growth types. Alternatives 1-4 would allow for limited management to achieve characteristics of artificial old growth by removing younger stems that would encourage faster growth of the remaining stems to reach larger diameters and taller canopies, retaining standing snags and den trees, creating multi-layered structure, and created more herbaceous cover through prescribe burning. While the effect will be positive for species associated with old growth, species associated with former open-closed woodland types, savannas and glades will decline as woody canopy and shrub species resulting from unnatural succession, due to overgrazing and fire suppression, increase.

All alternatives include guidelines for the amount of area managed as permanent old growth and restrictions on treatment of old growth stands. Forest inventory monitoring would validate these old growth guidelines.

Management activities, including prescribed fire and silivicultural activities would be allowed to promote appropriate site-specific old growth natural communities. Timber harvest activities such as thinning, group selection, improvement cuts, individual tree selection, and salvage of red oak would help diversify mature and old growth natural community types. These activities would open the canopy and increase soft mast plant species, grasses, forbs and shrubs in the understory.

Salvage within old growth areas may only be accomplished when there is an unacceptable risk to public health or safety, or a threat to forest health, such as oak decline. Activities such as salvage within old growth habitat would continue to enhance old growth characteristics and natural communities. By minimizing the impact and the area treated, salvage could provide for old growth characteristics by leaving woody material and snags within the area.

Natural disturbances, such as wind-throw and mortality provide for old growth characteristics by creating small canopy gaps, fallen logs and patchiness, all of which are important to species using old growth forests (Tanner and Hamel 2001).

Increased groundcover would directly or indirectly increase forage and cover for species like eastern wild turkey, white-tailed deer, indigo bunting, raccoon, and bobcat. Indigo buntings do not require large patches of early seral habitats; as a result, group selections would make these mature and old growth forests more suitable for the bunting. This trend would not hold true for other early seral species such as prairie warbler and white-eye vireo. These activities would not affect the pileated woodpecker as long as some den trees and snags were reserved. Wood thrush and ovenbird populations may decrease initially but would increase as shrubs become more dominant in the understory.

2005 Forest Plan standards and guidelines would be followed for protection of den trees and snags.

Alternative 1

Alternative 1 allocates the greatest amount of land to management where weather-related processes are the primary agent of stand and landscape disturbance. This alternative will likely limit progress toward restoring ecosystems, especially in creating diverse stand structure characteristics without commercial means. In the short term, this will result in an increase in late successional and old growth habitat outside the range of natural variability as existing stands age and woody species invade and fill in former open natural communities. The availability of different habitat structure stages will fluctuate primarily in response to forest gaps and catastrophic storm blowdowns over time and space. Since insects and diseases, and to some extent wildfires, are influenced by stand structure and drought, potential exists for large areas of the forest to experience natural disturbance when these high-risk conditions occur. This alternative has the least amount of vegetative manipulation planned. Therefore, the maximum number of stands would move toward old growth characteristics in both the short term and long-term. As stands age, wildlife species that are dependant on late successional and old growth habitat (such as pileated woodpecker, northern flicker, downy woodpecker, summer tanager, gray squirrel, spotted skunk, pine warbler, worm-eating warbler, ovenbird, whip-poor-will, Indiana bat, little brown bat, tiger salamander, slimy salamander, and five-lined skink) will have an increase in available habitat, and therefore should have stable to increasing population trends.

In addition, the variation within old growth habitats would be expected to decline with closed canopy forest becoming more dominant in the project area and open canopy forested habitats declining. These changes would benefit the wood thrush, pileated woodpecker, and ovenbird but not benefit species associated with former open, fire-adapted old growth communities including bluebirds, summer tanager, white-eyed vireo, red bat and woodland vole.

While the amounts of prescribed burning to treat fuels in moderate to high risk areas would benefit fire-adapted old growth stands, the use of fire is restricted to fuels treatments in moderate to high risk areas only. Prescribed burning used to restore ecosystems would be confined to MP 1.1 and 1.2 only in Alternative 1. Thus, prescribed burning likely would not occur at the frequency necessary to move dense overstocked timber stands toward the desired conditions for open woodlands and savannas. Again, aging of dense overstocked canopies in former open natural community types would reduce sun-adapted groundcover and animal species associated with their vegetation structure.

Alternative 1 would result in extensive amounts of dead and down timber within treated areas. This in turn would provide habitat for numerous species of amphibians and reptiles, including salamanders, skinks and snakes.

Effects common to Alternatives 2 through 5

Based on forest type and age, there are enough acres of forest that meet the old growth definition, with the exception of Alternative 5. However, there are two sources of possible concern. First, though the sum of all acres is large, much of this age class is in stands fragmented by past timber harvest and may not be highly suitable for many animals needing old growth in larger patches. Mapping of current areas meeting old growth age and forest type criteria show many patches that are perforated by past logging units or divided by roads. Second, in the long-term, areas outside of designated old growth could be cut repeatedly, as often as every 70-90 years. It is not known whether the provision of old growth and recruitment islands in a matrix that is harvested so frequently will provide indefinitely for viable population of the animals most dependent on structure related to old forest (for example, ovenbird, pine warbler, and whip-poor-will).

As the Forest ages, species found in old growth forests will increasingly benefit as shade-tolerant species become more prevalent across the landscape. However, other species may experience population declines since site species composition will change, tending to support less pine, oak and species associated with fire-adapted natural communities.

Cumulative Effects

<u>Cumulative Effects Question</u>

What are the effects to old growth habitat and old growth dependent species from land management practices?

<u>Cumulative Effects Spatial Boundary</u>

The area used to discuss cumulative effects for old growth habitat and old growth dependent species is the 29 county area in which the Mark Twain NF lies. This area roughly covers the Ozark Highlands ecological section, and a portion of the Central Dissected Till Plains section (see map in Timber Supply cumulative effects section displaying national forest and 29 county area as it relates to Missouri). Timberland in the 29 county area is 7,408,579 acres or 56% of the land area. Private landowners own 73.8% of the timberland followed by the Mark Twain with 18.6% and state agencies with 5.7%.

<u>Cumulative Effects Temporal Boundary</u>

For analyzing the effects to old growth habitats, the timeframe selected is from 1986 (original Forest Plan) to a period 2 decades out. This timeframe is sufficient enough from which to evaluate whether the forest is moving toward desired old growth conditions and areas are exhibiting characteristics of old growth.

<u>Past, Present and Reasonably Foreseeable Future Actions</u>

The incremental effects of other federal, non-federal, or private actions would not change, regardless of alternative. Any difference in cumulative effects would be reflected in the differences of an alternative’s direct and indirect effects.

The land surrounding and within the Forest is primarily private or corporately owned forested land, private industry, residential areas, or small farms. Any non-public forest is subject to harvest at any time and old-age forests are not necessarily afforded any protection.

Harvest of private lands currently exhibiting old growth characteristics, could result in dispersal of species requiring these conditions.

Forest Inventory and Analysis (FIA) data (Miles 2005) shows that between 1989 and 2003 the Mark Twain NF has gained timberland acres, while non-forest service lands have lost timberland acres. In addition, the data shows a steady increase in sawtimber sized stands in Missouri from 1947 – 2003. The 29 county area cumulative affects boundary has shown a slight decrease (approximately 2%) in sawtimber from 1989 to 2003, whereas the Mark Twain NF has shown an steady increase (approximately 25%).

FIA data shows over the 29 county area, there has been a decrease in forested acres over 100 years of age from 1989 - 2003. National forest lands show an approximate 20% decrease in older forest, while private within the 29 county area have almost a 60% decrease in 100 year old forest (Miles 2005). However, other public lands showed nearly 100% increase in acres over 100 years of age. FIA data does show in increase in acres in the 81-100 years age class for both forest service and non-forest service forestlands from 1989 to 2003. Although the data ranges from a sampling error of less than 25% to greater than 50% depending on year and county, it appears that non-public forestlands are becoming younger.

Cumulative Effects Analysis

Regardless of the alternative chosen, land outside National Forest System ownership would not influence amount of permanent old growth designation. An increase in old stands within the Forest would benefit local species that use interior forest, as well as old or large trees, by increasing prospects for inter-connecting areas of functional old growth associated with forest natural communities and closed canopies. Likewise, restoring the range of natural variability for structure, composition and variable vegetation/age class patterns for woodlands, savannas and glades would also benefit species associated with their respective old growth characteristics. However, for the once open and closed oak-pine woodlands, post oak savannas, post oak flatwoods and glades, permanent old growth conditions outside the range of natural variability would develop without any management, resulting in corresponding loss of associated plant and animal species diversity while benefiting some forest interior species.

The greatest impact to any plant or animal species requiring old growth habitat is the continued development and conversion of private forested lands to urban or agricultural uses. This trend is expected to continue in the short and long-term within the cumulative effects area. Mark Twain NF will remain over 90% in tree cover, and it is likely that other state and federal ownerships within the 29 county cumulative effects area will be primarily forested too. In addition, there are several large private ownerships in tree cover that would probably remain so in the foreseeable future. Since old growth habitat would continue to develop and be provided in both the short and long-term on the Mark Twain NF, there should be little effect to any species requiring old growth habitat within the proclamation boundary.

Other public lands are showing an increasing in older stands, however, their total acreage is only about 45% of the Mark Twain NF and more scattered across the landscape. Public forestlands within the 29 county area is expected to continue to age, however trends on private lands show a decline in forest age. With the Mark Twain being the largest landowner in the cumulative effects area, our contribution to old growth habitat and the viability of species depending on old growth habitat will increase. With the enhancement of old growth natural communities and old growth characteristics within the permanently designated stands, the Mark Twain NF should have a long-term positive impact on the cumulative effects of old growth habitat and old growth dependant species across the Missouri Ozarks..

Effects of transportation system on wildlife

Effects Common to all Alternatives

The transportation system includes both roads and motorized trails. Motorized trails are those specifically designed for off-road vehicle (ORV) or all-terrain vehicle (ATV) use. Under all alternatives, motorized vehicles are restricted to roads or designated trails. The effects to wildlife resources from vehicular traffic, OHVs and ATVs on roads and designated trails would be similar.

Roads and motorized trails can affect wildlife through direct removal of habitat, fragmentation of habitat, edge effects of differing types and depths, introduction of exotics, direct mortality (road kill, trampling of vegetation), disruption or dispersal of some organisms and isolation of populations, chronic disturbances from human activity and traffic, increased hunting and fishing pressure and alteration of disturbance regimes.

Off-road vehicle trail construction and use of the trails by OHVs and horses would likely injure or kill some wildlife. Wildlife could also be affected through habitat loss, fragmentation, edge effects, disturbance, avoidance, increased access and use of areas by humans, and reductions in air and water quality. Roads and trails store heat, which attracts animals such as birds and snakes and increases their risk of being run over. Many people fear snakes and would intentionally kill any observed on trails.

Construction would remove trees, shrubs, and grasses wildlife uses for forage. Cover used to rest, raise young, and escape predators would be reduced. Preferred mating habitat may also be reduced. Dens, potentially with animals in them, in live trees, snags, and logs would be removed in construction areas. During the study period, standing snags adjacent to trails and trailheads may be cut down if they pose a safety hazard to humans. Ground nests, possibly containing eggs, could be destroyed during trail maintenance. Underground burrows may collapse as a result of trail construction and use. Wildlife would be displaced as a result of physical habitat loss. They would have increased energy expenditures associated with disrupting hibernation, locating new territories, rebuilding nests, dens, and burrows, and starting new families. Wildlife that has been subjected to habitat loss may experience increased mortality.

Roads fragment populations of many small mammals, amphibians, and reptiles by creating barriers to dispersal. Direct mortality through road kill also affects populations of both large and small animal species. Temporary pools associated with road drainage features will provide habitat for amphibians and other wildlife species by retaining water at the end of the drainage feature. Revegetation following soil-disturbing activities would reduce additional sedimentation.

While road and trail-derived pollutants such as oil and gas can affect fish and other aquatic life, including salamanders, sediment is the primary pollutant associated with Forest roads and trails. Unmapped and unmaintained roads can channel surface water flows, increasing sediment into streams and rivers.

Off-road vehicles are damaging to ponds, not only because of the physical damage caused to ponds and soil compaction in upland habitat near ponds but also because of pollution caused by any type of motorized vehicle. Although tiger salamanders are surprisingly resistant to pollutants such as silt and motor oil, these pollutants cause reduced growth and affect the prey that tiger salamanders depend on (Lefcort et al., 1997). Off-road vehicles can also cut off migration routes amongst tiger salamander breeding ponds, depending on where the roads are placed. Off-road vehicle use within a buffer zone of 150 – 200 m is undesirable

(Semlitsch 1998), and off-road vehicle use should be restricted in areas where many breeding ponds may be situated close to each other.

Roads and other corridors have varying effects on forest wildlife. In forested landscapes, the worm-eating warbler had comparable nesting success in large forest tracts and in small forested tracts separated by paved two-lane roads and wood lots (Gale et al 1997). However, Ortega and Capen (1999) observed in heavily forested landscapes, that the density of ovenbirds was lower within the edge areas of roads than within interior areas. Forest roads were also found to reduce the species richness and abundance of macro invertebrates for up to 330 feet into the forest, with greater effects from wider roads (Graham 2002).

Linear corridors have proved to be dispersal barriers for some small forest mammals such as white-footed mice and gray squirrels. However, medium-sized mammals showed higher road mortality due to their higher rate of road crossing attempts. Woods roads have little effect on movement of salamanders, while primary forest roads have significant impact on movement and can fragment populations.

Roads can impact wildlife species by direct removal of habitat during construction and reconstruction or indirect loss of habitat associated with increased human use and disturbance associated with the use. This loss is greatly reduced when roads are obliterated. Generally, those alternatives proposing the fewest miles of road pose the least risk to sensitive species and their habitat. With the transportation system on Forest Service-managed land largely in place, no noticeable changes would be made to the current transportation system in any of the alternatives.

With the transportation system largely in place, more existing roads are reconstructed and maintained rather than constructing new roads to accomplish resource objectives. The result should be less impact to wildlife from fragmentation, soil disturbance, edge effect, introduction of exotics and disruption and dispersal of some organisms and isolation of populations. Other factors, such as traffic volume and speed, amount and frequency of road maintenance, and location, may have a greater effect on wildlife. Road access also allows for a variety of recreation activities, such as driving for pleasure and sightseeing, hunting, bird watching, camping, and picnicking.

Some effects or impacts on wildlife and their habitat on the Mark Twain NF which have occurred over the past decade or so from the transportation system include: direct removal of habitat, fragmentation of habitat, edge effects of differing types and depths, introduction of exotics, direct mortality (road kill, trampling of vegetation), disruption or dispersal of some organisms and isolation of populations, chronic disturbances from human activity and traffic, increased hunting and fishing pressure, alteration of disturbance regimes, and disruption of hydrological processes.

Under all the alternatives, habitat for demand species (both terrestrial and fisheries) would decrease with increases in road miles. Standards and guidelines for Alternatives 1-4 are designed to protect or minimize negative effects from roads on wildlife. Less stringent standards and guidelines exist for Alternative 5. If necessary, additional mitigation measures would be identified at the project level, during site-specific analysis.

The primary effect of illegal travel on roads is disturbance to wildlife, especially during the hunting. Disturbance is generally limited to times of high forest use (such as hunting season and OHV activity) and does not vary by alternative. Management through obliteration or other physical closure as identified during project implementation will reduce the effects to wildlife due to any illegal use of these roads.

Cumulative Effects

Cumulative Effects Spatial Boundary

The area used to discuss cumulative effects for effects on wildlife species and their habitat is the 29 county area in which the Mark Twain NF lies. This area roughly covers the Ozark Highlands ecological section, and a portion of the Central Dissected Till Plains section (see map in Timber Supply cumulative effects section displaying national forest and 29 county area as it relates to Missouri).

Cumulative Effects Temporal Boundary

For analyzing the effects to wildlife and their habitats, the timeframe selected is from 1986 (original Forest Plan) to a period 1 decade out. This timeframe is sufficient enough from which to evaluate whether wildlife and their habitats are being impacted by the transportation system.

Past, Present and Reasonably Foreseeable Future Actions

The incremental effects of other federal, non-federal, or private actions would not change, regardless of alternative. Any difference in cumulative effects would be reflected in the differences of direct and indirect effects. The Forest will continue to partner with agencies addressing local, state, and regional transportation needs and provide a seamless transportation system between the various agencies. The incremental effects of other federal, state, and local road actions would not change, regardless of the alternative chosen.

The land surrounding and within the Forest is primarily private or corporately owned forested land, private industry, residential areas, or small farms. As land uses change and increase, roads are increasingly necessary to access these farms, subdivisions, forested lands, etc. In addition, highway widening and expansion result in increased impacts to wildlife.

Within the Forest boundary, visitors are likely to see road improvement projects, such as; highway resurfacing, shoulder widening, and bridge improvements or replacements. Major highway projects planned during the next five years include dual dividing US Highway 60. The twenty-nine Missouri counties containing Forest-managed land are also expected to continue maintain their existing road network. Some improvements, such as road widening and paving are expected where development for housing and industry demands. Access to the Forest by county roads is expected to increase somewhat in the future, due to increased private and industrial development within or near the Forest.

Cumulative Effects Analysis

The transportation system or lack thereof, outside National Forest System ownership would influence amount of additional roads needed within Mark Twain NF. With the forest service road system primarily in place, additional forest service roads would be minimal.

With roads continuing to be build throughout the 29 county area, cumulative effects on wildlife and habitats would continue to worsen. Although Mark Twain NF would implement standards and guidelines protecting and improving resources and habitat, roads outside our jurisdiction could result in increased creation of edge effect , removal of wildlife habitat, mortality of wildlife, increased hunting and fishing pressure from improved access to areas, disruption of hydrologic processes and introduction of exotic species.

Management Indicator Species and Ecological Indicators

Introduction

The National Forest Management Act (NFMA) requires that "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." Management Indicator Species (MIS) is the concept adopted by the Forest Service (36 CFR 219.19) to serve as a way to evaluate the viability of fish and wildlife populations. Language in FSM 2620.5 WO amendment 2600-91-5 expands MIS to include "plant and animal species, natural communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation to assess the effects of management activities on their populations and the populations of other species with similar habitat needs that they might represent." Management (Ecological) Indicators provide a means of monitoring and evaluating the effects of actions on biotic resources, natural communities, habitats and specific species. By selecting a limited but appropriate set of Management Indicators, the Mark Twain NF can focus inventory and monitoring efforts where needed.

Proposed Changes

The Notice of Intent called for changes to the Management Indicator Species (MIS) as a means of better reflecting changes in habitat composition and quality. The goal is to revise the list to reflect a natural community orientation, ensure that species overlap into different habitats, and select species that truly indicate effects of management on national forest lands. The 1986 Forest Plan has 13 management indicator species. Many of these species are generalist that are not effective at indicating effects of Forest Service management activities, particularly on species restricted to or highly dependent on special habitats. Furthermore, current species selection may not be providing valid information on the viability of other associated plant and animal species; some generalist species positively respond to certain wildlife habitat methods, which may be detrimental to conservative species associated with the potential natural community.

Criteria used for selecting Revised MIS list

- Species occurs in a habitat that we are likely to affect through management, or in an area (MP 1.1 and 1.2) that drives our management direction.
- Species is closely associated with the habitat of interest, and population levels should respond to changes in that habitat (ecological indicator species).
- Basic biology or ecology (habitat requirements, threats, demography, etc.) is known for species or habitat.
- Species is not so rare or obscure that its populations cannot be monitored with a reasonable amount of effort.
- Species, or habitat, occurs at a scale that allows us to monitor population in replicate treatments and control units.
- Species populations or habitats respond (positively or negatively) to management quickly enough to allow before and after monitoring within a reasonable timeframe.

The final selection of Management Indicators focused on species and natural communities considered most likely to provide an indication of the effects of management in response to the need for change issues. The use of the natural communities (Ozark fen, open woodland and glade) can more efficiently serve to represent their characteristic and restricted plant and animal species (Groves 2003, Baydack et al. 1999). Management indicator natural communities were developed to generally encompass coarse filter habitats associated with as many species as possible to provide a practical and efficient approach to addressing the thousands of species that are found on the Mark Twain NF. A few species are selected that would detect effects of restoration and management for fire-adapted natural communities and special habitats. The Forest did not attempt to develop a list of MIS representing the full range of natural communities or habitat types on the Mark Twain NF. No indicators were selected for caves, riparian or aquatic communities or for old growth or early successional forests. Monitoring of conditions for these habitat components will be done by methods other than MIS. Rather, the Forest selected species to meet a limited objective for maintaining ecological conditions that contribute to long-term abundance and distribution of species associated with declining natural communities.

Table 15 - Proposed Management Indicator Species and Ecological Indicators

Animals	Associated Conditions and Species
Northern bobwhite (2)(5)	Grassland interspersed with shrubs; open woodlands; field sparrow (2); yellow-breasted chat; dickcissel (2)
Summer tanager (2)	Open woodland, prairie warbler (2)(3); eastern bluebird; spotted skunk (4)(5); red-headed woodpecker (2)
Bachman's sparrow (1)(2)(3)(4)	Open pine woodland, glades, brown-headed nuthatch; prairie warbler (2)(3); pine warbler
Worm-eating warbler (2)(3)	Forest interior; wood thrush (2)(3); Kentucky warbler (2); ovenbird (2); yellow-billed cuckoo (2); four-toed salamander; gray squirrel (5); southern flying squirrel; evening bat; luna moth
Red bat	Open and closed woodland, northern long-eared bat, Indiana bat (4)(6), whip-poor-will (2)(3)
Natural Communities	**Associated Conditions and Species**
Glade	Red cedar invasion/lack diversity; Ozark woodland swallowtail; painted bunting (2); collared lizard; roadrunner; western pigmy rattlesnake; Missouri tarantula, many endemic plant species
Open Woodland	Indiana bat (4)(6), fox squirrel (5), black bear, whip-poor-will (2)(3); wild turkey (5); deer (5); eastern wood peewee (2); great crested flycatcher (2); osage copperhead; timber rattlesnake; three-toed box turtle; Missouri woodland swallowtail
Groundwater seepage communities (fens, acid seeps)	Hydrologic regime; unique plant associations; swamp metalmark; ringed salamander; four-toed salamander; Hine's emerald dragonfly (6); Ozark snaketail dragonfly; Ozark emerald dragonfly, relict plants

(1) Regional Forester's Sensitive Species
(2) PIF Priority Species for Ozark/Ouachita Physiographic region
(3) Fish and Wildlife Service Species of Concern
(4) Missouri Endangered species
(5) Hunted/trapped species
(6) Federal Endangered/Threatened species

Issue - Wildlife Habitat Management

There are divergent views about how the Forest should be managed for the full array of wildlife species and habitats, whether rare or common, and what habitats and species should be emphasized. Forest Plan revision will establish goals for the types, amounts, distribution, spatial pattern, and function of wildlife habitats.

Key Indicators

Management Indicator Communities (MIC) trends

This indicator highlights the differences between alternatives because changes in the amount, distribution, and quality of the natural communities most severely degraded by historic land uses (i.e. glade, open woodland, groundwater seep communities) determine, in large part, the long-term viability of many of the plant and animal species which make the Ozarks a unique landscape.

MIS habitat trends

This indicator highlights the differences between alternatives because changes in the amount, distribution and quality of habitat for MIS are assumed to indicate changes in habitat, and associated changes in population trends, for a host of native Missouri wildlife which are represented by these species.

Affected Environment

Two goals listed in the 2005 Forest Plan for the Mark Twain NF are 1) provide habitat to maintain, enhance and restore site appropriate natural communities, including their full range of vegetation composition and structural conditions, and 2) restore and maintain biodiversity within fire-dependent areas. Using management indicators provides information to the decision-maker because changes in their abundance, quality, or distribution are believed to indicate the effects of management and can serve as measures toward meeting these goals. An analysis of the location and distribution of the selected management indicators may allow us to determine how each alternative meets these requirements.

The unique isolation of the 9 land units on the Mark Twain NF, and their relative relationship to distinctive ecological subsections places constraints on the distribution of management indicators. Thus, the concept of providing habitat to maintain viable populations well distributed throughout the planning area (36 CFR 219.19) is limited by the species' or habitats' characteristic qualities for each ecological subsection.

Environmental consequences

General Effects on MIC and MIS

Each alternative has the potential to affect management indicator habitats. Alternatives 1, 2, 3 and 4 employ the ecosystem approach to management in response to moving underrepresented natural communities and habitats toward the desired ecological condition in the amounts outlined in the objectives tables for MP 1.1 and 1.2 in Chapter 1of the 2005 Forest Plan. The amount of habitat treated in MP 1.1 and 1.2 varies by alternative. Projected treatments would move toward desired conditions for targeted natural communities identified in the Ozarks Ecoregional Conservation Assessment (OECA) (TNC 2003). The selected MIS are intended to compliment goals established by The Nature Conservancy and state/federal agencies, which improve the long-term survival of viable native species and natural community types through the design and conservation of portfolio sites within the Ozarks ecoregion.

Glade Management Indicator

Approximately 86,000 acres of glades and associated shallow bedrock woodland occur on or adjacent to the Mark Twain NF on various rock substrates, especially in the White River Hills and St. Francois Knobs and Basins subsections. Of this figure, approximately 36,000 acres occur on the Forest, much of which is overgrown in eastern red cedar and other mixed woody vegetation. Over 500 plant species native to Missouri occur on glades (Nelson and Ladd 1983). Many animals, particularly invertebrates, are characteristic to or restricted to glade habitats. At least ten plant and two animal Regional Forester Sensitive Species occur on glades on the Mark Twain. Smaller isolated glades averaging less than 5 acres occur in most other subsections, and do contain species at risk. Historically, overgrazing and fire suppression changed the plant composition and structure of glades, allowing the invasive increaser red cedar to flourish. This species is especially problematic on the extensive dolomite glades of the White River Hills Subsection. The presence of red cedar indicates a less than healthy glade natural community. Dense red cedar stands shade out sun-loving, glade adapted plant species including many Regional Forester Sensitive Species. Removing red cedar increases sunlight, decreases needle litter and stimulates otherwise depressed ground flora. Without removal, red cedar would continue increasing in coverage on glades and further reduce or eliminate habitat for glade-adapted plant and animal species, including several species at risk.

The use of glades as rangeland may be detrimental to recovery of species diversity associated with glades (Nelson 2005).

Direct and Indirect Effects to the Glade Management Indicator

Alternative 1

Alternative 1 would remove eastern red cedar from 3,100 acres. This is the minimum amount commensurate with protecting significant natural community targets identified in OECA for the first decade. This alternative does not permit commercial timber harvest. Trees would be cut and left on site, which could create a potential problem with hazardous fuels. Some red cedar may also be removed on glades using hazardous fuel treatments, which would improve glade MIS habitat, but this acreage is not known.

Alternative 2

Alternative 2 would increase the amount of glade habitat treated to a level that approximates the full range of portfolio boundaries with the targets identified in the Ozarks Ecoregional Conservation Assessment (TNC 2003). This alternative would maximize the increase of habitat for glade biodiversity and species at risk.

Alternative 3

Alternative 3 removes red cedar on 12,600 acres. It would increase habitat for glade biodiversity and species at risk.

Alternative 4

Alternative 4 removes red cedar on 5,800 acres. However, it would exceed the minimum acreage needed to ensure protection of biodiversity targets that include glades. However, unlike Alternative 1, commercial harvest of red cedar would be allowed. This alternative would increase additional glade habitat above current levels.

Alternative 5

Alternative 5 currently allows restoration of glade natural communities primarily in management prescriptions 3.4, 4.1 and 4.2. Some prescriptions in Alternative 5 emphasize limited investments and discourage ecosystem restoration activities. Certain standards and guidelines limit the ability of the Forest to effectively move degraded natural communities toward the desired condition due to social considerations, particularly in MP 5.1, 6.1, 6.2 and 7.1. The current plan provides little guidance regarding where and at what scale to focus ecosystem restoration management activities across the Forest. Approximately 1,000 acres of red cedar is projected for removal based on similar activity since 1986.

Cumulative Effects

The Missouri Department of Conservation is actively restoring dolomite glades and associated open woodlands on lands totaling no more than 10,000 acres in the White River Hills Subsection. Much of this restoration is occurring in a separate Nature Conservancy portfolio site (OECA) and outside of the Ava Glades portfolio area. The Missouri Department of Natural Resources is restoring approximately 800 acres of dolomite glade in Roaring River State Park, which compliments and includes the Cassville Glades portfolio area. Alone, the amount of glade restoration effort occurring on these lands does not meet global conservation goals.

The approximate 400,000 acres of dolomite glades occurring on private lands in the White River Hills Subsection will likely continue shifting toward dominance by red cedar and invasion by exotic species including sericea lespedeza and tall fescue. Analysis of land cover satellite imagery indicates that most of the privately owned glades surrounding and within the Mark Twain NF continue converting to invasive woody cover. Many privately owned glades are severely grazed. The fire risk analysis and human population growth in and around the Branson/Table Rock Lake area indicate rapidly expanding urban development and conversion of remaining glade/open woodland habitat. These trends suggest that loss of glade/woodland habitat will continue at a steady, rapid pace for several decades with corresponding loss of glade species diversity. The availability of glade/woodland habitat of sufficient size to ensure viability for some species, like Bachman’s sparrow and painted bunting, is currently unpredictable on the Mark Twain based on current estimates of population size.

The total area of glade coverage increases moderately for Alternatives 2 and 3 within ten years, especially for structural components (elimination of red cedar), and increases substantially within 50 years for the projected amounts of remaining red cedar to be removed. At the present rate, Alternative 5 would provide the least increase in glade treatments above the present quantity (1,000 acres red cedar removal per decade).

Open Woodland Management Indicator

Open woodland natural communities once covered an estimated 538,500 acres of the Mark Twain NF (Table 12). Shortleaf pine, post oak, white oak and chinquapin oak formed important dominant tree associations along with a nearly 100% grass and forb groundcover. Nearly 700 plant species native to Missouri occur in open woodlands with nearly 300 documented in pine woodlands alone. A combination of severe harvest through the early 1900’s, overgrazing and fire suppression degraded them over the past century. Most open woodlands are now overly dense with slow-growing, small diameter trees, deep leaf litter and lacking in ground flora richness and cover. Much of the former shortleaf pine-dominated woodland has changed to other dominant vegetation, especially red and black oak. Oak decline is linked to former open and closed woodland vegetation along with the decline of species at risk. Treatment objectives in Alternatives 1-4 would move open woodlands toward their desired condition through combinations of thinning and prescribed burns. The amount of open woodland projected for treatments varies from 1 to 17% across ecological subsections in proportion to the percentage of MP 1.1 and 1.2 by alternative.

Direct and Indirect Effects to Open Woodland Management Indicator

It will take 1-2 decades to begin recovering and stabilizing groundcover grasses, shrubs and forbs employing a variety of combined silvicultural treatments and prescribed burning.

Recovery of woodland structure may take as little as a decade for old growth stands to as long as 60-80 years for stands containing young regenerating woody growth. Native grass and forb diversity are expected to increase through the first decade and maintain dominance as canopy trees mature. The amount of recovery and desirable changes in bird and small mammal communities, insect pollinators and other species that represent woodland natural communities should generally take 1-2 decades.

Alternative 1

This alternative does not permit commercial timber harvest. Prescribed burning for purposes of restoring ecosystems, is limited primarily to MP 1.1 and 1.2. It is difficult to determine how much open woodland would be restored given the constraints of non-commercial harvest methods. Intermediate thinning would require funding for the cost of felling trees. Prescribed burning alone may restore some woodland; however, the effects vary greatly for closed, dense, high basal area stands. The amount of open woodland could increase in Alternative 1 in MP 1.1 and 1.2 providing prescribed burns are hot enough to remove understory and some canopy trees in overstocked stands. Prescribed burns are difficult and risky to execute under climatic and fuel conditions that provide these effects, especially in thick dense shortleaf pine and red cedar stands. As a result, plant and animal species characteristic of woodlands, including species at risk, would continue declining as undesirable second growth woody species mature and shade/leaf litter increases.

Alternatives 2, 3 and 4

Alternatives 2, 3 and 4 provide relative percentage ranges of open woodland natural communities as displayed in the goals and objectives tables for MP 1.1 and 1.2. The amount of acres treated varies in proportion to the percent increase or decrease from Alternative 3. Total acres projected for management treatments to restore woodlands would just meet the minimum target acres identified in the Ozarks Ecoregional Conservation Assessment.

Alternative 5

Alternative 5 currently allows restoration of woodland natural communities, primarily in management prescriptions 3.4, 4.1 and 4.2. Requirements for old growth shortleaf pine savannas are listed on IV-57-1. Management prescriptions 3.1, 4.2, 5.1, 6.1 and 6.2 in Alternative 5 emphasize limited investments for ecosystem restoration. Certain standards and guidelines limit the ability of the Forest to effectively move degraded natural communities toward the desired condition. Pre-commercial thinning is prohibited on over 512,000 acres of the Forest. No pre-commercial thinning is allowed in MP 3.1, 3.3 or 4.2. No release is allowed in MP 3.1, 3.2, 3.3 and 6.1and 7.1. The large amount of intermediate thinning planned in this alternative would not reduce basal area to restore natural community types in most areas. The current plan provides little proactive, detailed guidance regarding where and at what scale to focus ecosystem restoration management activities across the Forest although some project initiatives like Pineknot, are moving limited acres toward woodland conditions.

Cumulative Effects

The Missouri Department of Conservation is actively managing fire-dependent woodlands on approximately 150,000 acres scattered across the Ozarks, averaging over 20,000 acres of prescribed burns annually. The largest area of conservation lands is approximately 67,000 acres in the Current River Hills Subsection. Many of these treatments fall within the portfolio areas shared by Mark Twain NF lands (TNC 2003). A large portion of these woodland and savanna natural communities are concentrated in distinct, isolated portfolio areas outside Forest boundaries (Caney Hills (MDC), Drury-Mincy (MDC), St. Francois Mountains (DNR, MDC, USFS), Pickle Creek Complex (DNR, MDC), Mudlick Mountain (DNR, MDC) and

Western Ozarks Savanna (DNR, MDC)). The Missouri Department of Natural Resources is restoring woodlands on about 40,000 acres across the Ozarks, mostly in the above-referenced portfolio areas. The Nature Conservancy cooperates with state and federal agencies in actively restoring woodlands. If combined with projected US Forest Service acres for active woodland restoration, all woodland restoration projects should meet the minimum needs for woodland natural community complexes identified in the OECA.

An estimated 6 million acres of degraded, fragmented woodland remains across Missouri (Nelson 2005), with most occurring in the Ozark Highlands Section. Much of the privately owned woodland is either grazed or overgrown in densely stocked woody growth. Most of the historical groundcover of grass and forb has been removed by grazing, is sparse, or has been replaced by non-native cool season grasses. Management to restore or maintain the ecological integrity of historical woodlands on private lands is confined to areas of the Osage River Hills (a subsection outside any Mark Twain units) and a few small sites in the White River Hills. Trends in the expansion/conversion of woodlands to non-native pasture suggest that most privately owned woodland would continue degrading at a steady, rapid pace for the next several decades with corresponding loss of species diversity. The availability of glade/woodland habitat of sufficient size to ensure viability for some species (Bachman's sparrow, brown-headed nuthatch, prairie warbler, whip-poor-will) is currently unpredictable on the Mark Twain NF based on current estimates of population size.

The total area of woodland coverage would increase moderately for Alternatives 2 and 3 within ten years with approximately 25% of the estimated woodland in MP 1.1 and 1.2 treated, especially for structural components (reduction in basal area and increase in canopy openness), and increases in groundcover flora. At the present rate, Alternative 5 would provide the least increase in woodland treatments above the present quantity (1,000 acres red cedar removal per decade). Alternative 3 would phase in treatments to restore woodlands within a 50-year period in response to OECA viability projections and provide opportunities to select high quality, operational projects through conservation planning. Alternative 1 would limit the progressive restoration of woodlands with decreases in associated woodland flora and fauna likely over a 50-year period. Alternative 4 would phase in treatments for most of the MP 1.1 and 1.2 areas over a 50-year period, but this would just meet minimum viability acres identified in OECA. Because Alternative 5 provides no direction regarding proactive restoration of woodland natural communities, long-term achievement of desired conditions to meet OECA needs would have to rely on diagnostic, reactive Plan amendments only (Example: Pineknot 8.1 for pine savanna restoration).

Groundwater (Ozark Fen and Acid Seep) Management Indicator

Ozark fens and seeps are natural communities that harbor federal, state, and Regional Forester Sensitive Species. Over 100 plants native to Missouri occur in fens and acid seeps. They are naturally limited in abundance with 42 significant or exceptional fen features recorded by the Natural Heritage Database occurring on the Mark Twain, primarily in the Current River Hills, Gasconade River Hills and White River Hills subsections. A significant acid seep complex occurs in the Black River Ozark Border on the Poplar Bluff Ranger District. Their current condition indicates they are in need of management to restore their hydrologic and biologic integrity. Most Ozark fens and seeps vary in the occurrence and dominance of plant and animal species. The objective for treatment of these habitats is to reduce accumulated thatch and invasion by woody species, thereby increasing the amount, vigor and distribution of native ground flora and fauna. Some 11 areas totaling 889 acres are targeted for treatments across the Mark Twain NF in Alternatives 1-4.

Direct and Indirect Effects to Groundwater Natural Communities

Alternatives 1 through 4

Fens and seeps may be afforded active management under Alternatives 1 thru 4 given their 8.1 designations. However, MP 1.1 and 1.2 may afford them greater protection because larger portions of other associated natural communities within fen watersheds may be actively restored. Alternatives 2 and 3 afford the greatest opportunity to expand protection of fens and seeps given the relative size of the management prescription (663,800 and 438,400 acres respectively.) Alternatives 1 and 4 likely include the least amount of expanded buffer for fens (120,400 acres respectively).

Alternative 5

Alternative 5 differs in that many recently discovered fens listed in the Natural Heritage Database are not designated as MP 8.1. Further, the existing Plan provides no guidance on the active management/restoration of fens. Proposed Plan amendments are under study to delineate highly significant fen areas under MP 8.1.

Cumulative Effects

In general, objectives in MP 1.1 and 1.2 provide direction for the eventual evaluation/treatment of major fen complexes for Alternatives 1, 2, 3 and 4 on the Mark Twain NF. All alternatives provide a greater improvement through ecosystem restoration. Alternative 5 contains essentially passive management standards and guidelines. Fen/seep restoration projects are diagnostic and reactive only. Populations of fen/seep-associated Regional Forester Sensitive Species and general biodiversity may remain stable in the short term (first decade) based on past trends, but may decrease in the long-term without treatments under Alternative 5. The fen and seep natural community management indicator would best respond to Alternatives 2, 3 and 4. In Alternative 1, some fen complexes may be impacted by loss of groundwater due to silvicultural restrictions on restoration of woodland structure and groundcover flora.

Management Indicator Species: Animal

Each Management Indicator Species (MIS) will be discussed individually in this section. However, the direct and indirect effects to individuals are common for all species, and therefore will be discussed first. Management Indicator Species serve as an “umbrella” to consider potential effects on all vertebrate species that occur on the Mark Twain NF because:

- Their habitat is also needed by many other species,
- They play a key role as surrogates for ecological processes, and
- They convey information about the status and integrity of the natural communities in which they occur.

Therefore, effects to these species may indicate similar effects on other species and natural communities. We selected a limited number of MIS because of the scientific limitations on using individual species to represent entire groups of other species.

Direct and Indirect Effects to individuals

Since the Forest Plan makes no decisions regarding site-specific activities, the discussion of direct and indirect effects to individuals of a species is general, and only describes effects that may be possible. The actual occurrence of effects and impact of those effects cannot be described or analyzed at this level. Analysis of potential site-specific effects would take place as projects to implement the Forest Plan are proposed.

This analysis focuses on how possible effects might differ between alternatives due to different land allocations.

The five MIS animals chosen have differing life history requirements, as shown in Table 16 below. However, effects to individuals are in large part dependent on effects to the vegetation they depend on. Therefore, possible effects can be discussed in general for all these species.

Table 16 - Life History Needs of Animal MIS

MIS Species	Feeding method	Feeding sites	Nest Sites	Other
Summer tanager	Glean/flycatch	Ground/shrubs/trees	Shrubs/trees	
Northern bobwhite	Glean/browse	Ground/herbaceous vegetation	Ground	
Worm-eating warbler	Glean	Ground/shrubs/trees	Ground	Area sensitive
Bachman's sparrow	Ground search	Herbaceous vegetation	Ground	
Red bat	Glean/flycatch	Air/herbaceous veg/tree leaves	Trees	Active at night

Each alternative has varying amounts of each management prescription. The emphasis of each area is different, and implies that the future composition, structure, and disturbance patterns of vegetation within them would also be different. To create and maintain these vegetation patterns, various techniques would be used. Activities which remove or alter vegetation structure and/or composition, or which disturb the ground have potential to impact individuals of these species, as well as others that they represent. On the Mark Twain, these activities may include:

- tree harvest through commercial or non-commercial methods
- prescribed or wild fire
- maintenance, reconstruction, or construction of permanent and/or temporary roads.

Other types of decisions that affect the composition and structure of vegetation include:

- Amount of area to be regenerated with even-age silvicultural systems
- Designation of old growth or other special areas
- Control of non-native invasive species (NNIS).

Effects of Management Activities on Management Indicator Species

Tree harvest

Since summer tanager, worm-eating warbler and red bat use trees to nest and feed, tree harvest, which could occur in any alternative, may have direct and indirect effects. Tree harvest during nesting and brood rearing season may inadvertently destroy bird nests or young unable to fly. Tree harvest may also cause roosting red bats to fly, using additional energy to find a new tree roost. Tree harvest for even-aged regeneration may make some areas of the Mark Twain NF temporarily unsuitable as habitat during the time approximately 15-25 years after the harvest, as this successional stage is normally too dense for most species to use. However, most types of tree harvest would have indirect benefits by opening up the canopy, allowing more light to reach the ground, and encouraging growth of herbaceous vegetation and insect abundance. In the long-term, this would create a continuous supply of suitable habitat well-distributed across the Mark Twain NF.

Tree harvest creates a mosaic of varying age and size classes in close proximity to one another. This mix of structural stages is one type of fragmentation, and creates gaps in the canopy as well as edges between young and mature forest/woodland. This type of fragmentation is also present in natural systems where natural mortality creates gaps in the canopy and gradations in age or size of dominant plant species. In some cases, this can increase the vulnerability of nests and young to predation, or cause birds to seek other nesting sites further from an edge. Nesting and fledging success may be compromised along these edges. Whether or not these effects to individuals lead to significant changes in population trends probably depends on a combination of circumstances. For summer tanager, population trends in Missouri and the Ozark-Ouachita Physiographic Region suggest that it is not a significant problem for this species.

Breeding Bird survey information for Missouri shows that about the same proportion of neotropical migrant birds have significant positive trend estimates (0.20) as have significant negative trend estimates (0.22) from 1966-2003 (Sauer et al. 2004). Mid-story or canopy nesters have almost twice as many significant positive trends (0.30) as significant negative trends (0.17) during the same time period. Cavity nesters also have a greater proportion in significant positive trends (0.26) than significant negative trends (0.21). Ground nesters seem to be most hard-hit with significant negative trends (0.42), and much fewer significant positive trends (0.16) (Sauer et al. 2004). Open-cup nesters have slightly higher significant negative trends (0.32) than significant positive trends (0.25) (Sauer et al. 2004).

This intermixing of age and size classes can also be an important habitat component for some species. Summer tanagers and red bats are known to forage near edges and canopy gaps. Worm-eating warblers have nested in 7-year-old clearcuts with hardwood reserve trees. They are most abundant in mature woods but also may be common in young and medium-aged stands (NatureServe 2004). Bachman's sparrows require shrubby conditions created by even-aged regeneration harvest for nesting.

Fragmentation of habitat by permanently converting tree cover to non-forest uses would not occur in any of the alternatives. Therefore, Mark Twain NF would not contribute to landscape fragmentation that increases agricultural or urban areas at the expense of tree cover, and increases the potential for cowbird populations to increase and thrive. Breeding bird survey data for 1966-2003 and from 1980-2003 both show slight negative trends for cowbirds in Missouri and the Ozark Ouachita Plateau (Sauer et al. 2004). In all alternatives, Mark Twain NF would remain over 90% tree cover. The landscape matrix for much of Mark Twain NF lands would remain above 70%, even considering private lands within Mark Twain NF proclamation boundary. This type of landscape does not support the same type of cowbird populations as landscapes that are less forested with more interspersed agriculture and pasture land (Clawson et al. in Shifley and Kabrick, eds. 2000). In fact, the lower Ozarks is considered a "source" for many neotropical migratory birds because reproduction is less affected by cowbird parasitism than in other parts of the Midwest (Fitzgerald and Pashley 2000). None of the alternatives would change the landscape matrix, or contribute to conditions favoring cowbird population increases.

The use of mechanized equipment to commercially harvest trees, construct temporary roads or skid trails, or to construct firelines, may also have direct and indirect effects on individuals of these species. Because all the MIS bird species nest on the ground or in shrubs (summer tanager uses trees as well as shrubs for nesting), the use of skidders or other heavy equipment during the breeding season could destroy nests or young unable to move out of the way. Mechanized equipment may also crush vegetation, making it unsuitable as a nesting place. These are localized adverse impacts to individuals, but do not appear to be major threats to the viability of the MIS species as a whole.

Alternative 1 has the least amount of tree harvest, temporary roads and skid trails and the second lowest amount of prescribed burning, and therefore has the least potential for these effects to occur, but also the least potential for long-term beneficial effects. Alternatives 2, 3, and 4 are similar in the amount of tree harvest, temporary roads and skid trails, and prescribed burning, so potential for effects would be similar. Alternative 5 has the most tree harvest, temporary roads and skid trails, but the least prescribed burning, and therefore the most potential for effects to occur.

Prescribed burning

Prescribed burning may have direct or indirect effects on all MIS. Direct effects are most likely if prescribed burns are conducted during the nesting/brood rearing season. Direct effects on red bat are also possible when prescribed burns are conducted during the hibernation season, when the bats may be roosting underneath leaf litter. Indirect effects may occur regardless of the timing of the burn.

Prescribed burns on Mark Twain NF are almost exclusively ground fuel driven (i.e. leaf litter, grasses, shrubs are the fuels which propel the fire). Trees may be scorched, but very rarely burn all the way to the top. MIS red bat and summer tanager normally roost/nest higher than fire would reach, and adults could fly away from any smoke created by a prescribed fire. Young birds incapable of flying (i.e. non-volant) may be exposed to smoke for a short period of time (normally less than a few hours), but effects on their long-term well-being are unknown. The remaining three MIS nest on the ground, with nests made of grasses, forbs, and feathers, which would be very susceptible to being damaged or destroyed by fire, depending on the nest's location, adjacent fuels, and fire intensity. Non-volant young would also be susceptible to being hurt or killed by fire. Large, landscape scale burns do not burn consistently throughout; i.e. there are places within the burn unit that do not burn at all, and other places where fire burns with very little intensity and burns in a mosaic pattern. Thus, not all ground nests within a burn unit are certain to be affected.

Red bats roost in leaf litter in winter, usually when temperatures fall below freezing, although some bats returned to tree roosts and others stayed in leaf litter when temperatures warmed (Mormann et al. 2004). Prescribed fires that occur during winter months may harm or kill red bats that are in deep torpor underneath leaf litter, although more research is needed to determine if red bats have an evolutionary mechanism to escape ground fires, or if the species' population is being affected by the use of prescribed fire. Mark Twain NF prescribed burn specialists have seen bats fly up from the leaf litter on the ground and leave burn units enough over the past 20 years to suggest that the bats may have some mechanism to sense an approaching fire and avoid it .

Indirect effects of prescribed burns are a reduction in midstory canopy, an increase in ground flora abundance and variety, and a subsequent increase in insect variety and abundance. The overall effect of continued prescribed fire would be a healthy species composition, structure and functioning that would provide quality habitat for all the MIS.

Old Growth

Old growth in varying types and amounts would be present in all the alternatives. Permanent old growth would be designated in all alternatives, and natural community old growth would be present as part of the range of natural variability in MP's 1.1 and 1.2. None of the MIS are obligate old growth users, but all would use old growth areas which had attributes which met their habitat needs. For instance, both northern bobwhite and Bachman's sparrow could certainly be present in old growth pine woodlands that had scattered large pine trees over an abundant herbaceous ground cover. Summer tanager and red bat could forage easily in oak flatwoods old growth. Worm-eating warbler would find appropriate habitat in mesic old growth bottomlands or northeast slopes, where dense understories were present.

Non-native invasive species

One non-native invasive species has potential to adversely impact 3 or 4 of the 5 MIS. Feral hogs have probably been present in small numbers on the Mark Twain NF sporadically since the late 1960's when open range ended. However, the problem became significant in the early 1990's when illegal releases of feral hogs increased dramatically. These animals are increasing in number and extent across the Mark Twain NF. They root in the soil and can cause extensive damage to vegetation and soil. Feral hogs also eat the eggs or young of ground nesting birds, which 3 of the 5 MIS are. Control efforts to date have consisted of shooting and trapping hogs, with limited success. As long as illegal releases continue, all the Mark Twain NF can do is to continue destroying the animals wherever and whenever possible. Mark Twain NF is also working with MDC and APHIS to develop additional control measures.

Non-native invasive plant species also have the potential to out-compete native plants and simplify the plant and insect communities across the Mark Twain NF. This has implications for insect-eating species such as all 5 of the MIS. However, what actual impacts this might have are unknown. In Alternatives 1-4, control of NNIS is based on risk to resources, as well as other factors. Some steps are taken to reduce potential for new infestations. In Alternative 5, NNIS control complies with state law, but there is no other direction to minimize new occurrences.

Effects of Alternatives on Management Indicator Species

Alternative 1

Alternative 1 has most of the Mark Twain NF (77%) with an emphasis on providing motorized semi-primitive recreation opportunities and experiences. There would be no commercial tree harvest, but tree harvest by non-commercial means would be done in MP 1.1 and 1.2 to restore and enhance natural communities. Prescribed fire would also be a disturbance method used throughout the Mark Twain NF. Miles of maintained National Forest System road would decrease, resulting in reduced motorized access and the opportunity for motorized recreational activities would be reduced, while opportunities for non-motorized recreational activities would increase. There would be minimal even-aged regeneration done, and old growth would be designated on a percentage of the Mark Twain NF. NNIS control would be based on assessment of risk, among other factors, and would be similar to Alternatives 2-4.

In both the short and long-term, this alternative would result in vegetation conditions that perpetuate existing dense, overstocked, slow-growing forest natural communities, in some cases with tree species that are not historically dominant on those sites. Herbaceous ground cover would continue to be stunted and sparse under these closed canopies. This alternative also results in a large proportion of the Mark Twain NF in older age classes, with very little early successional habitat available. Older age classes would consist primarily of "artifact" old growth, or older age classes of dense, overstocked forest communities on sites that were historically more open, with more open old growth conditions. In other words, while a large amount of "old growth" would be available, conditions would be dissimilar to historic old growth that occurred within woodland natural communities and outside of the range of natural variability for these communities.

Summer tanager, red bat, northern bobwhite, and Bachman's sparrow, all require more open conditions and in the latter two species, a thriving ground cover of herbaceous vegetation, which supports a varied and abundant insect community. In the short term, all four of these species would find habitat conditions much the same as the existing condition and populations would be stable at the current levels. However, in the long-term, vegetative conditions would not improve for these species, and in many areas of the Mark Twain NF, would become less suitable. It is likely that population trends for these species would decline in the long-term under Alternative 1. There is a high likelihood that Bachman's sparrow would be extirpated from Missouri due to lack of open woodland and early successional habitat. In addition, savanna and open woodland species, as well as early successional species, would also most likely have declining populations under Alternative 1.

Worm-eating warblers primary requirement seems to be large areas of hardwood tree cover with dense understories. In Alternative 1, the amount, type, and configuration of tree cover would not change substantially on Mark Twain NF, so habitat for this MIS is expected to be stable in both the short and long-term under Alternative 1.

Alternatives 2 and 3

Alternatives 2 and 3 have a large part of the Mark Twain NF (44% and 29% respectively) with an emphasis on natural community restoration and enhancement. Within these prescriptions, much of the structure would be altered, and some changes in species composition would occur. The major types of disturbance would be commercial and non-commercial tree harvest and prescribed fire. No noticeable changes would be made to the current transportation system for Alternatives 2 and 3. The public’s ability to access the Mark Twain NF by motorized vehicles is not expected to change significantly for Alternatives 2 and 3.

About 7% of Mark Twain NF would receive even-aged regeneration harvest over a 10-year period. Old growth would be designated on a percentage of MP 2.1, but in MP 1.1 and 1.2, old growth would develop naturally as part of the restoration and enhancement of natural communities. NNIS control would be based on assessment of risk, among other factors, and would be similar to Alternatives 1 and 4.

In both the short and long-term, this alternative would result in vegetation conditions that are changing across a good part of the Mark Twain NF to canopies that are more open, more abundant and diverse ground cover, and increasing dominance of shortleaf pine on its historical sites. Insect populations would likely respond to increased ground cover by also becoming more abundant and diverse, thereby providing a food source that is varied and easily available.

Summer tanager, red bat, northern bobwhite, and Bachman’s sparrow, all require the kind of open conditions that would be created and maintained in MP 1.1 and 1.2. Bachman’s sparrow would also benefit from areas where shortleaf pine is returned to dominance on its historical sites, and where red cedar is removed from glades. In the short term, only a small portion of the Mark Twain NF would reach these conditions, and population trends of these species would likely be stable. In the long-term, there would be substantially more habitat available for these MIS, and population trends are likely to increase in the future under Alternatives 2 and 3.

Worm-eating warblers primary requirement seems to be large areas of hardwood tree cover with dense understories. In Alternatives 2 and 3, the amount of tree cover would not change substantially on Mark Twain NF, but composition and structure would change appreciably on a large part of the Forest. However, worm-eating warblers are apparently able to use a variety of tree ages and sizes that have had a variety of silvicultural treatments. Habitat for this MIS is expected to be stable in both the short and long-term under Alternatives 2 and 3.

Alternatives 4 and 5

Alternatives 4 and 5 would look the most similar to current conditions. Commercial timber harvest and prescribed fire would be the primary types of disturbance. No noticeable changes would be made to the current transportation system for Alternatives 4 and 5. The public's ability to access the Mark Twain NF by motorized vehicles is not expected to change significantly for Alternatives 4 and 5.

About 7-8% of Mark Twain NF would receive even-aged regeneration harvest over a 10-year period. In Alternative 4, old growth would be designated on a percentage of MP 2.1, but in MP 1.1 and 1.2, old growth would develop naturally as part of the restoration and enhancement of natural communities. Since Alternative 5 does not have MP's 1.1, 1.2 or 2.1, old growth would be designated on a portion of the Mark Twain NF based on MP and Landtype Association. NNIS control would be based on assessment of risk, among other factors, and would be similar to Alternatives 1-3.

In both the short and long-term, these alternatives result in vegetation conditions that are similar to current conditions. A variety of ages, sizes, and types of tree cover would be present. In Alternative 4, the amount of shortleaf pine would increase across the Mark Twain NF in proportion to oak as artificial regeneration restores shortleaf pine to many of its historic sites (i.e. where black and scarlet oak exist today). Insect populations would also be similar in type and amount to what exists today. Alternative 4 has about 8% of Mark Twain NF in MP1.1 and 1.2, and habitat conditions in these areas would be similar to that described in Alternatives 2 and 3. However, the amount present would be small enough that the impact on MIS would not be significant.

In Alternative 5, the amount, type, and composition of tree cover would not change substantially on Mark Twain NF. Habitat conditions for all MIS would be very similar to current conditions, and therefore, population trends of all MIS are expected to be stable in both the short and long-term under Alternative 5. For Alternative 4, although there would be substantially more shortleaf pine present on the Mark Twain NF, the structure, disturbances, and management of those areas would be similar to other areas of shortleaf pine today. The Bachman's sparrow is the MIS representative of pine woodland natural communities, but this species requires more open conditions than would be maintained on the majority of sites, and therefore Alternative 4 would not result in vegetation changes that are significant to any of the MIS.

Cumulative effects

The cumulative effects area for MIS is the twenty-nine county area in which Mark Twain NF lands occur. The greatest impact to any of the MIS is the continued development and conversion of private forested lands to urban or agricultural uses. This trend is expected to continue in the short and long-term within the cumulative effects area. Mark Twain NF will remain over 90% in tree cover, and it is likely that other state and federal ownerships across the state will be primarily forested too. In addition, there are several large private ownerships in tree cover that would probably remain so in the foreseeable future.

Because summer tanager is able to adapt to some developed areas with open, park-like characteristics, continued development and conversion of private forested lands to urban or agricultural uses may not affect summer tanagers as much as some other, less tolerant, species. However, the lack of open woodlands on Mark Twain NF in Alternative 1 would have some minor negative impacts on summer tanagers in the cumulative effects area. Activities on Mark Twain NF under Alternatives 2-5 would not contribute toward impacts to this species, or others with similar habitat needs.

The future of northern bobwhite in Missouri, as in the rest of its range, is much more dependent on what management activities do or do not occur on other ownerships than on National Forest lands. Continued clean farming, emphasis on exotic, cool season pasture/hay grasses and development of wild lands for urban and agricultural uses will continue to decrease the amount and quality of available northern bobwhite habitat across the state. The decrease of early successional habitat on Mark Twain NF in Alternative 1 would add to adverse impacts on other ownerships, resulting in questionable viability in the long-term for northern bobwhite in Alternative 1.

Because of the large area inhabited by Bachman's sparrows, Mark Twain NF has little influence on the cumulative effect to this species in the next 10 years. Any gains in habitat on Mark Twain NF will probably be offset and maybe even decreased by the reduction in habitat on private lands in all alternatives. The best we can hope for is to maintain a stable habitat condition across the Missouri range. With the decrease of early successional habitat in Alternative 1, long-term viability of Bachman's sparrows is questionable at best. If this alternative is implemented, it is probable that Bachman's sparrow would become extirpated from Missouri.

One of the most significant new threats to red bats, as for other migratory bats, may be the dramatic increase in wind turbines across the eastern United States. Apparently, red bats and hoary bats are disproportionately injured or killed by contact with operating wind turbines; estimates are that up to 300 red bats per night per tower could be killed (Amelon, personal communication). However, no alternative would contribute to this threat, as there are currently no wind towers permitted on Mark Twain NF and no outstanding applications for this type structure. Continued viability of red bats is not in question in the short term, and probably not in the long-term. Habitat for red bat should be available across the state in about the same amount as it is currently, and viability would be consistent with current conditions.

Species at Risk (SAR)

Species at risk (SAR) include Federally listed threatened and endangered species, Regional Forester Sensitive Species (RFSS), State-listed endangered species, migratory birds and bats, and other species with viability concerns.

Species with Viability Concerns

The 1982 Planning Regulations (CFR 219.19) require that Forest Plans provide direction to manage fish and wildlife habitat to maintain the viability of populations of plant and animal species on national forest lands.

Analysis Area

The analysis area for species with viability concerns is Mark Twain NF lands for direct and indirect effects, and the twenty-nine county area in which Mark Twain NF lands are located for the cumulative effects area. Effects are considered in the short-term (10 years) and long-term (100 years).

Species Viability Evaluation

The Mark Twain National Forest used a Species Viability Evaluation (SVE) to determine which species may have viability concerns on Mark Twain NF lands, and whether or not changes were needed to the 1986 Forest Plan in order to maintain ecological conditions that provide well-distributed habitat across the landscape that supports viability of all species. Documentation for this process, including current status of individual species' populations and habitats, is found in the Project File.

To evaluate potential ecological sustainability effects on SAR, the following factors, which are tabulated in charts and graphs, were considered:

- Threats and risks to each SAR, and whether or not those occur on Mark Twain NF lands;
- Viability outcomes for each SAR,
- Which species had significant viability concerns on Mark Twain NF, as well as those species which do not have significant viability concerns on Mark Twain NF,
- Which SAR are addressed by each Conservation Approach,
- If Conservation Approaches are met by each alternative,
- Habitat and population objectives for TES, RFSS, and MIS, and
- How well habitat and population objectives were met by each alternative.

All federally listed and candidate species that could occur on or be affected by Mark Twain NF were included in the SVE process. All but 8 of the 112 RFSS species were included in the SVE process. Those 8 are discussed in the RFSS section of the EIS. All State Endangered species that could occur on or be affected by Mark Twain NF were included in the SVE process. Other species that may have viability concerns were identified through review of Partners in Flight (PIF) plans, Fish and Wildlife Service documents, and discussions with species experts.

Table 17 - Species Included in SVE Process

Mammals	**Fish**	**Amphibians**
Gray bat	Lake sturgeon	Ringed salamander
Eastern small-footed bat	Alabama shad	Mole salamander
Indiana bat	Crystal darter	Eastern tiger salamander
Plains spotted skunk	Current river saddled darter	Eastern hellbender
Swamp rabbit	Blacknose shiner	Ozark hellbender
Birds	Ozark shiner	Four-toed salamander
Sharp-shinned hawk	Sabine shiner	Northern crayfish frog
Bachman's sparrow	Topeka shiner	**Naiads**
Whip-poor-will	Checkered madtom	Tumbling creek cavesnail
Northern harrier	Bluestripe darter	Spectaclecase
Northern bobwhite	Longnose darter	Western fanshell
Cerulean warbler	Stargazing darter	Curtis pearlymussel
Prairie warbler	Eastern slim minnow	Snuffbox
Bald eagle	**Reptiles**	Pink mucket
Worm-eating warbler	Timber rattlesnake	Scaleshell
Loggerhead shrike	Eastern collared lizard	Ouachita kidneyshell
Swainson's warbler	Alligator snapping turtle	Rabbitsfoot
Red-headed woodpecker	**Insects**	Purple lilliput
Kentucky warbler	Ozark snaketail dragonfly	Bluff vertigo
Summer tanager	A springtail	**Crayfish**
Field sparrow	Hine's emerald dragonfly	Coldwater crayfish
Blue-winged warbler	Ozark emerald dragonfly	Meek's crayfish
Bell’s vireo	A heptageniid mayfly	Big Creek crayfish
		St. Francis River crayfish
		William's crayfish

Proposed Changes

Emphasis would change from achievement of specific habitat units to providing the full range of environmental conditions with which native Missouri species evolved. Two new Management Prescriptions have been developed which emphasize the restoration and enhancement of terrestrial natural communities; Ecosystem level or Coarse Filter Approach. In addition, specific standards and guidelines are proposed for elements of individual species' needs that are not fully addressed at the ecosystem level; Species level or Fine Filter Approach. Specific direction for Federal T&E species and specialized habitats has been updated to reflect new information acquired since the 1986 Plan was approved.

The Ecosystem level and Species level directions comprise the Mark Twain NF's Conservation Approaches to contribute to the viability of all species. Our Conservation Approaches are (letters in parenthesis correspond to Table 18 below):

- Maintain riparian structure and function (A)
- Maintain free-flowing streams and rivers (B)
- Minimize sedimentation from National Forest lands (C)
- Maintain hydrologic integrity of wetland and lowland forest natural communities (D)
- Maintain forested landscapes (with all successional stages present) (E)
- Restore prescribed fire regimes and manage fire-adapted natural communities (F)
- Protect the structural and biological integrity of caves and reduce human disturbance to cave systems (G)
- Protect and manage known locations of species at risk (H)
- Retain den trees and snags, downed woody material (particularly large size) (I)
- Control non-native invasive species (J)

Table 18 shows the Conservation Approaches and the species and habitats they benefit.

Table 18 - Conservation Approaches

	Conservation Approaches									
	A	B	C	D	E	F	G	H	I	J
Mammals										
Gray bat	X	X	X		X		X	X		
Eastern small-footed bat					X		X	X		
Indiana bat					X	X	X	X	X	X
Plains spotted skunk					X	X		X	X	X
Swamp rabbit	X								X	X
Amphibians										
Ringed salamander				X					X	X
Mole salamander				X					X	X
Eastern tiger salamander				X						X
Eastern hellbender	X	X	X					X		X
Ozark hellbender	X	X	X					X		X
Four-toed salamander				X					X	X
Northern crayfish frog				X		X				X
Birds										
Sharp-shinned hawk					X					
Bachman's sparrow						X		X		X
Whip-poor-will					X					X

	Conservation Approaches									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Northern harrier								X		
Northern bobwhite						X				X
Cerulean warbler	X	X			X			X		
Prairie warbler						X				
Bald eagle	X	X						X		
Worm-eating warbler					X					
Loggerhead shrike								X		
Swainson’s warbler	X	X						X		
Red-headed woodpecker	X					X			X	X
Kentucky warbler	X			X	X					
Summer tanager						X				
Field sparrow						X				
Blue-winged warbler						X				
Bell’s vireo				X						
Crayfish										
Coldwater crayfish	X	X	X					X		
Meek’s crayfish	X	X	X					X		
Big Creek crayfish	X	X	X					X		
St. Francis River crayfish	X	X	X							X
William's crayfish	X	X	X					X		
Fish										
Lake sturgeon	X	X	X					X		
Alabama shad	X	X	X							
Crystal darter	X	X	X					X		
Current river saddled darter	X	X	X							
Blacknose shiner	X	X	X					X		
Ozark shiner	X	X	X					X		
Sabine shiner	X	X	X					X		
Topeka shiner	X	X	X					X		X
Checkered madtom	X	X	X							
Bluestripe darter	X	X	X					X		
Longnose darter	X	X	X					X		
Stargazing darter	X	X	X					X		
Eastern slim minnow	X	X	X					X		
Insects										
Ozark snaketail dragonfly	X	X	X	X				X		
A springtail							X	X		
Hine's emerald dragonfly	X	X	X	X		X		X		X
Ozark emerald dragonfly	X	X	X							
A heptageniid mayfly	X	X	X					X		
Naiads										
Tumbling Creek cavesnail	X	X	X			X	X	X		X
Spectaclecase	X	X	X					X		X
Western fanshell	X	X	X					X		X
Curtis pearlymussel	X	X	X					X		X
Snuffbox	X	X	X					X		X
Pink mucket	X	X	X					X		X
Scaleshell	X	X	X					X		X
Ouachita kidneyshell	X	X	X					X		X
Rabbitsfoot	X	X	X							X
Purple lilliput	X	X	X					X		X
Bluff vertigo					X			X		

	Conservation Approaches									
	A	B	C	D	E	F	G	H	I	J
Reptiles										
Timber rattlesnake					X				X	X
Eastern collared lizard						X				X
Alligator snapping turtle	X	X		X				X		
Habitats										
Stream/River/Spring Branch	X	X	X					X	X	X
Riparian	X							X	X	X
Pond/Lake			X	X				X	X	X
Wetland			X	X		X		X		X
Cave/Cliff							X	X		X
Glade						X		X		X
Upland Hardwood Forest					X			X	X	X
Open Woodland						X		X	X	X
Savanna						X		X	X	X
Grassland						X		X		X

Direct. Indirect and Cumulative Effects on Individuals

The Species at Risk comprises a diverse group of organisms with many different habitat needs and varying threats to their viability. The effects on individuals discussion focuses on these threats and the activities occurring on Mark Twain NF that might contribute to them. Table 19 shows the major threat groups for SAR, and the species most affected by each. The threat groups are:

- Loss of Habitat from Permanent Land Conversion
- Water Quality and Quantity Degradation or Alteration
- Loss or Reduction of Fire-Dependent Communities
- Collecting and/or Human Disturbance
- Competition/Predation/Parasitism
- Pesticide Contamination
- Seasonal Threats Outside Mark Twain NF

Table 19 - Threat Groupings for SVE Species

Loss of Habitat (66 species)	Water Quantity, Quality (38 species)	Loss of Fire Dependent Communities (14 species)
All 7 Amphibians	Ozark hellbender	Bachman's sparrow
All 17 Birds	Eastern hellbender	Bobwhite
All 5 Crayfish	All 5 Crayfish	Prairie warbler
All 13 Fish	All 13 Fish	Loggerhead shrike
All 5 Insects	All 5 Insects	Red-headed woodpecker
All 5 Mammals	Gray bat	Summer tanager
All 11 Naiads	Indiana bat	Field sparrow
All 3 Reptiles	All 9 mussels	Blue-winged warbler
	Tumbling Creek cavesnail	Bell's vireo
	Alligator snapping turtle	Indiana bat
		Hine's emerald dragonfly
		Ozark snaketail dragonfly
		Ozark emerald dragonfly
		Collared lizard

Competition/ Predation/ Parasitism (34 species)	Collecting or Human Disturbance (17 species)	Pesticides (12 species)
Ringed salamander	Eastern tiger salamander	Northern crayfish frog
Mole salamander	Ozark hellbender	Ringed salamander
Eastern tiger salamander	Eastern hellbender	Mole salamander
Ozark hellbender	Coldwater crayfish	Eastern tiger salamander
Eastern hellbender	Bald eagle (illegal shooting)	Four-toed salamander
Bobwhite	Northern harrier	Eastern hellbender
Cerulean warbler	Swainson's warbler	Sharp-shinned hawk
Prairie warbler	A springtail	Whip-poor-will
Loggerhead shrike	Gray bat	Loggerhead shrike
Red-headed woodpecker (starlings)	Indiana bat	Gray bat
Kentucky warbler	Swamp rabbit (hunting)	Indiana bat
Summer tanager	Spotted skunk (trapping)	Spotted skunk
Field sparrow	Bluff vertigo	
Blue-winged warbler	Tumbling Creek cavesnail	
Bell's vireo	Timber rattlesnake	
St. Francis River crayfish	Collared lizard	
A springtail	Alligator snapping turtle	
All 9 mussels	**Threats on seasonal habitat outside MTNF (8 species)**	
Four-toed salamander	Sharp-shinned hawk	
Northern crayfish frog	Cerulean warbler	
Timber rattlesnake	Prairie warbler	
Eastern collared lizard	Worm-eating warbler	
Bachman’s sparrow	Kentucky warbler	
Whip-poor-will	Summer tanager	
Hine’s emerald dragonfly	Bell's vireo	
Tumbling Creek cavesnail	Indiana bat	

Loss of Habitat from Permanent Land Conversion

Loss of habitat through conversion of suitable habitat to other non-suitable conditions is probably the primary threat for all species on all ownerships. This loss may be conversion of riparian forest natural communities to agriculture, conversion of forest or woodland natural communities to urban development, blocking a cave entrance so it is unusable, draining or filling a wetland to build a factory, converting native prairie to exotic grasses, channelizing or impounding a stream, or a wide variety of other situations. All SAR are subject to some form of habitat loss. However, this threat is very unlikely to occur on Mark Twain NF lands, as conversion to non-forest land uses is extremely rare. The only “permanent” conversions would be where forest cover was removed to create new recreation developed sites (such as campgrounds and river accesses), construct new roads, or clear corridors for construction of new powerlines (under special use permit). In developed recreation sites, many trees are retained, and only a small portion of most would be an actual permanent change from forest cover.

The Mark Twain NF is currently over 90% tree cover, and is expected to remain about that in any alternative. There would be no conversion of Mark Twain NF lands for urban development.

From 1999 through 2004, about 60 acres of MTNF was converted from forest cover for special uses (43 acres of this was for the Highway 60 reconstruction). Normally, less than 10 acres per year are affected by special use permits. In this same time period, one new recreation developed sites was constructed, and one recreation site was expanded. Together, these two projects affected less than 10 acres of land. Also in this time period, no new roads were constructed. Even considering these impacts (about 0.005% of MTNF), MTNF is expected to remain over 90% tree cover over the Plan period.

Streams would not be impounded in any alternative, and riparian forest natural communities are likely to increase in acreage, rather than decrease, in all alternatives.

Cave entrances and wetlands are protected from physical alteration by specific standards and guidelines in all alternatives.

There is very little native prairie left, and all alternatives contain direction to manage native grasslands.

Cumulative Effects

No alternative would have loss of habitat through permanent land conversion on Mark Twain NF. Habitat loss from permanent land conversion is very unlikely to occur on other state or federal conservation agency ownerships in Missouri. Habitat loss of many types would continue on private ownerships, possibly at an accelerated rate in some of the twenty-nine county area. However, since Mark Twain NF activities would not cause direct or indirect effects, there would be no cumulative effects.

Water Quality and Quantity Degradation or Alteration

Threats to water quality and quantity are common to all of the aquatic SAR, including fish, mussels, hellbenders, alligator snapping turtle, some insects, and gray and Indiana bats, which eats aquatic insects. Primary threats to water quality and quantity from all ownerships include siltation, nutrient enrichment and pesticide runoff, and impoundments.

- On Mark Twain NF, impounding free-flowing streams is prohibited in all alternatives. The only impoundments constructed on Mark Twain NF are small wildlife waterholes and ponds of generally less than 2 acres as livestock watering facilities.
- Activities on Mark Twain NF that may cause siltation, nutrient enrichment, or pesticide runoff include road reconstruction and maintenance, timber harvest, prescribed burning, grazing, and some recreation uses. Road maintenance also has the potential to decrease sediment movement by maintaining proper drainage and sediment traps.
- More information on water quality and quantity effects can be found in the sections on Riparian Areas and Water Quality and Soils in this EIS.

All alternatives have standards and guidelines for protection of riparian corridors, water quality and minimizing soil movement. Alternative 1 has the least ground-disturbing activity, so the least potential for soil or water impacts. However, Alternative 1 has the least potential for long-term improvement of watershed condition and hydrologic regimes across the Mark Twain NF. Alternatives 2-5 have similar amounts of ground-disturbing activity, so are similar in the potential for impacts. Alternatives 2 and 3 have the most potential for long-term improvements in watershed quality as they have the most area subject to natural community restoration and enhancement.

Cumulative effects

Water quality is protected by best management practices on other state or federal conservation agency ownerships in Missouri. Activities that contribute to water quality degradation would continue on private ownerships, possibly at an accelerated rate in some of the twenty-nine county area. Mark Twain NF activities under any alternative have the potential for some sedimentation to reach area waters. However, the minor amount of sedimentation from National Forest lands and the limited National Forest ownership in most watersheds would not significantly increase water quality problems in the twenty-nine county area.

Loss or Reduction of Fire-Dependent Communities

A large number of native Missouri species are members of fire-dependent natural communities (Nelson 2005). At least three federal endangered (Hine's emerald dragonfly, Indiana bat, and Mead's milkweed) and one state endangered species (Bachman's sparrow) are among the SAR that would be affected by Mark Twain NF success in addressing this threat. A major threat to their viability is the continued lack of fire disturbance in those communities, because of fire suppression policies of the past 70 years.

- Most of Mark Twain NF is currently closed canopy, deciduous tree cover (see Vegetation Effects section), where the historic vegetation was primarily open and closed woodland, some savanna, and large glades on a part of Mark Twain NF.
- The lack of these communities and their distinctive structure and vegetative composition has reduced available habitat for several SAR. This lack is a direct result of a changed fire regime (i.e. fire suppression).
- More information on natural community effects can be found in the Ecosystem Sustainability section of this EIS.

Alternatives 2 and 3 have the most potential for fire-dependent communities to be restored, enhanced, and maintained due to the amount of area in MP 1.1 and 1.2 with emphasis on natural community restoration. Alternatives 1 and 4 have far less area in these Management Prescriptions, and therefore, less potential for fire-dependent communities and SAR to thrive. Alternative 1 has the least potential for fire-adapted natural communities to persist, because fire is only used for natural community restoration in the relatively small area of MP 1.1 and 1.2. In other areas of the Mark Twain NF, it would be used only for hazardous fuel reduction, and would not result in long-term improvement of fire-dependent communities in Alternative 1. Alternative 5 has no area in these Management Prescriptions and no particular emphasis for restoration of fire-dependent communities.

Cumulative effects

Other state and federal conservation agencies in Missouri also recognize the need to manage fire-dependent communities, and are working toward that effort on varying portions of their ownerships across the state. Private ownerships generally use prescribed fire to achieve objectives other than restoration of fire-dependent natural communities (i.e. forage improvement, cleaning up the woodlot, etc.). If fire-dependent natural communities are to be available in the amounts, sizes, and configurations that can support the flora and fauna that are a part of those communities, federal and state ownerships will have to provide them.

Implementation of Alternative 1 would contribute to an adverse cumulative effect across the twenty-nine county area, since so little area of Mark Twain NF would be managed with prescribed fire to benefit fire-dependent natural communities. Alternatives 4 and 5 would have minor cumulative effects since prescribed fire is used on more area of Mark Twain NF, but not necessarily to benefit fire-adapted natural communities. Some minor improvement in the condition of these natural communities would occur from prescribed fire used for other resource needs. Alternatives 2 and 3 have a beneficial cumulative effect on fire-dependent communities, since they include management of the most area for restoration of natural communities.

Collecting and/or Human Disturbance

Some species may be at risk from over-zealous collecting (usually illegal), for the pet trade, for private collections, for scientific study, or for commercial use (i.e. plants for medicinal purposes). This risk category also includes threats associated with hunting/trapping/fishing (i.e. swamp rabbit may still be taken legally and spotted skunk may be inadvertently trapped; darters may be inadvertently seined for fishing bait; endangered mussels may be mistaken for common ones, etc.).

- In all alternatives, collecting of any species must be authorized by permit on Mark Twain NF, and may also require a Missouri State permit and/or a permit from the US Fish and Wildlife Service. In the past 15 years, very few permits for plant or animal collection have been issued, and most have been for scientific study.
- Mark Twain NF lands are subject to State wildlife regulations in all alternatives.
- Illegal activities are difficult to discover or prosecute, but both State and Federal law enforcement agents patrol National Forest lands, and would continue to do so under any alternative.

All alternatives provide equal protection from illegal collecting and have provisions for limiting collecting if necessary to protect species viability.

Human disturbance is a major threat for some species. Eagle nests or young may be disrupted by activities close by; hibernating or summer roosting gray or Indiana bats may be disrupted by human visitation in caves. All alternatives have standards and guidelines for protection of eagle nests and bat caves.

Hellbenders, mussels or crayfish may be inadvertently injured or displaced by canoeists, and Swainson's warblers may exhibit behavioral changes if subjected to excessive calls from eager birders. Over the next 10 years, recreational activities on and near rivers on the Mark Twain NF are likely to be similar in amount and type to current activities. No specific standards and guidelines address recreational impacts to aquatic species in any alternative.

The timing of agricultural practices can destroy ground nests or young. All alternatives allow control of timing, duration and intensity of livestock grazing to achieve desired structure and species composition. During site-specific analysis of proposed agricultural practices, timing may be adjusted to minimize impacts to nesting birds, and still meet resource objectives, based on site-specific analysis of conditions.

Cumulative effects

Other state and federal conservation agencies have made efforts to limit human disturbance to bat caves and eagle nests/roosts on their ownerships. Private landowners may or may not provide protection to caves and eagle sites on their properties. Education of the public to recognize differences between species (i.e. spotted/striped skunks and swamp/cottontail rabbits) have been undertaken by the Missouri Department of Conservation. In all alternatives, Mark Twain NF would take steps to prevent or minimize human disturbances to species at risk. However, there may still be minor cumulative effects to some species from collecting and human disturbance.

Competition/Predation/Parasitism

Some species are at risk from competition with other native or non-native species, or from excessive predation/parasitism, many times exacerbated by human activities.

- Non-native zebra mussels and Asiatic clams are displacing mussels in many parts of their ranges. Neither of these species has yet appeared in Mark Twain NF streams or rivers, but zebra mussels do occur in the Missouri and Mississippi Rivers. Alternatives 1-4 have standards and guidelines to address treatment of NNIS when or where they are discovered. Alternative 5 does not address NNIS animals.

- At least one crayfish is being displaced or out-competed by another native crayfish that is used as bait (NatureServe 2004). This crayfish has been introduced into streams where it did not formerly occur when anglers empty their bait buckets. Alternatives 1-4 have standards and guidelines to address treatment of NNIS when or where they are discovered. Alternative 5 does not address NNIS animals.
- Salamander eggs and young are eaten by fish. The presence of fishless ponds and pools is important for salamander reproductive success throughout Mark Twain NF. All alternatives have standards and guidelines to provide fishless ponds and temporary pools throughout the Forest.
- Both Ozark and Eastern hellbenders may be prey for introduced non-native rainbow and brown trout (USDA Forest Service 2003b). Trout may also compete with hellbenders for prey. All streams on Mark Twain NF with known hellbender populations also contain non-native trout species. All alternatives allow additional stocking of trout in waters where they currently exist, but prohibit stocking in waters where they are currently absent.
- In recent years, an increasing number of feral hogs have been released deliberately and illegally onto Mark Twain NF lands in order to provide hunting opportunities. These animals can do a substantial amount of rooting and wallowing, and in the process cause damage to forest lands, contributing to soil erosion and stream siltation. Feral hogs are efficient predators and eat anything they can catch, including reptiles, amphibians, fawns and bird eggs, including turkey and quail. Feral hogs also compete with native wildlife for food, rooting up roots, berries, fruits and acorns with such efficiency that native species may find none left. Pseudorabies, a disease which some feral hogs carry, can fatally infect wild mammals, which can also pass the disease to hunting dogs. Feral hog rooting seriously disturbs native plant communities and affects the survivability of some plant species (Mead’s milkweed, running buffalo clover, Virginia sneezeweed), particularly in riparian areas. Feral hog activity can destroy fen habitats (Hine’s emerald dragonfly) and increase siltation of streams (pink mucket, scaleshell, Topeka shiner, Tumbling Creek cavesnail, gray bat, bald eagle). Of the 66 Species at Risk (SAR), all of the terrestrial amphibians, timber rattlesnake, eastern collared lizard, spotted skunk, swamp rabbit, ground and shrub nesting birds, and all of the habitats are at risk from the presence of this species.
- Breeding birds, particularly some neotropical migrants, have various levels of parasitism by brown-headed cowbirds, which reduces reproductive success for the host species. This effect is magnified in landscapes that are heavily fragmented by agricultural land, but seems to be much less severe in the heavily forested Missouri Ozarks landscape (Robinson et al. 1995, Donovan et al. 1995, Robinson et al. 1996, and Thompson et al. 1996 as cited in Fitzgerald and Pashley 2000). All alternatives are designed to provide a variety of habitats well distributed throughout the landscape. Tree cover would remain relatively constant for any alternative. The Partners in Flight Ozark/Ouachita Bird Conservation Plan agrees that “maintaining the forested landscapes needed to support source populations of forest birds is probably the single most important contribution that the physiographic region (Ozark Ouachita) can make to the conservation of non-game birds”(Fitzgerald and Pashley 2000).

- Breeding birds, particularly ground nesters, are also subject to predation by a host of mammal, reptile, and other bird species. This effect can be worse near forest or woodland/opening or young forest/mature forest edges (Robinson et al. 1995, Donovan et al. 1995 and Porneluzi and Faaborg 1999 as cited in Fitzgerald and Pashley 2000). All alternatives are designed to provide a variety of habitats well distributed throughout the landscape. Predation is a natural part of ecological systems that appears to be operating at a sustainable level in the Ozarks (Clawson et al. in Shifley and Kabrick, eds. 2000).

Cumulative effects

Competition, predation and parasitism would continue to occur across all ownerships, including Mark Twain NF, into the foreseeable future. All alternatives contain measures that would minimize human-caused alterations of these natural environmental functions. It is unclear what cumulative effects are to many species, because of a lack of knowledge about what their limiting factors truly are.

Pesticide Contamination

Effects from pesticides may still be a threat for some SAR, particularly those associated with prairie or wetland habitats, where agriculture is now the primary land use. Pesticides, primarily herbicides, are used on Mark Twain NF to reach various resource objectives. The major use is to control non-native invasive species or convert exotic cool-season grasses to native warm-season grasses. Some of these areas may be habitat for northern crayfish frog. In all alternatives, chemical use is restricted or prohibited within wetlands, the frequently flooded riparian area (Alternative 5) or within the Riparian Management Zone (RMZ) (Alternatives 1-4). All pesticide use must follow label directions. Insecticides are only used for incidental housekeeping purposes, such as “bee-boppers” to kill wasps, etc. in recreation areas. Due to these restrictions, pesticide runoff of any kind is unlikely to affect habitats occupied by SAR.

Cumulative effects

Pesticides are and will continue to be used on other ownerships across the twenty-nine county area. The amount and variety of pesticides used annually on other ownerships within the twenty-nine county area is collectively much more than those used annually on Mark Twain NF. With strict standards and guidelines directing use of pesticides on the Forest, there are unlikely to be direct or indirect effects, and thus no cumulative effects.

Seasonal Threats Outside Mark Twain NF

Migratory bird and bat species face threats in their wintering grounds that may affect populations, but over which Mark Twain NF has no control. The primary threat is loss of habitat through land conversion. Threats during migration include weather conditions, tall towers and buildings in migratory paths, predation, and loss of stop-over habitat due to land conversion. These threats are also outside the control of Mark Twain NF, but may affect population trends measured in Missouri or on Mark Twain NF.

Cumulative effects

Since these threats and potential effects occur outside Mark Twain NF, there are no direct effects and thus no cumulative effects.

Direct and Indirect Effect to Populations and Habitats

The SAR comprises a diverse group of organisms with many different habitat needs and varying threats to their viability. Populations and habitats effects discussion focuses on general habitat types and activities occurring on Mark Twain NF which might affect them. Population effects are discussed below under SVE Results. Table 20 shows the major habitat groups for SAR, and species typical of each. Habitat effects are discussed immediately below. The habitat groups are:

- Streams, Rivers, and Spring branches
- Riparian
- Ponds/Lakes
- Wetlands (Springs, Seeps, Fens, Sinkhole Ponds)
- Caves/Cliffs
- Glades
- Upland Hardwood Forest
- Open Woodland
- Savanna
- Grassland

In addition to 66 animal SAR, which were analyzed individually, 176 plant species were included in the SVE. Plant species at risk were analyzed in the context of their associated natural community/habitat associations. Each plant species was grouped into one or more habitats in which it can be found. Effects of Forest Plan revision on these habitats were then evaluated to determine potential effects on individual species. For many of the plant SARs, there is not enough information about that particular species' needs to make a reasoned analysis of effects. However, there is enough information about what habitats they are found in, and about those habitats in general to make a reasoned analysis of potential effects to habitat. In this way, potential impacts on plant biodiversity can be evaluated and considered, even where specific information on individual species is lacking. It is not necessary nor is it practical to have detailed information about all organisms and processes in an ecosystem to develop a management scheme based on maintaining the integrity of systems of natural communities (Hunter 1991).

Table 20 - Habitat Groups for Species at Risk

Streams, Rivers, Spring branches	Riparian	Pond/Lake	Wetland	Cave/Cliff
Eastern hellbender	Cerulean warbler	Ringed salamander	Ringed salamander	Bald eagle
Ozark hellbender	Bald eagle	Mole salamander	Mole salamander	White River midget crayfish
Four-toed salamander	Swainson's warbler	Eastern tiger salamander	Eastern tiger salamander	A springtail
All 5 crayfish species	Red-headed woodpecker	Four-toed salamander	Four-toed salamander	Eastern small-footed bat
All 13 fish species	Kentucky warbler	Bald eagle	Northern crayfish frog	Gray bat
Ozark snaketail dragonfly	Gray bat	Lake sturgeon	Northern harrier	Indiana bat
Ozark emerald dragonfly	Indiana bat	Indiana bat	Cerulean warbler	Tumbling creek cavesnail
A heptageniid mayfly	Swamp rabbit	Alligator snapping turtle	Bald eagle	Bluff vertigo
Gray bat			Worm-eating warbler	Timber rattlesnake
Indiana bat			Red-headed woodpecker	
All 9 mussels			Kentucky warbler	
Alligator snapping turtle			Blue-winged warbler	
			Bell's vireo	
			Ozark snaketail dragonfly	
			Hine's emerald	
			Gray bat	
			Indiana bat	
			Swamp rabbit	
			Alligator snapping turtle	
Upland Forest	**Open Woodland**	**Savanna**	**Grassland**	**Glade**
Ringed salamander	Eastern tiger salamander	Eastern tiger salamander	Eastern tiger salamander	Bachman's sparrow
Mole salamander	Four-toed salamander	Bachman's sparrow	Northern crayfish frog	Prairie warbler
Eastern tiger salamander	Sharp-shinned hawk*	Northern harrier	Northern harrier	Red-headed woodpecker
Four-toed salamander	Bachman's sparrow*	Northern bobwhite	Northern bobwhite	Blue-winged warbler
Whip-poor-will	Whip-poor-will	Prairie warbler	Loggerhead shrike	Plains spotted skunk
Bald eagle	Northern bobwhite*	Loggerhead shrike	Field sparrow	Eastern collared lizard
Worm-eating warbler	Prairie warbler*	Red-headed woodpecker		
Kentucky warbler	Bald eagle	Blue-winged warbler		
Summer tanager	Red-headed woodpecker	Bell's vireo		
Eastern small-footed bat	Summer tanager	Indiana bat		
Indiana bat	Blue-winged warbler*	Plains spotted skunk		
Plains spotted skunk	Indiana bat			
Timber rattlesnake	Plains spotted skunk			

Streams, Rivers, and Spring branches

There are about 5,460 miles of streams, rivers and spring branches on Mark Twain NF, providing habitat for over half of the animal SAR.

All alternatives have standards and guidelines for management of permanent streams and rivers. In addition, all alternatives have standards and guidelines for soil and watershed protection and management, as well as resource-specific standards and guidelines to minimize soil movement from activities on Mark Twain NF (i.e. timber harvest, prescribed burning, road reconstruction and maintenance, grazing, etc.). Effects to these habitats are discussed in detail in the Riparian Areas and Water Quality section of the EIS. Alternative 1 has the least ground-disturbing activities and therefore the least potential for soil movement, but also the least potential for improvement of watershed conditions. All other alternatives have about the same amount of ground-disturbing activities and therefore similar potential for soil movement.

However, the Conservation Approaches to “Maintain free-flowing streams and rivers” and “Minimize sedimentation from National Forest lands” would be achieved in all alternatives.

Also, implementation of a specific objective and a specific standard for woody debris in streams, would achieve Conservation Approach “Retain den trees and snags, downed woody material (particularly large size)” in Alternatives 1-4 for this habitat. There is no specific direction for in-stream woody material for Alternative 5, and Conservation Approach “Retain den trees and snags, downed woody material (particularly large size)” may or may not be achieved in individual streams and rivers across Mark Twain NF.

There is also specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach “Control non-native invasive species” could be achieved in these alternatives for stream, river and spring branch habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach “Control non-native invasive species” may or may not be achieved across the Mark Twain NF.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives.

Cumulative effects

Activities on Mark Twain NF under any alternative would not contribute to cumulative effects of impounding streams, since none would occur on Mark Twain NF. Mark Twain NF activities under any alternative have the potential for some sedimentation to reach area waters. However, the minor amount of sedimentation from National Forest lands and the limited National Forest ownership in most watersheds would not significantly increase water quality problems in the twenty-nine county area.

Riparian

Closely tied to the permanent streams and rivers is riparian habitat. Mark Twain NF currently has about 61,500 acres in Riparian Management Zones (RMZ).

All alternatives have standards and guidelines for management of the riparian areas (Alternative 5) or RMZ (Alternatives 1-4) that were designed to maintain, restore, and/or enhance the ecological processes and functions of aquatic, riparian and upland components that contribute to healthy, sustainable watersheds, including water quality and flow. Alternative 1 would have the most forested riparian corridor in the long-term, as little management would be done in the RMZ. Alternatives 2 - 5 all have some management within the RMZ, from promoting restoration of riparian vegetation to grazing portions of the RMZ at least 100 feet from any permanent stream/river bank.

All alternatives would achieve the Conservation Approach “Maintain riparian structure and function”, as well as the Conservation Approach “Maintain hydrologic integrity of wetland and lowland forest natural communities” for riparian habitat.

Implementation of a specific objective and a specific standard for woody debris in streams, would achieve Conservation Approach “Retain den trees and snags, downed woody material (particularly large size)” in Alternatives 1-4 for this habitat. There is no specific direction for in-stream woody material for Alternative 5, and Conservation Approach “Retain den trees and snags, downed woody material (particularly large size)” may or may not be achieved in individual streams and rivers across Mark Twain NF.

There is also specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach “Control non-native invasive species” could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach “Control non-native invasive species” may or may not be achieved across the Mark Twain NF.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives. The highest quality riparian habitat would be available in Alternatives 2 and 3 since restoration of natural communities (MP 1.1 and 1.2) would occur on the greatest number of acres.

Cumulative effects

Ownership of the riparian corridor adjacent to most Mark Twain NF rivers is overwhelmingly non-National Forest. Changes to riparian habitat on Mark Twain NF in any alternative would result in more forested cover, not less. Therefore, in all alternatives, there would be no cumulative adverse impacts to riparian habitat from activities on Mark Twain NF.

Ponds/Lakes

Ponds and lakes provide important breeding sites for salamanders (as long as they are fishless), and drinking water for many species, including the federally endangered Indiana bat. There are around 3,000 constructed ponds and lakes on Mark Twain NF, ranging from less than 1/10 acre seasonal waterholes to the 440-acre Council Bluff Lake. There is no reliable estimate of how many of these are fishless.

The 1986 Forest Plan (Alternative 5) has objectives for number of water sources per square mile. Overall, this objective has been met, although some localized areas may fall short. In Alternative 5, additional ponds and lakes could be constructed to meet the water source objective. Alternatives 1-4 allow existing ponds and waterholes to be maintained, but discourage construction of new ones. Temporary pools would be constructed during road reconstruction or maintenance to provide seasonal water sources off roadways. In this way, water is provided, but eggs and young are not killed or injured when vehicles drive through water-filled road ruts.

Alternatives 1-4 have specific standards and guidelines for providing downed woody material in and around constructed waterholes to provide habitat. Alternative 5 allows the improvement of habitat by providing downed woody material along pond banks. Therefore, all alternatives would achieve Conservation Approach “Retain den trees and snags, downed woody material (particularly large size)” for this habitat.

There is also specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach “Control non-native invasive species” could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach “Control non-native invasive species” may or may not be achieved across the Mark Twain NF.

SAR that use or occur in ponds or lakes would have suitable habitat available in all alternatives. Some would be fishless and others would have fish. Downed woody material would be available in and near ponds for those SAR that use this habitat component. Additional water sources (waterholes/ponds in Alternative 5; temporary pools along roads in Alternatives 1-4) would be constructed in all alternatives.

Cumulative effects

Constructed ponds and lakes are available in varying density and distribution on private ownerships throughout the twenty-nine county area. Some of these ponds are fishless and some are stocked with fish. Some are used for livestock watering – some fenced, some not. Some are within forested cover and some are in openlands. Constructed ponds and lakes are also present on other state and federal conservation agency ownerships. Since there would not be any significant increase or decrease in water sources on Mark Twain NF in any alternative, there would be no cumulative effect on the availability of water sources in the twenty-nine county area.

Wetlands (Springs, Seeps, Fens, Sinkhole Ponds)

The Natural Heritage Database identifies 42 significant fens and seeps occurring on the Mark Twain National Forest totaling 3,905 acres. They occur primarily in riparian zones. These include Ozark fens, forested fens and acid seeps. Prior to acquisition by the Forest Service, early settlers attempted to drain and alter the hydrology of fens and seeps to make them productive farmland. Many have been overgrazed and invaded by undesirable woody species or non-native invasive species. There are also 468 springs and dozens of sinkhole ponds located on Mark Twain NF lands.

All alternatives recognize small wetlands as special habitats, and have specific standards and guidelines to protect and manage their unique characteristics; although fens do not appear on the list of wetland habitats in the 1986 Plan. The 1986 Plan does not give any specific direction for the active restoration and management of fens other than restrictions on activities within protection zones. In Alternatives 1-4, however, management activities may include restoration of adjacent upland natural communities to improve soil/water infiltration, increase species richness and restore hydrological functions, particularly in MP 1.1 and 1.2 and for large fens designated as MP 8.1.

Alternatives 2 and 3 afford the greatest opportunity to expand restoration of fens and seeps given the relative size of MP 1.1 and 1.2, and the best opportunity to achieve Conservation Approach “Maintain hydrologic integrity of wetland and lowland forest natural communities”. Alternatives 1 and 4 include the least amount of expanded buffer for fens, and Alternative 5 maintains the current limited management of fens and their watersheds. These alternatives would only partially achieve the Conservation Approach “Maintain hydrologic integrity of wetland and lowland forest natural communities”.

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach “Control non-native invasive species” could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach “Control non-native invasive species” may or may not be achieved across the Mark Twain NF.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives. However, the quality of wetland habitats would be highest in Alternatives 2 and 3, as these have the most area in MP 1.1 and 1.2, where restoration of natural communities is emphasized. Wetland habitats would decrease in both size and quality in Alternative 1, as little or no management would occur outside the small area of MP 1.1 and 1.2. This would result in a decrease in suitable habitat for the federally endangered Hine's emerald dragonfly, as well as other wetland species. Alternative 4 and 5 would have about the same amount of wetland habitat as currently exists, with some having better quality with management to restore hydrology and decrease woody invasion; and some having decreased quality because of lack of management.

Cumulative effects

Wetland habitats occur on private ownerships within the twenty-nine county area. Some are managed as wetlands, and others are altered to meet other objectives (i.e. drained for farming, used as garbage dumps, etc.). Wetlands on private ownerships will continue to be subject to alteration, degradation or destruction by landowners who have higher priority uses for their land. Wetland habitats on state and federal conservation agency ownerships are generally recognized as special habitats and protected from disturbance. Alternative 1 would have an adverse cumulative effect on the availability and quality of wetlands, as little or no management would occur on many of these habitats on Mark Twain NF. Alternatives 2 and 3 would have a beneficial cumulative impact on the availability and quality of wetland habitats, as hydrologic and biologic integrity would be restored to most wetlands present on Mark Twain NF. Alternatives 4 and 5 would have no cumulative effect, since the availability and suitability of wetland habitat would be little different from the present.

Caves/Cliffs

There are over 500 known caves on Mark Twain NF, and an unknown number of cliffs. Undoubtedly, other caves exist, but have yet to be discovered. In the 1986 Plan (Alternative 5), rock formations are recognized as a geologic feature, with minimal protection provided by standards and guidelines.

In Alternatives 1-4 cliffs, rock bluffs and outcrops have specific standards and guidelines to protect their special features. In all alternatives, caves are recognized as specialized habitat with specific standards and guidelines to protect their unique qualities, including endangered or rare species. Overall management objectives for caves are essentially the same that is to protect caves, associated cave life from physical disturbance, and maintain the unique set of climatic and physical conditions present at each cave. All alternatives could achieve the Conservation Approach "Protect the structural and biological integrity of caves and reduce human disturbance to cave systems". Additional discussion of effects to caves can be found in the RFSS discussion.

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach "Control non-native invasive species" could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach "Control non-native invasive species" may or may not be achieved across the Mark Twain NF.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives.

Cumulative effects

See Cumulative Effects for Caves in the RFSS section of this EIS.

Glades

An estimated 36,000 acres of treeless glades occur on the Mark Twain NF, much of which is overgrown in eastern red cedar and other mixed woody vegetation. The 1986 Plan has standards and guidelines for minimum percentages of glade habitat to be managed as open or semi-open lands (Forest Plan IV-56). In Alternatives 1-4, four MP 1.1 and 1.2 areas (2005 Forest Plan Appendix A) target globally distinct glade complexes for restoration. These are:

- Big Creek Basin Glades on the Ava District
- Cassville Glades on the Cassville District
- Bald Hill Glades/Woodland on the Eleven Point Ranger District
- Lower and Upper St. Francois Mountains on the Fredericktown District

Also in Alternatives 1-4, all areas in MP 1.1 and 1.2 that contain glade and woodlands shall be closed to grazing when the current permit expires. Before then, the Mark Twain NF shall control the timing, duration, and intensity of livestock grazing to achieve desired structure and species composition objectives for glades.

Alternatives 1, 4 and 5 significantly constrain the establishment of desired conditions for restoration of glades. The reduced emphasis on restoration by smaller areas designated as MP 1.1 and 1.2, and the lack of commercial timber harvest as a tool for removing red cedar in Alternative 1, would allow red cedar to continue increasing in coverage on most large glades, further reducing or eliminating habitat for glade-adapted plant and animal species, such as the collared lizard. These three alternatives would only partially achieve the Conservation Approach “Restore prescribed fire regimes and manage fire-adapted natural communities.” Alternatives 2 and 3, with large areas of glade habitat designated for restoration in MP 1.1 and 1.2, would increase the amount of open glade habitat, contributing to enhanced viability of glade-adapted species. These two alternatives would achieve the Conservation Approach “Restore prescribed fire regimes and manage fire-adapted natural communities.”

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach “Control non-native invasive species” could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach “Control non-native invasive species” may or may not be achieved across the Mark Twain NF.

Additional discussion of effects to glades can be found in the MIS discussion.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives. However, the amount and quality of habitat would vary greatly between alternatives. Alternative 1 would have the least amount and quality of glade habitat because little or no treatment would occur outside the small area of MP 1.1 and 1.2. Alternatives 2 and 3 would have the greatest amount and quality of glade habitat since they have the most area included in MP 1.1 and 1.2 where restoration of natural communities is emphasized. Alternatives 4 and 5 would have a moderate amount of glade habitat ranging from poor to good quality.

Cumulative effects

See Cumulative Effects in the MIS section of this EIS.

Upland Forest

It is estimated that, historically, upland forest natural communities covered about 223,000 acres or 15% of Mark Twain NF. Today, there are approximately 1.2 million acres of upland hardwood forest cover on Mark Twain NF (about 81% of Mark Twain NF). The age class distribution is about 3% 0-9 years; 19% 10-49 years; 58% 50-89 years; and 21% greater than or equal to 90 years. Composition is about 82% oak/hickory and 17% oak-pine. Most of the current Mark Twain NF is densely stocked with canopy closures of 80% or greater (USDA Forest Service 2004a).

Within MP 1.1 and 1.2 in Alternatives 1-4, objectives for natural community restoration would result in fewer acres of forest natural community and more acres of open and closed woodland natural communities across the Mark Twain NF. It is likely that the acres of forest natural community would not change significantly under Alternative 5, since it has no objectives for natural community restoration.

All alternatives have standards and guidelines for management of age classes, regeneration, and old growth. Alternative 5 also has standards and guidelines dealing with specific structural conditions of forest natural communities (i.e. canopy closure, ground cover, mast production, etc.). Alternatives 1-4 emphasize achievement of desired conditions for various natural communities, including forest natural communities, as the method for achieving the natural variation of tree composition and structure, particularly in MP 1.1 and 1.2. All alternatives would be able to achieve the Conservation Approach “Maintain forested landscapes (with all successional stages present).”

Implementation of specific standards and guidelines for snags, dens cavity trees, and downed woody debris, could achieve Conservation Approach “Retain den trees and snags, downed woody material (particularly large size)” in all alternatives for this habitat.

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach “Control non-native invasive species” could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach “Control non-native invasive species” may or may not be achieved across the Mark Twain NF.

Additional discussion of old growth and early successional habitat can be found in the Old Growth and Regeneration sections of this EIS.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives.

Cumulative effects

Since the amount of upland forest would not change substantially in Alternatives 1, 4 and 5, there would be no cumulative effect on this habitat in the twenty-nine county area. In Alternatives 2 and 3, from about 38% to 25% respectively of the Mark Twain NF would be in MP 1.1 and 1.2 where restoration of open and closed woodlands and savannas on appropriate sites would decrease the amount of forest natural community. Some of MP 1.1 and 1.2 would remain in forest natural communities. SAR which use upland forest would still have abundant suitable habitat on Mark Twain NF in Alternatives 2 and 3, and there would be no cumulative effect on upland forest.

Open woodlands

Open woodland natural communities once covered an estimated 538,500 acres of the Mark Twain NF (about 36%). Nearly 700 plant species native to Missouri occur in open woodlands with nearly 300 documented in pine woodlands alone. Most open woodlands are now overly dense with slow-growing, small diameter trees, deep leaf litter, and are lacking in ground flora richness and cover. Much of the former shortleaf pine-dominated woodland has changed to other dominant vegetation, especially red and black oak.

Alternatives 2-4 would move open woodlands toward their desired condition through combinations of thinning and prescribed burns in varying amounts. Alternative 5, has no specific direction for restoring open woodland natural communities, and achievement of desired conditions would be a result of reaching other resource objectives. Alternative 1, with no commercial harvest, would be least likely to reach desired conditions on the acres treated, since it is the combination of structural alteration (harvest) and ground flora improvement (prescribed fire) that results in the highest quality conditions. As a result, plant and animal species that are characteristic of woodlands, including species of conservation concern, would continue declining in Alternative 1 as undesirable second growth woody species mature and shade and leaf litter increases.

For those areas treated, it would take 1-2 decades to begin recovering and stabilizing groundcover grasses, shrubs and forbs, as well as detecting desirable changes in bird and small mammal communities, insect pollinators and other species that represent woodland natural communities, such as summer tanager, red-headed woodpecker, northern bobwhite, and Bachman's sparrow. It would take more than 2 decades to reach the varying structural conditions, including large, old trees, typical of the range of natural variation for the Ozark woodlands.

Alternatives 2 and 3 are likely to achieve the Conservation Approaches "Maintain forested landscapes (with all successional stages present)" and "Restore prescribed fire regimes and manage fire-adapted natural communities." Alternatives 1, 4 and 5 would achieve Conservation Approach "Maintain forested landscapes (with all successional stages present)", but would only partially meet Conservation Approach "Restore prescribed fire regimes and manage fire-adapted natural communities."

Implementation of specific standards and guidelines for snags, dens cavity trees, and downed woody debris, could achieve Conservation Approach "Retain den trees and snags, downed woody material (particularly large size)" in all alternatives for this habitat.

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach "Control non-native invasive species" could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach "Control non-native invasive species" may or may not be achieved across the Mark Twain NF.

For additional discussion of effects on open woodland habitat, see MIS section.

SAR that use or occur in open woodland habitat would have at least some suitable habitat available in all alternatives. However, the distribution and abundance of this habitat would vary greatly between alternatives. Alternatives 1 and 4 only have about 8% of the Mark Twain NF in MP 1.1 and 1.2 and the Management Areas are widely separated from each other. While some open woodland habitat would be restored in these areas, the impact of these changes on SAR would be minimal due to the small amount and scattered distribution. Alternative 4 would have some additional open woodland outside MP 1.1 and 1.2, where management for other resource objectives resulted in enhancement of open woodland conditions. Alternatives 2 and 3 would have the greatest amount, distribution, and quality of open woodland habitat, since they have the greatest amount of MP 1.1 and 1.2. Alternative 5 would have some open woodland developed as a result of meeting other resource objectives.

Cumulative effects

See Cumulative Effects discussion in the MIS section of this EIS.

Savanna

An estimated 120,700 acres of shrub barrens (savanna) historically occurred across Mark Twain NF (less than 1%). Today, 24,000 acres are classified as Animal Habitat Savanna-grass or Savanna-shrub (USDA Forest Service 2004a). However, most of this is simply a treatment classification rather than an ecological classification. Most of these acres are areas treated for semi-open habitat, but are not on ecological sites suitable for savanna. Much of the original savanna has become densely stocked young or mature hardwood or mixed woodland or forest cover due to red cedar invasion and fire suppression over the past 70 years.

Alternatives 1-4 have direction for restoration of savanna natural communities as part of MP 1.1 and 1.2. Although Alternatives 1 and 4 have much less acreage in MP 1.1 and 1.2 than do Alternatives 2 and 3, much of the area of historic savanna is captured in these smaller units. Therefore, Alternatives 1-4 have essentially the same impact on the potential to restore savanna natural communities.

Alternatives 2 and 3 have the most potential to achieve Conservation Approach ""Restore prescribed fire regimes and manage fire-adapted natural communities." Alternatives 1 and 4 have much the same potential, but probably less opportunity to achieve Conservation Approach "Restore prescribed fire regimes and manage fire-adapted natural communities." Alternative 5 has no specific direction for restoring savannas, but savannas are listed as natural vegetation communities to manage (1986 FP page IV-14-17). There are standards and guidelines for providing open/semi-open habitat across the Mark Twain NF. Traditionally, savannas have been considered a semi-open habitat. Any improvement in savannas would be a result of moving toward a wildlife habitat objective. This alternative would only partially achieve Conservation Approach "Restore prescribed fire regimes and manage fire-adapted natural communities."

Implementation of specific standards and guidelines for snags, dens cavity trees, and downed woody debris, could achieve Conservation Approach "Retain den trees and snags, downed woody material (particularly large size)" in all alternatives for this habitat.

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach "Control non-native invasive species" could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach "Control non-native invasive species" may or may not be achieved across the Mark Twain NF.

SAR that use or occur in this habitat would have suitable habitat available in all alternatives.

Cumulative effects

The majority of former savanna habitat on other ownerships has been converted to other uses, primarily agricultural or urban development. There is little or no potential to restore these habitats. Alternatives 1-4 would have a beneficial cumulative effect, as all increase the amount and quality of savanna habitat on Mark Twain NF. Alternative 5 would have no cumulative effect on savanna habitat, since management would continue much as it has over the past 15 years.

Grassland

An estimated 1,500 acres of prairie historically occurred on Mark Twain NF, maintained primarily by fire and native ungulate grazing. Today, almost none of that remains. For Alternatives 1-4, several small areas of remnant prairie (totaling about 20 acres) are the core of MP1.1 on the Cedar Creek unit. Alternative 5 has no specific direction for restoring prairies, but prairies are listed as natural vegetation communities to manage (1986 FP page IV-14-17). There are standards and guidelines for providing open/semi-open habitat across the Mark Twain NF.

Grasslands on Mark Twain NF include native, warm-season grass fields (about 12,000 acres) and non-native, cool-season grass fields (about 14,000 acres), as well as open/shrub/grass (about 15,000 acres). Many of these grasslands are located on sites that were originally private pastures or croplands, and may not be on ecologically suitable sites. Nevertheless, since grassland habitat is limited on Mark Twain NF and is an important habitat component for many declining species, these areas would likely remain as grasslands in any alternative.

All alternatives have standards and guidelines for grasslands. Grasslands are primarily wildlife habitat or range forage objectives in Alternative 5. The only limit on amount of grassland is achievement of wildlife habitat and range standards and guidelines. The amount of area in grasslands could increase in Alternative 5. The emphasis in Alternatives 1-4 is on management of native grasslands as part of the range of natural variability of the landscape. Grasslands in Alternatives 1-4 are limited to approximately the acres that currently exist. The amount of area in grasslands would not increase, but the proportion of native, warm-season grass to non-native, cool-season grass would likely increase, creating a small amount of additional habitat more suitable for the majority of grassland species, including northern harrier and field sparrow.

Because of the greater amount of area designated as MP 1.1 and 1.2, Alternatives 2 and 3 have the greatest opportunity to achieve Conservation Approach "Restore prescribed fire regimes and manage fire-adapted natural communities." Alternatives 1, 4 and 5 are about equal in their potential to achieve this Conservation Approach.

There is specific direction to prioritize treatment of NNIS, all species, not limited to plants, in Alternatives 1-4, and therefore Conservation Approach "Control non-native invasive species" could be achieved in these alternatives for this habitat. In Alternative 5, direction is limited to noxious weeds, and Conservation Approach "Control non-native invasive species" may or may not be achieved across the Mark Twain NF.

SAR that use or occur in this habitat would have some suitable habitat available in all alternatives.

Cumulative effects

Grasslands are a major component of private ownerships in the twenty-nine county area. Most are non-native, cool season grass pastures or hayfields, and are likely to remain so in the foreseeable future. Additional grasslands are likely to be created on private ownerships as landowners convert forest to pastureland. Since the amount of grassland would not increase on Mark Twain NF in Alternatives 1-4, there would be no cumulative impact on the availability of grassland habitat. Although Alternative 5 allows for increases in grassland habitat, that is much more likely to occur from acquisition of already open land, than from conversion of forest cover to grassland. Therefore, there would be no cumulative impact on grassland habitat from Alternative 5.

SVE Outcomes

Viability outcomes, considering predicted habitat and population trends, were assigned by alternative for each species for the short term (10 years) and long-term (100 years) on both Mark Twain NF lands and in the cumulative effects area. We compared viability outcomes to the current condition as a way to measure the effects that management of Mark Twain NF would have on the viability of the species in Missouri and/or rangewide.

The following describe the likely outcomes for species that could be supported by conditions on NFS land. Outcomes are based on likely effects on conditions that are under the control of management by the Forest Service. They have been determined by the Forest Service.

- **Outcome A**. Suitable ecological conditions are broadly distributed and of high abundance across the historical range of the species within the planning area. The combination of distribution and abundance of ecological conditions provides opportunity for continuous or nearly continuous intraspecific interactions for the species.

- **Outcome B**. Suitable ecological conditions are either broadly distributed or of high abundance across the historical range of the species within the planning area, but there are gaps where suitable ecological conditions are absent or only present in low abundance. However, the disjunct areas of suitable ecological conditions are typically large enough and close enough to permit dispersal among subpopulations and potentially to allow the species to interact as a metapopulation across its historical range within the planning area.
- **Outcome C**. Suitable ecological conditions are distributed frequently as patches and/or exist at low abundance. Gaps where suitable ecological conditions are either absent, or present in low abundance, are large enough that some subpopulations are isolated, limiting opportunity for species interactions. There is opportunity for subpopulations in most of the species range to interact as a meta-population, but some subpopulations are so disjunct or of such low density that they are essentially isolated from other populations. For species for which this is not the historical condition, reduction in overall species range from historical within the planning area may have resulted from this isolation.
- **Outcome D**. Suitable ecological conditions are frequently isolated and/or exist at very low abundance. While some of the subpopulations associated with these ecological conditions may be self-sustaining, there is limited opportunity for population interactions among many of the suitable environmental patches. For species for which this is not the historical condition within the planning area, reduction in overall species range from historical condition within the planning area may have resulted from this isolation.
- **Outcome E**. Suitable ecological conditions are highly isolated and exist at very low abundance, with little or no possibility of population interactions among suitable environmental patches, resulting in strong potential for extirpations within many of the patches, and little likelihood of re-colonization of such patches. There has likely been a reduction in overall species range from historical within the planning area, except for some rare, local endemics that may have persisted in this condition since the historical period.

A major problem with this analysis is that some, if not most threats to species' viability are either not found on Mark Twain NF (e.g. permanent conversion of forested land to urban development), or Mark Twain NF has so little habitat that whatever is done on the Forest would make little difference to the species as a whole (e.g. swamp habitat is limited to southeast Missouri). Therefore, activities on Mark Twain NF have little impact on the viability of a species as a whole. For instance, twenty-nine aquatic species are included as SAR. In contrast, Mark Twain NF has only 54% ownership of the watershed of the Eleven Point National Scenic River, and much less ownership in watersheds of other major rivers that run through the Mark Twain NF. In addition, ownership of the riparian corridor adjacent to most of these rivers is overwhelmingly non-National Forest. So, it is not surprising that many of the species show little to no change from present conditions on Mark Twain NF regardless of which alternative is evaluated.

Viability Outcomes Compared to Current Condition

When compared to the current condition, 56 of the 66 animal species (85%) show no change from current populations in the short term, and 41 of the 66 animal species (62%) show no change from current populations in the long-term on Mark Twain NF lands. This is primarily for three reasons. The first is that significant changes in habitat condition usually require more than 10 years, and associated changes in population trends may not be detectable within a 10-year period. The second is that many species are affected much more by activities on other ownerships and the contribution to viability by Mark Twain NF is low. The third is that the species may have no actual occurrences on Mark Twain NF, causes of decline cannot reliably be related to habitat, or the known population is so low that trends are impossible to establish.

Ten species show positive changes in short-term viability outcomes for Alternatives 2 and 3, with five of these showing negative changes for Alternative 1. The other five show no change for other alternatives. Positive outcomes are largely a result of the quantity and quality of shrub/grass habitat increasing with restoration of glade, savanna and open woodland natural communities. Negative results are largely a result of these habitats decreasing in amount and quality due to succession and dominance of dense, woody vegetation. All other species (56) show neutral effects in the short term.

In the long-term, 9 species show positive or neutral outcomes; 2 show negative or neutral outcomes, 2 show questionable or neutral outcomes, 1 shows a combination of negative, questionable and neutral outcomes, and 10 have a mix of positive and negative outcomes depending on alternative. In the long-term, 42 of the 66 species (64%) show only neutral outcomes regardless of alternative. Again, reasons for these outcomes are similar to those described for the short-term outcomes. Two of the negative outcomes are for grassland birds. Mark Twain NF historic vegetation includes very little area of native prairie and only some savanna, where these birds would have thrived. Most of the Mark Twain NF is at the edge of or outside the optimum habitat for these species.

In summary, implementation of any of the alternatives shows neutral effects on most of the SVE species in both the short and long-term. Alternative 1 shows the most negative impacts of all alternatives, with neutral impacts for most species. Alternatives 2 and 3 are neutral or beneficial for all but 3 species in both the short and long-term; 3 species have questionable effects for Alternatives 2 and 3. Alternatives 4 and 5 show primarily neutral impacts, but with some positive and a few negative impacts. Cumulatively, other ownerships have more effects on species viability outcomes than do any of the alternatives for Mark Twain NF lands.

Table 21 - Historical, Current and Future (Decades 1 & 10) Outcomes for SVE Animals on MTNF Lands

Species	Historical	Current	Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
			Decade 1	Decade 10	Decade 1	Decade 10	Decade 1	Decade 10	Decade 1	Decade 10	Decade 1	Decade 10
Mammals												
Eastern small-footed bat	?	C	C	C	C	C	C	C	C	C	C	C
Indiana bat	B	C	C	C	C	**B**	C	**B**	C	C	C	C
Plains spotted skunk	A	C	C	**D**	C	**A**	C	**B**	C	C	C	C
Birds												
Sharp-shinned hawk	C	C	C	D	C	**?**	C	**?**	C	C	C	C
Bachman's sparrow	A	D	D	**E**	**C**	**B**	**C**	**B**	D	D	D	D
Whip-poor-will	?	B	B	B	B	**?**	B	**?**	B	B	B	B
Northern harrier	C	C	C	**D**	C	C	C	C	C	C	C	C
Northern bobwhite	A	D	D	**E**	**C**	**B**	**C**	**C**	D	D	D	D
Prairie warbler	A	B	**C**	**C**	**A**	**A**	**A**	**A**	B	B	B	B
Migrant loggerhead shrike	C	D	D	**E**	D	D	D	D	D	D	D	D
Swainson's warbler	C	D	D	**E**	D	**C**	D	**C**	D	**E**	D	**E**
Red-headed woodpecker	A	C	C	C	**B**	**A**	**B**	**B**	C	C	C	C
Summer tanager	A	B	**C**	**C**	**A**	**A**	**A**	**A**	B	B	B	B
Field sparrow	A	C	**D**	**D**	**B**	**A**	**B**	**A**	C	C	C	C
Blue-winged warbler	A	B	**C**	**C**	**A**	**A**	**A**	**A**	B	B	B	B
Bell's vireo	D	D	D	**E**	**C**	**C**	**C**	**C**	D	D	D	D
Amphibians												
Ringed salamander	C	D	D	**C**	D	**C**	D	**C**	D	**C**	D	**C**
Eastern tiger salamander	A	B	B	B	**A**	**A**	**A**	**A**	B	B	B	B
Ozark hellbender	B	C	C	C	C	**B**	C	**B**	C	C	C	C
Northern crawfish frog	C	D	D	**C**	D	**C**	D	**C**	D	**C**	D	D
Reptiles												
Timber rattlesnake	B	D	D	D	**C**	**C**	**C**	**C**	D	D	D	D
Collared lizard	A	C	**D**	**D**	**B**	**A**	**B**	**B**	C	**D**	C	**D**
Fish												
Topeka shiner	B	E	E	**D**	E	**D**	E	**D**	E	**D**	E	**D**
Crayfish												
Orconectes williamsi	?	D	D	D	D	D	D	D	D	D	D	D
Snail												
Tumbling Creek cavesnail	?	E	E	**?**	E	**?**	E	**?**	E	**?**	E	**?**
Insects												
Hine's emerald dragonfly	C	D	D	D	D	**C**	D	**C**	D	D	D	D
Ozark emerald dragonfly	C	D	D	**C**	D	**C**	D	**C**	D	**C**	D	**C**
A heptageniid mayfly	B	E	E	E	E	E	E	E	E	E	E	E
Summary												
Positive change from current outcome			0	4	9	19	10	20	0	3	0	3
Negative change from current outcome			5	13	0	0	0	0	0	2	0	2
Unknown effect			0	1	0	3	0	3	0	1	0	0

*Letters shown in **bold** indicate a change from current condition*

Species Which Have Significant Viability Concerns on Mark Twain NF

Through analysis of information gathered on the 66 animal species, we determined that about half of the species considered do not truly have viability concerns on Mark Twain NF. These include species with stable or improving population trends in Missouri that may have declining populations elsewhere in the range, including many bird species; or that naturally have so little habitat on Mark Twain NF that management of Forest lands would not affect them one way or another (i.e. swamps and lowland forest species). Implementation of any alternatives would not affect the long-term viability of these species.

However, there are some species that have serious viability concerns on the Mark Twain NF, as well as on the regional and national scale. These species are: experiencing a continued sharp population decline, are extremely rare in occurrence on Mark Twain NF as well as throughout the range, are at the brink of extirpation, limiting factors are unknown, or are endemic to Missouri, the Ozarks, or a specific area of Missouri. Some species are included that do not have known occurrences on Mark Twain NF. All these species are aquatic and occur in locations that are near or downstream of Mark Twain NF lands, or Forest lands make up a moderate to large part of the watershed of occupied streams. For these species, management of Mark Twain NF lands has potential to affect the aquatic habitat they depend on, and so are included in this analysis. The species with significant viability concerns are in Table 22.

Table 22 - Species with Significant Viability Concerns on Mark Twain NF

Species	Viability Concerns	Effects of Alternatives
	Aquatic Habitat	
Ozark hellbender	Population declining/factors unknown/recruitment questionable	Neutral or beneficial
Eastern hellbender	Population declining/factors unknown/recruitment questionable	Neutral
Big Creek crayfish	Only 3 sites in Missouri/ Displacement by introduced *Orconectes hylas*	Neutral
Meek's crayfish	One of rarest crayfish in Missouri; Population trends unknown, although new locations discovered 2003	Neutral
St. Francis River crayfish	Endemic to St. Francis River/ Only 4% of known sites are on MTNF	Neutral
William's crayfish	Only one known site on MTNF/ Development and recreation in Branson/Table Rock Lake area threatens species' habitat	Negative all Alternatives long-term for cumulative effects area
Current River saddled darter	On verge of extirpation due to impoundments/ Both known sites in MO on MTNF	Neutral
Crystal darter	Statewide population decreasing	Neutral
Checkered madtom	Appears to be declining/ 36% known sites on MTNF/ Most White River watersheds in other ownerships	Neutral
Blacknose shiner	Rapid global decline - No sites on MTNF in 2003	Neutral
Ozark shiner	Impoundments eliminated habitat	Neutral
Topeka shiner	Precipitous decline statewide/ No known sites on MTNF	Beneficial for MTNF habitat long-term all alternatives
Bluestripe darter	Endemic to Gasconade and Osage river drainages/ Recent population decline	Neutral
Eastern slim minnow	Only found MO and AR; Continued decline; No sites on MTNF in 2003	Neutral
Springtail	Subterranean obligate/ groundwater pollution	Neutral

Species	Viability Concerns	Effects of Alternatives
Spectaclecase	Populations reduced to few disjunct sites; rapid decline throughout former range, except Gasconade River, whose populations may be fairly stable	Neutral
Pink mucket	Low populations in 3 major drainages in Missouri	Neutral
Rabbitsfoot	Distribution and numbers greatly reduced from historic levels No sites on MTNF	Neutral
Purple lilliput	Two known sites on MTNF	Neutral
Tumbling Creek cavesnail	Precipitous decline/Unknown factors/few individuals found	Neutral/Unknown
Curtis' pearly mussel	Possibly extirpated/few individuals found/ No recent sites on MTNF	Neutral
Snuffbox	No sites on MTNF Drastic reduction in range/ Extant populations small and isolated from each other	Neutral
Scaleshell	Population considered stable in only 3 of 14 streams/ Regional endemic in Interior Highlands	Neutral
	Open fens	
Hine's emerald dragonfly	44% known sites in MO on MTNF	Beneficial Alternatives 2 and 3; Neutral all others
	Riparian	
Swainson's warbler	Limited to cane along major rivers/north edge range -31% known MO sites on MTNF / North edge of range	Neutral short term/ Alt 2 and 3 Beneficial long-term/ Alt 1, 4, 5 Negative in long-term
	Riparian/Caves/ Woodland	
Indiana bat	Continued decline/ Most severe in KY and MO/ factors unknown	Beneficial long-term Alternatives 2 and 3; Neutral all others
	Caves/ Unknown	
Eastern small-footed bat	Too little known to make assessment	Neutral/Unknown
	Woodland/ Glade	
Bachman's sparrow	50% known MO sites on MTFN/Lack open pine woodland/ North edge of range/ Too few occurrences to show on BBS survey results	Alt 2 and 3 Beneficial/ Alt 1 Negative/ Alt 4 and 5 Neutral
	Open woodlands, brushy, openland mix	
Northern bobwhite	Declining in Missouri and throughout range	Negative Alternative 1; Beneficial Alternatives 2 and 3
	Grassland	
Loggerhead shrike	Rapidly declining population in Missouri	Neutral/ Alt 1 Negative long-term
	Rocky outcrops	
Timber rattlesnake	Declining rangewide and decline throughout MO	Beneficial Alternatives 2 and 3; Neutral
	Cliffs	
Bluff vertigo	Unknown trends; 8 known sites in MO –2 on MTNF	Neutral

Concerns for long-term viability of species are generally those species that Mark Twain NF management has the least impact on, i.e. aquatic species, grassland species, or species with very few occurrences on Mark Twain NF. For these species, Mark Twain NF contribution to viability can only be protection of known sites, management of watersheds to minimize impacts on water quality, and restoring and maintaining healthy and diverse natural communities on ecologically appropriate sites.

All alternatives have standards and guidelines that direct protection of known sites of TES species, and management of special habitats to maintain their unique qualities. Species that are not officially listed by the federal or state government are not included in these standards and guidelines, unless they depend on one of the special habitats. Therefore, all alternatives would be able to at least partially achieve Conservation Approach “Protect and manage known locations of species at risk”.

All alternatives have standards and guidelines that protect soil productivity and water quality and minimize the amount of soil movement as a result of management activities. For aquatic and riparian species, all alternatives have specific standards and guidelines that direct management within the Riparian Management Zone (RMZ), to maintain the structure and functioning of the riparian/aquatic system. All alternatives would be able to achieve Conservation Approach “Minimize sedimentation from National Forest lands”.

Alternatives 1-4 also have MP 1.1 and 1.2, which emphasize restoration and enhancement of natural communities across the Mark Twain NF. Alternatives 2 and 3 provide the most beneficial impacts to riparian and aquatic species in the long-term, through restoration of natural communities that support the range of conditions under which these species have evolved. Alternative 1, on the other hand, has the most negative impacts to these species by allowing the current condition of overstocked, dense canopy, slow growing forest cover to occupy the majority of acres on Mark Twain NF, and providing the least amount of early successional habitat. Alternatives 4 and 5 are primarily neutral, but have long-term negative impacts on one species (Swainson’s warbler) due to lack of management of the riparian corridor and native canebrakes that this species depends on; Alternative 4 because commodity emphasis would decrease emphasis on riparian restoration and Alternative 5 because treatment in riparian areas is limited.

Species for which Mark Twain NF contributes greatly to viability in Missouri and Rangewide

There are several SVE species for which Mark Twain NF habitats contribute towards viability in Missouri and range-wide. These are species which have a large proportion of occurrences on Mark Twain NF, have a large proportion of the breeding population in the Ozarks, or for which Mark Twain NF has a majority of available habitat. Those for which the contribution is high for both Missouri and range-wide include:

Table 23 - Mark Twain NF Contribution towards Viability

Species	Contribution Missouri	Contribution Rangewide	Reason	Effects of Alternatives
Ozark hellbender	High	High	33% known locations on MTNF	Neutral or beneficial
Whip-poor-will	High	High	30% breeding population Ozark/Ouachita	Neutral or Unknown
Coldwater crayfish	High	High	Endemic to 11 Point River; 7 of 8 known MO sites on MTNF	Neutral
Ozark shiner	High	High	31% known MO sites on MTNF	Neutral
Spotted skunk	High	High	Remaining viable population in MO on Ozark Plateau/ 23% known sites on MTNF	Neutral or beneficial/ Alt 1 Negative long-term
Tumbling Creek cavesnail	High	High	24% cave recharge on MTNF	Neutral or Unknown
Eastern hellbender	High	Moderate	17% known sites on MTNF	Neutral
Bachman's sparrow	High	Moderate	50% known MO sites on MTNF	Alt 2and3 beneficial, Alt 1 negative, Alt 4and5 neutral
Cerulean warbler	High	Moderate	Major rivers southern Mo stronghold/other populations in range threatened	Neutral
Worm-eating warbler	High	Moderate	>10% breeding population in Ozark/Ouachita	Neutral
Gray bat	High	Moderate	12% MO maternity caves on MTNF	Neutral
Collared lizard	High	Moderate	32% known MO sites on MTNF	Alt 1, 4, 5 Negative; Alt 2and3 Beneficial
Bluestripe darter	High	High	37% known sites globally on MTNF	Neutral
A springtail	High`	Unknown	3 of 5 known sites in MO on MTNF	Neutral
Hine's emerald dragonfly	High	Unknown	44% known sites in MO on MTNF	Neutral short term/ Alt 2and3 beneficial long-term

Alternatives 2 and 3 provide the most beneficial impacts to these species in the long-term, through restoration of natural communities that support the range of conditions under which these species have evolved. Alternative 1, on the other hand, has the most negative impacts to these species by allowing the current condition of overstocked, dense canopy, slow growing forest cover to occupy the majority of acres on Mark Twain NF, and providing the least amount of early successional habitat. Alternatives 4 and 5 are neutral

Summary of Species Viability Analysis

The species viability evaluation (SVE) started with a list of over 1600 plants, animals, and communities that may occur in Missouri. That list was eventually reduced to 66 animal species which were analyzed individually and 176 plant species which were grouped into habitat associations for analysis. The final list was composed of species for which we determined there may be a viability concern on MTNF.

Through analysis of habitat needs, threats, distribution and occurrence of those 66 animal species, it was determined that continued viability was not a concern for about half. 32 species were found to have viability concerns on MTNF. Of these 32, only 7 were found to have viability outcomes which varied by alternative. These 7 are listed below, with a summary of the ecological level and species level measures developed for the 2005 Forest Plan that address each species' needs. In addition, the contribution of MTNF to each species' viability in Missouri and rangewide is summarized, along with our conclusions regarding the impact of implementing each alternative on each species' viability.

- Hine's emerald dragonfly showed increased viability for Alternatives 2 & 3. This is a result of aggressive restoration of fen habitats, including the upland watersheds which contribute to hydrologic functioning of fens. The Mark Twain National Forest is an important contributor to continued viability of this species in Missouri, but the importance of MTNF contribution to rangewide viability is unknown. Conservation Approaches D & F (maintain hydrologic integrity of wetland communities and manage fire-adapted communities address the ecological needs of this species. Conservation Approach H (protect known locations) address species specific needs. Standards and guidelines have been developed specifically to protect wetlands (2005 Forest Plan pages 2-13 through 2-15) and to improve or maintain habitat quality for Hine's emerald dragonfly, as well as protect known occurrences (2005 Forest Plan page 2-8). Our conclusion is that implementation of Alternatives 2 or 3 would significantly contribute to the continued viability of Hine's emerald dragonfly in Missouri by improving hydrologic and vegetative conditions of open fen habitat. Implementation of Alternatives 1, 4 or 5 would not affect viability.
- Swainson's warbler showed increased viability for Alternatives 2 & 3, and decreased viability for Alternatives 1, 4, & 5. This is a result of emphasis on restoration of natural communities in Alternatives 2 & 3, including cane stands along rivers which harbor Swainson's warblers. In Alternatives 1, 4, & 5, less emphasis is given on restoration, and cane stands would probably receive little or no attention. The Mark Twain National Forest is an important contributor to continued viability of this species in Missouri, but is only a minor contributor to rangewide viability. Conservation Approaches A & B & (maintain riparian structure & function and maintain free-flowing rivers) address the ecological needs of this species. Conservation Approach H (protect known locations) address species specific needs. Standards and guidelines for Riparian Management Zones (2005 Forest Plan pages 2-3 through 2-4) are designed to maintain the inherent ecological processes and functions of the aquatic and terrestrial parts of the RMZ, and would help insure the continued existence of cane as a viable component of the riparian ecosystem. Our conclusion is that implementation of Alternatives 2 or 3 would significantly contribute to the continued viability of Swainson's warbler in Missouri, through active management of cane. Implementation of Alternatives 1, 4 or 5 could slightly decrease the viability of Swainson's warbler in Missouri by providing no management to insure the continued availability of cane habitat.
- Indiana bat showed increased viability for Alternatives 2 & 3. This is a result of aggressive restoration of open woodland natural communities throughout the Forest in Management Prescriptions 1.1 and 1.2. The Mark Twain National Forest is of moderate importance to continued viability of this species in Missouri and rangewide. Conservation Approaches E & F (maintain forested landscapes and manage fire-adapted communities) address the ecological level needs of this species. Conservation Approaches G, H, I & K (protect caves, protect known locations, retain snags, and control non-native invasive species) address species specific needs.

Management Prescriptions 1.1 and 1.2 (2005 Forest Plan pages 3-3 through 3-9) guide the development of desired conditions that would also provide suitable foraging and roosting habitat for Indiana bats. Standards and guidelines developed specifically for Indiana bat are designed to provide suitable roosting and foraging habitat across the Forest, as well as protect winter hibernacula, fall swarming, and spring dispersal sites (2005 Forest Plan pages 2-6 through 2-8, 2-12, & 2-13). Our conclusion is that implementation of Alternatives 2 or 3 would moderately contribute to the continued viability of Indiana bat in Missouri by improving the quality of foraging and roosting habitat available. Implementation of Alternatives 1, 4 or 5 would not affect viability.

- Bachmans's sparrow showed increased viability for Alternatives 2 & 3, and decreased viability for Alternative 1. This is a result of aggressive restoration of glade and open pine woodland natural communities in Alternatives 2 & 3 in the southern part of the Forest. Many currently open glades would be invaded by eastern red cedar in Alternative 1 and their suitability as habitat for Bachman's sparrow would be reduced or eliminated. The Mark Twain National Forest is an important contributor to continued viability of this species in Missouri, but is only a moderate contributor to rangewide viability. Conservation Approach F (restore & manage fire-adapted communities) addresses the ecological level needs of this species. Conservation Approach H (protect known locations) address species specific needs. Management Prescriptions 1.1 and 1.2 (2005 Forest Plan pages 3-3 through 3-9) and standards and guidelines for glades (2005 Forest Plan page 2-9 through 2-10) guide the restoration and management of glades and open woodlands. Our conclusion is that implementation of Alternatives 2 or 3 would significantly contribute to the continued viability of Bachman's sparrow in Missouri by improving the quality and availability of glade and open woodland habitat and that implementation of Alternative 1 would significantly decrease the viability of Bachman's sparrow in Missouri by providing no management to insure the continued availability of these habitat types. Implementation of Alternatives 4 or 5 would not affect viability.
- Northern bobwhite showed increased viability for Alternatives 2 & 3 and decreased viability for Alternative 1. This is a result of aggressive restoration of open woodland natural communities throughout the Forest in Alternatives 2 & 3 in Management Prescriptions 1.1 and 1.2. In Alternative 1, less active management would lead to increased density of formerly open woodlands and openlands, reducing or eliminating their suitability as bobwhite habitat. The Mark Twain National Forest is of moderate importance as a contributor to continued viability of this species in Missouri, but is only a minor contributor to rangewide viability. Conservation Approaches F & K (manage fire-adapted communities and control non-native invasive species) address the ecological level needs of this species. Management Prescriptions 1.1 and 1.2 (2005 Forest Plan pages 3-3 through 3-9) and standards and guidelines for grasslands (2005 Forest Plan page 2-9 through 2-10) guide the restoration and management of grasslands and open oak or pine woodlands. Our conclusion is that implementation of Alternatives 2 or 3 would contribute somewhat to the continued viability of Bachman's sparrow in Missouri by improved availability and quality of grassland and open woodland habitat, but that the long-term fate of this species is dependent on habitat availability on private lands. Similarly, while implementation of Alternative 1 would slightly decrease viability of northern bobwhite on MTNF, it would not be significant in terms of population viability in Missouri or rangewide due to the overwhelming influence of private land. Implementation of Alternatives 4 or 5 would not affect viability.

- Migrant loggerhead shrike showed decrease viability for Alternative 1. This is a result of less active management of openlands, potentially leading to invasion by woody species and a decrease in suitability as loggerhead shrike habitat. The Mark Twain National Forest is only a minor contributor of viability for this species in Missouri and rangewide, due to the small amount of openlands in comparison to the amount of openlands in other ownerships across the state. Conservation Approach F (manage fire-adapted communities) addresses the ecological level needs of this species. Conservation Approach H (protect known locations) addresses the species level need. Standards and guidelines for management of grasslands (2005 Forest Plan page 2-9 through 2-10) emphasize the maintenance and improvement of natural grasslands which could be suitable shrike habitat. Our conclusion is that implementation of Alternative 1 would slightly decrease viability of migrant loggerhead shrike on MTNF due to lack of openland management resulting in decreased habitat quality, it would not be significant in terms of population viability in Missouri or rangewide due to the overwhelming influence of private grasslands. Implementation of Alternatives 2, 3, 4 or 5 would not affect viability.
- Timber rattlesnake showed increased viability for Alternatives 2 & 3. This is a result of aggressive restoration of open woodlands in Management Prescriptions 1.1 and 1.2. The Mark Twain National Forest is of moderate importance as a contributor to continued viability of this species in Missouri, but is only a minor contributor to rangewide viability. Conservation Approach E (maintain forested landscapes) addresses the ecological level need of this species, while Conservation Approaches G, I & J (protect caves, retain den trees, snags, and downed woody material and control non-native invasive species) address species level needs. Standards and guidelines for cliffs, rock bluffs, and outcrops and caves (2005 Forest Plan pages 2-11 through 2-13) are designed to protect these physical features that may be used by timber rattlesnakes as denning sites. Our conclusion is that implementation of Alternatives 2 or 3 would moderately contribute to the continued viability of timber rattlesnakes in Missouri, through increased availability and quality of habitat in restored open woodlands, and protection of potential denning sites. Implementation of Alternatives 1, 4 or 5 would not affect viability.

Cumulative Effects

Viability cannot be assured on Mark Twain NF alone for any species on the SVE list. There are too many factors operating on each species outside Mark Twain NF boundaries, over which Mark Twain NF has no control. There are very few of the 66 animal SAR for which changes from current status occur in the Cumulative Effects area. Alternative 1 has the most negative effects of all alternatives, due primarily to long-term continued loss of open areas, early successional habitat, and open woodlands. However, most of the species show neutral effects from Alternative 1. Alternatives 2-5 also show primarily neutral impacts, although there are several species with positive impacts from Alternatives 2 and 3. Alternatives 4 and 5 are primarily neutral, with a few species positively impacted and a few species negatively impacted.

Habitat degradation or conversion on private lands is still the major threat to viability of most of these species.

Federal Threatened, Endangered, Candidate and Proposed Species

Analysis Area

The analysis area for the federal species is Mark Twain NF lands for direct and indirect effects, and the twenty-nine county area in which Mark Twain NF lands are located for the cumulative effects area. Effects are considered in the short term (10 years) and long-term (100 years).

Ozark hellbender

Proposed Changes

Standards and guidelines for riparian areas, watercourse protection zones, soil and water protection, grazing, and road construction and maintenance have all been updated. However, basic management objectives continue to be maintenance of free-flowing streams, and protection of water quality. Therefore, all alternatives provide the same level of protection for the Ozark hellbender.

Direct and Indirect Effects to individuals

Any activity which causes soil to move into streams or which removes riparian tree cover has potential to affect hellbenders by increasing sedimentation, and altering flow and temperature regimes, which can affect oxygen levels in the stream and respiration of individuals. In addition, increases in sedimentation rates would decrease the available interstitial spaces among the rock substrates for the species to utilize as cover and forage by the larvae, destroy eggs and juveniles, and reduce prey abundance. On the Mark Twain NF, activities that have this potential include timber harvest, road construction/ reconstruction and grazing. Grazing also has potential to add excess nutrients to streams, which could further affect oxygen availability.

Other activities that are suspected to adversely affect hellbenders, but are not yet proven, include deleterious effects from human and livestock hormones released as body wastes into streams and rivers from cattle grazing pastures adjacent to streams and rivers and recreationists (floaters, trail riders, etc); and predation by introduced rainbow and brown trout. All of the Mark Twain NF rivers in which hellbenders are found are popular recreation rivers, primarily for canoeing, but also for fishing and boating. All of these rivers also have introduced rainbow and/or brown trout.

Pesticides, primarily herbicides, are used on Mark Twain NF to reach various resource objectives. The major use is to control non-native invasive species or convert exotic cool-season grasses to native warm-season grasses. Fertilization and chemical use are restricted or prohibited within the frequently flooded riparian area (1986 Forest Plan) and within the Riparian Management Zones (2005 Forest Plan). All pesticide use must follow label directions. Pesticide runoff of any kind is unlikely to reach waters occupied by hellbenders due to these restrictions.

Direct and Indirect Effects to populations and habitat

There is no Recovery Plan for the Ozark hellbender. There is no designated critical habitat for Ozark hellbender on Mark Twain NF. The Forest Service has been participating in the Ozark Hellbender Working Group for the past 2 years to address conservation and recovery of the species in Missouri and Arkansas. To date, no actions have been identified that Mark Twain NF would be responsible for.

On the Mark Twain National Forest, terrestrial habitat on National Forest lands within the watersheds of the North Fork and Eleven Point Rivers is likely to remain over 90% tree cover. The Ozark National Scenic Riverways protects riparian corridors on large stretches of the Current River, although much of the watersheds are in other ownerships. Mark Twain NF lands also comprise a portion of the Current River watershed. These streams are highly unlikely to be impounded and water quality in general is considered good.

The population objective for Ozark hellbender is to reduce the rate of decline at a minimum and aim for stable populations in all sections of rivers running through Mark Twain NF. The habitat objective is to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and habitat objectives for this species.

In all alternatives, river recreation would likely continue to be popular and may increase somewhat in the future. Stocking of non-native fish would continue in rivers and streams where they already exist. Although grazing is a threat to the species, maintaining functionality of the RMZ and WPZ would provide adequate protection to minimize sedimentation or addition of excess nutrients into streams. Water flow and quality in the Mark Twain NF rivers which currently support Ozark hellbender should be unaffected due to implementation of standards and guidelines in all alternatives and may benefit by increases in natural community quality within hellbender stream watersheds in Alternatives 2 and 3.

Forested riparian corridors should continue to age and natural communities within the watersheds should achieve healthier conditions. Population trend for Ozark hellbenders is unpredictable because there is no consensus on the cause of continued declines.

Cumulative effects

Ozark hellbenders are only found on three rivers on Mark Twain NF. For these three rivers, North Fork River, Eleven Point River and Current River, about 30%, 1-54%, and 23-51% of the watershed respectively is comprised of Mark Twain NF lands. Activities which occur on other ownerships have more potential to affect water quality and flow of these streams than those which occur on Mark Twain NF lands.

Since the factor or factors responsible for the current decline of this species have not been fully identified, it is difficult to determine effects on the species or predict future populations. The best the Mark Twain NF can do to contribute to the viability of this species is to maintain forested riparian corridors and free-flowing streams, minimize soil movement from management activities, and maintain free passage at road crossings. These actions would insure that habitat is provided in waters that run through Mark Twain NF and that, to the extent possible, water quality is maintained or improved on these waters.

Eastern hellbender

Proposed Changes

Standards and guidelines for riparian areas, watercourse protection zones, soil and water protection, grazing, and road construction and maintenance have been updated. However, basic management objectives continue to be maintenance of free-flowing streams, and protection of water quality. Therefore, all alternatives provide the same level of protection for Eastern hellbender.

Direct and Indirect Effects to individuals

Any activity which causes soil to move into streams or which removes riparian tree cover has potential to affect hellbenders by increasing sedimentation, altering flow and temperature regimes which can affect the oxygen levels in the stream and respiration of individuals. Also increases in sedimentation rates will decrease the available interstitial spaces available among the rock substrates for the species to utilize as cover and forage by the larval, destroy eggs and juveniles, and reduce prey abundance. On Mark Twain NF, activities that have this potential include timber harvest, road construction/ reconstruction and grazing. Grazing also has the potential to add excess nutrients to streams which could further affect oxygen availability.

Other activities that are suspected to adversely affect hellbenders, but are not yet proven, include deleterious effects from human and livestock hormones released as body wastes into streams and rivers from cattle grazing pastures adjacent to streams and rivers and recreationists (floaters, trail riders, etc); and predation by introduced rainbow and brown trout. The Big Piney River is a popular river for floating and fishing, and trout are present in Stone Mill Spring Branch, which feeds the Big Piney River.

Pesticides, primarily herbicides, are used on Mark Twain NF to reach various resource objectives. The major use is to control non-native invasive species or convert exotic, cool-season grasses to native, warm-season grasses. Fertilization and chemical use are restricted or prohibited within the frequently flooded riparian area (1986 Forest Plan) and within the Riparian Management Zone (2005 Forest Plan). All pesticide use must follow label directions. Insecticides are only used for incidental housekeeping purposes, such as “bee-boppers” to kill wasps, etc. in recreation areas. Pesticide runoff of any kind is unlikely to reach waters occupied by hellbenders due to these restrictions.

Direct and Indirect Effects to populations and habitat

Because it is not yet listed, there is no Recovery Plan for the Eastern hellbender. There is no designated critical habitat for Eastern hellbender on Mark Twain NF.

On Mark Twain NF, terrestrial habitat on National Forest lands within the watershed of the Big Piney River is likely to remain over 90% tree cover. This stream is highly unlikely to be impounded and water quality in general is considered good.

The population objective for Eastern hellbender is to reduce the rate of decline at a minimum and aim for stable populations in all sections of rivers running through Mark Twain NF. The habitat objective is to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and the habitat objective for this species.

In all alternatives, river recreation would likely continue to be popular and may increase somewhat in the future. Stocking of non-native fish would continue in rivers and streams where they already exist. Although grazing is a threat to the species, maintaining the functionality of the RMZ and WPZ would provide adequate protection to minimize sedimentation or the addition of excess nutrients into streams. Water flow and quality in the Mark Twain NF rivers, which currently support Eastern hellbender should be unaffected due to implementation of standards and guidelines in all alternatives and may be benefited by increases in natural community quality within hellbender stream watersheds in Alternatives 2 and 3.

Forested riparian corridors should continue to age and natural communities within the watersheds should achieve healthier conditions. Population trend for Eastern hellbenders is unpredictable because there is no consensus on the cause of continued declines.

Cumulative effects

For the Big Piney River, the only river on Mark Twain NF in which Eastern hellbenders are documented to occur, about 21-41% of the watershed is comprised of Mark Twain NF lands. Activities which occur on other ownerships have more potential to affect water quality of these streams than those which occur on Mark Twain NF lands.

Since the factor or factors responsible for the current decline of this species have not been fully identified, it is difficult to determine effects on the species or predict future populations. The best the Mark Twain NF can do to contribute to the viability of this species is to maintain forested riparian corridors and free-flowing streams, minimize soil movement from management activities, and maintain free passage at road crossings. These actions would insure that habitat is provided in waters that run through Mark Twain NF and that, to the extent possible, water quality is maintained or improved on these waters.

Bald eagle

Proposed Changes

Standards and guidelines for riparian areas, watercourse protection zones, soil and water protection, grazing, and road construction and maintenance have been updated. There are also several standards and guidelines specific to bald eagle habitat protection and management. However, basic management objectives continue to be maintenance of free-flowing streams, protection of water quality, and protection of occupied habitat. Therefore, all alternatives provide the same level of protection for bald eagle.

Specific standards and guidelines related to bald eagle management include:

- Maintain suitable habitat for nesting, roosting, and foraging bald eagles. Protect all occupied nest sites from disturbance from January through July (or during active breeding, incubation and brood rearing periods).
- Conduct management activities planned near known nesting sites in a manner that protects the existing nest site, maintains suitable alternate nesting habitat, and occurs outside of the breeding, incubation and brood rearing periods (approximately January through July).
- In cooperation with U.S. Fish and Wildlife Service and Missouri Department of Conservation, develop educational signs regarding appropriate behavior near occupied bald eagle nests or near roosting eagles. Post signs at accesses on rivers or lakes where eagles may be present.
- Designate a ¼ mile old growth corridor along the waters' edge of Table Rock Lake and Lake Wappapello, which are traditional bald eagle wintering areas.

Direct and Indirect Effects to individuals

Although bald eagles seem to prefer areas with limited human activity, in Missouri, birds are successfully nesting and roosting along edges of major lakes and rivers with extensive motorboat and canoe traffic in all seasons.

Major threats outside the control of the Forest Service include development of forestland and riparian lands for other land uses, like roads, homes, mining, farming, resulting in loss of habitat. Urban development around major lakes in Missouri (Lake of the Ozarks, Truman

Lake, Stockton Lake, Table Rock Lake, Lake Wapapello, etc.) continues to reduce forested riparian corridors as well as uplands near them.

Illegal shooting and disturbance of nests by increasing numbers of eagle-watchers or recreationists is probably the major threat to individuals in Missouri, but is not likely to affect the overall population. Heavy recreation use along major lakes and rivers may be a deterrent for eagles selecting new nesting sites. Local wintering populations could be affected if there was a fish kill in waters of traditional wintering areas.

Direct and Indirect Effects to populations and habitat

The Northern States Bald Eagle Recovery Plan was approved July 29, 1983. There is no designated critical habitat for bald eagle on Mark Twain NF. Missouri's goal for number of occupied breeding areas was 50 by the year 2000. As of 2001, there were over 75 known nesting territories in Missouri   The 1986 Forest Plan has protection measures identified for nests and riparian areas, which meets Recovery Outline items 3.2.1 Protect and manage breeding season habitat and prey resources and 3.22 Protect and manage habitat and prey resources used by wintering eagles. Mark Twain NF personnel have also participated in surveys of wintering bald eagles over the past 20 years, which meets Recovery Outline item 1.212 Conduct surveys.

Population objectives for bald eagles are to maintain stable wintering populations in Missouri and increase nesting pairs on Mark Twain NF to 10. Habitat objectives are to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and habitat objectives for this species.

Area in tree cover should not change significantly in short or long-term on Mark Twain NF. Primary habitat for bald eagles on Mark Twain NF is riparian corridors of major rivers in southern Missouri, which are protected by Forest Plan standards and guides. Riparian zones and watercourse protection zones have been defined and protection measures developed.

Since all alternatives provide the same level of protection for bald eagle, habitat on Mark Twain NF is predicted to be stable in the short-term (10 years) and long-term (100 years). In all alternatives, habitat for bald eagle would continue to be available along major river corridors running through Mark Twain NF, as well as along the shoreline of Table Rock Lake, Lake Wappapello and Council Bluff Lake. Areas along these rivers and lakes that are within Mark Twain NF would be managed to retain and restore forested riparian corridors. As these riparian forests age, more large and supercanopy trees will develop and be available for eagle use. Population trend is predicted to be stable or increasing in the short term (10 years) and long-term (100 years) on Mark Twain NF lands.

There is no viability concern for bald eagles in Missouri or on Mark Twain NF. Breeding populations are increasing and wintering populations are stable.

Cumulative effects

Private lands along the Mississippi and Missouri Rivers, and the large recreation lakes in the state continue to be developed for urban and agricultural uses, reducing the amount of quality habitat available for bald eagles. Recreational use of lakes and rivers continues to increase, with increases in the amount and size of motors being used. Personal motorized watercraft use is also increasing on most lakes and some rivers. However, bald eagles have appeared to adapt readily to the presence of boats and people on the large lakes and rives of the state. In spite of recreational use of waterways, wintering eagle populations are steady in Missouri, and breeding populations have been increasing steadily. Riparian corridors on Mark Twain NF and Forest lands along the shores of major lakes are primarily tree cover and are likely to remain in tree cover for the foreseeable future.

It is likely that sufficient habitat and food will be available on public lands and on some private lands along the waterways of Missouri that populations of bald eagles will continue to thrive.

Topeka shiner

Proposed Changes

Riparian zones and watercourse protection zones have been defined and protection measures developed. Management activities within these zones are limited or restricted to protect water quality and integrity of the hydrologic system. Standards and guidelines to minimize soil movement have been updated. The overall management objectives remain protection of free-flowing streams and water quality.

Direct and Indirect Effects to individuals

Topeka shiner is intolerant of human-caused disturbances and habitat alterations which reduce water quality and increase water temperature. This would include such things as removal of trees along riparian corridors, road construction in riparian areas, lack of road maintenance allowing soil to move off-site and reach waterways, and grazing in riparian areas or allowing livestock to water in streams.

Direct and Indirect Effects to populations and habitat

There is no approved Recovery Plan for Topeka Shiner. There is no designated critical habitat for Topeka shiner on Mark Twain NF or in Missouri. Topeka shiner has been extirpated from Mark Twain NF streams that were documented historic locations. It only occurred on the Cedar Creek unit of Mark Twain NF.

There is no population objective for this species since there are no documented locations on Mark Twain NF. The habitat objectives are to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting the habitat objective for this species.

In all alternatives, areas along rivers that are within Mark Twain NF would be managed to retain forested riparian corridors. Implementation of soil and water standards and guidelines would minimize soil movement so that sedimentation of rivers due to Mark Twain NF management activities is expected to be extremely low. Since there are no known locations of this species on Mark Twain NF lands, there would not be direct effects. Locations of current populations of Topeka shiner are not in watersheds that would be affected by Mark Twain NF management, so there would be no indirect effects on the species.

Cumulative effects

Statewide threats are increased sedimentation as a result of more intensive row-crop production, wide spread application of pesticides, increased urbanization resulting in habitat loss and degradation of water quality, and competition from introduced populations of blackstripe topminnow and western mosquitofish. Alteration of streams by impoundment or channelization can also reduce or eliminate suitable habitat.

Because there are no direct or indirect effects on Topeka shiner from activities on Mark Twain NF, there would be no cumulative effects.

Hine’s emerald dragonfly (HED)

Proposed Changes:

Management of natural communities is the primary means of providing quality terrestrial and aquatic wildlife and rare plant habitat on Mark Twain NF. Fens are unique features and have specific standards and guidelines to protect and enhance their qualities. There are also specific standards and guidelines for protection and management of Hine’s emerald dragonfly habitat. The major change from the 1986 Plan is recognition of this species and its need for open fen habitat.

Specific standards and guidelines that deal with Hine’s emerald dragonfly include:

- Control non-native invasive and/or undesirable plant species in fen habitats through the most effective means while protecting water quality.
- Restore local hydrology by eliminating old drainage ditches or other water diversionary structures when possible if such activities would not result in loss of habitat.
- To control invasion of woody species or as part of a larger landscape restoration/enhancement project, prescribed burning should be utilized on fens that harbor known populations of Hine’s emerald dragonfly.
- Prescribed burns on fens that harbor known or suspected populations of Hine’s emerald dragonfly must be scheduled to occur from November through April.

Direct and Indirect Effects to individuals

Any change in the openness of fens, through invasion of woody and/or non-native invasive species reduces available habitat. Changes in surface and sub-surface hydrology could be detrimental. Alteration of water regimes could affect surface water flow, cause loss of seep heads, and reduce existing or potential larval habitat. Permanent loss of appropriate hydrology also has potential to reduce the amount of suitable breeding and larval habitat. Periods of drought or inundation also have potential to affect larval populations.

On Mark Twain NF, problems identified at HED sites include: invasion of woody and non-native species; illegal ATV/OHV use that compacts soil, changes water flow, and crushes larval burrows; feral hogs that can root up and destroy vegetation and can crush larval burrows; alteration of water flow from historic farming activities; and at Grasshopper Hollow Natural Area, acid water leaching from the sawdust pile; dust from nearby lead mine tailings ponds blowing into Grasshopper Hollow, and alteration of water table within the recharge area of Grasshopper Hollow. Some fens shared with private property have cattle grazing the fen on private ownership. In addition, prescribed burns that include fens and are conducted during the breeding season have potential to disrupt breeding and foraging, or to harm individuals.

Due to habitat fragmentation and small population size, populations of this species are vulnerable to contamination of ground and surface water from landfills, chemicals, insecticides, herbicides, fertilizers leaching from other areas, habitat destruction/alteration through developing commercial and residential areas, quarrying, creating landfills, constructing pipelines, and/or filling of wetlands; environmental extremes, collisions with vehicles, demographic and genetic isolation, and disease/predation. Direct loss of breeding and/or foraging habitat has potential to reduce the fitness of adults, resulting in females laying fewer eggs.

Direct and Indirect Effects to populations and habitat

The Hine's Emerald Dragonfly Recovery Plan was approved September 27, 2001(USDI Fish and Wildlife Service 2001). There is no designated critical habitat for Hine's emerald dragonfly on Mark Twain NF. The overriding priority for species recovery is "to protect and maintain the known populations and their associated terrestrial and aquatic habitat." The second component is survey to discover additional populations and detect population trends. Missouri is in the Southern Recovery Unit. Mark Twain NF has been involved in both these priorities, particularly in meeting Recovery Outline items1.3.4 **Manage habitat**; 2.3.4 **Conduct hydrologic studies**, and 3.4 **Conduct searches for additional populations**, and will continue to do so under any alternative.

The population objective for Hine's emerald dragonfly is to determine population sizes and trends for sites on Mark Twain NF. The habitat objective is to treat 100% of known Hine's emerald dragonfly fens to maintain openness and to restore hydrologic integrity to those sites altered by previous human activity. All alternatives have an equal probability of meeting the population objective for this species. Alternatives 2 and 3 have the best probability of meeting the habitat objective, while Alternatives 4 and 5 have a good probability of meeting the habitat objective. Alternative 1 has the least probability of meeting the habitat objective.

In all alternatives, habitat for the Hine's emerald dragonfly would continue to be available in fens across the Mark Twain NF. Alternatives 2 and 3 have the most potential to improve the condition of degraded fens due to the emphasis on natural community restoration and enhancement, and the most acres in Management Prescriptions 1.1 and 1.2. Prescribed fire, woody vegetation reduction, and non-native invasive species prevention/control would be used to maintain or increase species diversity, abundance, distribution and vigor in fens.

These same management tools may also be used in Alternatives 1, 4 and 5, but fewer acres would be treated than in Alternatives 2 and 3. In Alternatives 1, 4 and 5, some fens may become unsuitable habitat in the long run as woody species invade because of lack of treatment.

Habitat is predicted to be stable in the short-term (10 years) in all alternatives; decreasing in the long-term (100 years) in Alternative 1, stable in the long-term in Alternatives 4 and 5, and increasing in the long-term in Alternatives 2 and 3. Population trends are difficult to predict since new sites are still being located in Missouri and population census work has not been completed on Mark Twain NF lands.

Cumulative effects

Continued private land conversion, loss of wetlands, and grazing open wetlands would result in a decrease in available habitat, and probably a decrease in population numbers and further restricted distribution of the species. Mark Twain NF has some significant, though not critical sites for this species in Missouri. Alternatives 2 and 3 with an emphasis on natural community restoration and enhancement have the most potential for improving Hine's emerald dragonfly habitat in the long-term, and therefore the most influence on cumulative effects. Even if private land sites continue to be degraded, it is possible that high-quality sites on Mark Twain NF could allow the species to persist in Missouri under these two alternatives, particularly Alternative 2. Alternatives 4 and 5 would not contribute to a decrease in habitat availability or suitability and thus would have no cumulative effects. Alternative 1, with the potential for some fens to become less suitable habitat has a slight negative cumulative effect, when considering actions on other ownerships. Whether or not it is enough to cause viability concerns in Missouri is unclear.

Gray bat

Proposed Changes

Standards and guidelines for riparian zones and watercourse protection zones, to protect cave entrances, cave passages, and cave recharge areas, and soil and water protection, have been updated. In addition, updated standards and guidelines specific to gray bats still include protection of caves from physical disturbance and protection of foraging habitat. However, overall management objectives remain protection of free-flowing streams and water quality, and protection of caves and foraging areas.

Standards and guidelines specific to gray bats include:

- Maintain existing gates at occupied Indiana or gray bat caves. All structures placed at cave entrances must permit bats to pass with minimal danger and must not alter airflow into or out of the cave.
- Regularly evaluate known gray and Indiana bat caves to determine needs for adequate protective measures, including signing, structures, closures, etc.
- Designate an area of at least 20 acres surrounding an Indiana or gray bat cave entrance(s), including the area above known or suspected cave/mine passages, foraging corridor(s) and ridge tops and side slopes around the cave for permanent old growth management. Within this old growth area, only vegetation management activities needed to reach the desired condition are allowed.
- Maintain an additional 130 acres of mature forest or mature woodland around each occupied Indiana or gray bat cave.
- Maintain and/or restore a mature forested corridor at least 100 feet wide and with at least 70% canopy closure between a cave used by gray bats and their foraging areas in streams and rivers. Within the corridor, allow only vegetation management activities needed to restore, enhance or maintain mature forest or woodland natural communities.
- The area around occupied Indiana or gray bat caves shall be a smoke-sensitive area and prescribed burn plans shall be developed to avoid or minimize smoke influences at or near these caves. The U.S. Fish and Wildlife Service shall be given an opportunity to review and comment on prescribed burn plans within these areas.
- Except for regularly scheduled population monitoring or other legitimate scientific purposes do not allow human entrance to gray bat hibernacula or summer caves during the periods of bat use.
- Abandoned mines must be evaluated for bat use prior to permanent closure.
- Conduct an evaluation for the presence of Indiana and gray bats prior to any decision to remove a building or bridge.
- Bridges proposed for construction or reconstruction across streams that are 40 or more feet wide should be designed of concrete with girders or chambers to provide suitable bat roosting space underneath whenever possible.

Direct and Indirect Effects to individuals

Decline of this species began with cave disturbance associated with saltpeter production during the Civil War. Some of the largest colonies were lost as a result of cave commercialization. Gray bats are especially vulnerable due to high fidelity to particular favored caves. They are very sensitive to disturbance, including the mere presence of humans with lights; disturbance may result in bats moving to less favorable roosting places. Other threats include pesticides, deforestation, and impoundment of waterways (NatureServe, 2004).

With most roost and hibernacula caves found in forested areas, forested corridors between caves and riparian foraging areas are critical. These forested areas influence temperature and humidity, which is critical, inside the hibernacula and summer caves. Deforestation near cave entrances and between caves and rivers or reservoirs may cause adverse effects to bat populations, including decrease in prey availability, decrease in foraging efficiency and increase in vulnerability to predators (Tuttle 1979). Clearing vegetation near cave entrances increases gray bat susceptibility to predators, such as the screech owl, which has great difficulty capturing bats in tree canopy (Mitchell and Martin 2002).

Hibernation and maternity caves must be kept free from human disturbance September 1 - April 30 and April 1 - October 30, respectively (MDC 2004a). Gray bats may abandon summer caves because of human intrusion. Cave entrances should be protected with properly designed gates or fencing, as well as posted notices.

Although factors such as flooding, cave-ins, freezing and disease occasionally impact gray bats, population decline has been attributed chiefly to human disturbance of bats and alteration of their habitat (Mitchell and Martin 2002).

Direct and Indirect Effects to populations and habitat

The Gray Bat Recovery Plan was approved July 8, 1982. There is no designated critical habitat for gray bats on Mark Twain NF. Needed recovery actions include: Acquire and Protect Caves, Control Habitat Destruction, Public Education, and Research Needs. Mark Twain NF has been involved in many of the Step-Down Recovery Actions, including all of the three major items, 1. Prevent Disturbance to Important Roost Habitat; 2. Maintain, Protect, and Restore Foraging Habitat; and 3. Monitor Population Trends. Gates have been constructed at six Mark Twain NF occupied gray bat caves over the past 20 years (Items 1.2.1 and 1.2.2). Several old gates were replaced with newer, bat-friendly designs (Item 1.3.1). Specific standard and guidelines restrict certain activities within areas near occupied cave entrances and passages (Item 1.3.1 and 1.3.2). Foraging corridors between occupied caves and the nearest water are maintained in forested condition (Item 2.2.3) and any project that may affect these corridors is reviewed by USFWS during consultation (Item 2.2.5). Interpretive signs have been placed at some of the caves (Item 1.1.2). Protection needs for other gray bat caves on Mark Twain NF are regularly reevaluated (Item 1.1.1.1.1.1). Mark Twain NF personnel have conducted winter and summer population surveys in cooperation with Missouri Department of Conservation (Items 1.2.3, 3.1 and 3.2). Mark Twain NF biologists regularly give talks to schools and civic organizations regarding bat conservation (Item 1.1.3). There is nothing in any of the alternatives that would prevent the Forest Service from continuing to contribute to these recovery objectives.

The population objective for gray bat is to maintain stable or increasing population trends on Mark Twain NF that contribute to downlisting of species from Endangered to Threatened. Habitat objectives are to:

- Maintain gates at all currently gated gray bat caves;
- Evaluate significant gray bat caves for gating/protection needs and construct structures for 100% of those caves determined to need protection;
- Maintain a minimum 100-foot wide forested corridor between all known gray bat caves and their foraging areas and along Mark Twain NF rivers and streams;
- Maintain all existing streams as free-flowing;

- Maintain or increase the amount of streamside tree cover of at least 100 feet wide; and
- Eliminate livestock watering in streams or rivers.
- All alternatives have an equal probability of meeting both the population and habitat objectives for this species.

In all alternatives, caves and abandoned mines would be protected from physical and human disturbance. Known gray bat caves would be monitored to determine additional needs for physical protection. Riparian corridors would be managed to retain and restore forested riparian corridors. Forested corridors would be retained between known gray bat caves and their foraging areas. Prescribed burns would be planned to minimize smoke exposure at occupied gray bat caves. Mature and over-mature forest/woodland would be abundant across the Mark Twain NF landscape; with the most in Alternative 1, and the least in Alternative 5. Soil movement from National Forest management activities would be minimized by application of standards and guidelines, and water quality should be unaffected, thereby ensuring a sustained supply of aquatic insect prey. Since all alternatives provide the same level of protection for gray bats, both cave and foraging habitat is predicted to be stable in the short-term (10 years) and long-term (100 years). Habitat quantity and quality would be at least equal to what is currently available on the Mark Twain NF. Population trends are currently stable, and are predicted to remain stable or increasing in any alternative.

Cumulative effects

Across Missouri, gray bat populations appear to be stable or possibly increasing. Many gray bat caves are protected from human disturbance by physical barriers. However, riparian corridors continue to be converted from forest to non-forest uses, particularly for urban development and agriculture. Since habitat on Mark Twain NF would not change substantially in any of the alternatives, there would be no cumulative adverse impact from implementation of any of the alternatives. In fact, the continued protection of known habitat, and provisions for protection of any additional habitat discovered on Mark Twain NF would contribute to a positive cumulative effect in Missouri.

Indiana bat

Proposed Changes

Standards and guidelines for riparian zones and watercourse protection zones, to protect cave entrances, cave passages, and cave recharge areas, and soil and water protection, have been updated. Updated standards and guidelines specific to Indiana bats still include protection and management of hibernacula, foraging and roosting habitats. Management Prescription 3.5 has been dropped, however overall management objectives remain protection of caves and providing foraging and roosting habitat across the Forest.

Standards and guidelines specific to Indiana bats include:

- Maintain, and replace as needed, existing gates at occupied Indiana or gray bat caves. All structures placed at cave entrances must permit bats to pass with minimal danger and must not alter airflow into/out of the cave.
- Designate an area of at least 20 acres surrounding an Indiana or gray bat cave entrance(s), including the area above known or suspected cave/mine passages, foraging corridor(s) and ridge tops and side slopes around the cave for permanent old growth management. Within this old growth area, only vegetation management activities needed to reach the desired condition are allowed.

- Maintain an additional 130 acres of mature forest or mature woodland around each occupied Indiana or gray bat cave.
- Maintain or restore a mature forested corridor at least 100 feet wide and with at least 70% canopy closure between a cave used by gray bats and their foraging areas (streams and rivers). Within the corridor, allow only vegetation management activities needed to restore, enhance, or maintain mature forest or woodland natural communities.
- The area around occupied Indiana or gray bat caves shall be a smoke-sensitive area and prescribed burn plans shall be developed to avoid or minimize smoke influences at or near these caves. The U.S. Fish and Wildlife Service shall be given an opportunity to review and comment on prescribed burn plans within these areas.
- Except for regularly scheduled population monitoring or other legitimate scientific purposes do not allow human entrance to Indiana bat hibernacula during the fall swarming, hibernation, and spring emergence period.
- Abandoned mines must be evaluated for bat use prior to permanent closure.
- Maintain trees with characteristics of suitable roosts (i.e. dead or dying with exfoliating bark or large living trees with flaking bark) wherever possible with regard for public safety and accomplishment of overall resource goals and objectives.
- If occupied Indiana bat maternity roost trees are discovered, protect them from physical disturbance until they naturally fall to the ground.
- Based on site specific consultation, designate an area of use (foraging and roosting) based on site conditions, radio-tracking or other survey information, and best available information regarding maternity habitat needs.
- Minimize human disturbance in the maternity colony areas of use until the colony has left the maternity area for hibernation.
- Conduct prescribed burning within the maternity colony area of use only during the hibernation season.
- Maintain or enhance the character of the site year-round by: maintaining an adequate number of snags, including known roost trees; maintaining large live trees to provide future roosting opportunities; and maintaining small canopy gaps (and/or opening the mid-story) to provide a continual supply of foraging habitat.
- Periodically assess all occupied Indiana and gray bat caves to determine needs for physical protection of the cave entrance.
- Periodically monitor all cave gates and protective structures to detect trespass, vandalism, or other situations which render those structures ineffective.
- Prohibit core drilling or other surface disturbing mineral operations over known caves and in the 20 acres designated around Indiana or gray bat caves, and the additional 130 acres designated around Indiana bat caves.
- Protect known male roost trees from physical disturbance until they naturally fall to the ground.
- Protect occupied Indiana bat male roost trees discovered during the summer season (not migration), from physical disturbance by designating a 75-foot radius buffer zone around the tree(s). The buffer zone shall remain in place until hibernation season begins (around November 1.)
- Prohibit ground-disturbing activity or timber harvest within the buffer zone.

- Prescribed burning may be done within the buffer zone if a fireline is manually constructed no less than 25 feet from, and completely around, the tree to prevent it from catching fire.
- Identify and remove hazard trees between November 1 and April 1 whenever possible.
- Using the current, accepted technology, determine the location of summer roost trees and foraging areas for female Indiana bats.
- Prohibit removal of suitable roost trees and prescribed burning within the 20 acres of old growth and 130 acres of forest or mature woodland surrounding an Indiana bat hibernacula during the swarming and staging periods. Determine dates individually for each cave (normally between September 1 and November 1 and between March 15 and April 30 respectively.)
- Conduct an evaluation for the presence of Indiana bats prior to any decision to remove a building or bridge.
- Bridges proposed for construction or reconstruction across streams that are 40 or more feet wide should be designed of concrete with girders or chambers to provide suitable bat roosting space underneath whenever possible.

Direct and Indirect Effects to individuals

Human disturbance in hibernacula can cause Indiana bats to wake, and use energy that is needed to survive through hibernation and the first part of emergence. Indiana bats are very vulnerable during hibernation. Human presence causes metabolic increases, arousal and reclustering, which all use fat reserves (Johnson et al. 1998, Humphrey 1978). When a bat is aroused, as much as 68 days of fat supply may be used in a single disturbance. If this happens too often, bats' fat reserves may be exhausted before the species is able to forage in the spring (USDI Fish and Wildlife Service 1999a). Humans have also been known to deliberately kill hibernating bats. Extreme cold events and flooding of hibernacula can kill individual or groups of Indiana bats.

Because Indiana bats use dead and living trees as summer roosts, any activity that removes dead trees and large living trees with flaking/exfoliating bark may affect Indiana bats directly or indirectly. If a bat or bats are roosting in a tree when it is cut, the bat(s) would normally arouse and fly, or may be injured or killed if it is non-volant or does not arouse in time to fly. Indirectly, removal of dead trees and large, living trees with flaking bark reduces the amount of potential roost trees for Indiana bats. In addition, if a tree is removed that was previously used as a roost tree, bats would have to use energy to find another tree when they return. However, Indiana bats evolved using ephemeral roosts, and routinely use more than one roost, presumably as a method of checking possible roosts. Site fidelity seems to be more important than roost tree fidelity. The site needs to have suitable roost trees available – that is more important than a specific tree being there when they get back after hibernation.

Prescribed burning or wildfires may directly or indirectly affect Indiana bats roosting in trees. Fire may destroy some existing snags, so they are no longer available as roost trees, but fire also creates new snags that may be suitable roost trees. It is unknown how smoke affects roosting bats, but personal experience of over 20 years of fire management in the Ozarks indicates that most bats are able to fly through smoke and leave a fire area. Of course, this would require them to use additional energy during the day. In addition, if a maternity roost tree caught fire while non-volant young were in it (late May – July), they may be injured or die, depending on the intensity of the fire and amount or areas of the tree that burned. Mothers may attempt to carry non-volant juvenile bats out of a burning tree or a smoky area, but depending on when the fire was to occur, the young may be too big. Even if they are not too big, the mother may drop them while trying to escape.

Direct and Indirect Effects to populations and habitat

The Indiana Bat Recovery Plan was approved on October 14, 1983 (USDI Fish and Wildlife Service 1983b). An Agency Draft Indiana Bat (Myotis sodalis) Revised Recovery Plan was issued in March 1999 (USDI Fish and Wildlife Service 1999a). There is no designated Indiana bat critical habitat on Mark Twain NF. Mark Twain NF has been involved in many of the Step-Down Recovery Actions, including all of the major items, 1. Prevent Disturbance to Important Hibernacula; 2. Maintain, Protect, and Restore Foraging and Nursery Habitat; 3. Monitor Population Trends; 4. Public Education, and 5. Research Needs.

Gates are in place at two of the Mark Twain NF occupied Indiana bat hibernacula and are monitored for effectiveness (Items1.1.2 and 1.1.3). Specific standard and guidelines restrict certain activities within areas near occupied cave entrances and passages (Items 1.1.5, 1.2.1, 1.2.2). Interpretive signs have been placed at some of the caves (Item 1.1.2). Mark Twain NF in partnership with Cave Research Foundation has conducted biological inventories of over 100 caves on Mark Twain NF over the past 10 years (Item 1.3.1). Mark Twain NF personnel have conducted winter population and summer presence/absence surveys in cooperation with Missouri Department of Conservation and North Central Research Station (Items 1.1.3, 3.1, 3.2).

Standards and guidelines restrict the amount and type of management activities that may occur within forested riparian corridors (Item 2.1.3). Mark Twain NF biologists regularly give talks to schools and civic organizations regarding bat conservation (Item 4.6). Mark Twain NF has been involved in research applicable to both summer and winter habitat needs (Items 5.1, 5.4, 5.7).

Many of these items, as well as additional items, are also included in the Agency Draft Revised Recovery Plan. There is nothing in any alternative that would prevent the Forest Service from continuing to contribute to these recovery objectives.

The population objective for Indiana bats is to achieve stable population trends at both known Indiana bat hibernacula on Mark Twain NF. Habitat objectives are to:

- Maintain continued reproduction at known maternity colony,
- Determine summer population occurrences in Missouri, in cooperation with USFWS, MDC and NCRS,
- Maintain gates on both known Indiana bat hibernacula on Mark Twain NF,
- Maintain mature forest on 150 acres around both cave entrances,
- Increase amount of open woodland on Mark Twain NF by 50%, and
- Maintain suitable habitat for known maternity colony(s) on Mark Twain NF.

All alternatives have an equal probability of meeting the population objective for this species. All alternatives have an equal probability of maintaining the gates and tree cover around hibernacula, and maintaining suitable habitat for maternity colonies. However, Alternatives 2 and 3 have the highest probability of achieving the objective for increasing area in open woodlands due to the emphasis on restoration of natural communities. Alternatives 1 and 4 have a slight probability of achieving the open woodland objective, while Alternative 5 has a good probability of reaching the objective within the 3.5 management areas and only a slight possibility of reaching the objective in other management areas.

The greatest threat to the Indiana bat across its range appears to be the loss of key hibernation caves. Indiana bats are highly vulnerable, as a majority of the total population hibernates in relatively few sites. Changing temperatures in hibernacula due to alteration of entrances can make hibernacula unsuitable for Indiana bats. Improperly constructed gates may also alter airflow, restrict bat movement or trap debris, making caves unsuitable for Indiana bats.

Vandalism and indiscriminant killing have been a problem at some caves. Commercialization and intentional elimination by cave owners are also factors. Poorly designed gates, changes in cave temperatures induced by opening additional entrances, or poorly designed barriers to human access are additional threats (NatureServe 2004). Improperly constructed gates can alter airflow, trap debris and block the entrance by not allowing enough flight space (Kurta and Kennedy 2002). Altered air exchange can cause significant changes in cave temperature and humidity and may cause the bats to abandon caves (NatureServe 2004). Improperly constructed gates may also subject bats to severe predation as they attempt to pass through the gates (Tuttle 1977) and have resulted in microclimate alterations (BCI 2001). Some hibernacula have been rendered unavailable by the erection of solid gates in the entrances (Humphrey 1978).

The degradation of summer habitat and roost sites because of impoundment, stream channelization, urban development and conversion of forest or woodland natural communities to agricultural use may also be factors in recent population declines (NatureServe 2004). Application of pesticides to crops grown in maternity areas may also have impacts on individual bats, or to reproductive success of populations (USDI Fish and Wildlife Service 1999a).

Over 90% of the acres of Mark Twain NF, are currently in tree cover; caves and abandoned mines would be protected from physical and human disturbance in any alternative. Snags and cavity trees (potential Indiana bat roost trees) would be abundant across the Mark Twain NF landscape, and protected from disturbance whenever possible. Known Indiana bat hibernacula and maternity colonies would be protected from physical disturbance. Preferred foraging habitat would be provided where tree canopies were reduced by commercial thinning in Alternatives 2-5. Non-commercial thinning in Alternative 1 would only occur in MP 1.1 and 1.2, resulting in minimal preferred foraging habitat, not well distributed across the Forest landscape. Timber harvest which reduces tree canopy below about 30% (clearcut, seedtree, and some shelterwood cuts) would be accomplished in varying amounts in all alternatives, and these areas are traditionally thought to be less than optimal roosting or foraging habitat for Indiana bats. However, these areas may still provide roost trees (standards and guidelines for retention of dens, snags, and cavity trees in harvest units) and foraging areas, as demonstrated on Mark Twain NF during the summer of 2004 on the Salem Ranger District (Amelon and Bradley, pers. comm. 2004). “Managing for roost trees may involve implementing cutting regimes (e.g. shelterwood and highgrade cuts – Vonhof 1996) that maintain multi-aged stands and retain a component of mature trees following harvest, leaving dead and damaged trees standing, and leaving all trees previously used by Indiana bats” (Kurta and Kennedy 2002). Indiana bat conservation “seems to be compatible with forestry practices that maintain structural features important to their roosting and foraging needs such as snags for roosting and small openings and edge habitats, especially along streams, for foraging” (BCI 2001). Forest managers “should work to create numerous areas of mixed-forest types, ages, and stand conditions near hibernacula, while maintaining a continuing supply of suitable roost trees” (Kurta and Kennedy 2002).

Alternatives 2 and 3, with the highest amount of natural community restoration and enhancement would have the most potential for creating and maintaining open woodland habitat, which formerly covered about 27-47% of the Forest, and closed woodland habitat, which formerly covered about 32%-50% of Mark Twain NF. These two habitats are most likely the foraging habitat with which Indiana bats in Missouri evolved and are best suited. Alternatives 1 and 4, with emphasis on semi-primitive recreation experience and commodity production respectively, would have some natural community restoration, but at much lower levels of both quantity and quality than Alternatives 2 and 3. In Alternative 5, the current condition would continue, with primarily closed canopy forest natural communities, with a small amount of open and closed woodland habitat available. The majority of the Mark Twain NF would be in habitat that is considered less than optimal for Indiana bat.

Indiana bats are known to forage and travel along road corridors, and therefore, maintenance of the road system on Mark Twain NF is unlikely to have any effects on Indiana bats. The greatest effect would be access to hibernacula. The easier it is for people to get to the hibernacula, the greater chance that there could be human disturbance to hibernating bats. In all alternatives, there is no road to White's Creek Cave and none could be proposed since it is Wilderness; and there is a Forest System road that comes within 0.17 mile of Cave Hollow Cave, which would be maintained in all alternatives.

On Mark Twain NF, foraging and roosting habitat for Indiana bats would continue to be available in at least the present amount and quality under Alternatives 2-5. Alternative 1 would have less foraging habitat in the long run, as more of the Mark Twain NF approaches 100% canopy cover. Alternatives 2 and 3 have the most opportunity to provide optimum foraging habitat, as well as good roosting habitat. Cave habitat would also be unaffected by Mark Twain NF activities, regardless of alternative implemented. Habitat trends on Mark Twain NF are expected to be stable in the short-term for all alternatives. However, if climate change is responsible for long-term changes in hibernacula temperatures, winter habitat trends are not predictable.

Since there is still disagreement over the primary cause or causes of continued decline of Indiana bat, we do not know if habitat is the limiting factor. Therefore, it is difficult to predict future population trends. Unless something changes, it is likely that the declines seen in Missouri and Kentucky, as well as most southern hibernacula, over the past decade will continue. Whether or not this will be offset by increases in northern populations is uncertain.

There are no significant changes to the protection and management of cave habitat in any alternative. There is no significant change in the protection and management of dead trees or cavity trees in any alternative.

3.5 Management Prescription

The 3.5 Management Prescription was developed in response to the June 23, 1999 Programmatic Biological Opinion. The purpose of the prescription was to provide management to protect Indiana bats and their habitat in and around hibernacula and known sites of reproductively active females. The emphasis is on habitat most likely to be used as foraging habitat by male Indiana bats in summer (U.S. Forest Service 2002). Management areas would be variable sizes and would provide a continuous supply of suitable roost trees and preferred foraging habitat for Indiana bats.

Over the past seven years of survey, a total of 11 male and 4 female Indiana bats have been captured on MTNF. Of these, 8 males and 3 females have been radio-tracked. There have been 23 male roost trees and 6 female roost trees (in two separate maternity colony areas) located on MTNF as a result of radio-tracking these individuals (as well as radio-tracking of two females captured on ACOE lands and tracked to a roost tree on MTNF).

Some information from captures and radio-tracking of Indiana bats on MTNF over the past seven years contradicts the information on male use of areas near hibernacula used to develop the RPM/TC of the June 23, 1999 Programmatic Biological Opinion, on which the 3.5 Management Prescription was based. Current information leads us to conclude that even though the area around hibernacula is undoubtably important for Indiana bats, the bats are also using areas outside the recognized literature distances, and those other areas also need to support adequate foraging and roosting habitat. Therefore, new information supports the direction of Alternatives 1 through 4 to manage ecological communities over the entire Forest, rather than concentrate management for a specific species in a few locations (Alternative 5, 1986 Forest Plan).

Because the Revised Forest Plan emphasizes the management and restoration of natural communities, the desired condition of about 29% of MTNF (Management Prescriptions 1.1 and 1.2) in the long term would be more similar to landscape conditions in which Indiana bats evolved in Missouri. The Forest Service believes that this change in management emphasis would, in the long term, provide the type, amount, and distribution of habitat components on about 1/3 of the Forest that Indiana bats lived in prior to the dramatic changes to caves, riparian landscapes and upland forest in the Ozarks and the start of decline of the species range wide. In the 2.1, 6.1 and 6.2 Management Prescriptions (63% of MTNF), management to provide a wide variety of goods and services will be done so that vegetation within these areas falls within the natural range of variability, and in turn, provides to a much greater degree than presently, the kind, amount, and distribution of habitat conditions in which Indiana bats evolved and survived prior to European settlement.

There are currently (Alternative 5) about 77,000 acres included in Management Prescription 3.5 on MTNF. This is about 5% of MTNF acres.

Table 24- Comparison of MP 3.5 distribution in Alternatives 1-4

Management Prescription	Alt 1 (%)	Alt 2 (%)	Alt3 (%)	Alt 4(%)
1.1 Ecosystem Restoration	5	40	12	5
1.2 Ecosystem Restoration SPM (& SPNM)	0	4	4	0
2.1 Multiple Use Management	0	46	74	81
6.1 Limited Management (SPNM)	4	4	4	4
6.2 Limited Management (SPM)	89	4	4	8
8.1 Designated Special Areas	2	2	2	2

Table 16 in Chapter 2 compares standards and guidelines for the 3.5 management area in Alternative 5 with those for Alternatives 1-4. It shows that standards and guidelines for Alternatives 1-4, in most cases, provide the same or more protection of Indiana bat hibernacula, maternity colony areas, roosting and foraging habitat as does the 3.5 Management Prescription found in Alternative 5.

However, in Alternative 1, the majority of the Forest, and 89% of the current MP 3.5 would be included in MP 6.2, which emphasizes semi-primitive motorized recreation opportunity, and has limited vegetation management. With much of the Forest currently in an overstocked, dense forest, and Indiana bats preferring moderate stocking as foraging habitat, the amount of MP 6.2 would severely limit the ability of MTNF to provide quality foraging habitat for Indiana bats across the Forest.

In Alternatives 2-4, about 90% of the current MP 3.5 is available for active management subject to the Forest-wide standards and guidelines. This will enable the Forest Service not only to protect habitat (through application of standards and guidelines), but also to actively improve habitat conditions across the Forest (through careful thinning of dense forest, restoration of natural communities, and increase in abundance & diversity of ground flora).

As early as 1980, LaVal and LaVal (1980) recognized that public land alone could not provide enough habitat to recover the Indiana bat, and that management of individual roost trees alone will not ensure the maintenance of suitable habitat for this species (Gumbert et al. 2002; U.S. Fish and Wildlife Service 1999).

Later researchers also note that management cannot be limited to the few national forests and parks or other agency-owned lands occurring within the summer range of Indiana bat (Kurta et al., 2002). Most maternity colonies documented to date have been on private lands in highly agricultural areas (Gardner and Cook 2002). If management for the species must occur on areas greater than all public lands in the range, it does not make sense to limit the management of those public lands to a small area around known hibernacula or known maternity colony sites (which is what the 3.5 Management Prescription was designed for). We will still vigorously protect known roost trees, foraging areas, and maternity colony areas, while ensuring that suitable habitat is available as appropriate to the landscape throughout the Forest.

The protection afforded hibernating and maternity bats is at least as good under Alternatives 1-4, and in some cases, may be better than the existing AOI provides in Alternative 5. By providing quality foraging, roosting, migrating, swarming and hibernating habitat in a landscape matrix, the Forest is meeting the purposes of the Endangered Species Act identified in Section 2(b):

- "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved"
- "to provide a program for the conservation of such endangered species and threatened species," and
- "to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section."

and is carrying out its responsibilities under ESA

- Section 2(c) "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."
- Section 7(a)(1): "All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act."

Cumulative effects

Continued private land conversion and loss of riparian forest natural communities to agriculture and urban expansion would result in a decrease in available summer habitat on other ownerships. Summer habitat would continue to be available in at least the amount and quality it is currently on Mark Twain NF lands. Many Indiana bat hibernacula have been protected from physical disturbance by gating or other closures. However, the question still remains whether or not temperature and humidity is optimum in currently used hibernacula, or is sub-optimal, and therefore affecting survival in Missouri.

Since both summer and winter habitat on Mark Twain NF would not change substantially in Alternatives 2-5, there would be no cumulative adverse impact from implementation of any of these alternatives. Alternative 1 would result in less optimum foraging habitat on Mark Twain NF. However, cumulative effect on Indiana bat of this alternative is difficult to determine, since so few individuals have been captured on Mark Twain NF in the past 7 years of surveying.

Tumbling Creek cavesnail (TCC)

Proposed Changes

Standards and guidelines to protect cave entrances, cave passages, and cave recharge areas, to minimize soil movement, and regarding riparian and watercourse protection zones have been updated. The major change from the current plan is that Big Creek basin, in which the cave recharge area falls, is included in Management Prescription 1.1 in all alternatives except Alternative 5. This prescription emphasizes the restoration of natural community structure, function and composition.

Direct and Indirect Effects to individuals

The Tumbling Creek cavesnail is "highly vulnerable to changes in the quality and quantity of that water. In turn, the quality and quantity of the subsurface water is highly dependent upon conditions and human activities on the land surface." (USDI Fish and Wildlife Service 2002, Federal Register 67(157): 52883). Conversion of forested land to pasture or urban uses can increase sedimentation and stream turbidity in the cave stream. High water levels of Bull Shoals Lake may threaten cavesnails by backing up water into the cave (USDI Fish and Wildlife Service 2002. Federal Register 67(157):52886). On Mark Twain NF lands, uncontrolled grazing in the cave watershed, mechanical fireline construction that exposes bare soil for a long time period, and poor road maintenance can cause sediment and excess nutrients to enter the cave stream.

Direct and Indirect Effects to populations and habitat

There is no population objective for Tumbling Creek cavesnail since there are no known locations on Mark Twain NF. Habitat objectives are: a) Take action to eliminate leakage from Mark Twain School sewage lagoon; b) Maintain roads in TCC recharge area to minimize soil movement; and c) Restore openness and diversity of glade natural communities within TCC recharge area. Alternatives 2 and 3 have the highest probability of meeting habitat objectives for this species because of the emphasis on restoration of the most acres of natural communities in the Big Creek basin area, which is within the recharge area for TCC. Alternatives 1 and 4 have a good probability of partially meeting habitat objectives, since they have some acres of restoration in the cave recharge area. Alternative 5 also has a good probability of partially meeting habitat objectives for openness since large glade management is included as part of the wildlife standards and guidelines.

The only element of TCC habitat that could be affected by Mark Twain NF is quality and quantity of water in the cave stream. In all alternatives, roads within the cave watershed will be maintained to minimize soil movement. In Alternatives 1-4, grazing (permitted by Mark Twain NF on existing allotments) may continue on a limited basis for the short term, but would be eliminated from glades and woodlands within the Big Creek basin in the long-term. Movement of soil off-site from these and other National Forest management activities, including timber harvest and prescribed fire, would be minimized by application of standards and guidelines.

Currently, the sewage lagoon for the Mark Twain School in Taney County is operated on Mark Twain NF lands under a special use permit. This lagoon has been leaking for many years, and is within the cave recharge area. The Forest Service is moving ahead with actions to transfer this land to the school, which will make federal monies available to fix the leaking facility. This will enable the school to replace it with a facility that meets the school's needs and does not contribute effluent to the cave recharge area. This action would take place no matter which alternative is selected, and would have positive impacts on quality of the cave stream.

Both quality and quantity of water flowing from Mark Twain NF lands within the recharge area are likely to stay the same or improve with implementation of any of the alternatives. Future population trends cannot be predicted at this time because the cause of decline has not yet been fully determined, and the recent surveys found so few individuals.

Cumulative effects

About 77% of Tumbling Creek cave recharge area is in private ownership. Therefore, activities occurring on these ownerships are much more likely to affect quality and quantity of water flowing through the cave stream than activities on Mark Twain NF land. Much of the private ownership is in pasture grazed by cattle. The cave owner has acquired several tracts of land in the past decade and is steadily improving the condition of these lands. However, there are still activities occurring within the recharge area that have potential to adversely affect water quality. Because activities on Mark Twain NF lands would be conducted to minimize soil movement, and because Mark Twain NF lands comprise less than 25% of the cave recharge area, no alternative would contribute to adverse cumulative impacts. Alternatives 2 and 3, with the emphasis on restoration of natural glade/woodland communities in the recharge area, would provide greater water holding capacity in the long-term, and restore that part of the recharge area's historical hydrologic functioning. However, the long-term future for this species is uncertain due to the low population currently existing.

Spectaclecase

Proposed Changes

Standards and guidelines for riparian zones and watercourse protection zones, to minimize soil movement off-site, and for grazing have been updated. However, the 6.3 Management Prescription does not change and basic management objectives continue to be maintenance of free-flowing streams, and protection of water quality. Therefore, all alternatives provide the same level of protection for spectaclecase.

Direct and Indirect Effects to individuals

The biggest threat for this species, as for most mussel species, is habitat loss and degradation. Except for the Missouri, particularly the Gasconade River, populations, the species is threatened with extirpation by various forms of pollution and channel modification, including impoundments. Freshwater mussels, because of their sedentary nature and their filter-feeding habit, are very susceptible to degraded water quality (USDI Fish and Wildlife Service 1998b). Siltation and loss of riparian forest natural communities from conversion to other uses are continuing major threats in Missouri, particularly for this species due to its specialized habitat needs (Davidson, pers. comm. 2004). The areas in which spectaclecase occur are also areas of streams that are typically the first to fill in with sediment (Davidson, pers. comm. 2004). On Mark Twain NF, riparian forest natural communities are not converted to other uses, but some activities do have potential to add to sediment loads in streams, including timber harvest, road construction/ reconstruction and grazing (Riparian Areas and Water Quality section). Uncontrolled off-road vehicle use can also cause localized heavy inputs of sediment. Grazing, if allowed in riparian areas and if livestock are allowed in streams can also contribute to excess nutrients in streams, which could further affect oxygen availability.

Direct and Indirect Effects to populations and habitat

Because the spectaclecase is not yet federally listed as endangered or threatened, there is no approved Recovery Plan for this species, and no designated critical habitat on Mark Twain NF.

The population objective for specatclecase is to reduce the rate of decline at a minimum and aim for stable populations in all sections of rivers running through Mark Twain NF. The habitat objectives are to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and habitat objectives for this species.

In all alternatives, habitat for spectaclecase would continue to be available in the Gasconade, Big Piney, and Roubidoux Rivers, and Huzzah and Courtois Creeks. Areas along these rivers within Mark Twain NF would be managed to retain and restore forested riparian corridors. There is some potential for sediment to reach flowing waters in any alternative, but implementation of soil and water standards and guidelines would minimize soil movement so that sedimentation of rivers due to Mark Twain NF management activities is expected to be low. The functionality of the RMZ and WPZ would be maintained and not be degraded. Although grazing is a threat to the species, maintaining functionality of the RMZ and WPZ would provide adequate protection to minimize sedimentation or the addition of excess nutrients into streams.

Since so much of the watershed of occupied rivers is on other ownerships, habitat trends for spectaclecase, as for all aquatic species, cannot be predicted for Mark Twain NF lands and waters alone. However, because all alternatives provide the same level of protection for water quality and quantity, activities on Mark Twain NF lands within the occupied watershed(s) are unlikely to result in changes to spectaclecase habitat in either the short or long-term.

Population trends cannot be predicted, because so much of the watersheds are outside Mark Twain NF ownership.

Cumulative effects

Since so little of this mussel’s watershed is owned by Mark Twain NF, and since off-site soil movement from National Forest management activities would be minimized, effects on the species from activities occurring on Mark Twain NF would be minimal in any alternative. However, continued private land conversion, gravel and sand mining within stream reaches, and loss of riparian forest on private ownerships would result in some level of increased turbidity, siltation and loss of aquatic vegetation, which would very likely continue to have a negative short and long-term effect on the species.

Curtis’ pearly mussel

Proposed Changes

Management Prescription 1.1 has been designated for an area adjacent to Black River on the Poplar Bluff unit where the last known location for Curtis pearly mussel occurs. Standards and guidelines for riparian zones and watercourse protection zones, to minimize soil movement off-site, and for grazing have been updated. However, basic management objectives continue to be maintenance of free-flowing streams, and protection of water quality. Therefore, all alternatives provide the same level of protection for Curtis’ pearly mussel.

Direct and Indirect Effects to individuals

Anything that can affect water quality could negatively impact this species. While not much is known about this species, some generalized threats to all *Unionid* species include, dams, which block movement and may isolate individuals or populations; bank, channel, or substrate instability; pollution from chemicals or runoff from livestock operations; and exotic species such as the zebra mussel. The major causes of such alteration are channelization, damming and impoundment, and nonpoint and point source pollution. The most pernicious effects of these factors are contamination and sedimentation. Freshwater mussels, because of their sedentary nature and their filter-feeding habit, are very susceptible to degraded water quality (USDI Fish and Wildlife Service 1998).

Siltation and loss of riparian forest natural communities from conversion to other uses are continuing major threats in Missouri. On Mark Twain NF, riparian forest natural communities are not converted to other uses, but some activities do have potential to add to sediment loads in streams, including timber harvest, road construction/ reconstruction and grazing. Uncontrolled off-road vehicle use can also cause localized heavy inputs of sediment. Grazing, if allowed in riparian areas and if livestock are allowed in streams can also contribute to excess nutrients in streams, which could further affect oxygen availability.

Direct and Indirect Effects to populations and habitat

The Curtis' Pearly Mussel Recovery Plan was approved February 4, 1986 (USDI Fish and Wildlife Service 1986). The major Recovery objective is to prevent the extinction of the species by protecting and enhancing existing populations and habitat. There is no designated critical habitat for Curtis' pearly mussel on Mark Twain NF.

The population objective for Curtis' pearly mussel is to reduce the rate of decline at a minimum and aim for stable populations in all sections of rivers running through Mark Twain NF. Habitat objectives are to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and habitat objectives for this species.

The last known sites for this species in the Castor and Little Black Rivers are far from any Mark Twain NF lands, and Mark Twain NF lands comprise only a small portion of the watersheds of these rivers. Cane Creek and Black River have had shells only (no live animals) found since 1970. Mark Twain NF lands comprise a small portion of the Black River watershed, and most of the riparian corridor is in private ownership. While Mark Twain NF continues to apply standards and guidelines for management actions taken in the watersheds of rivers having Curtis' pearly mussel locations, there is not much direct habitat protection or improvement that Mark Twain NF can do, since so little Mark Twain NF lands are within riparian corridors of these streams. Each project within these watersheds is reviewed by USFWS during consultation, which meets the Recovery Outline Item A2. This would continue no matter what alternative was implemented.

In all alternatives, habitat for Curtis' pearly mussel would continue to be available in the Black River. Areas along this river that are within Mark Twain NF would be managed to retain and restore forested riparian corridors. Implementation of soil and water standards and guidelines would minimize soil movement into rivers due to management activities on the Mark Twain NF and sedimentation is expected to be extremely low. Functionality of the RMZ and WPZ would be maintained and not be degraded. Although grazing is a threat to the species, maintaining the functionality of the RMZ and WPZ would provide adequate protection to minimize sedimentation or the addition of excess nutrients into streams. Since so much of the watershed of occupied rivers is on other ownerships, habitat trends for Curtis' pearly mussel, as for all aquatic species, cannot be predicted for Mark Twain NF lands and waters alone. However, because all alternatives provide the same level of protection for water quality and quantity, activities on Mark Twain NF lands within the occupied watershed(s) would be unlikely to result in changes to Curtis' pearly mussel habitat in either the short or long-term.

Population trends cannot be predicted, because so much of the watersheds are outside Mark Twain NF ownership and so few individuals of this species exist. The species may be extirpated from Missouri.

Cumulative effects

Habitat destruction and alteration are major threats to the continued existence of this species. Plans for two large Soil Conservation Service impoundments proposed for the Upper Black River in the early 1980's have been dropped, but smaller impoundments in tributaries are still being considered (Buchanan 1992). Continued private land conversion, gravel and sand mining within stream reaches, channelization, urbanization, and loss of riparian forest natural communities could result in increased turbidity, siltation, alterations in water quality, flow rates and seasonal patterns, water temperature, nutrient and chemical composition, bed loads, sediment structure, and fish community, and loss of aquatic vegetation which would have a negative long-term effect on the species.

Since it is probable that this species is extirpated from Missouri, there would be no direct effects to either population or habitat. Implementation of any alternative would have indirect effects on only a limited amount of potential habitat on Mark Twain NF. None of the alternatives would contribute toward additional adverse impacts to this species.

Pink mucket pearly mussel

Proposed Changes

Management Prescription 1.1 is designated for an area adjacent to Black River on the Poplar Bluff unit where several known locations for pink mucket occur. Standards and guidelines for riparian zones and watercourse protection zones, to minimize soil movement off-site, and for grazing have been updated. However, basic management objectives continue to be maintenance of free-flowing streams, and protection of water quality. Therefore, all alternatives provide the same level of protection for pink mucket pearly mussel.

Direct and Indirect Effects to individuals

Anything that can affect water quality could negatively impact this species. While not much is known about this species, some generalized threats to all *Unionid* species include, dams, which block movement and may isolate individuals or populations; bank, channel, and substrate instability; pollution from chemicals or runoff from livestock operations; and exotic species such as the zebra mussel. The recovery plan for *Lampsilis abrupta* identifies impoundments, siltation and pollution as reasons for the declines of freshwater mussels due to their longevity and sedentary nature (USDI Fish and Wildlife Service 1985). Siltation and loss of riparian forest natural communities from conversion to other uses are continuing major threats in Missouri. On Mark Twain NF, riparian forest natural communities are not converted to other uses, but some activities have potential to add to sediment loads in streams, including timber harvest, road construction/ reconstruction and grazing. Uncontrolled off-road vehicle use can also cause localized heavy inputs of sediment. Grazing, if allowed in riparian areas and if livestock are allowed in streams can also contribute to excess nutrients in streams, which could further affect oxygen availability.

Direct and Indirect Effects to populations and habitat

The Pink Mucket Pearly Mussel Recovery Plan was approved on January 24, 1985 (USDI Fish and Wildlife Service 1985). There is no designated critical habitat for pink mucket pearly mussel on Mark Twain NF. Recovery Objective 2 Preserve populations and present habitat of *L. abrupta* is the only action which applies to Mark Twain NF. While Mark Twain NF lands comprise a portion of the Black River watershed, most of the riparian corridor is in private ownership. Mark Twain NF lands also comprise portions of the Gasconade and Meramec watersheds. While Mark Twain NF continues to apply standards and guidelines for management actions taken in the watersheds of rivers having pink mucket pearly mussel locations, there is not much direct habitat protection or improvement that Mark Twain NF can do, since so little Mark Twain NF lands are within the riparian corridors of these streams. Each project within these watersheds is reviewed by USFWS during consultation, which meets the Recovery Objective 2. This will continue no matter which alternative is implemented.

The population objective for pink mucket is to reduce the rate of decline at a minimum and aim for stable populations in all sections of rivers running through Mark Twain NF. Habitat objectives are to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and the habitat objective for this species.

In all alternatives, habitat for pink mucket would continue to be available in the Black River. Areas along this river that are within Mark Twain NF would be managed to retain forested riparian corridors. Implementation of soil and water standards and guidelines would minimize soil movement so that sedimentation of rivers due to Mark Twain NF management activities is expected to be extremely low. Although grazing is a threat to the species, maintaining functionality of the RMZ and WPZ would provide adequate protection to minimize sedimentation or the addition of excess nutrients into streams. Habitat quality of known and potential pink mucket habitat is not expected to change significantly in any alternative.

Since so much of the watershed of occupied rivers is on other ownerships, habitat trends for pink mucket, as for all aquatic species, cannot be predicted for Mark Twain NF lands/waters alone. However, because all alternatives provide the same level of protection for water quality and quantity, activities on Mark Twain NF lands within the occupied watershed(s) are unlikely to result in changes to pink mucket habitat in either the short or long-term.

Population trends cannot be predicted, because so much of the watersheds are outside Mark Twain NF ownership.

Cumulative effects

For most mussels, including the pink mucket, the principal cause of decline is habitat destruction. This includes channelization, damming and impoundments, and a decline in water quality from sediment and point and nonpoint source pollution. Gravel mining is also a concern in some areas (USDI Fish and Wildlife Service 1985). These types of activities still occur on private ownerships within the range of pink mucket in Missouri. The majority of the watershed of the Black River is in private ownership.

Because forested riparian corridors would be maintained, grazing limited in riparian areas, soil movement is minimized, and Mark Twain NF comprises so little of the watershed, implementation of any alternative would not add to adverse impacts occurring within the Black River watershed, which is the only watershed with current documented locations of pink mucket pearly mussel.

Scaleshell

Proposed Changes

This species influenced designation of Management Prescription 1.1 within the Gasconade, Meramec, Big Piney and Upper St. Francis watersheds. Management Prescription 6.3 will still be applicable to portions of the Gasconade River and Huzzah and Courtois Creeks.

Standards and guidelines for riparian zones and watercourse protection zones, to minimize soil movement off-site, and for grazing have been updated. However, basic management objectives continue to be maintenance of free-flowing streams, and protection of water quality. Therefore, all alternatives provide the same level of protection for scaleshell.

Direct and Indirect Effects to individuals

Anything that can affect water quality could negatively impact this species. While not much is known about this species, some generalized threats to all *Unionid* species include, dams, which block movement and may isolate individuals or populations; bank, channel, and substrate instability; pollution from chemicals or runoff from livestock operations; and exotic species such as the zebra mussel. For most mussels, "the principal cause of this decline is habitat destruction. Habitat degradation--as a result of physical, chemical, and biological alteration--has and continues to threaten *L. leptodon* populations. The major causes of such alteration are channelization, damming and impoundment, and nonpoint and point source pollution. The most pernicious effects of these factors are contamination and sedimentation. Freshwater mussels, because of their sedentary nature and their filter-feeding habit, are very susceptible to degraded water quality" (USDI Fish and Wildlife Service 1998b).

Siltation and loss of riparian forest natural communities from conversion to other uses are continuing major threats in Missouri. On Mark Twain NF, riparian forest natural communities are not converted to other uses, but some activities do have potential to add to sediment loads in streams, including timber harvest, road construction/reconstruction and grazing. Uncontrolled off-road vehicle use can also cause localized heavy inputs of sediment. Grazing, if allowed in riparian areas and if livestock are allowed in streams can also contribute to excess nutrients in streams, which could further affect oxygen availability.

Direct and Indirect Effects to populations and habitat

A Draft Recovery Plan for scaleshell was issued in August 2004 (USDI Fish and Wildlife Service 2004a). There is no designated critical habitat for scaleshell on Mark Twain NF. Recovery objectives are to stabilize and protect existing populations and restore habitat and waters they depend on. Recovery Action 2.1.2 Conduct searches for additional populations within historic range is currently being carried out by Mark Twain NF, in cooperation with Missouri Department of Conservation and USFWS. Surveys for this and other TES species will continue in the future regardless of which alternative is selected

Recovery Item 2.4 Carry out cooperative projects using existing programs to protect the species and its habitat, restore degraded habitat, and improve surface lands in occupied watersheds, has also been carried out through careful application of standards and guidelines to activities on Mark Twain NF lands in the watersheds of the Gasconade, Meramec, Big Piney and St. Francis Rivers. Habitat restoration and improvement of surface lands in occupied watersheds will continue through restoration and enhancement of natural communities in MP 1.1 and 1.2, and continued application of standards and guidelines to all activities in these watersheds, no matter which alternative is implemented.

The population objective for scaleshell is to reduce the rate of decline at a minimum and aim for stable populations in all sections of rivers running through Mark Twain NF. Habitat objectives are to a) Maintain all existing streams as free-flowing; b) Maintain or increase the amount of streamside in tree cover of at least 100 feet wide; and c) Eliminate livestock watering in streams or rivers. All alternatives have an equal probability of meeting both the population and habitat objectives for this species.

In all alternatives, habitat for scaleshell would continue to be available in the Gasconade, Meramec, Big Piney and Upper St. Francis Rivers and their tributaries. Areas along these rivers that are within Mark Twain NF would be managed to retain and restore forested riparian corridors. There is some potential for sediment to reach flowing waters in any alternative, but implementation of soil and water standards and guidelines would minimize soil movement so that sedimentation of rivers due to Mark Twain NF management activities is expected to be low. Functionality of the RMZ and WPZ would be maintained and not be degraded. Although grazing is a threat to the species, maintaining functionality of the RMZ and WPZ would provide adequate protection to minimize sedimentation or the addition of excess nutrients into streams.

Since so much of the watershed of occupied rivers is on other ownerships, habitat trends for scaleshell, as for all aquatic species, cannot be predicted for Mark Twain NF lands and waters alone. However, because all alternatives provide the same level of protection for water quality and quantity, activities on Mark Twain NF lands within the occupied watershed(s) are unlikely to result in changes to scaleshell habitat in either the short or long-term.

Population trends cannot be predicted, because so much of the watersheds are outside Mark Twain NF ownership and because the species is so rare.

Cumulative effects

Since so little of this mussel's watershed is owned by Mark Twain NF, and since off-site soil movement from National Forest management activities would be minimized, effects on the species from activities occurring on Mark Twain NF would be minimal in any alternative. However, continued private land conversion, gravel and sand mining within stream reaches, and loss of riparian forest natural communities on private ownerships would result in some level of increased turbidity, siltation and loss of aquatic vegetation, which would very likely continue to have a negative long-term effect on the species.

Running buffalo clover

Proposed Changes

Management prescriptions 1.1 and 1.2 emphasize restoration and enhancement of natural communities, including open woodland and riparian mosaics. Periodic disturbance, in the form of prescribed burning and/or timber harvest would occur in these prescriptions to maintain or improve species composition, structure and function of the various natural communities. In addition, a specific standard in the 2005 Forest Plan for running buffalo clover is to "Design prescribed burns to include streamsides with open woodland natural communities that may be suitable running buffalo clover habitat."

Direct and Indirect Effects to individuals

Running buffalo clover has very palatable leaves and is subject to heavy grazing pressure by both native wildlife and livestock. Excessive grazing by livestock could significantly decrease vigor of individual plants or populations or could eliminate them altogether. This is particularly possible with low population size,which is the case for most of the known locations. Individual plants may be displaced or destroyed by vehicle or foot traffic, use of heavy equipment, or competition from non-native plants, especially white clover, bluegrass, and the grass *Microstegium vimineum*. These species are not much of a problem on Mark Twain NF lands, but other non-native invasives, such as sericea lespedeza and garlic mustard are known to occur on Mark Twain NF and could easily out-compete running buffalo clover in suitable habitat.

Prescribed or wildfire during the growing season may damage or destroy individual plants. Several viruses have been observed attacking plants in Missouri, and fungal diseases may affect plants. Any changes in tree canopy can affect vigor and survival of running buffalo clover; reduction of the canopy may cause too much sunlight to reach the ground and conversely, the canopy may close in and cause too much shade for the plant to survive. On Mark Twain NF, some timber harvest does remove most of the canopy, and those areas would be too sunny for running buffalo clover. However, there are also many areas of Mark Twain NF where canopy closures are greater than 80% and the lack of timber harvest keeps those areas too shady for running buffalo clover. Construction of temporary roads and skid trails may create the moderate soil disturbance preferred by running buffalo clover.

Direct and Indirect Effects to populations and habitat

The Running Buffalo Clover Recovery Plan was approved June 8, 1989. There is no designated critical habitat for running buffalo clover on Mark Twain NF. Mark Twain NF has contributed to Recovery outline item 122. Survey for additional wild populations, by surveying about 150,000 acres of Mark Twain NF lands for TES species, including running buffalo clover. This action will continue regardless of which alternative is implemented.

There is no population objective for running buffalo clover since there are no known locations on Mark Twain NF. The habitat objective for running buffalo clover is to improve open woodland conditions on a minimum of 10,500 acres. All alternatives have an equal probability of meeting the population objective for this species. Alternatives 2 and 3 have the best probability of meeting the habitat objective due to their emphasis on restoration of natural communities, including open woodlands with frequent, low-intensity disturbance that could be habitat for running buffalo clover. Alternatives 1 and 4 would probably at least partially meet the habitat objective with fewer acres of restoration emphasis than Alternatives 2 and 3. Alternative 5 might partially meet the habitat objective through achievement of other resource objectives.

On Mark Twain NF, an indirect effect, and the primary threat to running buffalo clover habitat is lack of moderate disturbance in potential habitats. In all alternatives, except Alternative 5, Management Prescriptions 1.1 and 1.2 emphasize restoration and enhancement of natural communities such as open woodland, savanna, and prairie/forest ecotones that running buffalo clover prefers. Alternatives 2 and 3 have the most acres in these prescriptions and would have the most potential for improvement of running buffalo clover habitat. Alternatives 1 and 4 have a moderate amount of area in these prescriptions, and Alternative 5 continues current management, so has no acres in MP 1.1 or 1.2. Intermittent streams and riparian areas that might also have running buffalo clover may have some management that would cause periodic disturbance, or they may be left undisturbed. The former would improve potential habitat for running buffalo clover and the latter would not improve potential habitat. Whether or not running buffalo clover would ever colonize potential habitat on Mark Twain NF is uncertain.

Since there are no known populations of running buffalo clover on Mark Twain NF, there would be no direct effects on populations.

Cumulative effects

Land development, succession of open canopies to closed canopies causing severe shading, removal of canopies to the point that too much sunlight reaches the ground, any irreversible, catastrophic disturbance, such as new road construction, and heavy grazing by livestock are all actions that occur on private ownerships in and around Mark Twain NF. All of these activities can reduce the quality of habitat or eliminate habitat completely.

Competition from non-native plants may also reduce the vigor or eliminate small populations. Other potential effects to populations include loss of pollinators, susceptibility to new viruses, and small populations leading to inbreeding depression.

Because there are only two known sites for running buffalo clover in Missouri (neither on Mark Twain NF), it is very difficult to assess cumulative effects for this species. Mark Twain NF would create potential habitat in any alternative, but whether or not it would be occupied is unknown.

Mead's milkweed

Proposed Changes

There are no changes proposed to Wilderness management direction.

Direct and Indirect Effects to individuals

Habitat loss and modification is a primary cause of past and present declines (U.S. Fish and Wildlife Service. 2003). Other factors that may threaten small, isolated populations of this species include predation, pathogens, unpredicted catastrophes, and sexual incompatibility (USDI Fish and Wildlife Service 2003a).

Because there is a limited amount of high-quality tallgrass prairie remaining in the Midwest, available habitat size may be a limiting factor in the recovery of this species (USDI Fish and Wildlife Service 2003a). In addition, habitat fragmentation has reproductively isolated most populations of Mead's milkweed (USDI Fish and Wildlife Service 2003a), leading to loss of genetic material and failure to sexually reproduce.

On the Mark Twain NF site, there is a slight possibility that people engaged in recreational activities might travel across the Mead's milkweed site, trampling the plants if not in the dormant season. Arson is a problem on the Mark Twain NF and a wildfire occurring during the growing season might damage or destroy some or all of the plants. Most arson fires occur in the fall, after leaf-fall, and in the late winter or early spring (through early April). On the other hand, a wildfire occurring in the dormant season could actually benefit plants by top-killing encroaching woody vegetation. Collecting could be a threat to this population if unscrupulous botanists, nursery owners, or herb dealers knew the site existed. This plant is not known for any medicinal properties, is not showy, and would not be a particularly good target species.

Direct and Indirect Effects to populations and habitat

The Mead's Milkweed Recovery Plan was approved September 16, 2003 (USDI Fish and Wildlife Service 2003a). There is no designated critical habitat for Mead's milkweed on Mark Twain NF. The Recovery Strategy is to address the loss of prairie and glade habitats by working with landowners to maintain these habitats. Recovery Action 2.1 Conduct management assessment of public…lands, has been done for Mark Twain NF. Recovery Action 2.2 Perform prescribed burns on a regular basis has not done on Mark Twain NF due to Wilderness issues. However, Recovery Action 4 Conduct field surveys for new population occurrences has been done specifically on about 550 acres of Mark Twain NF lands, and on another 150,000 acres of Mark Twain NF lands surveyed for the presence of any TES/RFSS plant species.

Using Table 6 on page 22 of the Recovery Plan, the population viability index for the Mark Twain NF site in Bell Mountain Wilderness scores a 9 of 21 points, or low viability. At the Mark Twain NF site, the current threat to the known Mead's milkweed population is the lack of active management. The site is located within a Congressionally designated Wilderness, where evidence of man's work will be substantially unnoticeable and biological diversity depends entirely on the forces of nature. Woody vegetation is encroaching on the Mead's milkweed site, and there has been no fire on the site for decades.

The population objective for Mead's milkweed is to increase populations on Bell Mountain Wilderness to between 50-100 flowering ramets. The habitat objective is to restore openness of known glade location through the application of prescribed fire and removal of woody vegetation. All alternatives have an equal probability of meeting both the population and habitat objective for this species. However, without action to get approval for prescribed fire in Wilderness, all alternatives are equally likely not to meet population and habitat objectives for Mead's milkweed.

With no prescribed fire and no cutting of encroaching woody vegetation, it is likely that habitat quality at the Bell Mountain Wilderness site will decline. Woody vegetation will eventually take over the site, shading the plants. Missouri Department of Natural Resources has found that Mead's milkweed will disappear from glades if fire is not used on a regular basis (USDI Fish and Wildlife Service 1999b). With no active management, plants will eventually disappear from this site, thus losing a genetic component that might otherwise help in recovery of this species. "A small proportion of unique alleles also occur among different populations, making small populations important genetic resources." (USDI Fish and Wildlife Service 2003a).

Glades that are not within Wilderness may be managed as part of natural community restoration or enhancement in any of the alternatives. Prescribed fire and control of encroaching woody vegetation would provide conditions suitable for Mead's milkweed (i.e. grass/forb ground cover with little accumulated mat and few to no woody stems) across the Ozark-St. Francois Mountains Physiographic Region. Alternatives 1 and 4 would have the least acres treated and thus the least amount of potentially suitable habitat maintained. Alternatives 2 and 3 would have the most acres treated, and thus the most potentially suitable habitat maintained. While suitable habitat may exist, it is unclear whether or not that habitat would be occupied by Mead's milkweed even if available.

Cumulative effects

There is only one documented site for Mead's milkweed on Mark Twain NF. The Bell Mountain Wilderness site constitutes about 0.67% of the known extant sites in the United States and about 2% of known sites in Missouri. With no active management, it is reasonably foreseeable that the population on Mark Twain NF will decline in vigor and health, and eventually disappear from the site.

Most Missouri sites are on private land, many of which are in hay meadows or grazed pasture. It is reasonably foreseeable that these uses will continue in the short term. In the long-term, these uses may continue or the land may be developed for other purposes.

In the short-term, loss of 0.67% of the known sites for Mead's milkweed would not appear to have an impact on viability of the species. However, while the known population on Mark Twain NF is a small fraction of Missouri's population and an even smaller fraction of the range-wide population, its genetic material may be important in cross-pollinating other genets to achieve sexual reproduction. This may contribute to the recovery of the species in the long-term. It is impossible to say whether or not the existence of the Bell Mountain Wilderness population is critical to the species' survival.

Virginia Sneezeweed

Proposed Changes

Virginia sneezeweed was unknown on the Forest in 1986 and there are still no known locations on MTNF lands, although the species has been documented to occur within the proclamation boundary of the Willow Springs Unit. Potential habitat for this species does occur on MTNF.

Direct and Indirect Effects to individuals

Habitat loss and modification is a primary cause of past and present declines (Biological Assessment), particularly modification of hydrologic functioning. Poorly timed grazing and mowing may also have long-term impacts on flowering or seed production.

On the Mark Twain NF, standards and guidelines for wetlands and grasslands would minimize the potential for impacts to individuals if there are any located on MTNF.

The invasion of non-native invasive species to Virginia sneezeweed habitat, particularly purple loosestrife, has been a problem elsewhere, and could be a future concern in Missouri. The 2005 Forest Plan includes standards and guidelines for dealing with non-native invasive species.

Direct and Indirect Effects to populations and habitat

There is no approved Recovery Plan for Virginia Sneezeweed. There is no designated critical habitat for Virginia sneezeweed on Mark Twain NF. Twenty sites of the Eleven Point District and several other sites on MTNF lands in Howell County (Willow Springs Unit) were searched for Virginia sneezeweed in 2004. No locations were found. Surveys efforts may be continued regardless of which alternative is implemented.

There is no population objective Virginia sneezeweed since there are no known locations on Mark Twain NF. The habitat objective for Virginia sneezeweed is to manage natural sinkhole ponds, open fens, and seasonally wet, open grasslands with the type and intensity of disturbance that maintains open conditions which would have naturally occurred. All alternatives have an equal probability of meeting the population objective for this species. Alternatives 2 and 3 have the best probability of meeting the habitat objective due to their emphasis on restoration of natural communities, including seasonally wet, native grasslands with frequent, low-intensity disturbance that could be habitat for Virginia sneezeweed. Alternatives 1 and 4 would probably at least partially meet the habitat objective with fewer acres of restoration emphasis than Alternatives 2 and 3. Alternative 5 might partially meet the habitat objective through achievement of other resource objectives.

On Mark Twain NF, an indirect effect, and the primary threat to Virginia sneezeweed habitat is disruption of hydrologic functions in potential habitats. In all alternatives, standards and guidelines prevent or minimize alteration of hydrologic functioning; but Alternatives 2 & 3 have the most area in restoration of natural communities and thus the best potential to reach the habitat objective. Whether or not Virginia sneezeweed would colonize potential habitat on Mark Twain NF is uncertain.

Since there are no known populations of Virginia sneezeweed on Mark Twain NF, there would be no direct effects on populations.

Cumulative effects

Because there are no direct or indirect effects on Virginia sneezeweed, there would be no cumulative effects.

Regional Forester Sensitive Species

Introduction

The Mark Twain National Forest has 36 animal and 76 plant species on the Regional Foresters Sensitive Species List (RFSS) as of August 2004. The RFSS List was developed to ensure that species do not become threatened or endangered because of Forest Service actions, and that viable populations of all native and desired non-native wildlife, fish, and plant species are maintained in habitats distributed throughout their geographic range on National Forest System lands. The Forest Service Manual (FSM 2670.15) defines sensitive species as “those plants and animal species identified by a Regional Forester for which population viability is a concern as evidenced by significant current or predicted downward trend in numbers and density” and “habitat capability that would reduce a species existing distribution.”

Forest Service Manual 2672.1 states that “Sensitive species of native plant and animal species must receive special management emphasis to ensure their viability and to preclude trends toward endangerment that would result in the need for Federal listing. There must be no impacts to sensitive species without and analysis of the significance of adverse effects on the populations, its habitat and on the viability of the species as a whole.”

Forest Service Policy is to avoid or minimize impacts to species whose viability has been identified as a concern and if impacts cannot be avoided, analyze the significance of potential adverse effects on the population or its habitat within the area of concern and on the species as a whole.

Conservation Strategies for RFSS

The vision of the Eastern Region of the Forest Service Sensitive Species Program is to encourage a combined coarse and a fine filter interdisciplinary approach for species conservation and ecosystem management (USDA Forest Service 2002).

The primary conservation strategy for all RFSS on Mark Twain NF is to restore, enhance, and maintain the natural communities of which they are a part (coarse filter). In this way, the natural range of variability of composition, structure, and function will be present, and both plant and animal species can fulfill their ecological roles – whether they are a common or more unique species in those natural communities and across the Mark Twain NF. The following conservation measures applied to major habitat types across Mark Twain NF contribute to the primary conservation strategy of keeping common species common and maintaining appropriate habitat for species that are not common.

Aquatic, Riparian, and Wetlands

- Maintain riparian structure and function
- Maintain free-flowing streams and rivers
- Minimize sedimentation from National Forest lands
- Maintain hydrologic integrity of wetlands and lowland forest natural communities

Forest, Woodland, Savanna and Prairie

- Maintain forested landscapes (containing all successional stages)
- Restore prescribed fire regimes and manage fire-adapted natural communities

Caves and Karst

- Protect structural and biological integrity of caves and reduce human disturbance

Other (fine filter)

- Retain den trees and snags, downed woody material (particularly large size)
- Control non-native invasive species

Forest-wide standards and guidelines (fine filter) were developed to implement each of these conservation measures. All alternatives contain standards and guidelines that pertain to each of these conservation measures. Alternatives 1-4 also have new Management Prescriptions 1.1 and 1.2 which emphasize restoration and enhancement of natural communities, which is the primary conservation strategy for RFSS. Alternatives 2 and 3 have the most area designated as MP 1.1 and 1.2 and would therefore have the most opportunity to implement the conservation strategy for RFSS.

Analysis Area

The analysis area for Management Indicators is Mark Twain NF lands for direct and indirect effects, and the twenty-nine county area in which Mark Twain NF lands are located for the cumulative effects area. Effects are considered in the short term (10 years) and long-term (100 years).

Environmental Consequences

Of the 36 RFSS animal species, only three non-cave species were not evaluated during the SVE process. These are the American peregrine falcon, which only occurs due to reintroductions in Kansas City and St. Louis, the blue sucker, which is common and widely distributed in the Missouri and Mississippi Rivers and micro caddisfly, which is a historic record almost 70 years old and which viability of this species would not be affected by the five alternatives. These three species will not be further evaluated since Mark Twain NF management would not affect habitat in the urban areas or big rivers.

All RFSS plant species were also evaluated as part of the SVE process. A habitat-based analysis was used to determine potential effects to generalized habitats across the Mark Twain NF. All plant species were assigned to the habitat(s) they are found in. The discussion of these effects is found in the SVE section of this EIS.

Caves

There are six RFSS cave animal species that were not evaluated during the SVE process. There is so little known of most cave species' life history needs that an evaluation of effects to caves themselves would provide the decision maker more and more accurate information than evaluating individual species' about which almost nothing is known.

Current Status

There are over 500 known caves on Mark Twain NF. Undoubtedly, other caves exist, but have not yet been discovered. At least 25 of these caves are known to harbor one or more RFSS species.

Population and Habitats

Three of the RFSS cave species are known only from one Mark Twain NF cave/spring. Another species is only known from 2 caves. The other two species are known from 6 and 12 caves respectively. Some of the known locations are from just one specimen. Population trends for these cave RFSS species is impossible to determine with the limited information we have on each species.

Cave Research Foundation, in partnership with Mark Twain NF, has been conducting biological inventory of Mark Twain NF caves since 1991. They have completed surveys of over 100 caves, and are continuing to survey about 10-20 caves per year. It is possible that other caves will be found to harbor one or more of the RFSS cave species.

Population and Habitat Objectives

There is no way to set population objectives for these species since there are so few occurrences known. Habitat objectives are almost as difficult to set since so little is known about specific habitat needs for these species. The habitat objective for this group of species for the plan period will be to protect caves from physical alteration.

Proposed Changes

Standards and guidelines to protect cave entrances, cave passages, and cave recharge areas have been updated. In addition, updated standards and guidelines specific to Indiana and gray bats still include protection of caves from physical disturbance. The overall management objectives for caves are essentially the same – that is to protect caves and associated cave life from physical disturbance and maintain the unique set of climatic and physical conditions present at each cave.

Direct and Indirect Effects to individuals

Most cave creatures are very small, and live on the cave floor, walls, roof, or in cave streams. Anything that affects cave temperature and humidity, cave stream water quality, cave air quality, or input of energy (in the form of guano, woody material, etc.) has the potential to affect these species. On Mark Twain NF, this would include changing vegetation around cave entrances, blocking cave entrances with inappropriate structures, prescribed or wildfires where smoke enters a cave, National Forest management activities which cause soil to move off-site (i.e. timber harvest, prescribed burning, wildfire suppression, road construction/reconstruction or maintenance, etc.) and enter a cave stream. Illegal activities, such as dumping garbage in sinkholes or ATV/OHV use in streams or inside caves themselves could also have adverse impacts on cave fauna.

In addition, cave researchers or recreational cavers can physically trample individual animals or disturb their habitat without even knowing.

Direct and Indirect Effects to populations and habitat

All alternatives have an equal probability of meeting the habitat objective. In all alternatives, caves and abandoned mines would be protected from physical disturbance. Designation of old growth buffers around cave entrances would maintain cave entrance microclimates. Occupied gray and Indiana bat caves would be considered smoke sensitive areas, and prescribed burns planned to minimize smoke impacts to those caves and their inhabitants. Application of these standards and guidelines would maintain stable conditions in and around cave entrances. This in turn, ensures that cave fauna has stable environmental conditions to live in that are affected only by environmental and not human-caused fluctuations.

Protection from human disturbance depends in large part on the accessibility of the cave, the depth and interest (i.e. formations or other unique qualities) that each cave possesses. Some caves, notably the occupied Indiana and gray bat caves, have bat-friendly gates that maintain air flow, but are locked closed all or part of the year, thereby reducing the amount of human visitation. Other caves are very difficult for any but the most determined caver to reach, or have passages that are not for the faint-hearted. These caves are fairly secure from all but very light human disturbance. Other caves are well-known, have been shown on topography maps for years, and have moderate to heavy human visitation. Impacts to small cave fauna may be light to heavy. However, most populations are so small or so unknown that it is impossible to determine actual impacts.

Cumulative effects

There are currently over 5,000 known caves in Missouri. Mark Twain NF caves are about 10% of the known caves of the state. However, some of the RFSS cave species are only known from Mark Twain NF caves.

Caves on private ownerships are managed in many different ways – from commercial operations that have substantially altered cave conditions and probably cave fauna, to wild caves that no one is allowed to enter. Caves on other public ownerships are protected and managed in much the same way as Mark Twain NF caves, although there are a few commercial caves and teaching caves on other state and federal agency lands.

Populations of RFSS cave species on Mark Twain NF and across Missouri are so small that trends cannot be established. The only way to effectively contribute toward maintenance of viability of these species is to maintain the unique physical conditions of each cave and minimize human disturbance. Cave habitat on Mark Twain NF would not change substantially in any of the alternatives.

State Endangered Species

Species listed as endangered by the state of Missouri are considered Forest Species of Concern.

Forest Service Manual (FSM) 2670.32 states “Assist States in achieving their goals for conservation of endemic species.” and “Avoid or minimize impacts to species whose viability has been identified as a concern.” The August 2, 2004 Memorandum of Understanding between Mark Twain NF and the Missouri Department of Conservation states that “it is the intent of the parties to use their knowledge and resources towards conservation of fish, wildlife, plants and their habitats.”

Species listed as Missouri endangered as of July 31, 2004 include 11 birds, 6 mammals, 19 fishes, 7 reptiles, 2 amphibians, 10 mussels, 10 plants and 3 invertebrates, for a total of 68 species (3 CSR 10-4.111(3)). Of these, 12 species are also federally listed that may occur on Mark Twain NF and are discussed in the Federal TES section. Seven species are also RFSS and 6 others were included in the Mark Twain NF’s Species Viability Evaluation (SVE) process. These 13 species are discussed in the SVE section. Plant species are grouped by habitats and are also discussed in the SVE section of this EIS.

All State endangered species were included as part of the initial identification of species at risk during the SVE process. Twenty-nine of the state endangered species were not carried through that process because their range does not include Mark Twain NF; and 4 were dropped because they are considered globally secure. All state endangered species that might be affected by management of Mark Twain NF lands have been considered and evaluated in the Federal, RFSS, or SVE sections of this EIS.

Migratory Birds and Bats

Migratory birds are represented by MIS summer tanager, worm-eating warbler, and Bachman’s sparrow; by RFSS/SVE Bachman’s sparrow, Cerulean warbler, Migrant loggerhead shrike, and Swainson’s warbler; and by additional SVE species Whip-poor-will, Prairie warbler, Kentucky warbler, Field sparrow, Blue-winged warbler, and Bell's vireo. These species represent habitats ranging from grassland to early successional forest/shrubland to immature, dense woodland to mesic bottomland and riparian, to open oak and pine woodlands.

Forest bats are represented by MIS red bat, and by SVE species Eastern small-footed bat, gray bat and Indiana bat. The red bat is a tree bat, roosting in live trees, and leaf litter, both in summer and winter; gray bats are cave obligate species both summer and winter; Indiana bats use caves in winter and tree roosts (both dead and living) in summer; and eastern small-footed bats are closely associated with rocky outcrops and caves in winter, but are known to roost in human-built structures near hibernacula in summer.

For analysis of effects to these species, see MIS, RFSS, and SVE sections of this EIS. A short summary of effects to these species' groups follows.

Habitat for all migratory birds and forest bats native to southern Missouri would be available in varying amounts and configurations in all alternatives. Activities that create and maintain even-aged regeneration, open glades, savannas, and open woodlands would benefit the early successional and shrub bird species that seem to be experiencing some of the largest declines in the Ozarks; i.e. Bachman's sparrow, prairie warbler, blue-winged warbler, Bell's vireo (Fitzgerald and Pashley 2000; Sauer et al. 2004). Most forest bats would also benefit from the open foraging area available in open woodlands. Grassland habitat is the least available natural habitat on Mark Twain NF, but existing grasslands may be maintained in all alternatives, slightly benefiting species such as migrant loggerhead shrike and field sparrow. Old growth designation and development of old growth characteristics within the range of natural variability for natural communities would particularly benefit cavity nesters. Maintenance of forested riparian corridors would be beneficial to species such as cerulean warbler, Swainson's warbler, Kentucky warbler, gray bat, and Indiana bat.

Alternative 1 would have significant long-term negative impacts on species requiring early successional forest, shrub/brush, open glade or open woodland habitat. Alternatives 2-5 are similar in the amount of the habitat they would provide, with habitat quality being highest in Alternatives 2 and 3 due to restoration and enhancement of natural communities in MP 1.1 and 1.2.

Riparian forested corridors, bottomland forest natural communities, old growth, snags and cavity trees, and caves, would be managed much the same in all alternatives. Rock outcrops and bluffs have minimal protection in Alternative 5. Alternatives 1-4 have specific standards and guidelines to protect rock outcrops and bluffs. The amount of tree cover would not change significantly from the current > 90%. However, Alternatives 1, 4 and 5 would have more closed canopy, densely stocked immature and mature forest and less open or closed woodland than Alternatives 2 and 3. Habitat for area-sensitive, forest interior or snag and cavity-dependent species would not change significantly from the present in Alternatives 2-5. Alternative 1 would have the highest proportion of forest interior, and may have the most snags, as management activities are limited.

Fire Management

Introduction

Proposed Changes

Several proposed changes could affect the fire management program on the Mark Twain NF. They include:

- the addition of prescriptions emphasizing restoration of natural communities(Revision Topic 2a);
- increases in the amount of prescribed burning and fuels management (Revision Topics 3a and 3c).

Issue Statement

While prescribed fire is needed to reduce hazardous fuels and restore ecosystems, there is concern that increasing the use of prescribed fire will harm forest ecosystems and air quality. Forest Plan revision will determine how, where, and to what extent prescribed fire may be used to mimic natural processes and restore natural processes and functions to ecosystems, and to reduce fuels.

Key Indicators

Acres treated to progress toward Fire Regime Condition Class 1

This indicator displays the health of ecosystems on the Mark Twain NF. Each alternative expresses the amount of area in percent of acres that will be treated to achieve healthy ecosystems.

This indicator highlights differences between alternatives because it characterizes current condition degree of departure from the historic natural fire, vegetation, and fire regimes. The departure is a result in the change of one or more ecological components. FRCC is a performance measure for the Healthy Forests Restoration Act (HFRA) of 2003, National Fire Plan, and President’s Healthy Forest Initiative. Refer to Affected Environment for explanation of FRCC.

Acres burned to reduce fuels and restore ecosystems

This indicator includes all activities that require prescribed fire for accomplishment. While the majority of prescribed fire will be applied to reduce hazardous fuels, it is generally understood that prescribed fire applied for any reason will be beneficial in the restoration of ecosystems; that is movement from FRCC 3 to FRCC 1.)

This indicator highlights the differences between alternatives because the scope of proposed projects, displayed by decade, can be compared by acres planned.

Table 25 - Key Indicators for Fire Management

Key Indicator	Units	Current Condition	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5 No Action
Acres treated to progress toward Condition Class 1	Percent of total available Acres	0.07	0.51	0.59	0.57	0.54	0.57
Area treated with Prescribed Fire	Acres/Year	<17,000	61,630	72,420	68,800	63,700	59,320

Analysis Area

The affected environment for this analysis is National Forest System lands of the Mark Twain National Forest.

Affected Environment

Prescribed fire has important ecological benefits necessary to maintain the resilience and health of the Mark Twain NF's fire-adapted ecosystems. Ecosystems on the Mark Twain are not as healthy as they should be. This reality has been demonstrated by thousands of acres of red, scarlet, and black oak that have experienced oak mortality, and attacks from the red oak borer. Research has shown that the most likely cause for the reduction in vigor is because the area in which they reside is too far removed from its historical fire regime. Historically, where once there were stands of pine and white oak/pine there are now are stands of red, scarlet or black oak. Extensive logging and grazing followed by the exclusion of fire favored black and scarlet oak regeneration. These species now dominate space previously occupied by the pine/oak group. Because of the exclusion of fire, prairies and glades once covered with native forbs and grasses were invaded by eastern red cedar. Today many of those prairies and glades have been totally replaced by stands of continuous red cedar.

Fire Regime Condition Class (FRCC)

Stands can be classified according to how far removed they are from historical fire regimes, and the potential risk of losing key ecosystem components. In the Ozarks, changes from the historical fire regime tend to include less frequent and possibly higher intensity fires than occurred pre-European settlement. Ecosystem losses include relatively gradual changes in canopy composition, but also relatively rapid reduction in or losses of fire dependant and /or shade tolerant understory species such as big blue stem, and Indian grass. Rare species are the first to disappear (Santurf et al. 2002). Loss and impoverishment across the continent of the fire-dependant herbaceous layer "following 20th century fire suppression is one of the unrecognized ecological catastrophes of landscape history" (Frost 1998).

In the late 1990's, the nation's fire managers engaged researchers at the Fire Laboratory in Missoula, Montana to research and classify the nature of fire in ecosystem cycles. The methodology compared current measures to historic ecosystem components with respect to vegetation-fuel composition and structure, fire frequency, fire severity, and other disturbances. Key ecosystem components include indicators such as large old trees, grass/herb cover, soil productivity, water quality, native species and air quality. The resulting fire regime condition classes (FRCC) characterize the degree of departure from natural fire, vegetation, and fire regimes. The three classes are based on the low (FRCC1), moderate (FRCC2), and high (FRCC3) departure from the natural (historical) regime. The departure is a result in the change of one or more of the ecological components. The fire regime condition classes were applied spatially across the lower 48 states in coarse-scale assessment maps. FRCC is also used to assist with project prioritization, and effectiveness monitoring. Improvements in condition class are correlated with enhanced sustainability and resilience to disturbance.

Estimates of acres in each class for the Mark Twain NF were determined using data from "Development of Coarse-Scale Data for Wildland Fire and Fuel Management" (Schmidt et al. 2002). The three classes, as defined for conditions on the Mark Twain NF are:

FRCC1

For the most part, fire regimes in this class are within historical ranges, and the risk of losing key components is low. Fire-dependant ecosystem components are maintained by desired fire regimes. This class represents 6,506 acres or .04 percent of the Mark Twain NF. This class would best be represented by areas that have been within the prescribed burn program for the longest period, and which are exhibiting significant white oak and or short leaf pine regeneration in the midstory, plus a diversity of grasses and forbs in the under story, compared to unburned areas. Also included in the class are the mesic areas scattered through out the forest, and some dry mesic areas on extreme east and north facing slopes.

FRCC2

Condition Class 2 on the Mark Twain is represented by 388,934 acres or 26 percent of the total acres. Fire regimes on these lands have been moderately altered from their historical range by decreased fire frequency, removal of grass/forb cover due to historical overgrazing and or other catastrophic events. A moderate risk of losing key ecosystem components has been identified on these lands. Glades invaded by red cedar, oak stands experiencing oak decline and attacks from the red oak borer, and shortleaf pine stands invaded by hardwoods would best represent this condition class on the Forest. Condition Class 2 vegetation is often intermediate in character between FRCC1 and FRCC3 in that either the land area is of moderate to good quality compared to desired condition, or has undergone some preliminary fuel reduction/ecosystem management treatments. This includes initial thinning, removal of red cedar or one or two initial prescribed fires.

FRCC3

Fire regimes have been significantly altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies of multiple return intervals. This has resulted in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been significantly altered from their historic range. These lands verge on the greatest risk of ecological collapse. Condition Class 3 on the Mark Twain is represented by 1,052,952 acres or 73 percent of the total acres. Lands in this condition class would include closed canopy stands of oak, pine, and cedar where leaf and needle litter completely cover the forest floor. Historically these stands were pine or oak woodlands and savannas, or open glades where the forest ground layer was grasses and forbs.

Recognizing that the majority of Mark Twain NF is in Condition Class 2 or 3, an effort has been initiated to move these lands toward Condition Class 1. While some of these treatments involve thinning followed by prescribed fire, the majority of treatments have been just prescribed fire.

Forest Risk Assessment

Identification of risk to the wildland/rural interface has been accomplished by the Forest Risk Assessment. The Forest Risk Assessment used the following parameters to determine risk: distance to wildland urban interface, historic ignition point densities, current fuels models, response times, ignition proximity to wildland urban/rural interface, ignition proximity to infrastructure, and ignition proximity to threatened species. These elements or parameters were assigned a point value and a computer model identified “High”, “Medium”, and “Low” risks. Based on the model, roughly 60% (902,100 acres) of the Forest are in Low risk, 37% (558,000) is in Medium, and 2% (35,900) is at High risk.

Current Prescribed Fire Program

The landscape that burned in previous centuries, by lightning or humans, is now greatly altered. Roads, agricultural areas and developments have created firebreaks not previously existing in forest communities. Whereas historic fires tended to burn until rain or a large natural barrier was encountered, modern prescribed fires are conducted in blocks normally ranging from 200 to 6,000 acres. Patterns of human development affect when and where prescribed burns can be conducted. The relative location of hospitals, nursing homes, subdivisions, cities and highways to National Forest System lands influence the prescribed burning program. While this influence limits prescribed fire due to smoke emission considerations, it also generates the need to protect communities, from wildfire.

The Forest has had an active prescribed fire program since the late 1960's. Those early burns were used to reduce eastern red cedar in glade ecosystems, restore ecosystem health, and enhance range forage. From the late 1960's prescribed fire, has been implemented to also enhance forage and habitat conditions for wildlife, to reduce hazardous fuels, to restore ecosystems, and to prepare for sites for timber regeneration.

The following table displays actual prescribed fire accomplishments from 2001 to 2004.

Table 26 - Prescribed Burn Accomplishments 2001 - 2004

Year	Hazardous Fuels Reduction	Wildlife Habitat Improvement	Cost Share with National Wild Turkey Federation	Site Preparation	Totals
2001	8,288	1,356	612	0	10,256
2002	8,394	1,350	594	140	10,478
2003	7,614	2,796	184	54	10,648
2004	12,117	3,124	704	528	16,473
Four Year Average	9,118	2,479	584	296	11,964

As displayed in table above, the Mark Twain is increasing acres burned in an attempt to meet ecosystem and hazardous fuel reduction needs. Because 73 percent of the forest is in FRCC3, treated acres will need to be increased to further protect against the loss of threatened ecosystems, protect communities, and reduce the wildland fire risk to an existing and ever growing urban/rural interface. (See section on wildfire for identification of communities at risk and associated protection methods).

Environmental Consequences

Effects of Prescribed Fire

Prescribed fire may be used in any alternative to achieve a variety of resource objectives, including ecosystem restoration or maintenance, hazardous fuels reduction, wildlife habitat improvement, timber site preparation and other treatments. Decisions on where and when to use prescribed fire to meet objectives will be made on a site specific basis, considering a variety of factors. For hazardous fuels reduction projects, identification of risk to communities and private properties would be a primary factor. Hazardous fuels mitigation projects in all alternatives would be targeted at High and Medium risk areas as designated across the Forest, with the highest priority being high and moderate risk areas in Management Prescriptions 1.1 and 1.2.

Effects Common to all Alternatives

Long-term, fire has had the greatest influence on ecosystems within the forest. Fire has been the driving force in shaping forest ecosystems for thousands of years and as such, many species and plant communities are fire-adapted. They have survived fire and many even require it for a competitive advantage.

Fire alters vegetative characteristics that contribute to coarse and fine scale vegetative mosaics on the landscape (Heinselman 1996). Fire also modifies vegetative succession, providing early seral stages and snags important to some wildlife species (Lyon et al. 2000).

Exclusion of prescribed fire would have the same effects in all alternatives. Those areas not treated with fire would continue to progress to a closed canopy while building a continuous heavy layer of leaf and needle litter. The absence of sunlight and build-up of fuels have lead to local extirpation of many grasses and forbs and the decline of species diversity. Forest health would generally decline; oak mortality and insect attacks on oak would continue unchanged. Fire behavior intensifies because of increased fuel buildup. Resistance to control measures would increase as more dead trees shed limbs and/or fall to the ground. The environment in which firefighters work will become more hazardous because of increased fire behavior, and the abundance of standing dead trees.

Before management ignited or wildland fire use fires can be used for resource benefits a plan must be developed and signed by an appropriate line officer. Plans must include specific weather and fuel parameters that would help achieve the desired results. If these parameters cannot be met, the prescribed fire will not be initiated.

Every prescribed fire has the potential to escape established firelines. Contingency plans would be developed that include alternate firelines and resources (firefighters and equipment) sufficient to control the fire, should it escape.

Seasonal timing of prescribed fire would be planned to benefit the resource. Long-term benefits to ecological systems must be weighed against possible short-term impacts to various resources when deciding the timing and intensity of prescribed fires.

As the prescribed fire program grows from 18,000 to 60,000, prescribed fires would need to be easy to accomplish. The most time-consuming preparation activity for prescribed fire is the construction of firelines. Firelines would be planned using existing roads, trails, and natural barriers whenever possible. Fireline construction should be avoided. By avoiding fireline construction, soil movement from constructed firelines will be reduced. Where fireline construction cannot be avoided, standards and guides for fireline construction have been developed.

Direct and Indirect Effects

Alternative 1

Prescribed fire for ecosystem restoration will only be used in Management Prescriptions 1.1 and 1.2. Prescribed fire for hazardous fuels treatments are identified to be accomplished on 593,200 acres of high and moderate risk per decade, inclusive of all management prescriptions.

Alternative 1 produces the lowest number of opportunity acres available for management-ignited fire for ecosystem restoration. The continued lack of fire in these fire-dependant ecosystems would contribute to decline of pine, oak/pine, and post oak species and their associated ecosystems over time. Red and black oak would continue to occupy sites that historically were occupied by pine/pine white oak ecosystems. Cedar would continue to encroach on glade ecosystems.

Only five percent of the Forest (749,300 acres per decade) 5% is only about 70,000 ac. would receive prescribed fire and or mechanical treatments to move from Condition Class 3 to Condition Class 1.

Alternative 1 does not allow for commercial harvest. As a result mechanical fuels reduction treatments and follow-up prescribed fire treatments would be greater than in Alternatives 2, 3, 4, and 5, in an attempt to provide protection for wildland urban/rural interface communities from wildfire.

More frequent catastrophic stand replacing wildfires are a possible result in Alternative 1. The absence of commercial timber sales to reduce crown closure and subsequent reduction of crown fires, and continued fuel build-up in fire-dependant ecosystems would create a more flammable condition.

To meet wildlife objectives it is estimated that 50,000 to 55,000 acres per decade of saw timber would be cut to create temporary openings. Because of the absence of commercial sales in Alternative 1, sawtimber cut for wildlife would remain on the ground. If these regeneration cuts occur in areas determined to be high or moderate risk to communities, follow-up prescribed fire and or mechanical treatments would be planned. In untreated areas such as low risk this fuel build-up may lead to catastrophic stand replacing fires during extreme weather conditions.

Alternative 1 may allow thinning to be accomplished in any management prescription, but only to achieve hazardous fuels reduction projects in high or moderate risk. Thinning projects would have follow-up treatments such as prescribed fire and or mechanical treatments.

While the most effective, inexpensive follow- up treatment is prescribed fire, much of the follow-up treatment would need to be accomplished mechanically. At the present time, the Forest is not prepared to burn 50,000 to 60,000 acres a year. It will take at least five years to “ramp” up to this level. In the interim, the Forest would need to rely on private contractors using anything from chainsaws to heavy equipment, equipped with rotary choppers, to reduce fuel loadings. Mechanical treatments are very expensive ranging from $400 to $600 dollars per acre. If half of the acres included for regeneration cuts, and thinning, were treated mechanically, it would cost between $1,000,000 and $1,500,000 per year. See the soils analysis for the effects of heavy equipment use on soil and water resources.

Dead and dying timber would only be salvaged to protect human health or safety. In areas of low risk this would mean dead and dying timber would not receive any follow-up treatment. The result may be several acres of standing dead timber which would add to fuel loading and the likelihood of catastrophic stand replacing wildland fires.

The generation of nuisance smoke emissions from wildfires will be greater in Alternative 1 when wildfires occur. The increased amount of emissions is due to the accumulation of large fuels, resulting from the absence of commercial timber sales, and the large volume of sawtimber that will be cut and left on the ground to produce wildlife habitat.

Alternatives 2, 3, and 4

Prescribed fire for hazardous fuels treatments, wildlife habitat improvement, and site preparation for silvicultural practices remains relatively constant in Alternatives 2, 3, and 4. The increase or decrease in prescribed burning is determined by the number of acres treated with prescribed fire in Management Prescriptions 1.1 and 1.2 for ecosystem restoration. Alternatives 2, 3, and 4, at least double the acres of ecosystem restoration treated in Alternative 1. The maximum acres prescribed burned for ecosystem restoration in Alternative 2 are nearly six times the acres treated in Alternative 1.

Table 27 - Projected Prescribed Fire Acres by Alternative

Treatment Type	Alt 2	Alt 3	Alt 4
Ecosystem Restoration	130,100	93,900	42,900
All Other Rx Fire Treatments	594,100	594,100	594,100
Total	724,200	688,000	637,000

As acres treated by fire increase, both positive and negative effects can be expected. Fire-adapted and fire-dependant ecosystems would begin the gradual process of returning from FRCC3 to FRCC1. Communities and local residents will benefit from reduced fuel loading as the risk of catastrophic stand replacing fires is reduced. Wildland fires occurring in treated areas would have less intense behavior and smoke emissions, while being safer to suppress.

As acreage of prescribed fire increases, so would the amount of fireline needed to control it. Many of these lines will be constructed to mineral soil increasing the possibility of soil movement. Standards and guidelines have been designed to minimize soil movement created by the construction of firelines.

Commercial harvest is permitted at a fairly consistent level in Alternatives 2, 3, and 4. These harvests would reduce crown closure and potential for crown fires in treated areas. Activity fuels residual from harvest activities add to the fuel load and would need to be treated mechanically or by prescribed fire to reduce the hazardous fuels risk, and resistance to suppression efforts.

The Forest will begin the process of returning ecosystems to their historic vegetative condition. As a whole the Forest would be healthier, more resistant to insect and disease, and be less susceptible to damage by wildfires. Healthy natural communities will provide a full range of habitat conditions similar to conditions that existed when native Missouri species evolved.

Alternative 5

Alternative 5 represents the 1986 Forest Plan, which does not recognize the need to restore fire-dependant ecosystems or natural communities, other than in the Hercules Glades Wilderness. The 1986 Plan calls for research to better understand the effects of fire on natural vegetative communities. There is no provision to accomplish specific ecosystem restoration projects, other than restoration that is accomplished by hazardous fuels reduction and wildlife habitat improvement treatments. The 1986 Plan, while not discouraging hazardous fuels treatments, does not encourage them. It also does not recognize the need to protect the wildland urban or rural interfaces.

Alternative 5 includes the least amount of prescribed fire of any alternative. This is because Management Prescriptions 1.1, 1.2, and 2.1 do not exist in Alternative 5, and therefore there would be very limited use of prescribed fire to restore ecosystems and enhance natural communities. Prescribed fire would be used to reduce hazardous fuels, improve wildlife habitat, and to prepare sites for the regeneration of timber. These treatments will total 500,000 to 600,000 acres per decade.

Alternative 5 also has the greatest number of acres of commercial thinning, pre-commercial thinning and regeneration harvests. Follow-up hazardous fuels treatments, accomplished either mechanically, or by prescribed fire, would follow many initial timber treatments. Those areas not receiving follow-up treatments would add to the buildup of woody fuels consisting of twigs, limbs, and the boles of non-commercial trees. This particular fuel condition may threaten residual stands of trees and complicate suppression activities, unless treated.

The generation of smoke emissions in Alternative 5 is lower than Alternatives 1 – 4, but higher than the current program (see the Smoke Management Analysis). The increase in acres treated over the current program is due to the urgency to treat the wildland urban/rural interface condition.

Cumulative Effects

Other land management agencies such as the Missouri Department of Natural Resources, the Nature Conservancy, the Missouri Department of Conservation, the National Park Service, and the US Fish and Wildlife Service have all recognized the need to restore fire to the ecosystem, and protect communities at risk. This is displayed in the following table. Currently there is no reporting system to track the number of acres that are burned by private landowners. While this number may be significant, there is no way to gather this data.

Table 28 - Average Acres of Prescribed Fire in Missouri by Agency 1993 - 2003

Agency	Seven Year Average of Rx Burns Acres
Mark Twain National Forest	10,034
MO Department of Natural Resources	9,170
MO Department of Conservation*	32,500
National Park Service	2,800
The Nature Conservancy	3,558
US Fish and Wildlife Service	569
Total	58,631

** Includes private lands where MDC assisted in prescribed fire preparation and or execution.*

Table 29 - Summary of Prescribed Fire in Missouri by Agency 2003

Agency	2003 Rx Burn Acres
Mark Twain National Forest	10,647
MO Department of Natural Resources	12,161
MO Department of Conservation	21,370
National Park Service	733
The Nature Conservancy	5,170
US Fish and Wildlife Service	835
Total	50,916

Note: "For the fiscal year 2003 (July, 2002 – June 2003) MDC acres were down considerably, with a 41% drop (15,096 acres) from 2002. The extended drought in western parts of the state plus the very wet spring in the central and eastern portions was not conductive to prescribed fire. The total prescribed burn acreage reported was down 16% from 2002 and down 9% from the seven-year average. (Hartman 2004).

Within the State of Missouri, the Mark Twain National Forest accounts for about 20 percent of the total reported acres burned.

Overall, when considering other past, present, and reasonably foreseeable future actions in the vicinity of the Mark Twain NF, only one of the alternatives would be expected to result in adverse cumulative effects.

In Alternative 1, a hazardous fuels condition is created by leaving sawtimber on the forest floor. Each year as sawtimber is cut, hazardous fuels accumulate, creating the need for expensive follow-up treatments. These treatments will only occur where the accumulation of hazardous fuels is designated as high or moderate risk to local residents. Because of the expense and congressional direction for treatment of hazardous fuels, areas designated low risk will not receive any follow-up treatment, and fuels resulting from regeneration cuts, thinning, and timbered areas damaged by wind, ice, tornados, insects or disease would remain on the ground untreated. Because 60 percent of the Forest is designated as low risk, the Mark

Twain NF could face several thousand acres of untreated timber on the ground within the first decade. This accumulation of large fuel would create an unnatural condition which could be detrimental to residual standing trees when exposed to wildland fire. Firefighter's safety could be compromised due to increased fire intensity and resistance to control measures. Normal low-intensity, quick moving fires could be replaced with slow moving high intensity fires. Slow moving intense wildland fires would destroy more of the organic duff layer and soil stability. There is little emphasis to restore fire-dependant ecosystems.

In Alternatives 2, 3, 4, and 5, the accumulation of large fuels would be mitigated by removal of sawtimber by way of commercial timber sales. Salvage sales would be permitted to remove trees damaged or destroyed by ice, wind, tornadoes, insects or disease. Five to six percent of the Mark Twain NF would begin the process of moving from FRCC 3 toward FRCC 1. Historic fire-dependant ecosystems would be selected for restoration.

Wildland Fire

Throughout the twentieth century, fire management policy has continued to evolve in response to land and resource management needs, growing knowledge of the natural role of fire, and increased effectiveness of fire suppression. During the earliest stages of wildland fire management, programmatic knowledge indicated aggressive, total suppression to be the likely solution to limit widespread, damaging fires. As knowledge, understanding, and experience expanded, it became increasingly obvious that complete fire exclusion was not the best-suited management direction to support a balanced resource management program. In fact, in many situations, this management direction was detrimental to ecosystem health and functioning. (Zimmerman 1998)

Science has concluded that fire exclusion efforts combined with other land use practices, have in many places dramatically altered fire regimes (circumstances of fires, including frequency, intensity, and special extent) so that today's fires tend to be larger and more severe. (USDA et al. 2004). As knowledge and understanding increased, policies began to change and new priorities for fire suppression were developed.

Affected Environment

While the Mark Twain National Forest has an altered fire regime and stand replacement fires are not uncommon, the majority of fires remain low intensity surface fires. These fires can be beneficial and aid the process of ecosystem restoration. Response to wildland fire is based on ecological, social, and legal consequences of the fire. The circumstances under which a fire occurs, and likely consequences to the firefighter and public safety and welfare, natural and cultural resources, and values to be protected, dictate the appropriate management response to a fire. There are two options for wildland fire: wildland fire suppression and wildland fire use.

Wildland Fire Suppression

The appropriate management response to wildland fire may range from an aggressive suppression response in areas of high and moderate risk, to a confine strategy (see Glossary) in areas of low risk. To aid in the determination of appropriate management response to wildland fire, a Forest Risk Assessment (FRA) was developed. Elements that influenced the risk assessment included:

- distance to wildland urban interface,
- historic ignition point densities,

- current fuels models,
- response times,
- ignition proximity to wildland urban/rural interface,
- ignition proximity to infrastructure, and
- ignition proximity to threatened species.

These elements were assigned a point value and a computer model identified “High”, “Medium”, and “Low” risk. Wildland fires that occur in high and medium risk areas will require an aggressive suppression response to insure protection of values at risk. An aggressive suppression response may include pre-propositioning resources to insure a quick response time to areas where there are high concentrations of structures.

The Forest is heavily laced with roads and trails, with small towns interspersed throughout. For the most part, private ownership is intermingled with federal ownership and overall the areas are rural with low concentrations of houses surrounded by vegetation (Rural Interface). However, there are areas on the Forest that are close to populated areas such as Branson, Ozark, Poplar Bluff, and Fort Leonard Wood, where the interface is more urban than rural (Urban Interface). In the past decade population growth in counties around Branson, and Ozark, have grown 55 to 63 percent (Mo Dept. Economic Development 2000). These areas are designated as either High or Moderate risk by the FRA.

Wildland Fire Use

Wildland fire for resource benefits are fires that are caused naturally and allowed to burn to a predetermined boundary, maximum manageable area, or MMA, under specified conditions, to produce fire behavior and fire characteristics to attain planned treatment and resource management objectives. Wildland Fire Use is a management response that must be pre-approved before ignition, in the Fire Management Plan, thus allowing ranger districts to manage a naturally caused fire as a wildland fire use fire. Managers monitor the fire, to ensure it fits the same parameters required of a human-ignited prescribed fire and monitor the fire until weather or a change in fuel loading leads to its extinction, or to the MMA.

Regardless of possible resource benefits, by law, human-caused, non-management ignited fire must be suppressed. This has been the limiting factor to increased wildland fire use on the Mark Twain NF, as a majority of fires on the Forest are human-caused. Records from 1984 to 2003 show that lightning is the only reported cause of wildfire that is natural, resulting in 1.4 % of ignitions and 1.8% of total acres burned. Fully 98.6 percent of the fire ignitions, and 98.2 percent of the acres burned are human-caused, requiring a suppression action. Fires caused by lightning strikes, though uncommon, have occurred through out the Mark Twain NF. While the Mark Twain has not used fire for resource benefits in the past it is conceivable these natural fires would be used in the future.

Wildland fire for resource benefits is not appropriate in urban interface areas and an aggressive suppression response would be required.

Environmental Consequences

Effects Common to all Alternatives

Normally, human-caused wildland fires are ignited without regard for the damage they may cause. Inappropriate seasonality, intensity, or return interval, regardless of cause, can have negative effects on the ecosystem. Human-caused wildland fire often consume more of the litter and duff layer, exposing mineral soil, and killing more trees than a prescribed fire in the same area. This is because weather and or ignition patterns may be very different than those chosen for a prescribed fire.

Fire suppression in high risk emergency situations could adversely impact resources. Adverse effects could include increased sedimentation caused by fireline construction, fens or small steams damaged by tractor/plow and ATVs crossings, and stream flow and pond levels reduced by drafting large quantities of water. Unknown locations of heritage resources and threatened and endangered species may be disturbed by fireline construction. Uncontrolled smoke can become a serious problem as it can reach sensitive receptors such as hospitals, communities, roads and highways. Dead trees that would otherwise be left for wildlife may be cut if they are determined to be a safety or suppression hazard.

In areas that are designated as “Low” risk, factors such as firefighter safety and resource damage would be taken into consideration when firelines are planned and constructed. When possible, natural and man-made barriers would be used rather than fireline construction, to reduce the risk to firefighters and resources. The desired end result would be reduced acres burned in “High” and “Medium” risk, and increased acres burned in “Low” risk, providing better protection to the public and natural resources while providing a safer working environment for firefighters.

Fuels treatment projects would be centered on a collaborative approach with the Missouri Department of Conservation, the National Park Service and the Nature Conservancy, to protect local communities from wildland fire.

Direct and Indirect Effects

While weather is the greatest influence on the variability of number of fires and acres burned in the past decade, there other factors that contribute to variability. Any alternative could affect the number of fires ignited, particularly those caused by arson, campfires, and equipment. This could be based on the level of access to the Forest, as well as public reaction to management decisions, leading to arson fires. The probability of equipment use and resulting equipment-caused fires will vary by alternative based on the amount of resource production. The following table displays arson, campfire escape, and equipment use fires that have occurred during the past decade.

Table 30 - Wildland Fires by Source 1994 - 2003

	Arson		Campfire Escapes		Equipment Use		Total	
Year	Fires	Acres	Fires	Acres	Fires	Acres	Fires	Acres
1994	143	2,743	0	0	5	63	186	3,277
1995	236	8,067	2	15	7	117	311	9,802
1996	109	4,794	0	0	2	52	163	6,493
1997	82	2,050	1	25	1	1	117	4,403
1998	131	4,634	4	19	3	7	169	5,222
1999	174	3,398	2	5	4	62	243	6,235
2000	118	6,689	1	15	4	41	182	8,699
2001	119	3,665	4	87	3	203	247	5,283
2002	82	2,730	2	4	2	0	117	3,050
2003	120	1,653	4	262	1	1	151	3,522
Total	1,314	40,423	20	432	32	547	1,886	55,986

(Personal Computer Historic Analysis 6/21 data base)

Alternative 1

Generally, Alternative 1 minimizes the direct human influence on the forest environment by minimizing commercial activities. Commercial harvest of timber will not be permitted.

Salvage timber sales would only be permitted to protect human health and safety. To meet wildlife objectives it is estimated that 50,000 to 55,000 acres per decade of sawtimber would be cut to create temporary openings. Because of the absence of commercial sales in Alternative 1, sawtimber cut for wildlife would remain on the ground.

While some of these “activity fuels” in areas of high and moderate risk will receive follow-up treatments such as prescribed fire and/or mechanical treatment, much of the fuel will remain on the ground untreated. Untreated ground fuels would increase fire intensity and resistance to suppression efforts.

Fuel loadings would increase with the absence of commercial harvest and regeneration cuts. Dead and dying trees may no longer be removed by commercial harvest and therefore add to the build-up of flammable fuels. Resistance to suppression measures and the likelihood of stand replacement fire would increase.

Roads in the short term would become more difficult to travel due to limited maintenance and reconstruction. In the long-term, many local, dead-end maintenance Level 2 roads would be closed and or decommissioned, thus limiting motorized travel to a small road network of maintenance Level 3 and 4 roads. Limiting access to the Forest would have negative effects on fire suppression. Response times or the time it takes to get to a fire would increase, generally increasing the size of fires. More emphasis would be placed on expensive aerial detection and suppression methods. The opportunity to use roads for firelines would be reduced, increasing the amount of fireline constructed. Constructed firelines have the potential for negative impacts on soils and stream sedimentation. Most of the Forest’s arson fires occur along roads. With a reduced road system arson fires may be reduced or they may become more concentrated where roads remain open.

Because naturally occurring events such as insects, disease, fire, and weather are major influences that would alter the forest environment, it is appropriate to allow wildland use fires in areas of low risk as determined by the Forest Risk Assessment.

The Forest will continue to move away from fire-adapted ecosystems that historically dominated the Mark Twain. As this change continues to occur wildland fires have potential to become larger and more devastating.

Alternatives 2, 3, 4, and 5

Alternatives 2, 3, 4, and 5 allow management activities at varied levels. It is very difficult if not impossible to predict fire occurrence at each level. Generally, the more public use the Forest receives, the more fires will occur. Also as dense, closed canopy forest is restored to a lower density, open forest, lightning fires could become more common as well as increasing in size because environmental conditions would be more conducive to their spread. Thus, the percent of wildland fires caused by lightning could increase over time. Hunter, equipment, and arson fires could increase as access to the forest increases. While the permanent road system mileage is expected to remain stable, the number of temporary roads and skid trails increases as timber activities increase. Alternative 5 would have the greatest number of temporary roads and skid trails.

Wildland fire use fires are appropriate and may become more common as time progresses. The following chart displays the number of acres designated as low risk, by Management Prescription that could be managed under a “Contain” strategy (see Glossary.)

Table 31 - Acres of Low Fire Risk by Management Prescription for Alternative 3

Management Prescription	1.1	1.2	2.1	6.1	6.2	6.3	7.1	8.1	5.1
Acres of Low Risk	244,669	36,943	414,871	44,140	108,497	11,329	2,017	18,131	21,651
Percent of Area	65%	59.9%	61.9%	57.9%	55.2%	65.7%	68.1%	59.3%	33.8%

(FRA Summary)
Note: Fires in Management Area 7.1 would normally require aggressive suppression action to protect structures and other recreation facilities.

Cumulative Effects

No matter how effective a prevention or hazardous fuels program may be there would always be wildland fires. The arsonist would still use fire as a means of expression, and there would be careless mistakes made as in the case of escaped camp and debris fires. These fires would be suppressed as a cooperative effort involving MDC, local fire departments, and the National Park Service. The following table is a summary of wildland fires suppressed by the major wildland suppression agencies within the State of Missouri.

Table 32 - Wildland Fire Acres Suppressed by Agency in Missouri

Agency	Average Acres	Average Wildland Fires
USFS	5,392	188
MDC	53,739	3,175
NPS	78	15
Totals	59,209	3,378

The USFS and MDC are 10-year averages (1993-2003) and the NPS is a seven year average (1996-2003).

The exact time and location that these fires would occur is an unknown. There is no method to predict how the pattern of human-caused wildland fires would differ among the alternatives.

Air Quality

Introduction

The Mark Twain National Forest, like all federal land management agencies, is charged with protecting the air, land, and water resources under its jurisdiction from impacts of air pollution produced outside federal lands (Clean Air Act 1990). Statutes and regulations also require federal land managers to protect air, land, and water from the effects of air pollutants originating from within federal lands (Clean Air Act 1990, Organic Act 1977, Wilderness Act 1997, 40 CFR Part 50.) Activities such as prescribed burning, road construction and maintenance, recreation use, and timber harvesting may have impacts on air quality and must be considered. This analysis focuses on wildland and prescribed fire because emissions they generate are far greater than any other Forest activity, and because there is no data available to analyze road construction, recreation use, or timber harvesting impacts on air quality. The Forest Service must minimize and mitigate the impact of Forest activities on the quality of natural resources including air resources and general air pollution. Impacts of pollution originating from national forest lands and of pollution originating from lands outside the Forest must be considered when planning projects.

The EPA’s Interim Air Quality Policy on Wildland and Prescribed fires (US EPA 1998) employs the following language to describe public policy goals: (1) To allow fire to function, as nearly as possible, in its natural role in maintaining healthy wildland ecosystems; and, (2) To protect public health and welfare by mitigating the impacts of air pollutant emissions on air quality and visibility. The document comments on the responsibilities of wildland owners/managers and State/tribal air quality managers to coordinate fire activities, minimize air pollutant emissions, manage smoke from prescribed fires as well as wildland fires used for resource benefits, and establish emergency action programs to mitigate the unavoidable impacts on the public.

Proposed Changes

Several proposed changes could affect air quality in the vicinity of the Mark Twain NF. They include:

- the addition of prescriptions emphasizing restoration of natural communities(Revision Topic 2a);
- increases in the amount of prescribed burning and fuels management (Revision Topics 3a and 3c).

Issue - Fire Management

While prescribed fire is needed to reduce hazardous fuels and restore ecosystems, there is concern that increasing the use of prescribed fire will affect air quality. Forest Plan revision will determine how, where, and to what extent prescribed fire may be used to mimic natural processes and to restore natural processes and functions to ecosystems, and to reduce fuels.

Analysis Area

The affected environments for this analysis are the twenty-nine counties containing National Forest System lands of the Mark Twain National Forest, and the St. Louis metropolitan area...

Affected Environment

In 2002, the Missouri Air Pollution Monitoring Network included 165 monitors of three types, for monitoring pollutants including ozone and particulate matter (i.e. PM): Federal Reference Method (FRM) monitors, state and local agency monitors, and special use monitors. The Mark Twain maintains an IMPROVE (Interagency Monitoring of Protected Visual Environments 2002) aerosol monitor to collect data on particulate concentrations near the Hercules Glades Wilderness (Federal Class I Area). There are a number of these state monitors in counties near the Forest.

Findings from these monitors indicate that the air quality in Missouri generally meets National Ambient Air Quality Standard (NAAQS) accepted levels. The St. Louis area has historically violated the one hour ozone standard, but at the end of 2002 it met the standard (MO DNR 2002).

A small area near a lead smelter in Jefferson County exceeds federal standards for airborne lead, but has been making progress in lowering ambient air lead levels. Keep in if this is near Cedar Creek. Unit. Periodically both St. Louis and Kansas City recorded exceedances of the eight hour PM 2.5 standard (MO DNR 2002). However, in 2003 the St. Louis area was the only geographic area in the state that had a violation of the new annual PM 2.5 standard with only one monitor showing a violation (MO DNR 2003a).

Once an area is cited for non-attainment for any criteria pollutant, a state implementation plan is developed in an attempt to bring the area back into attainment. This usually involves placing controls on various sources that contribute to the pollutant of concern. Exceedance of

Particulate Matter (PM) 2.5 in St Louis usually occurs outside normal prescribed fire “window” and wildland fire season. An implementation plan that would involve the Forest would be unlikely.

Criteria Pollutants

The Mark Twain NF occupies a land mass that is currently designated as “attainment” for all six National Ambient Air Quality Standards (NAAQS) criteria pollutants. EPA defines attainment areas as “A geographic area in which levels of a criteria pollutant meets the health-based primary standard NAAQS for the pollutant.”

To evaluate impacts that wildland and prescribed fire have on Missouri’s air quality it is important to consider other sources of pollutants and where they are generated. The Mark Twain is surrounded by seventy-one coal-fired electrical generating facilities. These generating facilities are the number one producer for the following criteria pollutants and are responsible for 80% of total Nitrogen Oxides, 68% of total Sulfur Dioxide, 22% of total PM 10 (MO DNR 2002), and 27% of the PM 2.5 produced in the State (US EPA 1999).

Visibility

The 1977 amendments to the Clean Air Act (CAA) include a national goal of “the prevention of any future, and the remedying of any existing impairment of visibility in mandatory Class I Federal areas which impairment results from manmade air pollution” (42 USC 7491). In 1999 EPA issued regional haze regulations to manage and mitigate visibility impairment from the multitude of diverse regional haze sources (40 CFR Part 51). The regional haze regulations call for States to establish goals for improving visibility in Class I National Parks and wildernesses, and to develop long-term strategies for reducing emissions of air pollutants that cause visibility impairment. The rule requires States to establish goals for each affected Class I area to (1) improve visibility on the haziest 20 percent of days and, (2) ensure no degradation occurs on the clearest 20 percent of days over a period of each implementation plan.

The Hercules Glades Wilderness located within the Mark Twain NF and the Mingo National Wildlife Refuge in Puxico, Missouri, about 10 miles east of the Poplar Bluff District of the Mark Twain NF, are the only lands in Missouri designated as Class I with respect to air quality. The Clean Air Act defines Class I areas as “A geographic area designated for the most stringent degree of protection from future degradation of air quality. The Mark Twain NF is accountable for the protection of scenic vistas of the Hercules Glades Wilderness.

With the exception of Hercules Glades Wilderness, the entire Mark Twain National Forest lies within lands designated as Class II with respect to the air quality (visibility). (USDA and USDI 2000). The Clean Air Act (CAA) defines a Class II area as, “A geographic area designated for a moderate degree of protection from future degradation of the air quality”.

Environmental Consequences

Ninety percent of the lands within the Mark Twain National Forest are within fire dependant / fire-adapted ecosystems. Historically, fire has been a major contributor to the health of the Forest. As an ecological process, prescribed fire has been, and is essential to restore and maintain functional ecosystems. The effects of fire exclusion has led to a change in vegetation type and an increase in fuels buildup creating the potential for costly, more damaging fires. These fires contribute emissions to the atmosphere that may affect public health and visibility.

Emissions from prescribed fire, wildland fire use, and wildland fire affect quality of the air resource. In 1977, the Environmental Protection Agency (EPA) adopted stringent air quality standards for ozone and Particulate Matter 2.5 to protect human health (US EPA 1997b). One challenge in using prescribed fire is balancing the public interest objectives of protecting human health and welfare from air pollution, while sustaining ecological integrity. Recognizing this, the EPA developed an interim air quality policy for wildland and prescribed fires that allows fire to function, as nearly as possible, in its natural role of maintaining healthy ecosystems, but still protects health and welfare by mitigating the impacts of emissions on air quality and visibility (US EPA 1998)

Effects Common to all Alternatives

Emissions from both prescribed and wildland fires are generated by incomplete combustion and include particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides, and hydrocarbons (Hardy et al. 2001). Of the criteria pollutants that are generated by prescribed and wildland fire, the most significant is particulate matter (PM) 2.5 (fine matter less than 2.5 microns in diameter). PM 2.5 presents the greatest danger to human health and degradation of visibility. Fine particulates (PM 2.5) make up more than 70 percent of the mass of particulate matter produced by prescribed and wildland fire. For this reason PM 2.5 was used to compare the direct effects of alternatives on air quality. Emission estimates are calculated for the maximum acres planned for treatment using factors generated by “Short-term Improvements to the Wildland Fire Component of the National Emissions Inventory” Modified April 13, 2004. The figures in the following table are general and use average fuel moistures, and weather conditions. Specific conditions and mitigation measures will be considered during project planning.

Predicted changes in emissions are based on a regional assessment and are not representative of any one location on the Forest. Estimated emissions would not be evenly distributed across the Forest because treatment areas vary annually. Site specific analysis of smoke dispersion and downwind fine particulate impacts take place when sites are selected for treatment.

Table 33 - Estimated PM 2.5 Emissions from Prescribed Fires on Mark Twain NF

	Maximum Possible Annual PM 2.5 Emissions (in tons)	% Change From Current (10 year average)
Alternative 1	2,082	374
Alternative 2	2,445	457
Alternative 3	2,324	429
Alternative 4	2,151	390
Alternative 5	2,004	357
Current Level	439	0

Note: Alternate 5 is the current forest plan. It is expected that prescribed fire acres will increase from the current level to meet fuel reduction goals as indicated by the forest risk assessment.

Factors that have potential to reduce visibility include sulfate and nitrate particles, fine particles, elemental carbon and humidity. The closer the particle size is to the wavelength of light, the more effective the particle is in scattering light. The more light is scattered and absorbed, the poorer the visibility. As a result, relatively large particles of windblown dust are far less efficient in scattering light than fine particles found in wildland smoke. An important component of smoke from wildland or prescribed fire is elemental carbon (soot), which is highly effective at absorbing light. This combination of light absorption by elemental carbon and light scattering caused by very small particles that make up wildland and prescribed fire smoke explains why emissions from wildland and prescribed fire may play an important role in localized visibility impairment; prescribed fire smoke plays only a minor role in regional impairment. In addition, relative humidity also indirectly affects visibility. Relative humidity does not itself cause visibility to be degraded, but some particles, especially sulfates, accumulate water from the atmosphere and grow in size to where they are particularly efficient at scattering light. Poor visibility in the summer months is a result of the combination of high sulfate concentrations and high relative humidity. (Hardy et al. 2001)

Project Planning

To minimize negative effects of smoke and associated pollutants generated from prescribed fires, smoke management plans are required for every prescribed burn. These plans identify sensitive receptors near the project area and utilize a smoke model such as the Simple Approach Smoke Estimation Model (SASEM) or the First Order Fire Effects Model (FOFEM) to identify sensitive receptors within reach of the plume. Once the receptors are identified, weather parameters are developed and documented in the prescribed fire plan to utilize current weather conditions to guide smoke away from the receptor. Parameters that are considered include depth of the atmosphere available for smoke mixing (dispersion), transport wind speed and direction, and the probability of air stagnation for the day of, and the night following the prescribed fire. Where smoke cannot be manipulated by weather conditions to avoid receptors such as roads, other mitigation measures, such as signs, flashers or road guards, will be taken to insure public safety. When Smoke Management plans are written, emissions affecting Non-attainment areas like St. Louis, and Class I areas (Hercules Glades Wilderness and Mingo Wildlife Refuge) are avoided by planning and executing prescribed fires on days that maximize smoke dispersion and avoidance. By taking these measures, the negative effects of smoke can be reduced.

Mitigation is the key to successful smoke management. The following table summarizes potential emission reductions that may be achieved by employing various techniques as estimated by the emissions model “SASEM”. Any measures or a combination of measures may be used during implementation to reduce emissions. The more fuel available to consume, the more emissions are produced. In the case of mosaic verses non-mosaic burning: mosaic burning, burns half the area of non-mosaic burns, therefore half the fuel is consumed, and emissions are reduced by half. Where mechanical treatments have removed almost 60% percent of the fuel, emissions are reduced 40 percent. High fuel moisture limits the available fuel a fire can consume; this is the case for both large fuels and cured fuels. If large fuels and cured fuels have high fuel moistures they are not available for the burn to consume. More frequent burning reduces emissions because there is less fuel build-up and therefore less fuel available to consume, and therefore fewer emissions produced.

Table 34 - Potential Project Level Mitigation Measures

Practice and Emission Reduction Technique	Vegetation Type	Total Fuel Loading (tons of fuel/ac)	Size (Ac)	Fuel Consumption (Total)	Total PM 10	PM 10 Reduction	Total PM 2.5	PM 2.5 Reduction
Non-Mosaic	Southern Pine	10.9	200	593	6.19		5.91	
Mosaic burning	Southern Pine	10.9	200*	269	3.09	50%	2.95	50%
No Mechanical	Oak Hickory Leaf Litter	32.4	100	1,620	21.86		18.04	
Mechanical Removal	Oak Hickory Leaf Litter	19.4	100	970	13.10	40%	10.80	40%
Low Moisture in Large Fuels	Oak Hickory Leaf Litter	96.9	100	19.99	17.9		15.89	
High Moisture in Large Fuels	Oak Hickory Leaf Litter	96.9	100	13.75	12.39	31%	10.98	31%
Burn After Large Fuels Cure	Oak Hickory Leaf Litter	118.6	100	17.66	16.40		14.60	
Burn Before Large Fuels Cure	Oak Hickory Leaf Litter	118.6	100	8.81	7.49	50%	6.60	55%
Burn Less Frequently	Oak Hickory Leaf Litter	39.7	100	1,985	26.79		22.01	
Burn More Frequently	Oak Hickory Leaf Litter	6.7	100	335	4.52	83%	3.73	83%

**Estimated that only 100 of 200 acres will actually burn.*
EPA Contract No. 68-D-02-064.

Another common practice to mitigate the impact of smoke on sensitive receptors is re-distribution of emissions. Emissions can be redistributed spatially and temporally by burning during periods of good atmospheric dispersion (dilution) and when prevailing winds will transport smoke away from sensitive areas (avoidance) so that air quality standards are not violated. This technique is used to avoid the impact of smoke on Hercules Glades Wilderness, Mingo Wildlife Refuge, and sensitive areas in St. Louis.

Annual timing of prescribed burning is also an important consideration. Spring and fall are usually when atmospheric conditions are best for dilution and avoidance. Summer months are usually when visibility and regional haze are at there worst annual condition due to high humidities and temperatures.

Direct and Indirect Effects

All Alternatives

All alternatives would increase the amount of prescribed fire over what is currently accomplished. The suggested range from all alternatives would be an increase from the current level of 18,000 acres a year to approximately 60,000 to 70,000 acres a year by the end of the decade. This increase would be incremental for the first 5-6 years then level off at 60,000 to 70,000 acres per year. This increase in acres burned would increase annual emissions up to 80% over what is currently generated. Direct effects of smoke would impact sensitive receptors such as highways, hospitals, local residents with respiratory conditions, airports etc. The most significant possible indirect effect would be degradation of regional visibility. However, it is generally accepted by both state and federal regulators that visibility impacts from an effective prescribed fire program would likely be less than those effects from an alternative wildfire scenario, due to the consumption of significantly less fuel. (Hardy et al. 2001)

Cumulative effects

The Missouri Department of Conservation, the Missouri Department of Natural Resources, the National Park Service, and the Nature Conservancy make major efforts to restore ecosystems, and protect local residents from wildfire. The following table shows a seven-year average (1996-2003) of prescribed burning by these agencies with the associated emissions of PM 2.5 (Hartman 2004).

Table 35 - Estimated PM 2.5 Emissions from Prescribed Fires by Agency 1996 - 2003

Agency	Seven Year Average of Rx Burns	Estimated PM 2.5 Emissions (in tons)
USFS	10,034	439
DNR	9,170	310
MDC	32,500	1081
NPS	2,800	94
TNC	3558	120
Totals	58,062	2,044

Because wildland fires are sources of airborne fine fuel particulate matter emissions (PM 2.5) they must be considered when evaluating cumulative effects. These fires include wildfires in forests and grasslands. Wildland fires similar to prescribed fire release PM 2.5 directly into the atmosphere, and also produce gaseous pollutants that can react in the atmosphere to form secondary PM 2.5. These precursor pollutants include nitrogen oxides (NOx), volatile organic compounds (VOC), and ammonia (NH3). Small amounts of sulfur dioxide (SOx) are also released.

Emissions from wildland fire contribute to elevated ambient concentrations of PM 2.5, and impairment of visibility.

The following table is a summary of wildland fires suppressed by the major wildland suppression agencies within the State of Missouri. The USFS and MDC are 10 year averages (1993-2003) and the NPS is a seven year average (1996-2003).

Table 36 - Estimated PM 2.5 Emissions from Wildland Fires by Agency

Agency	Average Acres	Average Wildland Fires	Estimated PM 2.5 Emissions (in tons)
USFS	5,392	188	182
MDC	53,739	3,175	1815
NPS	78	15	3
Totals	59,209	3,378	2000

While it would appear that not much could be done to reduce wildfires and the resulting emissions, there are measures that can be taken. Prevention efforts can be effective. Aggressive suppression actions, as directed by the Forest Risk Assessment, can reduce the size of wildland fires. Areas treated by prescribed fire where there is a high occurrence of arson can reduce emissions by reducing fuel loading. There is an inextricable link between fuels management, prescribed fire, wildland fire severity, and emission production.

All the smoke producing agencies in the state of Missouri are currently working with Environmental Protection Agency (Kansas City) and the Department of Natural Resources-Air Pollution Control to develop Missouri's State Implementation Plan (Smoke Management Plan, SMP) for PM2.5 and Visibility. This plan should be completed by early 2005. The basic components of the smoke management plan identified in the Interim Policy include:

- Authorization to Burn
- Minimizing Air Pollutant Emissions
- Smoke Management Components of Burn Plans
- Actions to Minimize Fire Emissions
- Air Quality Monitoring
- Evaluate Smoke Dispersion
- Public Notification and Exposure Reduction Procedures
- Public education and awareness
- Surveillance and Enforcement

The Mark Twain NF will take into account the SMP (upon completion), when planning and creating prescribed fires.

Riparian Areas, Aquatic Systems and Water Quality

Introduction

The Mark Twain National Forest is located primarily in the Ozark Highlands of southern Missouri, an area traversed by rivers and streams that are fed by some of the largest springs in North America. The waters of the Mark Twain NF are recognized for their high quality. More than 350 miles of floatable streams are found within the national forest boundary. Recreational floating and fishing on the many streams, ponds, and lakes are some of the most popular activities on the Forest. Floating with canoes, kayaks, rafts, and inner tubes offers a chance to view numerous rocky bluffs, caves, springs, vegetation, and wildlife. Anglers are likely to catch bluegill, sunfish, catfish, trout, small mouth bass, or several other species of fish. Many of the national forest's campgrounds are located on these rivers and streams. Recreational use of the Forest's waters contributes significantly to the area's local economies, particularly during the summer months.

Streams, rivers and the riparian areas are essential for healthy watersheds and play vital roles in the proper functioning of terrestrial, aquatic, and karst ecosystems. Pollution of water has a serious impact on all living creatures and can negatively affect the use of water for drinking, household needs, recreation, fishing, and transportation.

Proposed Changes

The 2005 Forest Plan provides goals and objectives for soil, watersheds and water quality. The goals and objectives work together to move areas toward an ecologically sustainable desired condition, which is reflective of historic conditions while maintaining and improving the quality of the resources.

The proposed changes establish Riparian Management Zones (RMZ) and Watercourse Protection Zones (WPZ) to restore and maintain ecological function and processes of riparian areas, aquatic systems and water quality. Standards and guidelines have been developed to protect water quality and ecological processes associated with karst terrain and karst features.

Riparian

In the 1992 amendment to the1986 Forest Plan, the description and delineation of riparian areas was based on flooding frequency. The 2005 Forest Plan establishes RMZs and describes them using landform, soils, hydrologic criteria and plant communities. This provides a clearer, more usable description and bases the delineation on function. It takes into account natural communities, soils, hydrology and landforms and uses this as the basis of what areas need to be protected, instead of a standard 100 foot buffer strip. These changes provide protection for areas that are most critical to the proper functioning of the system.

Riparian Management Zones are not delineated as part of the 2005 Forest Plan. They would be delineated at the project level, using the best available information for landform, terrestrial natural communities, soils, and hydrology for each district. In cases where the RMZ boundary could not be effectively determined using characteristics previously described, the RMZ boundary would be set at least 100 feet horizontal distance from the top of each bank. RMZs continue upstream until a well-defined floodplain, continuous flow or permanent pools cease to exist, or riparian natural communities are no longer present.

Another notable change is the creation of Watercourse Protection Zones, which extend further up into the watersheds, beyond RMZs. The 1986 Forest Plan lacks protection for these headwater stream systems, which typically exhibit ephemeral flow. Watercourse Protection Zones are delineated along all stream channels that have defined banks and streambed, show signs of annual scour, have accumulated sediment and gravel of various sizes within the streambed, and are not included in the RMZ.

Changes in the goals and objectives have also been made to focus management of riparian areas on restoring and maintaining their ecological function and emphasizing the ecological processes that riparian areas play in supporting aquatic systems and water quality.

A full listing of the standards and guidelines can be found in the 2005 Forest Plan.

Water Quality

Numerous standard and guidelines have been created to minimize the impacts of activities on water quality. Many of these are designed to minimize disturbance in proximity of the stream. Most expand upon guidance from the 1986 Forest Plan due to knowledge that has been gained since the Plan was written and amended. Guidance is provided for both the RMZ and WPZ. The most notable change between the 2005 Forest Plan and the 1986 Forest Plan are the provision for variable size protection zones.

Geologic Features

Changes are proposed to recognize the importance of geologic features and the important roles that they play within a healthy functioning ecosystem. Steps have been proposed to protect groundwater systems, by limiting the amount of sedimentation that could reach direct conduits that are present around sinkholes and caves. Standards and guidelines have been developed to take into account the connectivity of the surface and groundwater systems in the Ozarks.

These features have been divided into those that are water dependent and those that are not. The water-dependant features have additional measures to protect the connected water systems, while those that are considered non-water dependent are primarily directed at no initial disturbance on site. Water dependent features are springs, seeps, fens, and sinkholes. Cliffs, bluffs and rock outcrops are classified as non-water dependent features. Caves are in a category by themselves.

Standards and guidelines are proposed to minimize disturbance on and around cliffs, bluffs and rock outcrops. The 1986 Forest Plan provides only minimal protection for these unique natural communities.

Water-dependent features have been grouped into those that are larger and more significant, and those that are smaller and more numerous. Protection of larger, more significant features is greater. Previously a buffer of 100 feet was used around any specialized habitats that are now in this group.

Resource Indicators

Acres of riparian areas moved towards the Desired Condition

This indicator highlights differences between alternatives in restoration of riparian areas and associated natural communities. Many riparian areas on the Mark Twain National Forest have been altered from their historic vegetation. A return to natural communities would improve the health and quality of riparian ecosystems of the Forest. Alternatives with more riparian areas in management prescriptions with a restoration focus would have a higher potential to move these areas toward their desired condition.

Management intensity on soils

This indicator highlights differences between alternatives because the amount of potentially ground-disturbing activities, primarily timber and fire, varies by alternative. A higher potential for ground-disturbing activities to occur would increase the possibility of erosion and sedimentation reaching water systems of an area. Increased activities also increase potential of adverse impacts on soil resources of an area through compaction and decreased productivity.

Acres of riparian open to grazing

This indicator highlights differences between alternatives because grazing livestock can have a pronounced effect on the health of riparian ecosystems. Alternatives differ in management direction for grazing in riparian areas.

Acres in riparian or watercourse management

This indicator highlights differences between alternatives because acres with increased protection would minimize potential of negative impacts to the watersheds and water quality.

Table 37 - Key Indicators for Riparian Areas and Water Quality

Resource Indicator	Units	Current Condition	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5 No Action
Total allotment acres of RMZ open to grazing*	Acres	3,315	1,050	1,780	1,780	1,770	0
Management intensity on sensitive soils	Relativity	Low	Low	Medium	Medium	Medium	Medium-high
Acres potentially moved toward the DC for riparian	Acres	0	12,330	31,300	24,900	12,330	0
Riparian or watercourse management**	Acres	65,000	84,500	84,500	84,500	84,500	65,000

**Total RMZ acres in allotments 3,315; 1443 acres would be removed by fencing out 100 feet from streambanks in Alternatives 1 - 4; allotments on non-native grasses in MP 6.1 and 6.2 are also removed. Using total allotment acres best represents impacts to natural resources in riparian areas.*
***There are an additional 22,000 acres in WPZ management. The 65,000 acres showing in Alternative 5, is the total acres that are listed as riparian ELTs, actual management would be done within the buffer strips of these areas, which would be 100 feet and may or may not include the entire area.*

Affected Environment

Riparian Areas

Riparian ecosystems play a critical role in the health of aquatic ecosystems (streams, lakes, and ponds). Along streams they provide shade which maintains cold or cool water temperatures. They provide the primary food source for headwater streams in leaf litter and detritus. They provide storage for floodwaters. Riparian ecosystems act as filter strips along streams to remove non-point source water pollutants. They produce large woody debris that enhances aquatic habitat and, when covered by appropriate vegetation, stabilize stream banks. Riparian ecosystems are also important wildlife habitats and recreational sites.

With the checkerboard ownership pattern of the Mark Twain National Forest the majority of lands that constitute riparian areas within the proclamation boundary are in private ownership. Historical land ownership patterns find National Forest System lands located on the steep valley side slopes, narrow ridge tops, and small headwaters drainages; broader stream bottoms and ridge tops have typically been retained in private ownership. Privately owned riparian areas typically support improved pasture and hay lands and in some cases cropland vegetation. A significant exception to this pattern is found in the Eleven Point River valley, in which as part of the establishment of the Eleven Point Scenic River, a conscious effort was made by the National Forest to acquire ownership of or scenic easements of riparian areas along the Eleven Point River. The Mark Twain NF owns 62,500 acres of riparian lands, approximately four percent of the Forest land base.

Riparian areas on private land are in poor to excellent condition, depending on land management practices and the presence or absence of a woody corridor along the river. Gravel mining is taking place on private land adjacent to, or within some streams. Many areas that are not currently being actively mined have piles of gravel and a broad flat stream; it appears that past mining occurred in these areas. Often, these areas of current and past mining combined with the lack of appropriate vegetation have contributed to the current active erosion of stream banks.

In many cases, the impact of past and current land use has altered the geomorphology of streams. Sinuosity patterns have been altered by channelization. The width and depth of many streams is drastically different from times prior to European settlement (Jacobson and Primm 1994). Historically, many Ozark streams were narrow and deep, compared to the broad shallow reaches that currently exist. Stream bottoms have also changed to a much more gravelly cobble substrate rather than sand. The combination of extensive logging, overgrazing and over burning that occurred in the late 1800's and early 1900's sent large gravel plumes down river. Almost a century later, large gravel plumes continue to move down river as a result of the activities at the turn of the 20th century. Loss of appropriate riparian vegetation has contributed to bank destabilization, which has also sent large amounts of sediment into streams.

Currently there are approximately 3,315 acres of riparian lands that are open as rangeland management allotments. These allotments are primarily supporting livestock grazing and haying activities. The majority of these allotments were converted to pasturelands prior to coming into Mark Twain NF ownership.

Vegetation

Today, riparian areas on the Mark Twain National Forest support a range of vegetation types, including bottomland hardwood forest, mixed broad-leaf shrub/scrub, open grasslands, managed and improved pasture and hay land, eastern red cedar thickets, and plantations of short-leaf pine. Currently, about 24 percent of the riparian areas on National Forest System lands have forest natural community cover, according to CDS data. The remaining riparian areas consist of open lands, and open and closed woodlands. Much of the forested riparian area on the Mark Twain is composed of immature hardwoods with a mixture of sapling (< 4" dbh) to small round wood (4 – 9" dbh). Very few riparian areas on the Forest support stands of mature bottomland hardwood forest or other relatively intact natural communities. Important bottomland hardwood forest and woodland species, such as bur oak (*Quercus macrocarpa*) and pin oak (*Q. palustris*) are virtually non-existent in the few remaining mature riparian forests.

Prior to influences of European settlement, riparian natural communities varied widely depending on the natural disturbance regimes and their relationship to characteristics of the landscape. Generally, riparian areas situated in more level to dissected plains contained greater groups of woodlands, savannas, and prairies, with many stream banks being dominated by woody vegetation. Forest natural communities increase in deeply-dissected hills and breaks. This is because effects of broad-ranging fires were mitigated by influences of steep topography and the greater number of natural fire breaks created by streams and rivers. Schoolcraft offered many descriptions of this varied riparian vegetation as he traveled the Ozarks in the early 1800s (Schoolcraft 1821, Jacobson and Primm 1994).

Historically, less than 10% of riparian areas in Mark Twain ownership were in an open state. The other 90% was covered in forest, and open and closed woodlands natural communities. Currently over 31% of riparian areas are in a barren scrub or open state, with the remaining in forest, and open and closed woodlands. The riparian areas of the Mark Twain NF have been subjected to a dramatic increase in the amount of open lands and a decrease in the open woodland component.

Table 38 - Comparison of Historic and Current Vegetation in Riparian Areas

Land Cover Type	% Vegetation Cover Historic	% Vegetation Cover Current
Barren / Scrub	10	31
Forest	17	24
Open Woodland	35	9
Prairie	0.3	0
Closed Woodland	38	36

The current vegetation cover is based on basal area.

Table 39 - Comparison of Historic and Current Vegetation in Riparian Areas (NFS Lands only)

Unit		Barren / Scrub	Forest	Open Woodland	Prairie	Closed Woodland
Ava / WS / Cassville	Historic (acres)	1,043	1,491	4,099	0	3,394
	Current (acres)	2,964	1,654	1,107	0	3,887
Houston / Rolla / Cedar Creek	Historic (acres)	2,116	603	5,739	242	4,333
	Current (acres)	5,446	2,472	993	0	3,559
Eleven Point	Historic (acres)	34	494	979	0	1,503
	Current (acres)	1,103	391	262	0	1,027
Poplar Bluff	Historic (acres)	1,107	1,864	3,189	0	4,325
	Current (acres)	1,721	3,694	1,008	0	3,626
Salem / Potosi / Fredericktown	Historic (acres)	1,858	6,361	7,710	0	10,059
	Current (acres)	6,495	6,678	2,067	0	9,830

Note: there are about 1500 acres of current vegetation cover that is unknown (the information was not found in CDS database).

Large Woody Debris

The lack of forested riparian zones along many streams, primarily due to conversion of forested areas to pasture lands, has contributed to a lack of suitable in stream-habitat for local fish populations as well as the general health and stability of the stream. Loss of wooded riparian areas has removed the source of woody debris recruitment opportunities into the stream, as well as removing anchoring points along the stream bank. The lack of woody debris in the stream causes a lack of diversity in stream habitats, as pools and eddies can form behind such placements, and provides fewer locations for fish populations to take refuge from currents, or provide ambush positions for predatory species.

Large woody debris is an important component for aquatic organisms in streams and ponds. It serves as a substrate for aquatic invertebrates. In rivers, it provides cover for fish, as well as helping create scour pools and complex habitat. While all large wood is generally beneficial to aquatic ecosystems, tall, large diameter decay-resistant trees, with root wads still attached, tend to provide the best aquatic habitat. Larger, tall trees are also a little more beneficial because they tend to reach further out into the channels and tend to remain more stable over time.

A majority of large woody debris in aquatic ecosystems has historically originated from the riparian ecosystem. Historical land use of logging and then agriculture removed large quantities of wood from riparian areas. Some areas had wood cleared from stream channels to make log drives down the rivers possible. Logging and agricultural clearing of these areas has removed future sources of large woody debris. As a result, aquatic habitat in the Mark Twain NF has been, and will continue to be affected by a lack of large woody debris.

Transportation System

Most of the Mark Twain’s riparian areas contain some elements of the county, State, and Forest transportation network. Many streams and riparian areas within the Forest have local roads and utility lines located adjacent to them. In some cases, State highways, railroad rights-of-way, and pipelines are located within national forest riparian areas. This concentration of transportation facilities in riparian areas usually has affected their ability to support natural hydrologic and riparian vegetation functions.

There are over 1,370 miles of roads and motorized trails within the RMZ in Mark Twain NF ownership. A majority of these roads are light duty gravel roads, many with private uses. Approximately 253 miles of the total are Forest Service System roads; this includes those that are administrative use only. All but 1.5 miles of the Mark Twain NF System roads and trails occurring in riparian zones are unimproved or have gravel surfaces.

Table 40 - Summary of Road and Motorized Trail Miles within RMZ

Description	All roads and trails (miles)	System roads and trails (miles)
Primary highway	26	0
Secondary highway	41	0
Lt. duty, composition unknown	4.7	0
Unimproved	248	172
Trail	8	0
Private	387	0
Lt. duty, dirt	22	0.3
Lt. duty, paved	108	1.5
Lt. duty, gravel	524	79

Many roads in the Ozarks have been in the same locations for over 100 years. Many have historically followed in bottoms where they criss-crossed the stream numerous times. There are 9,195 stream crossings with in the Mark Twain NF boundary; 2,999 within our ownership including roads that are not Forest System roads. This provides the Mark Twain with one of the highest stream crossing density in the United States (USDA Forest Service 2002b).

A majority of stream crossings that occur on smaller gravel roads, which generally have the most impact to riparian and aquatic resources, have low water fords. Several low water crossings are located in relatively unstable reaches. Subsequently, these stream crossings are more likely to wash out. Another problem associated with crossings located in unstable reaches is that, due to channel movement the crossing may no longer be in the in stream travel route. Currently several of these crossings transport high amounts of gravel and sand downstream.

Most culvert crossings on Mark Twain NF lands have been replaced with more stable structures, including various types of bridges. This lowers the risk of the culvert blowing out, and is friendlier to passage by aquatic organisms.

Watersheds

The Mark Twain NF is located within 70 different 5th level watersheds, with actual ownership in 65, nested within 25 4th level sub-basins. National Forest ownership is important because it determines the degree of influence the Mark Twain could have in any particular watershed. The Forest could have the greatest influence on those watersheds with a high percentage of National Forest land.

Mark Twain ownership within the 65 5th level watersheds ranges from 0.2% to 57%. There are 16 watersheds with more than 25% NF ownership and 7 of these have more than 40% NF ownership. The Forest could have a more significant influence on conditions of these watersheds through direct management and collaboration. Eleven watersheds have 15% to 25% National Forest ownership, which could have an important influence on conditions of these watersheds only through collaborations. In the 32 watersheds with less than 10% ownership, the Mark Twain NF would have limited opportunities to affect or influence watershed conditions.

The Mark Twain NF conducted a survey of conditions of the watersheds in 2001. The survey looked at many factors, including but not limited to: ownership, road density, species, land use, etc. The study identified nine priority watersheds and eleven watersheds in poor condition. Watersheds in relatively poor condition on the Forest were generally characterized by high road densities, high population density, and concentrations of hazardous waste sites and water pollution point sources (USDA Forest Service 2001b).

Priorities for watersheds were developed as guidance for specific watersheds in need of protection or restoration. Watersheds were evaluated on their vulnerability and condition parameters during the watershed assessment (USDA Forest Service 2001b). Other factors including partnership opportunities, state wide priorities, prior investments, on-going project plans, land acquisition, local Ranger District priorities and 1986 Forest Plan direction were also used in the decision making process.

Table 41 - Priority Watersheds on the Mark Twain National Forest

Priority Watershed Name	5th Order Hydrologic Unit Code	Condition	Ranger District
Rock Creek	11010001080	Fair	Ava/Cassville/Willow
Cedar Creek	10300102190	Fair	Houston/Rolla/CC
Big Piney River	10290202040	Fair	Houston/Rolla/CC
Meramec River	07140102020	Poor	Salem
Huzzah Creek	07140102030	Poor	Salem/Potosi
Courtois Creek	07140102040	Poor	Salem/Potosi
West Fork of the Black River	11010007020	Fair	Salem
Upper Eleven Point River	11010011030	Good	Eleven Point
Lower Black River	11010007060	Good	Poplar Bluff

In 2003 The Nature Conservancy (TNC) conducted an Ozarks Ecoregional Conservation Assessment. The purpose of this study was to determine the spatial configuration that would most efficiently conserve viable examples of all globally significant biodiversity features in the Ozarks. TNC study recognized all but two Mark Twain NF priority watersheds as significant. Two watersheds not recognized were Rock Creek and Cedar Creek (Cedar Creek is outside of the analysis area for the TNC study.) TNC also recognized 7 other Aquatic Sites in Mark Twain ownership.

Of those seven that were recognized by the Mark Twain as priority watersheds, the Current River, North Fork of the White River, and the Gasconade were given the highest priority of streams needed for conservation of biodiversity. The Eleven Point and Big Piney Rivers also received the highest priority listing by TNC.

High road densities, loss of forested riparian areas, gravel mining, industrial outfalls, limited public ownership and concentrated livestock watering generally characterize watersheds in poor condition on the Mark Twain. Watersheds found to be in poor condition usually have sections that are not functioning properly. The 2001 watershed assessment found only small differences between watersheds in poor and good condition.

Table 42 - Poor Condition Watersheds

Watershed	5th Order Hydrologic Unit Code	Ranger District
Bull Shoals	11010003030	Ava/Cassville/Willow
Roubidoux Creek	10290201060	Houston/Rolla/CC
Middle River	10300102240	Salem
Meramec River	07140102020	Salem / Potosi
Huzzah Creek	07140102030	Salem / Potosi
Courtois Creek	07140102040	Salem / Potosi
Fouche Renault Creek	07140104040	Potosi
Upper St. Fancis River	08020202010	Potosi
Saline Creek	07140105030	Potosi
Cane Creek	11010007070	Poplar Bluff
The “Boot Heel”	08020203020	Poplar Bluff

The watersheds identified as in poor conditions and those found to be of a higher quality through the EWAP (USDA Forest Service 2002b) and TNC evaluations were in line with the Aquatic Gap Analysis conducted by MoRAP (MoRAP 2004). The Aquatic Gap study was funded by joint agencies and provided a course scale view of the health of the watersheds of the state of Missouri. The EWAP conducted on the Mark Twain NF looked at similar threats and conditions in more depth and localized to our ownership, than the Aquatic Gap study.

Streams

Approximately 5,460 miles of perennial and intermittent streams flow through the Mark Twain NF. Stream headwaters are among the most important segments of stream systems, and they are more easily affected by management activities. These small streams provide high levels of water quality and quantity, sediment control, nutrients, and woody debris for the downstream reaches of the watershed. Generally, stream headwaters are in good hydrologic condition on the Mark Twain NF.

Headwater stream systems, those streams classified as ‘0’ and ‘1’ Order, which typically exhibit ephemeral flow, represent the maximum interface between terrestrial and aquatic ecosystems. Headwaters are the place where most sediment enters streams and extensive removal of streamside vegetation may occur. Current research and riparian area management on public lands in many areas of North America have identified protection of headwaters as critical to the proper functioning of hydrologic and ecological systems (Jensen and Sutton 2003). The Mark Twain NF may have hundreds of miles of unmapped ephemeral streams displaying small, but well-defined, permanent channels. It is estimated that headwater streams make up at least 80 percent of the nation’s stream network. In studies done, none in Missouri, almost 75 percent of these are not shown on USGS topographic maps (Jensen and Sutton 2003).

Streams on the Mark Twain NF are free flowing. This free flowing condition has not always been the case, but in southern Missouri after the large scale timber harvesting was complete, many dam structures were removed and the channelization allowed them to revert to a more natural sinuosity. Mark Twain NF management guidelines are designed to protect the free flowing quality of its streams.

“Losing” stream reaches (a karst landscape feature) are common in watersheds within the national forest, particularly those watersheds that contain high concentrations of highly soluble carbonate bedrock. A losing stream is one that distributes 30 percent or more of its flow into groundwater, through natural processes such as through permeable subsoil and/or cavernous bedrock. Losing stream reaches provide conduits for surface water pollution to directly affect the water quality of the groundwater supplies. There are hundreds of miles of losing stream reaches on the Mark Twain NF.

Impoundments

The Forest has around 3,000 impoundments, with the vast majority being small (<0.1 acre) fishless ponds and waterholes. Council Bluff Lake, the largest at 440 acres, is located in the upper reaches of the Big River Watershed. Numerous tailings ponds from lead and barite mining activities in the area are located in the Black, St. Francis, and Big River systems.

Several larger recreational lakes, such as Pinewoods Lake, have an abundance of watershield. The excess watershield can hinder recreational opportunities by being tangled in fishing line and boat motors, but does not have a major effect on water quality or fish populations. Fish populations may be impacted when watershield grows to a nuisance level. Cover for young fish and aquatic invertebrates is reduced when other plants are crowded out by watershield.

Table 43 - Major Impoundments on Mark Twain NF

District	Impoundment	Size (Acres)
Poplar Bluff	Beaver Lake	15
	Pinewoods Lake	32
	Upalika Pond	2
Houston / Rolla / Cedar Creek	Wilkins Spring Pond	2
	Yancy Mill Pond	2
	Roby Lake	5
	Carrington Pits	3
Salem	Loggers Lake	22
	Howes Mill Lake	6
	Howes Mill Pond	4
Potosi / Fredericktown	Palmer Lake	100
	Crane Lake	99
	Parole Lake	40
	Howell Lake	30
	Timberlane Lake	18
	Council Bluff Lake	440
Ava / Willow Springs / Cassville	Noblett Lake	26
	Sterling Hollow Dam	10
	Table Rock Lake	
Eleven Point	Ripley Lake	20
	McCormick Lake	12
	Fisher Pond	5
	Camp Five Pond	3
	Fourche Lake	49

In addition to the larger lakes and ponds on the Forest, there are numerous constructed waterholes and small livestock ponds. The Forest Service created some; others were present when the land was acquired. These waterholes and farm ponds vary in current condition from good to very poor. The major problems are water retention, vegetation on the dams, and water depth. Current maintenance consists primarily of removal of large vegetation from the dam.

Wetlands

Wetlands are areas inundated by surface or ground water with a frequency sufficient to support vegetation or aquatic life that requires saturated or seasonally saturated soil conditions. Wetlands in the Missouri Ozarks are relatively rare and localized, less than 1 percent of the land surface in the National Forest. Fens, backwater sloughs, small marshes, and beaver ponds are common in many Ozark valleys, but they tend to be quite small (less than 1 acre) in size and are typically located in or near riparian areas of major streams.

Sinkhole ponds, containing pond marsh, pond shrub swamp, and swamp natural communities) occur on upland plains and broad ridge tops. Sinkhole ponds are karst features with water tables at the surface.

The Salem Plateau (Central Plateau Subsection) and Current River drainage of the Ozark Highlands are known for fens and ground water seepage natural communities (Nelson 2005). Locally known as bogs, seeps, or swampy ground, occurrence of these generally small wetlands are concentrated in the eastern Ozark watersheds, occupying steep valley side-slopes, bases of bluffs, rock ledges, and glades.

A third common type of wetland found on the Forest is formed where beaver dams have impounded perennial streams, forming open water, emergent vegetation, and shrub and hardwood swamp wetland types. These wetlands tend to be more ephemeral than other types, depending largely on a stable local population of beaver for continued maintenance in the face of periodic severe storm flow events, typical of Ozark Plateau stream systems.

Water Quality and Quantity

Overall, water quality on the Mark Twain NF is good, and meets state standards for full body immersion. A number of Forest watersheds have very good water quality. However, surface waters on the Forest do not meet drinking water standards without treatment, generally because fecal coliform is present. Current Missouri Safe Drinking Water law indicates that for waters to be safe without treatment they must be total coliform negative (10 CSR 60-4 2003).

Seven water bodies within the Mark Twain NF proclamation boundary have been listed on the 2002 Missouri Department of Natural Resources Section 303(d) impaired waters listing, which was released in the autumn of 2004. Six of the seven water bodies listed as impaired have very little adjacent Mark Twain NF ownership. Three are listed for atmospheric deposition of mercury and one is listed for natural pH. For these four impaired waters, there is little management the Mark Twain could do that would further impair these waters, since the pollutants are naturally occurring. Two of the water bodies are listed for excess nutrients; grazing and other management could further degrade these waters. The other site is a short section of Indian Creek on the Potosi unit listed for zinc from a point source location; the Mark Twain NF has no ownership along the impaired reach.

Table 44 – 2003 303d Listing of Impaired Waters within Mark Twain NF Boundaries

District	Water Body	Year Listed	State Priority*	Pollutant
Houston / Rolla	Gasconade River	2002	Medium	Atmospheric Deposition of Mercury
Potosi	Indian Creek	2002	High	Zinc
Salem	West Fork Black River	1998	Low	Nutrients
Fredericktown	Trace Creek	1994	Medium	Natural pH
Eleven Point	Eleven Pt. River	2002	Medium	Atmospheric Deposition of Mercury
Willow Springs	Noblett Lake	2002	Medium	Atmospheric Deposition of Mercury
Cassville	Table Rock Lake	2002	Low	Nutrients

Note: All streams, except Indian Creek, have at least a portion in actual MTNF ownership.
** State priority listing for conducting a Total Maxium Daily Load (TMDL) study on the waterbodies. TMDL initiation will be done by the Department of Natural Resources.*

The U. S. Geological Survey, Water Resources Division (USGS-WRD) is the primary source of recent water quality and flow data on the Mark Twain NF. They maintain over 50 water quality and flow gaging stations in watersheds that encompass portions of the Mark Twain NF. Most of the information is collected through a regular monitoring project, contracted to the USGS-WRD from the Missouri Department of Natural Resources, Division of Environmental Quality, the Corps of Engineers, and the National Park Service.

The composition of most natural waters can be characterized in terms of major dissolved ionic constituents. Water type is determined by relative concentrations of major cation and anions. Water in the streams, springs, and wells of the Ozark Plateau are calcium-magnesium-bicarbonate type (Imes and Davis 1990). This water type is expected because of the dolomitic character of rocks in the basin. The hardness of water in the area is classified as moderate to very hard. Stream and spring waters tend to be similar in cation-anion composition due to interactions of surface and ground water because of the underlying karst environment.

The Mark Twain NF has maintained a water quality monitoring and gaging station at Greer Spring on the Eleven Point River for the past 10 years. A water quality monitoring and gauging station was maintained on Paddy Creek from June 1993 to February 1997; this monitoring site was approved by the Forest as part of the National Water Quality Assessment (NAWQA) Program of the Ozark Plateaus. The USGS maintains several water quality monitoring sites that are in the same watersheds as Mark Twain NF lands. This data provides valuable information on the quality of surface waters in our influence area. Data from these sites are in the USGS Water Resources Data–Missouri annual reports for those years, or on the USGS web page (www.mo.water.usgs.gov).

The Mark Twain NF has one authorized swimming site, the Chapel Hill Beach at Council Bluff Lake. The site is monitored for fecal coliform bacteria. Water samples are taken monthly, and test results obtained from the Missouri Department of Natural Resources (DNR) are on file in the Forest Supervisor's Office. Bacterial results have been within acceptable levels.

The Forest has collected water samples in wilderness areas since 1990. Water sampling for bacteria was done in the Hercules Glades, Paddy Creek, Piney Creek, and Devil's Backbone wilderness areas.

Missouri Stream Teams, a network of volunteers who conduct water quality monitoring, is a cooperative effort among the Missouri Departments of Conservation (MDC) and Natural Resources (MDNR), the Conservation Federation of Missouri (CFM), and citizen volunteers. The goal of the program is to halt degradation of the waters of the State through specific objectives of (a) establishing an extensive water quality monitoring network and (b) creating a proactive constituency who will be stewards and advocates for improved water quality. Stream Teams periodically monitor a number of sites on National Forest System lands and waters, and they contribute to aquatic restoration by performing stream clean-up and habitat restoration projects.

There are over 40 gaging stations in the watersheds that encompass the Mark Twain NF. There are extensive records for some of these sites. Historic and real-time flow information can be viewed on the World Wide Web at www.mo.water.usgs.gov. The web site also provides historic information on the annual mean flows for the locations as well as peak flows. Missouri streams are subject to flooding on a regular basis. Typically, the 1 and 5 year floods inundate the local floodplain and cause little damage. The 50 and 100 year events can cause damage to the surrounding infrastructure of roads and homes. The last major widespread flooding in the state was in 1993. Overall water levels were down from 1999 to 2003 due to drought-like conditions. During 2002, there was localized flooding that negatively impacted National Forest campgrounds along the Current and Huzzah Rivers.

Groundwater

Groundwater is socially and ecologically important. All drinking water at Forest-developed recreation sites is from groundwater, and most communities get their public water supplies from groundwater. Groundwater also has a significant effect on the ecology and flow of streams and wetlands, and contributes to many cave environments.

Most public water systems in the proclamation boundaries of the Forest receive their water supplies from groundwater. Virtually all rural populations receive their water supplies from groundwater as well. In most areas, groundwater supplies are abundant and have good quality. In many locations, multiple aquifers exist that can supply water demands.

Aquifers

Most of the Mark Twain NF is underlain by the Ozark Aquifer. A small portion along the eastern edge of the Forest has the St. Francois aquifer as its primary source, although in most cases it lays deep under the Ozark Aquifer. A small portion of the west side of the Forest has the Springfield Plateau aquifer as the primary aquifer.

The Springfield Plateau aquifer is mostly unconfined and tends to consist of limestone and cherty limestone. The rocks of this aquifer tend to be faulted and fractured (USDA Forest Service 1999c).

The Ozark aquifer consists of thick dolomites, sandstones, limestone and shale outcrops. The aquifer averages between 1,500 and 2,000 feet thickness throughout much of the Ozark Plateau. Water levels tend to mirror the surface topology (Imes 1990d).

Recharge to the Ozark aquifer is primarily by precipitation and by ground water inflow to the area. The U. S. Geological Survey conducted a well inventory in known mining areas in the Viburnum Trend, collecting water-level data from 59 domestic and public water supply wells in the Ozark aquifer. They used this information, along with data from 21 observation wells, to construct a water level map of the area (Kleeschulte 2001). During the summer and fall of 1999 water levels of the Ozark aquifer ranged from about 850 feet in the northwestern and southeastern portions to a high of about 1,200 feet near the center sloping downward in all directions. Areas with high potentiometric surface altitudes typically indicate ground-water recharge areas and serve as ground –water divides. Movement of water within an aquifer, assuming the rock is uniform in all directions, is perpendicular to the potentiometric contours.

The St. Francis aquifer is comprised of sandstones and dolomites. In some locations these rock layers outcrop in the St. Francois Mountains. This aquifer is rarely used as a primary water source where it is overlain by the Ozark aquifer.

Groundwater in the National Forest is complex and is largely a function of the local geology. There is some disagreement about how well the Derby-Doe Run dolomites and the Davis Formation restrict water movement. Some geologists believe these formations act effectively as confining units, or aquitards, while others believe these formations are fairly permeable and allow water to easily move through them. Several physical factors can affect the confining capabilities of a confining unit, including “the degree of cementation of the rock and secondary permeability features such as solution channels, fractures and faults that develop in the rock” (Kleeschulte 2001). Another study indicated that the vertical hydraulic conductivity of the St. Francois confining unit varied based on the shale content (Kleeschulte and Seeger 2003). This report also indicated that most impacts, such as dewatering of the Ozark aquifer, would likely occur along “preferred-path secondary permeability” such as faults and fractures or results from mining exploration activities.

The quantity of water moving across these confining units under the Forest is unknown. Interchange of water between two aquifers would not be desirable if one of the aquifers has poor quality water that would degrade water quality in the other aquifer. The public water supply wells in areas adjoining the Forest are open to both aquifers and meet State drinking water standards. Water quality in both aquifers is considered good, according to Missouri Department of Natural Resources standards. Since both of these aquifers extend under the Forest, the water quality beneath National Forest lands would also be considered good.

Precipitation is the major source of water for aquifers. Generally, drinking water from private wells is obtained from the Gasconade Dolomite (Ozark Aquifer). Most public water supplies go much deeper than private wells, and they obtain water mostly from the Potosi Dolomite, a different member of the Ozark Aquifer.

Total dissolved solids, or the quantity of minerals dissolved from rock, generally remain below the Missouri Safe Drinking Water law recommended limit of 500 milligrams per liter in the Ozark Aquifer. Most of the aquifer contains very low concentrations of sulfate, from 1 to 50 milligrams per liter. Other inorganic elements that may contaminate groundwater include trace elements such as copper, lead, iron, zinc, arsenic, cobalt, cadmium, nickel, selenium, and barium. Losing streams (streams that lose 30 percent or more of their flow to the subsurface) can channel water with high trace element concentrations directly into the groundwater.

As noted above, the Ozark Aquifer is characterized by water that is a calcium-magnesium-bicarbonate type. Varied concentrations of calcium or magnesium cations determine the dominant element, and there is usually a transition zone between areas of differing types. Water analysis of well samples shows that even though water from wells is predominantly the calcium-magnesium-bicarbonate type, there is a small difference in the water quality when compared to stream and spring samples. Several well-water samples show greater percentages of sulfate, chloride, and nitrate than stream and spring samples.

Nitrogen and phosphorus in ground-water can also be related to land use practices as well as water-rock interactions. Data collected between 1972 and 1990 show that less than 15 percent of samples from wells in the Salem Plateau province had phosphorous at concentrations above detection levels (Davis et al. 1995). Springs and shallow wells had higher concentrations than deep wells.

Karst Hydrology

Most of the Mark Twain NF lies within a large region of well-developed karst terrain that is characterized by the presence of caves, springs, sinkholes, and gaining and losing streams. Karst describes a type of topography that forms in carbonate rock terrain as the rock matrix is dissolved by precipitation and ground water.

A karst aquifer receives water by percolation though soil and by concentrated flow directly into the aquifer through sinkholes and losing streams. Rapid exchange between ground and surface water is typical. During the formation of karst terrain, water percolating underground enlarges subsurface openings by dissolving rock walls. Over time, some of these enlarged openings cause movement of water in the aquifer to change from diffuse flow through small, scattered openings in the rock to discrete flow that is concentrated in a few well-developed conduits. As openings continue to enlarge, ground water levels in former discharge areas can decline below the level of surface streams. Formerly flowing surface streams then may begin to lose water to the subsurface (losing stream) because of the increased streambed and aquifer permeability and become underground streams. Flow velocities of water in these underground streams commonly range from 0.1 to 5 miles per day (USDI Geological Survey 1985). Springs develop where larger subsurface conduits converge and intercept the water table at the land surface. If contaminants enter these subsurface conduits they can be transported quickly through the ground water system, with much less dilution or natural degradation occurring than in an aquifer where the ground water flow is through intergranular voids.

Sinkholes develop as a result of the collapse of surface or near-surface material into underlying cavities. Two types of sinkhole-forming collapses are carbonate rock and overburden collapses. Carbonate rock collapse occur when the enlargement of cave passages in carbonate rock causes the roof above the passage to weaken and eventually collapse. Overburden collapses are more common then carbonate-rock collapses (USDI Geological Survey 1985) and generally start as soils and residuum is washed into and through underlying solution channels. The remaining overburden bridges the opening as more material is removed, until the resulting overburden arch loses support and collapses. Aley (1975) reports most sinkholes in the Ozark springs study area are developed within the soil and residuum horizons, and bedrock outcrops seldom occur in these sinkholes. Aley (1975) also reports sinkholes are larger and more abundant in the Uplands and Rolling Hills zone than they are in the Dissected Lands Zone.

Springs

A spring is defined as any natural discharge of ground water from rock or soil onto the surface of the land or into a body of surface water. Many conditions work together to produce springs, such as geologic, hydrologic, topographic, hydraulic, and climatic conditions (Vineyard and Feder 1982). Since springs are primarily controlled by ground water, their flow rates tend to be relatively constant.

There are over 770 known springs within the Mark Twain NF boundaries. The Forest has actual ownership of 468. The following table shows spring concentrations by districts. It should be noted that the Cedar Creek unit has no known springs within its boundaries.

Table 45 – Number of Springs on Mark Twain NF by Ranger District

Unit	Within Forest Boundary	On NFS Lands
Ava / Cassville/Willow Springs	319	218
Houston / Rolla / Cedar Creek	60	34
Eleven Point	211	152
Poplar Bluff	6	3
Salem / Potosi / Fredericktown	182	61

The concentration of springs in the Salem Plateau physiographic province, which encompasses part of the Ozark Highlands, is one of the greatest in the United States (Vineyard and Feder 1982). The presence of massive sequences of highly fractured carbonate rocks beneath highly permeable soils allows large amounts of precipitation to be stored in the aquifer. Recharge and discharge of water in this type of geologic setting can be quite rapid, thus explaining the presence of thousands of springs. Unfortunately, the same geology that facilitates spring formation also provides direct conduits to the groundwater for contaminants present in the recharge water. Shallow groundwater can easily become polluted as a result of contamination introduced through karst features. It is therefore important to consider poor quality spring water as a possible indication of future contamination in deeper aquifers.

Because of the rapid recharge characteristics of springs, they tend to have highly variable water quality. Periodic sampling might show general trends in water quality; however, short-term contamination might be missed in routine sampling due to the rapid cycling of groundwater. Nearly all springs in this province also show evidence of nitrates; generally in concentrations less than 10 mg/l. Iron is present in most spring water in low concentrations. Water type is calcium-magnesium carbonate due to the predominantly dolomite formations in which the water resides and travels. Due to shorter residence time in the substrata, springs will typically contain between 25 and 50 percent less total dissolved solids than wells in the same area.

Spring water in the Ozarks is generally of good quality. Spring water in the region tends to be much more variable than water from deeper wells, due to the rates and ability of water to penetrate. The relative ease, by which contaminants can enter spring systems, makes them vulnerable to pollution. The primary pollutant that occurs in most springs is higher than expected fecal coliform counts (Vineyard and Feder 1982). It is difficult to determine the source of fecal coliform due to the large recharge areas influencing springs. Recharge areas for Ozarks springs can vary greatly. Most groundwater recharge basins are much larger than the surface water basins.

Springs are excellent sites for monitoring water quality in karst areas. Springs typically are the lowest point in the groundwater basin, with surface expression. This point is a location to which groundwater flows converge. While water from wells only represents quality of the groundwater near the well, water quality of a spring is representative of the entire recharge area of that spring. This recharge area can contain groundwater flow coming from several square miles to hundreds of square miles. Eventually any negative impacts that occur in a recharge area will be expressed in the springs.

Springs on the Mark Twain NF are non-thermal and tend to maintain year around temperatures below 60° F. These springs provide the basis for cold water trout streams that are found in southern Missouri. These cold water temperatures tend to produce unique of flora and fauna only found associated with cold-water spring systems. Most flora and fauna associated with these spring systems tend to have a narrow tolerance range of temperature, and thus are usually not found when water flows away from the vicinity immediately around the boil. As spring water travels away from the boil, it comes under greater influence from air temperature and will eventually assume a temperature that is not very different than that of nearby warm-water streams (Vineyard and Feder 1982).

Average water yields from these springs range from a few gallons of water per day to over 220 million gallons per day (USGS). Flows from Greer Springs, the second largest spring in Missouri have consistently had flow data recorded since 1921 (Vineyard and Feder 1982).

Water Use

Surface and ground waters flowing through the Mark Twain NF are used for consumptive uses such as agriculture, municipal, and private uses, as well as non-consumptive uses such as aquatic and riparian habitat, wetlands, fisheries, and recreation. Recreational uses may include drinking water for campgrounds, picnic areas, and special use areas; aesthetics (the visual quality of stream and lake waters and the amount of water present); fishing, swimming and boating.

No municipal water supplies utilize surface waters that flow through the Mark Twain NF. Most public and private water uses capitalize on the abundant high quality ground water found in the Ozarks. A majority of watersheds that encompass at least a portion of the Mark Twain NF have municipal water supplies that use groundwater that has passed through the Forest at some point. The Ozark and St. Francis aquifers, which underlie the Mark Twain NF, are both confined aquifers. Management activities on Forest System lands should not affect the water quality of any public water supply.

The Forest has sufficient water resources for all anticipated uses. Missouri does not have supply and demand issue where water needs are concerned. Missouri is a riparian water rights state, which means that although "water rights coincide with property ownership ... the water itself is not owned” (Gaffney and Hayes 2000). As a result, detailed records and scientific information on water uses have not been kept (DuCharme and Miller 1996). Data is recorded by DNR on major water users in Missouri. The USGS periodically gathers National Water Use Information by state; however the last comprehensive study done for Missouri occurred before the 1986 Forest Plan was developed.

Precipitation

Extreme precipitation events can lead to floods that can have a significant effect upon the area's natural resources. Floods can increase nutrient, trace metal, and organic chemical concentrations in streams and deposit gravel in streambeds. Floods can deposit large amounts of sediment on crop and pastureland. Property damage caused by flooding can create severe economic stress in the area.

The late summer months (August – September) show a weather pattern lacking precipitation. When this occurs, drought conditions result. From 1999 through 2003 there were extended drought periods that lasted many consecutive months. Extended periods of drought have a profound effect on the natural resources of an area. Moisture stress over an extended period can contribute to mortality in mature forest stands. Drought can contribute to crop and pasture failures or deterioration. Low flows in streams affect aquatic habitat, fish populations, and recreational opportunities. Extended drought also affects the aquifer water tables.

Environmental Consequences

A healthy watershed operates in dynamic equilibrium. This balance can be affected by Forest management activities. Activities that disturb the soil surface as well as those that impede stream flow have the greatest potential to affect aquatic and riparian resources. The risk of adverse impacts increases as the distance between a ground-disturbing activity and a stream or wetland decreases.

Surface water, groundwater, floodplains, and riparian areas are all closely related. Because effects on these resources are similar, they are discussed together unless specifically noted and described.

How forests are managed has a profound effect on the water quality of lakes, streams, wetlands, and groundwater and on the ability of watersheds to perform their most basic functions. Sound watershed management, protection, and restoration are key to maintaining and achieving healthy aquatic, riparian, and wetland ecosystem function and condition. Sound watershed management involves considering the types and locations of aquatic, riparian, and wetland ecosystems within the watershed during planning, design, and implementation phases of Forest management activities. The entire landscape that feeds a particular watercourse or courses must be considered when planning and implementing management activities.

Effects Common to all Alternatives

Aquatic, riparian, and wetland ecosystems are affected by the activities that occur within their watersheds. These activities can cause indirect effects when they occur on the terrestrial uplands within the watershed, or direct effects when they occur in close proximity to lakes, streams, or wetlands.

Water yields from timber harvests and fires, particularly wildland fire, can be significant on a small scale such as in a sixth-level watershed, resulting in channel degradation if significant. On a larger scale, such as from the Forest as a whole, these yields are a very small fraction of the Forest's overall water yield and are not measurably detectable on a year-to-year basis.

Watershed conservation practices and Forest Plan standards and guidelines prescribe extensive measures to protect soil, riparian, and aquatic resources. Generally, adverse impacts to these resources can be minimized when all applicable measures are applied and are effective. However, there is a point of diminishing returns where the protective measures fail to be fully effective. Hence, alternatives that propose greater levels of management activity may increase the risk of adverse impacts to aquatic and riparian resources.

Due to the recognized importance of protecting and restoring riparian ecosystems and watershed health, the standards and guidelines are the same in Alternatives 1 through 4. Alternatives 1 through 4 standards and guidelines clarify, define, and expand on protection of riparian areas, geologic features, and water quality found in Alternative 5.

Direct and Indirect Effects

Effects on Riparian Resources from Transportation System

The transportation system includes both roads and motorized trails. Motorized trails are those specifically designed for off-road vehicle (ORV) or all-terrain vehicle (ATV) use. Under all alternatives, motorized vehicles are restricted to roads or designated trails. The only designated trails on the Forest are at Sutton Bluff and Chadwick Use Area. The effects to riparian resources from vehicular traffic, ORVs and ATVs on roads and designated trails would be similar.

Roads and motorized trails can affect hydrology, water quality, stream channel morphology, fish movement, and wetlands. While road and trail-derived pollutants such as oil and gas can affect fish and other aquatic life, sediment is the primary pollutant associated with Forest roads and trails.

Road and trail systems modify surface and subsurface hydrology of the area by intercepting ground and surface water and routing it more quickly to stream channels through the ditch system. Many roads in the Mark Twain NF, particularly non-federal public and private roads have been in place for a long time, in some cases, over 100 years. Except for state highways, most of these roads are gravel, coarse rock or dirt surfaced (native surface) and have been graded and re-graded for decades, with little or no intent of maintaining the road crown, ditches or cross-drainage.

As a result of lack of maintenance several roads on the Forest are entrenched, sometimes to depths of several feet. Entrenched roads are usually located on ridge-tops, hill slopes and valley bottom positions throughout the Mark Twain NF. Valley bottoms, which often contain coarse alluvium, serve as recharge areas for surface and ground water systems. Ridge-top and mid-slope roads can reduce or alter overland flow processes by intercepting the water into the ditch system and routing it quickly to surface waters, or by compacting areas, which previously had been permeable. In addition, a number of existing unclassified roads and trails that intercept and channel surface water flows, are not mapped or maintained.

Hydrology and Hydrologic Connections

Roads and trails have three primary effects on hydrologic processes. They intercept rainfall directly on the road or trail surface, road cut banks, and subsurface water moving down hill slopes. Roads and trails concentrate flow, either on the surface or in an adjacent ditch or channel; and roads and trails divert or reroute water from flow paths that it would otherwise take if the road or trail were not present.

The presence of roads and trails can increase the drainage pattern density of a watershed. During rainfall events roads tend to channel water. Channeling overland water flow decreases infiltration and can increase flow velocities, which can increase sedimentation and erosion.

Roads and trails intercept, concentrate, and divert flows from natural flow paths. These changes can result in increased peak flows if surface and subsurface flows are intercepted and routed directly to streams. Where roads and trails intercept and store water, or route water away from streams and fens, they can have the opposite effect. The effect of roads on peak streamflow depends on the scale of the watershed. For example, capture and re-routing water from one small stream to another can cause major channel adjustments in the stream receiving the additional water. In large watersheds, roads and trails constitute a small proportion of the land surface and have relatively inconsequential effects on peak flow.

Road and trail segments are hydrologically connected to streams wherever runoff from their surfaces and ditches flow directly into streams. This direct connection can increase peak flow rates and deliver pollutants to streams. Within the Mark Twain NF, hydrologic connections occur primarily at stream crossings and typically extend up to the first slope break.

Impacts on the hydrology and connectivity of watersheds should remain fairly constant with respect to the permanent transportation system. There will be some variation among alternatives based on the miles of temporary roads and skid trails that are being proposed and the amount and quality of maintenance occurring. Several standards and guidelines would limit the impact of new construction on riparian areas. Closure and rehabilitation of any roads would improve the hydrologic regime of the area, regardless of location. Roads closed outside of the RMZ and WPZ would reduce the stream density of the watershed. Those closed within these areas would reduce the impacts on local vegetation as well as sedimentation and erosion potentials.

Precise impacts of the transportation system on the hydrologic connectivity of the system will vary based on the type of activity occurring and conditions of the specific location on the landscape. It is unrealistic to try to describe the exact impacts of the transportation system because there are numerous factors that can influence how it would affect the hydrologic regime. It is not practical to discuss specific impacts in a programmatic document designed to cover approximately 1.5 million acres. Site-specific analysis of localized impacts will occur at the project level.

Erosion and Sedimentation

Roads and trails affect water quality primarily through erosion and sedimentation. Surface erosion and sedimentation typically occurs when rainfall detaches soil particles (erosion) and runoff carries these particles into streams (sedimentation). Sediment is recognized as one of the most important pollutants in the United States in terms of total quantity, miles of stream affected, and adverse effects on aquatic communities (Waters 1995). Fine sediment, like sand, silt, and clay, is a particular water quality problem in streams because it reduces available habitat by filling pools, reduces survival of fish eggs and fry and reduces survival, composition, and abundance of aquatic invertebrates.

Sediment can originate from “hydrologically-connected” roads and trails with native surface material, inadequate gravel surface, poorly vegetated slopes or ditches, inadequate ditch armor and inadequate drainage. Potential for erosion and sedimentation increases as road slope increases. This occurs because water moves at higher velocities as slopes increase and water volume accumulates as slope length increases. Thus, both slope steepness and length contribute to gully erosion. Roads and trails that are paved or have a solid surface, and are maintained with a crowned surface, have good cross-drainage and low hydrologic connection could be minimal sources of sediment.

By their nature, roads are a major cause of erosion. Unpaved, they are vulnerable to rainfall and runoff eroding their surface. Paved or unpaved, they serve to accelerate runoff which, when concentrated, can cause erosion on unprotected down slope surfaces. In addition, without any means of detention such as vegetation or downed material, runoff from roads can efficiently convey sediments into a stream system. To prevent a direct deposit of sediment into a stream system, it must be diverted either onto a stable and well-vegetated slope or into a sediment basin.

Once sediment enters a drainage network, whether it is a created channel or perennial stream, it will be transported through the system as streamflow rates allow. Deposition of sediment occurs where or when flow rates are not sufficient for their transport in suspension. This process could cause adverse economic and ecological consequences if the amount of sediment exceeds the transport capacity of a stream system. These impacts cannot be estimated at the programmatic level such as a Forest Plan. They would be addressed in project-level analyses.

Sedimentation can inhibit flow through diversion structures, reduce reservoir capacity, and increase costs of water treatment. It also can adversely affect aquatic habitat by burying important gravels needed for spawning, filling interstitial spaces in a streambed inhabited by macro-invertebrates, reducing pool depths, and changing the balance of scouring and deposition within a stream system.

Ideally, roads and trails should be located as far away from streams as possible to avoid direct deposits of sediment into the drainage channel. Stream channels, riparian areas, wetlands, and other sensitive watershed resources should be avoided as much as possible. Stream crossings, when unavoidable, should be hardened as well as approaches leading to the crossings.

Runoff from roads is affected by many of the same factors that determine sedimentation into a stream system. Road runoff is a concern due to the efficiency with which it can reach a stream. In an unroaded area, runoff rain typically infiltrates into the soil of a vegetated slope before it can reach a stream channel. This process is interrupted when a road traverses a slope and collects the runoff. If no effective mitigations are applied to disperse the runoff collected on a road, it will flow directly into nearby channels, increasing the rate of streamflow. In turn, the available energy of a stream increases, resulting in accelerated erosion of banks and the streambed. Generally, the higher density of roads within a watershed, the quicker runoff is received by the stream network and the greater the risk of channel erosion.

It is not practical or feasible to try to predict the sedimentation and erosional volumes that could occur at a programmatic level. Due to the high variability of site conditions and soil types, these estimates should only occur at the project level. The transportation system of the Mark Twain NF is stable and new construction would be similar in Alternatives 2 through 5. Alternative 1 would see a decrease in quantity and condition of many of the smaller road systems. Maintenance would occur in all alternatives, however very little reconstruction would occur in Alternative 1. Also, many roads would not be maintained in Alternative 1, and would eventually revert to a vegetated state, thereby reducing effects that roads and trails can have. In general, based on the probable management activities for each alternative, Alternative 1 would have the smallest potential to increase sedimentation and erosion because it has the smallest amount of temporary road and skid trail construction, and reconstruction of permanent roads. Alternative 5 would have the most potential to create erosion and sedimentation through temporary road construction.

Water Temperature

Roads and trails paralleling streams that have permanently removed a substantial portion of riparian vegetation providing stream surface shade can increase the temperature of cold and cool water streams. This is a very common occurrence on private lands within the proclamation boundary. Effects of the transportation system on water temperature of streams across the Forest should be minimal and consistent for all alternatives.

Stream Channel Morphology

Geomorphic effects of roads on streams range from chronic and long-term contributions of fine sediment into streams to the catastrophic failures of road cuts and fills during large storms. Roads may alter channel morphology directly or may modify channel flow paths and extend the drainage network into previously unchannelized portions of hillslopes. The magnitude of road-related geomorphic effects varies by climate, geology, road age, construction practices, and storm history. Improvements in designing, constructing, and maintaining roads can reduce road-related erosion at the scale of individual road segments; but few studies have evaluated long-term and watershed-scale changes to sediment yields as roads are abandoned or obliterated.

Road and trail crossings can affect the shape or morphology of stream channels, both above and below crossings. These effects tend to occur where crossings or culverts are set too high or constrict the channel too much. In locations where wash outs occur regularly or where there is heavy sedimentation from the road surface, slopes and ditches these effects can be more pronounced.

Crossings that are set high and tend to constrict flow can cause sediment to deposit in the upstream channel. The stream gradient will dictate if this only occurs for a few feet upstream or hundreds of feet upstream. In lower gradient systems, deposits tend to be sand and silt. In higher gradient streams, deposits consist of more gravel and cobbles.

Undersized crossings, in particular culverts, that frequently wash out can cause the downstream channel to fill with sediment. In low gradient streams this can back water upstream, thereby causing similar problems if the culvert was set to high.

Heavy sediment loads from washouts or erosion of road surfaces can also affect the downstream channel by causing it to become wider and shallower. Wide, shallow channels tend to be poor habitat conditions for fish and aquatic invertebrates.

Actual impacts on stream morphology through alteration by the transportation system will vary based on proximity, actual site conditions and specific activities occurring. With the large number of stream crossings and hundreds of miles of roads that occur in riparian areas on the Mark Twain NF, the transportation system will continue to affect stream morphology in the Ozarks.

The transportation system of the Mark Twain NF is fairly stable and new construction should be similar in Alternatives 2 through 5. Similar maintenance would continue in Alternatives 2 through 5. Alternative 1 would create less maintenance and road construction. Some roads would naturally close themselves though natural regression processes, which would stabilize the stream morphology long-term in Alternative 1.

Fish Passage

Roads and trails can act as barriers to upstream movement of aquatic organisms, particularly at stream crossings. Fish are most commonly affected, but roads and trails can affect movement of a variety of species including salamanders, turtles, and mussels.

The existing road system presents a variety of potential obstacles to aquatic migration and movement. The following drainage structures are listed in order from the least to most negative impact on aquatic species:

- Bridges may provide a natural passageway for migration and movement of aquatic organisms where stream bank modifications do not increase water flow or soil erosion. Generally, a straightened channel under a bridge increases stream gradient and velocity and reduces diversity of stream current patterns. This will in turn cause erosion upstream and sediment deposition downstream. 2005 Forest Plan standards and guidelines include minimizing alteration to original stream channels and proper seeding or planting of vegetation to insure stream bank stability and decrease erosion and sedimentation. In addition, planting aquatic vegetation will promote biological productivity and diversify food webs (Waters 1995).

- Ford crossings where the streambed serves as the road provide a natural passageway for migration and movement of aquatic organisms. However, high use of ford crossings can increase turbidity in sufficient amounts to negatively impact aquatic life, especially near the crossing. 2005 Forest Plan standards and guidelines include enforcement of motorized traffic to cross streams at designated perpendicular crossings and to prohibit motorized traffic in the stream outside of the designated crossing.
- Multiple channel box concrete culverts are preferred over single channel box concrete culverts. A single channel culvert provides little or no habitat for aquatic organisms. Using a multiple channel box culvert where one box is lower than the other boxes to provide a narrow single channel during periods of low stream flow, helps prevent sediment buildup (Waters 1995).
- Culverts may pose a barrier to upstream movement and dispersal of invertebrates and small-stream fishes by 1) breaking the continuity of water flow in a stream, and 2) increasing the stream's velocity to a higher than natural rate if the culvert's bottom has no gravel, rocks, or cobbles.
- A solid concrete slab with no culverts may act as a stream dam if there is a vertical drop off, serving as barrier for aquatic passage.
- Road ditches intercept, collect, and re-route water and sediments, which may end up in streams. Sedimentation alters the natural relationship between biota and the stream substrate by changing the condition of the substrate. Increased sedimentation can adversely affect the biota by reducing or covering their food supply and interfering with feeding and respiration (Waters 1995). All types of aquatic species may be adversely affected by sedimentation. As sediment levels increase, macro invertebrate taxa changes. The two most important effects of deposited sediment upon the physical habitat of fish are filling space between rocks, which is essential to fry as winter cover, and reduction of water depth in pools, which decreases physical carrying capacity during summer (Waters 1995).

Specific impacts of the transportation system on fish passage would not vary between alternatives. New crossings would be designed and constructed to accommodate fish passage. Replacement of existing structures would be made after a site-specific decision and analysis. Due to the extremely high number of stream crossings that already occur on the Mark Twain NF, relocating roads out of riparian areas and reducing the number of crossing would improve the quality of fish passage. Location and construction of even temporary road and skid trail crossings can affect fish passage; however, site-specific analysis would need to be conducted to more accurately predict impacts. Alternative 1 would have the least amount of temporary roads and skid trails; Alternative 5 has the highest. Alternatives 2 through 4 have the same amount of proposed miles of temporary road construction.

Wetlands

Road and trail systems can affect wetlands in two primary ways: 1) direct loss through filling or heavy sedimentation and 2) alteration wetland types through changes in water levels and flow rates.

Roads and trails typically influence the hydrology in the wetlands they cross. The disruption of natural wetland water flow by road crossings is usually attributed to either equipment rutting of the wetland surface or compression of the upper layers of wetland soil. If flow disruption is serious enough, it can cause flooding on the upslope side of the road crossing, and drying on the downslope side. Although some disruption of natural water flow patterns across wetlands can be expected in all wetland road crossings, serious disruptions are generally avoidable through use of design and mitigation practices such as providing adequate cross drainage (using culverts or other means), or by limiting road use to frozen conditions.

Large areas of wetlands are not a common feature of the karst terrain, which is prominent on the Forest. Valley bottom roads cross wetlands in a few locations, typically at or near stream crossings. This is where the most direct impact of the road system occurs on wetlands. Very small and localized areas of wetlands occur as side-hill seeps in the vicinity of springs throughout the valleys of the Mark Twain NF. Most of these wetlands are relatively small (less than one acre) in size and are not mapped. Side-slope roads often intercept these seeps and re-route their flows into roadside ditches or under the road via culvert or small bridge.

The transportation system of the Mark Twain NF is fairly stable and new construction would be similar in Alternatives 2 through 5. While none of the alternatives propose to greatly increase the transportation system, Alternative 1 would see a decrease in the quantity and condition of many smaller road systems. Maintenance would occur in all alternatives, however very little reconstruction and general upkeep would occur in Alternative 1. In addition, because many roads would not be maintained in Alternative 1, they would eventually revert to a vegetated state, thereby reducing effects that roads would have on the hydrology of wetland communities. Alternative 1 would have the smallest potential to increase sedimentation and erosion due to the fact that it has the smallest amount of temporary road and skid trail construction and reconstruction of permanent roads. Alternative 5 would have the most potential to create erosion and sedimentation and disruption of the hydrologic regime through temporary road construction. Road closures and rehabilitation may occur in any alternatives; however, the impacts on wetlands are impossible to discuss at this time road locations are unknown. Project level analysis would address site-specific impacts of the transportation system on wetlands.

Riparian

The transportation system crossing the Mark Twain NF has over 1,370 miles of roads that occur in riparian areas. The presence of these roads can disrupt the connectivity of the riparian corridor, as well as many other impacts that have been discussed.

Changes in the hydrologic regime by the transportation system, as described previously, can have a large impact on riparian vegetation. A change in the water flow patterns can affect volume and timing that water is available to the vegetation. Most truly riparian species have specific water need requirements. Large amounts of sediment deposition in floodplains of these areas can cover and choke out fragile ground cover.

The transportation system of the Mark Twain NF is fairly stable and new construction should be similar in Alternatives 2 through 5. While none of the alternatives proposes to greatly increase the transportation system, Alternative 1 would see a decrease in the quantity and condition of many smaller road systems. Maintenance would occur in all alternatives, however very little reconstruction and general upkeep would occur in Alternative 1. In addition, many roads and motorized trails would not be maintained in Alternative 1, eventually reverting to a vegetated state, thereby reducing effects that roads would have on the riparian natural community. Alternative 1 would have the smallest potential to increase sedimentation and erosion because it has the smallest amount of temporary road and skid trail construction and reconstruction of permanent roads. Alternative 5 would have the most potential to create erosion and sedimentation, and disruption of the hydrologic regime through temporary road construction. Road closures and rehabilitation may occur in any alternative; however, impacts on riparian areas are impossible to discuss at this time because roads locations are unknown. Project level analysis would address site-specific impacts of the transportation system on riparian areas. The magnitude of the effects would vary by intensity as well as specific location and type of activity occurring.

Semi-Primitive Non-Motorized vs. Semi-Primitive Motorized

Amounts of area with semi-primitive non-motorized and semi-primitive motorized recreation emphasis will vary greatly from alternative to alternative. The variation between these alternatives can affect the amount of traffic, the miles of roads needed as well as the amount that would be potentially closed. Actual impacts would vary based on specific road or trail location in proximity to riparian areas and streams, as well as the actual site conditions (slope, aspect, soil type, etc.) and weather conditions when activities take place.

All five alternatives would keep the percent of semi-primitive non-motorized fairly constant, between 5 - 8%; however land allocations in semi-primitive motorized do vary. Alternative 1 has the highest allocation with 79% of acres in semi-primitive motorized; Alternatives 2 through 5 remain fairly constant, ranging from 17 to 23%. Alternative 1 in general would be less impacting than Alternatives 2 through 5. The decrease in management use of roads, combined with reduced maintenance and reconstruction should decrease overall impacts to the Forest. In general, it is impossible to accurately describe impacts at the programmatic level, because these would vary by site-specific conditions and the anticipated amount of use at a given location.

Non-native Invasive Species (NNIS)

Road and trail systems often contribute to the introduction of non-native invasive species (NNIS) aquatic or terrestrial plant species by providing access to lakes and streams and riparian areas. Boats and trailers are a major source of introduction of non-native species into lakes and rivers. Road-stream crossings provide angler access and may increase the likelihood of introduction of NNIS fish, mussel, and crayfish species. Current high numbers of stream crossings increase the potential of aquatic species introduction. With increased access potential from the road system throughout riparian areas, introduction of plant species could easily occur.

The likelihood of introduction of non-native aquatic species would not vary by alternative.

Alternatives and Overall Effects of Roads and Motorized Trails

All alternatives include continued use of existing road and motorized trail systems. These systems currently affect riparian and aquatic ecosystems through erosion, sedimentation, changes to channel morphology and by preventing upstream fish movement. This existing infrastructure and its continued use is the primary source of effects on riparian and aquatic resources. However, all alternatives include objectives, and standards and guidelines to reduce impacts over time and to avoid impacts from new roads and trails. These include objectives to relocate or reconstruct existing road and trail segments adversely affecting riparian and aquatic ecosystems and standards and guidelines to prevent adverse impacts from new road or motorized trail construction. Therefore, adverse effects of the existing road and trail systems would decline over time under all alternatives. Work to reduce road and trail effects is already underway and continues.

The proposed alternatives differ with regard to the amount of non-motorized area and temporary road construction. These differences would affect the extent to which road and motorized trail impacts to riparian and aquatic resources would decline in the future.

The transportation system of the Mark Twain NF is fairly stable and new construction should be similar in Alternatives 2 through 5. While none of the alternatives propose to greatly increase the transportation system, Alternative 1 would see a decrease in quantity and condition of many smaller road systems. Maintenance would occur in all alternatives, however very little reconstruction and general upkeep would occur in Alternative 1. In addition, many roads would not be maintained in Alternative 1, eventually reverting to a vegetated state, thereby reducing effects that roads and trails would have on the hydrology of a watershed. Alternative 1 would have the smallest potential to increase sedimentation and erosion because it has the smallest amount of temporary road and skid trail construction and reconstruction of permanent roads. Alternative 5 would have the most potential to create erosion and sedimentation, and disruption of the hydrologic regime through temporary road construction. Road closures and rehabilitation may occur in any alternatives; however impacts on wetlands are impossible to discuss at this time because road locations are unknown. Project level analysis would address site-specific impacts of the transportation system on wetlands. The magnitude of effects would vary by intensity as well as specific location and type of activity occurring.

Effects from Timber Management Activities

Risks to the condition of watersheds from timber harvest can include erosion, sedimentation, and increased water yield in small watersheds (i.e. sixth-level watersheds). Riparian ecosystems can be directly or indirectly affected by timber removal as well. Major increases in erosion from harvest areas themselves are unusual due to the ground roughness and the ability of downed vegetation to contain sediment-laden runoff. Roads and skid trails associated with harvest activity can increase the risk of erosion, increased runoff and sedimentation.

Logging in the headwater reaches of watersheds have been shown to increase sedimentation, loss of stream retention structures, and an altered hydrologic regimes (Sponseller and Benfield 2001).

The significance of water yield changes from timber harvesting is dependent on aspect, elevation, soils, geology, and vegetation cover as well as annual precipitation. Research indicates that removal of more than 20 percent of the forest canopy can measurably increase streamflow within the immediate watershed (Troendle and Olsen 1994). Typically such increases are seen during high runoff events as elevated peak flows over a longer duration. Higher flow rates create additional energy that can erode and transport sediment within the stream system. Significant increases in peak flows and their duration can adversely impact channel stability and aquatic habitat.

Riparian Vegetation

Past management of riparian areas has greatly altered the vegetation types that are found, and greatly increased the amount of openlands. The impacts of timber management activities would vary by the type of activities that occur, location, and timing of the activity.

Many riparian areas on the Forest could benefit from some vegetation management activities. Certain locations are in need of riparian planting to convert areas from fescue fields, other stands are overstocked with small non-desirable species, others need to be allowed to mature. All alternatives allow vegetation management to move riparian areas toward the desired condition. Historic vegetation mapping provides basic guidance of the direction that needs to be taken. On site determinations would have to be done to determine the best course of action.

There is a balance needed in most streams that requires some downed coarse woody debris within the system itself. Its function includes sediment retention, energy dissipation, and shade and pool creation for fish habitat. Removal of riparian vegetation could reduce the supply of coarse woody debris critical for stream health. Conversely, logging slash and debris, if allowed to enter a stream system in sufficient amounts, could choke a stream channel. This sets the stage for major channel alteration and reduces dissolved oxygen levels as material decays. Fish passage could be adversely affected and anoxic conditions toxic to fish and other aquatic organisms can result.

Vegetation management activities in a watershed would have impacts that would be seen in other portions of the watershed, as the entire system is dynamic and dependent on each other. The Ozarks are so highly dissected with drainages that sediment during rain events can travel for miles.

Alternatives 1 through 4 have numerous proposed standards and guidelines that would reduce impacts of vegetation management activities on riparian areas. Due to the fragile natural communities that exist in these areas, the Forest Service would locate all skid trails and temporary roads; current management requires FS approval. To facilitate management activities, single or double passes of mechanical equipment, like feller-bunchers, from a designated skid trail, are allowed in the WPZ without FS approval. The WPZ, however, would have a 25 foot no cut zone and mechanized equipment would be prohibited within this zone.

Because the exact location of management activities that could occur over the next 10 years is unknown, actual impacts are very difficult to discern. Based on the proposed activities, Alternative 1 would have the least impact, because it has the least amount of proposed acres of treatment. While this would allow for the least amount of negative impacts, it would also decrease positive benefits as well. Alternatives 2 through 4 would have moderate impacts in the same range, since the acres proposed for treatment are virtually the same. Alternative 5 would have the greatest impacts on watersheds because this has the most aggressive timber program.

Erosion and Sedimentation

All alternatives include implementation of standards and guidelines that would limit erosion and sedimentation from leaving a site and thereby reach a water source when timber or vegetation management activities are occurring.

The principal activities that increase the possibility of erosion and sedimentation associated with timber management are construction of skid trails and temporary roads, construction of log landings, and mechanical site preparation. Effects would be similar to those described in the transportation system.

It is not practical or feasible to try to predict sedimentation and erosional volumes that could occur at a programmatic level. Due to the high variability of site conditions and soil types these types of estimates can only occur at the project level. Alternative 1 would have the smallest potential to increase sedimentation and erosion due to the fact that it has the smallest amount of temporary road and skid trail construction. Alternative 5 would have the most potential to create erosion and sedimentation through temporary road construction.

Water Temperature

Trees and other vegetation serve as thermal buffers along streams. When removed, average stream temperatures can increase in summer and decrease in winter, stressing fish populations during these periods.

Timber management activities will have no direct effects on water temperature in perennial waters in any alternative. In all alternatives, standards and guidelines are in place that would create, in effect, buffer strips along permanent watercourses, which would maintain stream surface shade where it already exists. These same standard and guidelines should also provide for an increase in stream surface shade over time.

In smaller intermittent streams and drainages, protection will vary. Alternative 5 provides a buffer strip ranging from 100 to 290 feet, depending on slope, for intermittent streams. Alternatives 1 through 4 provide consistent management direction with a 25 foot “no cut” zone directly adjacent to watercourses with an additional 75 foot buffer that would allow limited activities.

Effects from Fire

The severity of impacts from wildfire and prescribed fire to aquatic and riparian resources depends on fire intensity as well as the degree of any suppression efforts. Low-intensity fires typically leave sufficient organic matter to protect the soil surface. In contrast, high-intensity fires can consume duff, litter, and much of the vegetation. A catastrophic wildfire has a greater potential to burn through riparian areas. A prediction of the acreage of high-intensity wildfires that might be expected over the life of the 2005 Forest Plan was not made for this analysis.

Sediment and turbidity are the water quality responses generally associated with fire. Sediment and turbidity result from overland flow and erosion; channel erosion; channel scouring due to increased discharge and greater stream exploration area (USDA Forest Service 1979).

Fire can benefit riparian ecosystems, especially in areas where fire historically occurred frequently. Frequently, fires are necessary to sustain high quality bur oak woodlands, as well as some prairie and prairie fen complexes.

Erosion and Sedimentation

Any activity that exposes bare mineral soil is subject to erosion and sedimentation. Fireline construction and removal of ground cover may contribute significantly to the possibility of soil leaving a project site and entering the stream network.

Wildland fires, if intense, can temporarily remove surface organic debris and groundcover vegetation down to the mineral surface. Removal of the surface cover may cause soil loss especially on lands in poor ecological condition. The timing of rain events after a fire can also facilitate soil movement.

Standards and guidelines have been developed to minimize impacts of prescribed burning and fire suppression on riparian areas and other aquatic resources. The exact impacts to an area would depend on the intensity of the fire, the amount of firelines constructed, fireline locations, soil types, location within the watershed and rainfall after the fire. These impacts are nearly impossible to predict at a programmatic level. Sedimentation and erosion models are highly variable as well. Project level analysis would provide a better synopsis of impacts to a given location.

The prescribed burning program is very similar in all alternatives. Alternative 5 has the least amount of prescribed burning with 593,200 acres projected for the first decade; Alternative 2 has the highest volume of prescribed burning proposed. Alternatives 1, 3, and 4 fall between

Alternatives 2 and 5. Alternatives 1 through 4 have numerous standards and guides designed to minimize potential sedimentation and erosion potential.

Riparian Vegetation

Response of riparian vegetation to fire would depend on the frequency, fire intensity, timing and the community type. Many historic riparian vegetation types responded to positively to fire disturbance. Low to moderate intensity prescribed fire can facilitate restoration and increase groundcover plant species historically adapted to open woodlands, prairie fens and savannas.

Hydrology and Hydrologic Connections

Wildfire suppression efforts can also affect watershed resources. Fire lines constructed with heavy equipment can be indiscriminate toward sensitive riparian areas and soils. They can disrupt surface and subsurface flows and deliver these flows along with precipitation runoff to stream systems more efficiently.

The creation of firelines can increase the drainage pattern density of a watershed. During rainfall events firelines, as well as roads, channel water. The channeling of overland water flow decreases infiltration and can increase flow velocities, which can increase sedimentation and erosion. Current flow patterns have been greatly altered from pre-settlement conditions.

Closure and rehabilitation of any firelines would improve the hydrologic regime of the area, whether they are located within riparian area or not. It is unrealistic to describe exact impacts of fireline construction since there are numerous factors that could influence how it would affect the hydrologic regime. Location, design, use, soils, closure and many other factors are more appropriately discussed in project level analysis.

The prescribed burning program is very similar in all alternatives. Alternative 5 has the least amount of prescribed burning with 593,200 acres projected for the first decade; Alternative 2 has the highest volume of prescribed burning proposed. Alternatives 1, 3, and 4 are in between on proposed acres. Alternatives 1 through 4 have numerous standards and guidelines designed to minimize the potential sedimentation and erosion potential. The location of future wildfires is unknown for this analysis; however, standards and guides have been created to ensure suppression activities use a “light on the land” approach, with importance placed on firefighter and public safety.

Effects from Mineral Exploration and Development

Management of mineral resources does not vary by alternative. Forestwide standards and guidelines addressing the protection of riparian and aquatic resources would be followed for any mineral exploration or development. Standards and guidelines would minimize the amount of ground disturbance that would occur. These would limit the amount of surface erosion and sedimentation moving from the site.

If mineral development occurred, other effects would need to be analyzed on a site-specific basis. At a local scale, the geohydrologic conditions and surface conditions would vary; a site specific analysis is the appropriate place to look in depth to the actual site impacts. At that level, it could be determined if additional mitigation measures would be needed to protect specific resources. Studies have shown that the extensive dewatering of the St. Francois Aquifer from mining activities can affect the water level of the Ozark aquifer (Fletcher 1974). Another study indicated localized areas of drawn downs on wells, drawn into the Ozark aquifer, in response to the dewatering of the St. Francois aquifer (Kleeshulte 2001).

Impacts of mineral exploration and development are similar in all alternatives. Specific impacts would vary based on location, intensity of management and the actual development. These impacts are more appropriately addressed in a project level analysis.

Effects from Rangeland Management

Rangeland management activities in riparian areas can have a variety of effects on the quality of aquatic resources. These management activities can affect current and potential vegetation, wildlife, water quality, and stream morphology.

If not managed properly the effects can be significant. Poor grazing practices are listed as a primary source of hydrologic alteration, sedimentation, nutrient loading and habitat destruction in the Ozarks Ecoregional Conservation Assessment (TNC 2003).

Management of rangeland activities does vary by alternative. Alternatives 1 through 4 would allow grazing to continue on existing permitted allotments in the Riparian Management Zones, approximately 3,315 acres. Livestock would be fenced out a minimum of 100 feet from the stream channel in the RMZ. The fencing would reduce the acres of RMZs actively grazed by approximately 1,400 acres. In addition, grazing on allotments that are currently located within the RMZ would be foreclosed at the earliest opportunity. This would most likely occur when the existing permits expire. Also, grazing would not be allowed to degrade the RMZ and WPZ, or their functionality. When fully implemented, Alternative 5 would prohibit all grazing and haying activities in the frequently and occasionally flooded areas.

The following discussion discloses effects that could result from livestock presence in riparian areas and watercourse protection zones. Although standards and guidelines are designed to minimize or eliminate adverse impacts, site-specific conditions, such as soil, vegetation, livestock numbers and use periods, would determine whether or not adverse impacts actually occur and to what degree.

Surface Erosion and Sedimentation

Vegetative cover can be altered and bare soil exposed in any place that livestock congregate or create trails. These areas are more prone to erosion and sedimentation, especially during rain events. Areas of exposed soil in the riparian area would be more likely to contribute sediment into local streams that would areas outside of the riparian area.

Livestock traversing stream banks contributes to bank instability and sedimentation. Repeated traffic on the stream bank results in areas devoid of vegetation, which may be a steady source of sediment into the hydrologic system. With each progressive rain event, already-weakened stream banks may continue to erode, sending sediment downstream. This sediment is deposited, causing depletion of deep holes and changing the morphology of the stream by creating shallower, wider streams.

In Alternatives 1 through 4, livestock would be fenced 100 feet from the stream channel in the RMZ, and allotments would be removed from riparian areas in Alternative 5. Therefore, these particular impacts to bank stability and sedimentation would not occur in the riparian areas. However, similar impacts would occur in some intermittent and headwater channels in all Alternatives. The presence of livestock in these areas, would allow for the possibility of sediment to be transported down stream during rainfall events. Livestock tend to congregate where there is shade, which in many cases occurs along channels. Where this occurs, soil may be compacted, and vegetation that helps stabilize the banks may be destroyed. When rains occur these trampled areas may wash out, sending sediment downstream into larger perennial water bodies. Wind, rain and continued damage by hooves can propagate erosion and head cutting in the small streams.

Alternative 5 would have the least erosion and sedimentation potential from rangeland management activities, since allotments are prohibited from the frequently and occasionally flooded areas. Alternative 1 would have fewer acres open to grazing in riparian zones and in the forest in general due to the acres that would be under MP 6.1 and 6.2, which only allows grazing on native grasslands. The amount of sedimentation and erosion that could be anticipated in Alternative 1 would be lower than in Alternatives 2 through 4. All alternatives would have the potential for increased amounts of sediment and erosion occurring primarily in the WPZ (headwaters and some intermittent stream channels), since livestock will be allowed free access to the channels.

Riparian Vegetation

The conversion of riparian areas into open pasturelands with non-native grasses has eliminated much of the historic native vegetation. Fescue pastures have been planted in many of the riparian areas bottomlands. Fescue tends to choke out other native riparian vegetation. These created open areas can disrupt the vegetative continuity of the riparian ecosystems.

Grazing affects vegetation structure and composition. Livestock grazing has the potential to decrease plant cover. Grazing intensities and timing can alter plant composition, which may have long-term effects on the hydrology of a watershed (USDA NRCS 2000).

When livestock are allowed to travel, they have the potential to introduce non-native species into the riparian areas. The introduction of certain non-native species can displace native species. The displacement of native species may result in loss of diversity and species richness, loss of food and habitat for wildlife, and a decrease in the amount of palatable forages.

Alternative 5 would have the least impact to riparian vegetation from the impacts of rangeland management activities, as allotments are excluded from the frequently and occasionally flooded areas. Alternatives 1 through 4 would have an effect on the riparian vegetation in the allotments. The exact impacts of grazing would have to be analyzed on a site-specific basis. Alternative 1 would have fewer acres open to grazing in riparian zones and in the forest in general due to the acres that would be under MP 6.1 and 6.2, which only allow grazing on native grasslands. The disturbance to riparian vegetation would be lower in Alternative 1 than alternatives 2 through 4. Impacts to the riparian vegetation would vary depending on the number of animals, timing, duration, natural community condition, and other factors that are not practical to analyze at a programmatic level.

Hydrology and Hydrologic Connections

The hydrologic regime of an area may be altered by grazing. The potential of soil compaction can increase runoff in a given watershed. The increase in runoff flow can affect the stream course as well as the local groundwater system. The changes in riparian vegetation can also affect the amount of precipitation that is absorbed by the local plants; this also affects the volume of water recharging the local groundwater system as well as the amount and velocity of waters subject to runoff.

Loss or alteration of local vegetation from grazing can affect the water table, as some noxious weeds require more water for survival than many warm season grasses. The uptake of water needed for these grasses limits the amount of water that infiltrates into the ground water system.

The continued presence of cattle may create defined trails. These created trails combined with the roads needed for maintenance of the allotments in the riparian areas, could provide additional flow paths for water to travel. This could affect the infiltration and runoff patterns and volumes.

Alternative 5 would have the least impact on the hydrology and the hydrologic connectivity in the riparian areas from the impacts of rangeland management activities, as allotments are excluded from the frequently and occasionally flooded areas. Alternatives 1 through 4 would have an effect on the hydrologic regimes of these areas. Alternative 1 would have substantially fewer acres open to grazing in riparian zones due to the acres that would be under MP 6.1 and 6.2, which only allow grazing on native grasslands. The effect of grazing on the hydrologic regime of the system would be lower in Alternative 1 than in Alternatives 2 through 4. All alternatives would have similar potential for changes in the local hydrologic regimes with respect to the WPZ (headwaters and some intermittent stream channels). Impacts to the hydrology of an area would vary depending on the number of animals, timing, duration, natural community condition, and other factors that are not practical to analyze at a programmatic level.

Water Quality

Livestock in riparian areas has the potential to increase nutrient loading in streams from animal waste. Fencing livestock 100 feet from the stream channel will decrease the continuous effect of nutrients entering the stream; however, the remaining 1,050 – 1,780 acres of allotments in the RMZs in Alternatives 1 through 4 are located in the floodplains of the river system. Therefore when flooding occurs, the animal waste in the form of nutrients may enter the local water system. Fencing of livestock 100 feet from the streams would provide for some attenuation of these effects. Similar effects would occur in the WPZ channels, however, without any attenuation from a buffer along the channel.

The increase in nutrient loading in streams can also create foul smelling water with excessive weed and algal growth down stream. The extent and intensity of the weed and algal growth will vary based on site-specific factors. The excessive algal growth can have negative impacts on the aquatic life, in particular on endangered mussels. The algal growth can cover up the mussel and interferes with its feeding ability.

Livestock in the riparian areas may also increase the fecal coliform concentrations in the local water systems. While fencing the animals out of the actual watercourses can decrease the continuous feed of fecal coliform into the water, flooding still occurs and transports concentrations of fecal coliform into the water systems.

Livestock in riparian areas has the potential to increase the sediment loading in streams due to erosion introduced by their presence and habits. Even if the livestock is fenced out of the stream, these riparian areas are in the floodplains of the river system and they will still be present in the headwaters and other intermittent channels. Therefore, when flooding and other rainfall events occur, sediment can be moved into the local water system.

Alternative 5 would have the least impact on water quality from the impacts of rangeland management activities, as allotments would be removed from the frequently and occasionally flooded areas. Alternatives 1 through 4 would have an effect on the water quality. Fencing the animals 100 feet from stream channels would decrease some of the impacts to water quality in RMZs. This would reduce a portion of the sediment pollution. These impacts would occur in WPZs in all Alternatives without any attenuation from a 100-foot buffer along the channel. Alternative 1 would have fewer acres open to grazing in riparian zones and in the forest in general due to the acres that would be under MP 6.1 and 6.2, which only allow grazing on native grasslands. Fewer acres open to livestock grazing in Alternative 1 would result in fewer impacts to water quality than Alternatives 2 through 4. The exact impacts of grazing would have to be analyzed on a site-specific basis. Impacts on water quality would vary depending on the number of animals, timing, duration, natural community condition, and several other factors that are not practical to analyze at a programmatic level.

Effects from Recreation Management

Water plays an important part in many aspects of recreation. Lakes and streams are attractions to those recreating on the Forest. Water provides basic needs in campgrounds and other recreation sites. The availability of water enhances most recreational uses, and conversely, recreational pursuits have varying degrees of impact on this resource.

Many developed and dispersed recreation sites are located on or near lakes and streams. Such concentrated use typically results in trampling of riparian zones and stream banks, damage to riparian vegetation, and soil compaction. Erosion and sedimentation can occur. The risk of water pollution from human waste, dishwashing, trash accumulation, fish cleaning, and horse use is higher where people congregate. These risks can be reduced by carefully designing recreation sites and trails to avoid riparian areas. Stream crossings must be minimized and routes for motorized and non-motorized off-highway vehicles must terminate a distance from water bodies to avoid adverse impacts to riparian zones and water quality. Interpretive tools such as signs and the presence of Forest personnel can help educate forest users about ways to reduce their impacts on water resources.

Another source of erosion and sedimentation in stream systems comes from the recreational use of jet boats. Wakes caused by these motors can contribute to undercutting banks and increasing bank erosion.

The effects of recreation on riparian and aquatic resources should be similar in all alternatives. New developments would be analyzed for site-specific impacts at the project level.

Summary of the effects of management activities on riparian and aquatic resources

Effects of management activities on riparian and aquatic resources by alternative are shown in Table 46 in relative terms of high, medium, and low impacts. Site-specific analysis would be done before any management activities were implemented and this would provide a more complete view of actual impacts.

Table 46 - Effects of Mark Twain NF Management Activities on Riparian and Aquatic Resources

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Transportation	Low	Medium	Medium	Medium	Medium
Hydrology / Hydrologic Connectivity	Medium	Medium	Medium	Medium	Medium
Sedimentation / Erosion	Medium	Medium	Medium	Medium	Medium
Water Temperature	Low	Low	Low	Low	Low
Stream Morphology	Medium	Medium	Medium	Medium	Medium
Fish Passage	Medium	Medium	Medium	Medium	Medium
Wetlands	Medium	Medium	Medium	Medium	Medium
Riparian Vegetation	Medium	Medium	Medium	Medium	Medium
Timber	Low	Medium	Medium	Medium	High
Riparian Vegetation	Low	Medium	Medium	Medium	High
Sedimentation / Erosion	Low	Medium	Medium	Medium	High
Water Temperature	Low	Medium	Medium	Medium	Medium
Fire	Low	Medium	Low	Low	Low
Mineral Exploration	Low	Low	Low	Low	Low
Recreation	Low	Low	Low	Low	Low
Range	Medium-	Medium	Medium	Medium	Low

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
	low				
Riparian Vegetation	Low	Medium	Medium	Medium	Low
Sedimentation / Erosion	Medium	Medium-high	Medium-high	Medium-high	Low
Hydrology / Hydrologic Connectivity	Low	Medium	Medium	Medium	Low
Water Quality	Low	Medium	Medium	Medium	Low
Cumulative Effects	Low	Low	Low	Low	Low

The impact of management activities on riparian and aquatic resources with the implementation of standards and guidelines remains consistent in all alternatives. Primary differences occur in timber, fire and rangeland management. The variation in the fire and timber potential impacts is due to different amounts of work being projected; with increased activities, the possibility of impacts also increases.

Differences in rangeland management impacts vary among the alternatives due to differences in standards and guidelines in Alternatives 1 through 4 and Alternative 5. Alternative 5 would prohibit all grazing in riparian areas. Alternatives 1 through 4 would allow for grazing in riparian areas if livestock are fenced back from the stream 100 feet. There would also be fewer allotments available for grazing under Alternative 1, due to the large amount of acreage in MP 6.2 that allows grazing only on native grasslands.

Cumulative Effects

The cumulative effects analysis for watershed resources pertains to the planning period, approximately 10 – 15 years and considers 5th level watersheds that contain all or a portion of National Forest System lands administered by the Mark Twain NF. The entire Forest is dissected by numerous intermittent streams, ponds and sinkholes. Most of these have good water quality, and based on the past, present, and proposed future activities in the area, this is not expected to change.

The scattered ownership of the Mark Twain NF combined with the minor portion of the land in most watersheds that is in Federal ownership has limited the effect that the MTNF management can actually have on the overall health of the watersheds. Management of Mark Twain NF System lands would not significantly improve or impair the overall quality of the 5 digit HUCs. In smaller localized 6 digit HUCs, where ownership patterns are more contiguous and in larger proportions, negative and positive effects will be more pronounced.

Various types of logging activities have and would continue to occur in the watersheds that compose the Forest System lands. Logging could increase sedimentation in the watersheds, not only from the actual logging activities, but also due to the loss of filtering capacity on slopes. Any effects from logging would be minimized by implementation of standards and guidelines designed to protect watershed integrity. Cumulative effects on watersheds, with proper implementation of the standards and guidelines, would be negligible. The FY 2002 Monitoring and Evaluation Report indicates that the Standards and Guidelines for maintenance of water quality from timber management projects are providing protection for the water resources in the area. Implementation of additional erosion control measures has provided additional protection for sensitive environments.

Grazing and other rangeland management activities would continue to occur on the Mark Twain National Forest System lands. The anticipated scope of the grazing program on the MTNF in upcoming years would be expected to decrease. Overall, the acres being grazed on the Forest would be minor compared to the grazing that is currently and anticipated to continue on private lands within the watersheds encompassing the MTNF. See the Range section of this analysis for more information.

While most riparian areas in the Ozarks evolved with animals feeding on the vegetation of these highly productive areas, they were occupied by occasional grazers. Historically these areas were grazed by bison and deer, which would move in and out of a location (Bellows, 2003). This rarely caused overgrazing of an area and allowed the native vegetation to replenish itself. The concentrated localized grazing that occurs on much private land today, as well as earlier last century, most of the time does not allow the areas to recover. In much of the private open lands in the Ozarks, the native vegetation is no longer present, and has been replaced with fescue and other cool season grasses. Grazing practices vary from private operation to operation. Some private landowners allow livestock to have free access to the streams, in some cases this can lead to destabilized banks and other water quality concerns. These grazing practices on private lands are expected to continue in the foreseeable future. Currently there are no State restrictions on cattle access and use of waterways, and none anticipated in the foreseeable future.

In Missouri, livestock grazing on private lands has impacted the water quality of numerous streams and water bodies. Livestock can and has affect the nutrient and sediment loading in some streams and water bodies in Missouri, as well as increasing the fecal coliform levels above acceptable standards. Currently in Missouri there are numerous miles and acres of water that are listed as impaired on the 303d listing for sediment, nutrients, and fecal coliform where livestock production and non-point source agriculture is listed as the source.

Various types of mining exploration and extraction activities have occurred on National Forest Systems lands in Missouri. Most of the activities that occur on National Forest lands consist of exploratory drilling and the construction of some vent shafts and activities associated with them. The mining that has been done associated with MTNF lands has been associated with hard rock minerals. The Bureau of Land Management oversees federal minerals and is the agency that actually issues a permit for activities. The Forest Service does issue consent for activities to take place and permits the surface activities to occur. The mining activities that occur on the Mark Twain National Forest are expected to continue in the same vein that they have in the past.

Mining activities on private lands in watersheds included in this analysis have been ongoing since the 1800s (Moore 2005). Hard rock minerals (iron and lead) as well as surface mineral (limestone, and gravel) extractions have been occurring and will continue to occur in the foreseeable future. Gravel and sand extraction from streams and floodplains can impair water quality and destabilize the streambed and banks. The removal of sand and gravel can increase sediment and change the channel morphology up and downstream of a removal site (Roell 1999). Sand and gravel mining is not allowed on Forest Service lands, however it is practiced on private lands. The increase in sediment loading and channel disruption caused by these activities on private lands will contribute to the cumulative effects of the area.

On public lands, the history of timber harvesting, and other management activities in the Mark Twain National Forest has had no documented detrimental long-term effect on water quantity or quality. On a cumulative basis, no streams on the Forest have been adversely affected by any past harvest or other land use activities. No roads or past timber harvest areas have produced sustained excessive amounts of sediment into drainages. Visual observations on the Forest show the current condition of a majority of old skid trails and log landings to be re-vegetated and stable. Most log landings and such on the Mark Twain National Forest will tend to have ground cover restored within one growing season and start showing signs of succession within one or two years. There is no evidence that Mark Twain NF timber management over the past years has had long-term effects on riparian and aquatic resources.

Currently there are a large number of user-made roads and trails in riparian zones, both on private and public lands. Trails located in the riparian areas can increase sedimentation loading to streams and can destroy sensitive habitats associated with riparian areas. Many of these unclassified roads become entrenched due to the high erosion capacity of the soil. Closure of these roads within the project areas would benefit the overall health of the watersheds. Historically roads were placed in these locations due to ease of the topography, location to people and access to water. Many historical settlements and homesteads were located in valley bottoms associated with water sources. It is not anticipated that many roads and trails located in the riparian areas of private lands will be closed in the future.

The history of prescribed burning on the Mark Twain National Forest has had no documented detrimental, long-term effect on water yield or quality. On a cumulative basis, past burning or other land use activities the Forest have adversely affected no streams permanently. . No firelines or previously burned areas have contributed excessive amounts of sediment into drainages. Visual observations on the Forest show the current condition of a majority of old firelines and burned landscapes to be re-vegetated and stable. There is no evidence that fire management over the past years has had long-term effects on riparian and aquatic resources.

The past, present and future land use of privately owned lands in the area is not expected to change. Most of the area is inhabited by private homes and small farming operations. Timber activities have and will continue to occur on private lands. These operations range in size from a few acres of clearing to several hundred acres. Livestock grazing has been and will continue to be prevalent in rural Missouri, including in riparian areas adjacent to many streams. Much of the privately owned livestock is allowed free access to the river systems. Bank destabilization and high algal growth concentrations are common at locations where cattle are allowed access to the streams. The extent of these effects from private lands varies based on the specific site conditions, number of animals and other management activities. Gravel mining is currently taking place on private land adjacent to or within some streams, and is expected to continue. Many areas that are not currently being actively mined have piles of gravel and a broad flat stream; it appears that past mining occurred in these areas. In some cases, these areas of current and past mining combined with the lack of appropriate vegetation have contributed to the current active erosion of stream banks.

Similar management activities could be proposed in the reasonably foreseeable future. Management activities proposed under any alternatives in this analysis would not result in appreciable water quality effects because appropriate standards and guidelines would be followed.

The incremental impacts of these past, present and future management activities would have no appreciable cumulative effects to water quality in the Mark Twain National Forest, nor would they impair long-term productivity. The actual influence of Forest activities on the cumulative water quality is quite small because of the checker-board ownership pattern of the Mark Twain National Forest combined with the small area of most watersheds in Federal ownership. Private lands, and in certain locations other public and government ownerships tend to have the largest influence on watershed and riparian quality and health.

Soils

Introduction

Soils are a primary component of ecosystems, functioning as more than a medium for plant growth. They influence vegetation, watershed condition, mineralogy, and land uses. Soils are a relatively dynamic ecological component, continuously evolving with influences of climate, organisms, topography, parent material, time, and disturbance processes. Due to their slow rate of formation, soils are essentially a non-renewable resource.

Soil quality can have a profound impact on the health and productivity of an ecosystem (Doran and Parkin 1994). Soils are a product of the physical and biotic environment, or ecosystem quality. Soil properties evolve over time and are influenced by landform, location on the landscape, parent material, climatic conditions, natural disturbances, hydrology, weathering, and terrestrial natural communities. These properties affect the ability of soils to sustain plant growth and biological activity by controlling nutrient levels, and oxygen and water available to transform sunlight into stored energy while providing physical support.

The primary goal of soil management is to maintain or enhance soil productivity and all of the chemical, physical, and biological functions and processes that contribute to healthy soils. Soil productivity in this section refers to the classification done by the USDA Natural Resource Conservation Service (NRCS) during their effort to map county soils and tends to refer to a soil's ability to produce crops or lumber. This context of soil productivity is not to the same as the soil's ability to support natural communities. In locations where natural community restoration is occurring, soils should be more like their historic structure and composition; closer to the historic range of natural variability. Although productivity is typically considered the primary function of soil, other functions like the capture, storage, and slow release of water are just as integral to ecosystem maintenance. Compaction, displacement, erosion, puddling, and severe burning, as defined in Forest Service Handbook (FSH) 2509.18-92-1, are the five disturbances that can be detrimental to various soil functions and processes. Standards and guidelines to minimize the possibility of these detrimental disturbances to soils from occurring have been developed and are included in the 2005 Forest Plan.

Proposed Changes

Numerous standard and guidelines minimize impacts on soils. The proposed Plan in many cases would provide more guidance on activities that should and should not occur. Many of these are designed to minimize disturbance on sensitive soils and limit ground-disturbing activities in general. The following is a summary of the proposed standards and guidelines that would protect soil quality on the Mark Twain National Forest:

- Minimize ground-disturbing activities on soils highly subject to compaction during wet periods.
- Design all ground-disturbing activities to prevent or minimize rutting, erosion, compaction, and rapid runoff, disruption of water movement and distribution or loss of water and soil quality.
- Prevent or minimize sedimentation by employing adequate erosion control measures where earth-moving activities unavoidably expose areas of soil for extended periods.
- Mechanically constructed firelines for prescribed burns should avoid fragipan soils where feasible.
- Mechanical site preparation that exposes bare soil on more than 25% of the treated area is not allowed.

Standards and guidelines specific to a soil series are better addressed at the project level analysis. The use of T values was removed due to concerns about the amount of useable information they provide and the ability of field personnel to effectively implement this information. County soil surveys are more readily available now than they were during the development of the 1986 Forest Plan. These surveys allow for a more complete and useable project level analysis.

The 2005 Forest Plan also includes a Soils Appendix (Appendix B) identifying soils of concern (i.e. highly compactable, highly eroadable, fragipan, and alluvial soils).

Proposed changes are the same for Alternatives 1 through 4.

Affected Environment

Soils vary throughout the Mark Twain National Forest due to differences in climate, parent material, topography, time of soil development, disturbances and soil organisms. Soils of the Ozark Plateau Province are moderately well drained to well drain and have moderate to slow permeability (OOHA 1999). Most soils developed in loess, cherty limestone and sandstones. Soils are generally old, shallow, stony, highly weathered and acidic, except on some broad ridges and bottomlands. Soils on some of these broad ridges and bottomlands tend to be neutral to slightly alkaline compared to other soils (USDA Forest Service 1999c).

The soils of the Mark Twain National Forest can also be very deep, well-drained mineral soils, which have formed in residuum and colluvium from local sandstone and dolomite bedrock. Alluvial soils, consisting mainly of stratified silt, sand, and gravel, are usually found on valley floor floodplains. These soils are usually well drained, although valley bottoms and areas with perched water tables can have areas of poor drainage. Some soils, particularly those on steeper ground, have very gravelly or stony surfaces and are skeletal (more than 35 percent rock fragments by volume) throughout the profile.

Soils of the Mark Twain National Forest can also be moderately well drained to well drained and have moderate to slow permeability. Most of the soils are developed in loess (a loamy material derived from glaciers and transported by the wind) and in residuum from cherty limestone, dolomite and sandstone. The soils are generally old, stony, highly weathered and acidic, except on some broad ridges and bottomlands. Some soils on broad ridges and bottomlands are loamy, neutral to slightly alkaline and more fertile than other soils in the area.

The following soil associations (general soil map units) are common to the Forest, and are not intended to be a comprehensive listing.

Clarksville-Coulstone association

Gently sloping to very steep soils that are cherty throughout, this association runs along the upper Eleven Point River valley and the Hurricane Creek valley. Soils are formed in cherty residuum on narrow ridge-tops and side-slopes. Clarksville soils make up 40 percent of the association; Coulstone soils 40 percent; and other minor soils make up the other 20 percent.

Clarksville soils are deep and somewhat excessively drained. They have a surface layer of brown cherty silt loam and a subsoil of brownish-yellow cherty silty clay loam.

Coulstone soils are deep and somewhat excessively drained. They have a surface layer of dark-gray cherty fine sandy loam and a subsoil of brown or red cherty sandy clay loam.

Minor soils in this association are the Captina and Wilderness soils on ridge tops; Poyner soils on side slopes; and Ashton, Secesh, and Midco soils on stream bottoms.

The part of this association on uplands is almost entirely forested. Doughtiness, steepness and high chert content are major limitations to land use.

Captina-Clarksville-Macedonia association

This association is in the north and central parts of the analysis area. Soils are in broad, nearly level to gently sloping areas on ridge-tops and moderately steep to very steep areas on side slopes. They formed in loess over residuum or in a mixture of loess and residuum. Captina soils make up about 35 percent of the association; Clarksville soils 26 percent; Macedonia soil 20 percent; and minor soils 19 percent.

Captina soils are deep, gently sloping to moderately steep, moderately well drained soils on broad ridge-tops and upper side slopes. They have a surface layer of brown silt loam and a subsoil of strong-brown silt loam and yellowish-brown silty clay loam. The lower part, below a depth of 17 to 30 inches, is a fragipan.

Clarksville soils are deep, gently sloping to very steep, somewhat excessively drained soils on steep side slopes and narrow ridge-tops. They have a surface layer of brown cherty silt loam and a subsoil of brownish-yellow cherty silty clay loam.

Macedonia soils are deep, gently sloping to moderately steep, well-drained soils on broad ridge-tops and side-slopes. They have a surface layer of dark grayish-brown silt loam and a subsoil of yellowish-brown silt loam and strong-brown cherty silty clay loam and silty clay.

Minor soils in this association are Wilderness soils on narrow ridge-tops and Coulstone soils on side slopes.

This association is used for both timber and forage. Steepness and doughtiness are major limitations.

Mano-Moko-Rock outcrop association

This association is on steep side slopes of deeply dissected plateaus. The major soils commonly have areas of gravelly colluvium on the surface. They typically are in a stair step pattern on benches and commonly follow the contour of the landscape.

This association is found mainly in the western parts of the Mark Twain National Forest. It is about 35 percent Mano and similar soils, 24 percent Moko and similar soils, 21 percent rock outcrop, and 20 percent minor soils.

Mano soils are typically very deep and moderately well-drained. The surface layer is dark grayish brown and dark gray, very friable, very gravelly or extremely gravelly silt loam about 3 inches thick. The subsurface layer is pale brown, very friable very gravelly silt loam and light yellowish brown and brownish yellow, friable very gravelly silt loam about 10 inches thick. The subsoil extends to a depth of 68 inches or more, it is brownish yellow and pale brown, friable very gravelly silt loam in the upper part; light yellowish brown and brownish yellow, mottled, very firm gravely silty clay loam in the next part; and yellowish brown, mottled, very firm clay in the lower part.

Moko soils are very shallow or shallow and are well drained. Typically, the surface layer is black, very friable flaggy silty clay loam about 8 inches thick. The subsoil is black, very friable very flaggy silty clay loam. Hard dolomite bedrock is at a depth of about 16 inches.

Areas of rock outcrop are on short, steep slope breaks throughout the association.

Minor soils in this association are those in the Blueye, Hercules, and Snead series. Blueye soils have a surface layer that is dark. They have bedrock at depths of 40 to 60 inches and are in landscape positions similar to those of the Mano soils. Hercules soils are very gently sloping and gently sloping and are on narrow flood plains. Snead soils have shale bedrock at a depth of 20 to 40 inches and are in landscape positions similar to those of the Mano soils.

Slope, low or very low available water capacity gravel in the surface layer, and the hazard of erosion are the main management concerns.

Midco-Secesh-Viraton association

This association consists of soils in long, narrow valleys along major streams. Valleys are 200 to more than 2,000 feet wide. They include flood plains, stream terraces, and foot slopes. Stream terraces are 5 to 15 feet above the flood plains. Foot slopes are generally 10 to about 100 feet above flood plains. Soils are between 5 and more than 10 feet thick. Slopes range from 0 to 9 percent.

This association is made up of about 60 percent Midco soils, 16 percent Sesesh soils, 10 percent Viration soils, and 14 percent minor soils.

Midco soils are nearly level and gently sloping and somewhat excessively drained. They are on flood plains. Typically, the surface layer is dark grown cherty loam about 7 inches thick. Below this to a depth of about 60 inches are strata of brown very cherty and extremely cherty loam and extremely cherty sandy loam.

Sesesh soils are nearly level and gently sloping and are well drained. They are on stream terraces. Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is dark brown silt loam, the next part is strong brown cherty clay loam, and the lower part is dark yellowish brown extremely cherty sandy clay.

Viraton soils are gently sloping and moderately sloping and are moderately well drained. They are on foot slopes. Typically, the surface layer is brown silt loam about 4 inches tick. The subsurface layer is yellowish brown silt loam about 4 inches thick. The part of the subsoil above the fragipan is about 13 inches of strong brown and yellowish brown silty clay loam and 10 inches of grayish brown, mottled silty clay loam. The fragipan is yellowish brown, brittle very cherty silt loam about 28 inches thick. The part of the subsoil below the fragipan extends to a depth of about 71 inches or more. It is yellowish brown cherty silty clay.

Of minor extent in this association are the Auxvasse, Courtois, and Fourche soils. Auxvasse soils are poorly drained and are on stream terraces. Courtois and Fourche soils are on foot slopes. They have reddish subsoil. Courtois soils are gently sloping to strongly sloping.

The soils in this association are suitable for cultivated crops, pasture, and hay. The major management concerns are maintaining fertility and reducing hazards of erosion and drought. Flooding and excessive chert in the surface layer are additional management problems in areas of the Midco soils. These soils are suitable for trees. The dominant tree species are white oak, northern red oak, black oak, and hickory on the Viraton soils and white oak, sugar maple, ash, black walnut and sycamore on the Secesh and Midco soils.

Poyner-Macedonia-Captina association

This association is in the southern part of the analysis area. The soils are mainly in gently sloping areas on ridge-tops and steep areas on side slopes. They formed in loess and underlying residuum. Poyner soils make up 28 percent of the association; Macedonia soils 20 percent; Captina soils 17 percent; and minor soils occupy 35 percent.

Poyner soils are deep, gently sloping to moderately steep, well-drained soils on the tops of broad ridges and on upper side slopes. They have a surface layer of dark grayish-brown cherty silt loam and a subsoil of red silty clay or clay.

Macedonia soils are deep, gently sloping to moderately steep, well-drained soils on broad ridge-tops and side-slopes. They have a surface layer of dark grayish-brown silt loam and a subsoil of yellowish-brown silt loam and strong-brown cherty silty clay loam and silty clay.

Captina soils are deep, gently sloping to moderately steep, moderately well drained soils on broad ridge-tops and upper side slopes. They have a surface layer of brown silt loam and a subsoil of strong-brown silt loam and yellowish-brown silty clay loam. The lower part, below a depth of 17 to 30 inches, is a fragipan.

Minor soils in this association are Wilderness soils on tops of narrow ridges, Doniphan soils on tops of broad ridges, and Clarksville soils on steep side slopes.

Most of this association is forested. Steepness and doughtiness are the major limitations to land use.

Environmental Consequences

General Soil Characteristics

In addition to erosion, most soils on the Mark Twain National Forest are generally susceptible to compaction, puddling, and displacement, particularly when land management treatments that result in ground disturbance are applied haphazardly.

The extent to which a soil is susceptible to compaction and puddling are dependent on soil texture, soil structure, soil moisture, ground cover, and activity type. Generally speaking, wet or moist soils with loamy or clay textures and weak structure are inherently more susceptible to compaction and puddling, regardless of ground cover or type of activity.

All soils are generally susceptible to displacement during heavy equipment-based management treatments or other activities that result in ground disturbance and loss of ground cover. During non-heavy equipment-based land management activities, displacement is largely dependent on soil texture, soil structure, soil moisture, rock fragments, and ground cover. Soils are typically most susceptible to displacement when they have sandy textures, weak structure, are dry, and have few rocks and ground cover.

Direct and Indirect Effects

Management actions with the greatest potential to affect soils are those that involve ground disturbance or vegetation removal. These include timber harvesting, travel ways construction and maintenance, recreation, mineral exploration and development, fire, and rangeland management activities. Potential detrimental impacts of concern are compaction, erosion, displacement and soil burning (possibly from wildland fires and pile burning).

Soil compaction is caused by ground pressure from vehicles, animals, or humans. It can reduce productivity and other soil functions by impairing infiltration, root growth, and soil organisms. Soil compaction can also lead to increased erosion resulting from reduced infiltration and increased overland flow.

Detrimental erosion can impair long-term soil productivity and degrade water quality through increased sedimentation. Detrimental soil displacement can reduce soil productivity and other soil functions by removing humus and topsoil. It can also lead to expanded noxious weed populations by exposing soil strata favorable to their establishment. Erosion will increase sediment loading and can affect the water quality of the watershed.

Detrimental soil burning is caused by hot fires that occur when large fuels or heavy concentrations of fuels are dry and consumed near the ground. Detrimentally burned soils can alter many chemical, physical, and biological soil functions and processes including infiltration and nutrient cycling. In general, the Mark Twain National Forest does not have fuel loading conditions that would create this effect in a wildland fire situation. These effects could occur through a concentrated pile burn or some other event, in which case they would be localized and not spread over a landscape type scale.

Long-term soil productivity can also be reduced when excess leaves and limbs are taken off-site during whole tree yarding or fuels reduction operations.

Effects on soil resources from transportation system

The primary impact of the transportation system is an increased potential for surface erosion to occur and sediment to leave the site. However, in areas of the actual road beds, soil compaction and soil productivity can be affected.

Surface erosion occurs because road surfaces, cut-slopes, fill-slopes and associated drainage structures are usually composed of erosive material exposed to rainfall and concentrated surface runoff.

The road system has the greatest potential to generate surface erosion in entrenched road segments. These roads typically follow the topography of the land, forming ad-hoc channels or ditches along ridge-tops, valley side-slopes and stream bottoms. Sediment is released at these created drainage outlets where water is released onto hillside, valley bottom or stream crossing. Erosion is also generated by networks of user-defined ORV trails that are concentrated in certain parts of the Forest, within most watersheds. ORV and ATV traffic on utility right-of-ways can also generate surface erosion.

The road and highway system in the Mark Twain National Forest contributes sediment and pollutants through surface erosion. Road surfaces prevent infiltration of precipitation, causing an increase in runoff. Road stream crossings can also generate surface erosion. The Mark Twain National Forest has over 9,000 stream crossings within its boundary. Each watershed in the Forest contains numerous stream crossings, many of which are aggregate and dirt surfaced. There are over 1,350 miles of roads within riparian areas, which add several miles of channel extension to the watershed. Additional miles of “other” roads of unknown condition are located in most watersheds. Each of these has the potential to increase surface erosion and sediment to the nearest stream system.

Non-systems roads and other unclassified roads have been used as networks for illegal ORV and ATV use. This has resulted in significant amounts of erosion in the past and will likely continue in the future. The primary opportunity for reducing this impact appears to be partnerships with ORV/ATV groups in rehabilitating and restoring these areas. Other options may be to designate and design trails for motorized use.

Constructed dips on system roads and water bars on skid roads are often outlets where water on roads is diverted onto the hillside. There is great diversity in the quality of dips and water bars throughout the Forest. Some water bars are quite effective at reducing surface erosion. Others appear to create more soil disturbance than they prevent due to inadequate construction or maintenance.

It is impossible to be specific about the exact amount of surface erosion the road system generates due to the density of classified roads as well as unclassified non-system roads and private roads within the Forest. Runoff and sediment production was modeled for representative Forest road types within the analysis area. A comparison was made between aggregate surfaced Forest roads and roads with paved surfaces. The analysis simulates the effects of ten years of weather and use upon Forest roads in various areas of the Mark Twain

National Forest. This analysis utilizes the Water Erosion Prediction Process (WEPP) Forest Road Erosion Predictor model. Results of the analysis are displayed in Appendix 3 of the Mark Twain NF Roads Analysis complete in 2003.

Inputs of the modeling indicate the factors associated with erosion of roads and sediment levels. Climate is one such factor. The model was run for six different locations encompassing many areas inside the Forest boundary. Data from climate stations near these locations were incorporated into the model; thus, erosion and sediment levels were different in each area. The following table outlines the climate stations used and the unit areas they apply to.

Table 47 - Climate Stations Used for Mark Twain NF Road Modeling

Climate Stations Used in WEPP model	Road Unit areas
Arcadia	Potosi and Fredericktown
Doniphan	Eleven Point and Poplar Bluff
Jefferson City Radio KWS	Cedar Creek
Rolla School of Mines	Rolla and Houston
Salem	Salem
Springfield	Ava, Willow Springs, Cassville

Other factors necessary for modeling include road type, surface type and road design. Three different road types were modeled (low gradient, ridge top road; low gradient, side slope road; and high gradient, side slope road), and erosion and sediment levels were different for each type. Two different surface types were modeled, aggregate and asphalt, to take into account maintenance Level 3 and 4 roads identified in this analysis. These two types of road surfaces also affected erosion and sediment levels. Four different road designs were included in the model. These were insloped with a bare ditch, insloped with a vegetated or rock ditch, outsloped with a rutted road surface, and outsloped with an unrutted road surface. Expanded results can be found in Appendix 3 of the Mark Twain National Forest Road Analysis Report, 2003.

The model had two outputs. These were surface erosion within the road prism and sediment leaving the road buffer (both in pounds per year). Overall, the combined amount of surface erosion and sediment leaving a road buffer was lowest on outsloped roads with an unrutted road surface. This result remained the same for every location, road surface, and road type. There were some insloped aggregate roads modeled with vegetated or rock ditches that had road prism surface erosion totals that were similar to outsloped unrutted aggregate roads, but the amount of sediment leaving the road buffer was higher. Sediment leaving the road buffer, as determined from the model, is important due to the possibility of this sediment ending up in adjacent streams. In general, outsloped, unrutted roads contribute less erosion and sediment than other road designs. They should be considered in road maintenance planning.

It is not practical or feasible to predict sedimentation and erosion volumes that could occur at a programmatic level. Due to the high variability of site conditions and soil types, these estimates should only occur at the project level. The permanent road system for the Mark Twain NF would remain similar in Alternatives 2 - 5. Alternative 1 would see a decrease in the quantity and condition of many smaller road systems. Road maintenance would occur in all alternatives, however very little reconstruction would occur in Alternative 1. In addition, due the fact that many roads would not be maintained in Alternative 1 eventually they would revert to a vegetated state, thereby reducing the effects that roads and trails would have. Alternative 1 would have the smallest potential to increase sedimentation and erosion due to the fact that it has the smallest amount of temporary road and skid trail construction, and reconstruction of permanent roads. Alternative 5 would have the most potential to create erosion and sedimentation through temporary road construction.

Effects on soil resources from timber management activities

Timber harvesting and its related activities can affect soils in several ways. Harvesting activities such as felling, skidding, and machine piling can result in detrimental soil compaction, puddling, displacement, and accelerated erosion. Skidding on slopes greater than 35 percent can cause excessive displacement and often lead to gullying. These potentially damaging activities can be mitigated through implementation of standards and guidelines or mitigation measures, which include the use of designated skid trails and temporary roads, re-vegetating log landings erosion control measures, suspending activities in wet weather, and equipment limitations.

When considering potential effects of timber harvest activities on soils, the type of silvicultural and harvest systems used are of prime importance. Clearcut, shelterwood, and select tree silvicultural systems can each affect soils differently. In comparing effects, there are advantages and disadvantages to each system. For example, compared to shelterwood treatments, clearcutting generally results in overall greater disturbance per unit area/time, and may potentially limit regeneration on drier sites. However, clearcutting is typically a one-time event that allows for continuous and complete recovery. Shelterwood and selection type harvests typically result in multiple entries over relatively short periods. In the absence of a permanently dedicated skid trail and landing system, repeated impacts will occur, continuously setting back recovery.

The type of harvest system used plays an important role in determining the direct effects of timber harvest activities on soils. Timber harvest operations employ either conventional or mechanized harvest systems. Conventional harvest systems utilize hand-falling of trees with chainsaws, followed by skidding them to landings with rubber-tired or tracked crawler-skidders. The use of standards and guidelines has made conventional harvesting relatively less soil disturbing.

Several types of mechanized harvest systems have become increasingly popular in recent years, primarily due to economics and rising insurance rates. Use of Feller-buncher systems is increasing on the Mark Twain NF. Feller-bunchers are typically low ground pressure machines that systematically cut and stack entire trees into piles that are then skidded on designated trails to landings where they are processed. Processing typically involves removing the limbs and tops. While this system has the potential to minimize physical affects to soils, it may have long-term nutrient cycling implications because most of a tree’s nutrients are tied up in the branches and foliage.

Alternative 5 would have potential for the largest impacts to soils from timber sale activities, because it has the most acres proposed for timber management, and subsequently the highest projected miles of temporary roads and skid trails. Potential differences in impacts between Alternatives 2 through 4 are negligible, because management intensities are nearly the same. Alternative 1 would have less impact on soils based on projected management activities. Alternatives 1 through 4 have more comprehensive standards and guidelines that would minimize impacts of timber harvesting activities compared to Alternative 5.

The actual impacts of timber activities will vary based on the actual site conditions of the soil and intensity of the activities. Due to the variation in soil types and harvest methods that could be used, a more detailed analysis would be appropriate at the project level.

Erosion and Sedimentation

Roads are commonly the greatest contributors of erosion and sediment in timber sale areas, and should be closely analyzed at the site-specific level to determine their effects. There is typically a pulse of erosion from roads (includes cut and fill slopes) during the first two years following construction or reconstruction before this levels off at the third year (USDA Forest Service 1981). Also, the timing of a heavy rainfall after any clearing of the land or skid trail construction, increased slope, and fragipan soils can increase erosion.

Erosion and sedimentation impacts from timber management activities are primarily the result of temporary roads, skid trails, and log landings. All of these activities result in the disturbance, and in many cases total removal, of the ground cover. This increases for the possibility of sediment to move off site. Loss of vegetative cover also facilitates increased runoff that can occur from a site. The actual volume of sediment lost will depend on many different factors including the actual soils on site, silvicultural methods used, slope, time of year the harvest is to occur, etc. Due to the extreme variation in soil types, condition and topography from site to site it is impossible to provide accurate estimates of soil loss, on a Forest-wide scale. That type of analysis should be done at the project level, when actual site conditions can be adequately analyzed.

Alternative 5 would have potential for the largest impacts to soils from timber sale activities, because it has the most acres projected for management, and subsequently the highest projected miles of temporary roads and skid trails. Potential differences in affects between Alternatives 2 through 4 are negligible, because management intensities are nearly the same. Alternative 1 would have the least affect on soils based on projected management activities. Alternatives 1 through 4 have more comprehensive standards and guidelines that would minimize the erosion and sedimentation potential of timber harvesting activities compared to Alternative 5.

The actual impacts of timber activities will vary based on the actual site conditions of the soil and intensity of the activities. Due to the variation in soil types and harvest methods that could be used, a more detailed analysis is appropriate at the project level.

Soil Productivity

Soil nutrient loss is associated with removal of vegetation and the loss of the organic layer from the forest floor. Soil organic matter plays a vital role in providing a nutrient source as well as maintenance of site productivity, soil water retention capabilities, and cation exchange capacity (Jorgensen and Wells 1986). The micro flora and micro fauna that are found in soil organic matter are important in nutrient cycling and soil formation. Soil organic matter is an essential component of soil because it provides a carbon and energy resource for soil microbes (USDA NRCS 1996). Organic carbon in the forest floor organic layer is what energizes most soil biotic processes, promotes nutrient and water flow, and provides for soil aeration (Powers 1998).

In the long-term, soil productivity would likely be enhanced in Alternatives 2 through 5. Following timber harvest, tree limbs, tops and other slash may remain on site and be scattered, recycling nutrients and organic matter back into the soil once they decompose. The addition of nutrients and organic matter to soil would continue to restore site productivity removed during harvest activities.

Alternative 1 would have the least impact to both present and future soil productivity as commercial timber harvests would not occur. In the MP 1.1 and 1.2, restoration activities such as thinning would be done non-commercially, and trees would be cut and dropped. The trees dropped and left on the site could contribute to a rise in nutrient levels of the soils, thereby increasing the long-term productivity over time as decomposition occurs. Trees would not be left in areas of moderate to high wildland fire risk to local residential communities based on the Forest Wide Risk Assessment.

The actual impacts of timber activities on soil productivity would vary based on the actual site conditions of the soil and intensity of the activities.

Soil Compaction

Soil compaction is a concern when heavy equipment makes multiple trips over the same location when yarding logs. Soil compaction has the potential to affect plant growth by reducing soil aeration, water infiltration, and in some cases, by making growth of plant roots through soil physically difficult.

Soil compaction can disrupt water and air movement into and through soil. This results in poor soil aeration, which negatively affects root growth and activity of soil organisms involved in nutrient cycling. Soil compaction also increases resistance to root penetration, resulting in limitations on the volume of soil available in which roots may grow. Effects also include reduced soil faunal activity, and reduced seedling survival. Reductions in water infiltration contribute to increased surface runoff and potential erosion. Soil compaction may also occur under frozen ground conditions, but does not result in a major decrease in soil productivity.

The impacts from all alternatives would be basically the same, varying only by the amount and intensity of management activities occurring, and soil conditions of the location at which the activities are occurring. Alternative 1 would have less impact, since there would be no commercial timber sales. Alternatives 2 through 4 would have similar effects because similar levels of activities are projected. Alternative 5 has the highest level of projected activities, and would therefore have the highest risk of soil compaction. There are standards and guidelines limiting activities on highly compactable soils in all alternatives, which would reduce any projected impacts.

The actual impacts of timber activities would vary based on the actual site conditions of the soil and intensity of the activities. Due to the variation in soil types and harvest methods that could be used, a more detailed analysis would be appropriate at the project level.

Effects on soil resources from fire

Historically, fire disturbances have occurred in the Ozarks. The soils of the Mark Twain NF have developed and adapted to the presence of fire. Soils respond differently to fire. Factors that can influence the effects of fire on soil are fuel loading, fire intensity, timing, topography, amount of restored ground cover, and soil characteristics. There is little research about the actual effects of prescribed and wildland fires on soils in the Ozarks, and the Midwest in general.

Wildland fires can affect soil productivity and soil stability should they occur under any alternative. Wildland fires can result in the loss of soil organic matter, loss of soil structure, increased runoff and erosion, chemical effects of lost nutrients through volatilization or leaching, and biological effects of lost soil organisms and their habitat (Poff 1996). High intensity wildland fires may cause a reduction in infiltration, thereby increasing overland flow (runoff). The loss of riparian vegetation removes buffers to streams. With reduced vegetation or organic matter to slow runoff down and intercept sediments, receiving stream systems can experience increased peak flows and sedimentation. Other potential effects to soils following wildland fire include those associated with fire suppression efforts and salvage operations. The effects of a wildland fire on soils vary by geology and soil types, slope, timing and fire intensity.

The effects of burning on soil nutrient loss are related to the intensity of the burn. Specific effects of a fire are complex and depend on a variety of factors. Fires can have an effect on the forest floor where carbon, nitrogen, and sulfur are volatilized, and calcium, magnesium, potassium, phosphorus, and other elements are left as ash. Prescribed burning on glade environments has shown to increases the soil nitrogen concentration, while calcium, magnesium and potassium were variable (Amelon 1991).

Prescribed fire can result in increased erosion and sedimentation. The impacts vary based on the actual soil characteristics, fire intensity, timing, slope and rainfall. In general, sedimentation and erosion potential are lower with prescribed fire than after high intensity stand replacement wildland fire. Side slopes tend to have accelerated erosion rates after prescribed burning until ground cover regrows (Statler et al. 1999). Loss of the duff layer increases the potential for soil to move off site. Prescribed burning prescriptions set forth in the FSM 5140, supplement number R9 Mark Twain 5140-2003-2 are designed to mitigate these effects.

Constructed firelines, whether for prescribed or wildland fires, are also a source of sedimentation and potential for increased erosion. Standard and guidelines have been developed to minimize erosion and sedimentation during prescribed burns and wildland suppression efforts. Guidance for fireline construction during prescribed burning is more comprehensive than during wildland fire suppression, because of site-specific project analysis that would be done prior to implementation. Wildfire suppression activities are encouraged to be light on the land when possible, realizing public and firefighter health and safety are the primary focus.

Mechanical hazardous fuels reduction may be done with wheeled or tracked rotary cutters. This type of equipment can have effects to soil similar to skidders used during timber operations. Soil compaction is a concern when any heavy equipment makes multiple passes over the same location. Soil compaction has potential to affect plant growth by reducing soil aeration, water infiltration and by making growth by plant roots through the soil physically difficult. Any locations where ground cover is removed during hazardous fuels reduction would have an increased risk of sedimentation and erosion leaving the site, until vegetation has been re-established.

There can be benefits to soils following cool fires accomplished within prescription. Specifically, nutrients that were previously tied up in unburned materials are released and made available to plants. Nitrogen fixation may be enhanced by an increase in soil surface temperature and pH, both favoring nitrogen-fixing bacteria (Martin and Dell 1978). With prescribed fire, burning would be detrimental under high fuel loading conditions and a long residence time of burning, conditions that typically do not occur in the Ozarks. Large logs and slash piles are primary sources of long residence burning. Time of year also influences the effects and intensity of prescribed fire.

The magnitude of effects would vary by intensity as well as specific location and type of activity occurring. While all alternatives project a much larger prescribed burning program than the Mark Twain NF has historically done, the prescribed burning program is similar in all alternatives. Alternative 5 would have the least amount of prescribed burning with 593,200 acres projected for the first decade; Alternative 2 has the highest volume of prescribed burning projected at 724,200 acres. Projections for Alternatives 1, 3, and 4 range from 616,300 to 688,000 acres of prescribed burning in the first decade. Alternatives 1 through 4 have numerous standards and guidelines designed to minimize sedimentation and erosion potential after prescribed burning as well as wildland fires.

The effects of wildland fires cannot be effectively predicted in any alternatives, due to numerous factors that can influence the effects. Historically, the majority of wildland fires on the Mark Twain NF have been low intensity surface fires. Specific information on wildland fires can be found in the Wildland Fire section of the EIS.

Effects on soil resources from mineral exploration and production

The effects from mineral exploration would be a potential increase in sedimentation and erosion, and a loss of soil productivity. Erosion and sedimentation runoff would result from clearing surface vegetation for roads, drill pads, and vent shafts. Contamination of the soil by extracted ore could occur during mineral production. Any activity that disturbs the vegetation cover and exposes mineral soil has potential to increase erosion above the natural rate of about 0.1 ton/acre/year (Patric 1976). The rate at which the soil might erode depends on actual soil type, the location of the clearing, the slope and the time of year. Heavy rainfall shortly after ground disturbing activities, increased slope location, and fragipan soils can increase erosion.

A greater risk of excess compaction occurs when drill sites and temporary access roads are developed on compactable soils. Excess compaction can affect soil productivity and its ability to recover after activities have ceased.

Productivity of soil can also decline due to the presence of high concentrations of chemical elements or heavy metals. This is unlikely to occur throughout normal mineral exploration processes. Drilling effluents could provide a localized source of contaminants, that could alter the productivity of the soil, but adherence to standards and guidelines should minimize any possible effects.

Effects from mineral exploration and production will be similar in all alternatives, and standards and guidelines remain consistent. The magnitude of effects would vary by management intensity, as well as the specific location characteristics and type of activity occurring.

Effects on soil resources from rangeland management activities

Livestock can affect soils in several different ways. Livestock can compact, puddle, displace soil and accelerate erosion processes.

Livestock exert relatively high ground pressures from their hooves. In areas of concentrated use, cattle can compact moist or dry soils with repeated use of a trail or shaded area. Livestock can also cause puddling of wet soils, which are common in riparian areas. Compacted soils on livestock trails are typically localized and while not spatially extensive, can be subject to accelerated erosion and concentrated runoff. Areas of shade and other places where animals congregate can also be a location of compacted soils and become devoid of ground vegetation. The loss of ground cover increases the risk of soil loss.

Livestock traversing banks of non-perennial stream channels would decrease channel stability and accelerate erosion. During rainfall events sediment that has already been detached would move into the larger stream systems and weakened banks would continue to erode, decreasing bank stability and adding more sediment into the stream system.

Trampling by animal hooves reduces the infiltration of water by altering the physical properties of soil. Compaction and reduced porosity are just a few impacts of trampling (USDA NRCS 2000). This can result in lower infiltration, higher runoff, and an increased potential for erosion. These effects are intensified if soils are wet. Compacted soils are not as productive in growing crops. Reduced infiltration rates associated with compacted soils can affect the moisture available for plant growth. While these effects can occur to varying degrees over the entire area, impacts would be more pronounced in localized areas of concentrated use.

The exact effects of rangeland management activities cannot be effectively measured or evaluated at a programmatic level. Site-specific analysis would need to be done to adequately assess impacts of specific conditions and proposed management. Soil types, number of animals, current vegetation, topography and timing can all affect impacts of rangeland management activities on soils. The riparian ecosystem is very dynamic and interconnected with soil resources and they must be considered together to estimate site-specific impacts. Alternative 1 would have the least impact on the soil resources from livestock activities, due to the smaller number of acres that would be available to grazing, primarily due to the placement of increased lands in 6.1 and 6.2 management prescriptions, which only allow grazing on native pastures.

Effects on soil resources from recreation management

Recreation activities can impact soil resources. People, OHVs, horses, and mountain bikes can degrade vegetation and compact, puddle, displace, and erode soils. However, most of these activities occur at designated sites such as trails and campgrounds, which are classified as lands taken out of production. Therefore, rather than soil productivity, maintaining site stability to protect other resources (e.g. streams from sedimentation) is the primary concern. Developed campsites and trails are constructed similarly to roads and most are fairly stable long-term, given appropriate maintenance. Trails, while similar to roads, are generally less impacting due to their smaller size and lack of use by heavy vehicles.

Dispersed recreation is generally less intensive than on designated sites and usually does not result in detrimental soil impacts. Dispersed camping can occur throughout the Forest and, with the exception of frequently used or traditional camps, generally has very little impact. Localized impacts are relatively small and limited in extent across the landscape.

Effects from recreation would be similar in all alternatives. Alternatives 1 through 4 maintain the same standards and guidelines. Alternative 5 has slightly different standards and guidelines, but the intent to protect sensitive soils and reduce impacts is the same. Magnitude of the effects would vary by management intensity, as well as the specific location, conditions and type of activity occurring.

Illegal ATV and OHV use in non-designated areas or trails can have detrimental effects on soil resources, especially if they occur on steep slopes or areas of sensitive soils. Magnitude of the effects would vary by the activity intensity, as well as the specific location and conditions where it is occurring.

Summary of effects of management activities on soil resources

Table 48 shows the impacts of other Forest management activities on soil resources by alternative. The effects are shown in relative terms of high, medium, and low impacts. Site-specific analysis would be done before any management activities were accomplished, which would provide a more complete view of the impacts.

Table 48 - Summary of Effects on Soil Resources

Activity	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Transportation	Low	Medium	Medium	Medium	Medium
Timber	Low	Medium	Medium	Medium	High
Sedimentation / Erosion	Low	Medium	Medium	Medium	High
Soil Productivity	Low	Medium	Medium	Medium	High
Soil Compaction	Low	Medium	Medium	Medium	High
Fire	Medium	Medium	Medium	Medium	Low
Recreation	Low	Low	Low	Low	Low
Range	Med – High	Med – High	Med - High	Med – High	Med
Minerals	Low	Low	Low	Low	Low
Cumulative Effects	Low	Low	Low	Low	Low

The effects of management activities on soil resources would remain similar in all alternatives. Any difference that would occur is based on the projected management intensity of both timber and fire programs.

Cumulative Effects

The cumulative effects analysis for soil resources pertains to the planning period, approximately 10 – 15 years, and considers 5th level watersheds that contain all or a portion of National Forest System lands administered by the Mark Twain NF. Watersheds were used because the surface and ground water systems in the Ozarks are so connected. Impacts from soil disturbance can affect a watershed several miles away. The entire area is dissected with numerous intermittent streams, ponds and sinkholes. Much of the surface horizon of the soil column in the Ozarks has been lost because of historic land use.

At the beginning of the twentieth century, continuing through the 1920s and 1930s, clear cutting pine was widespread practice, followed by large-scale clear cutting of hardwoods. Extensive farming, annual burning, and grazing followed, and conversion of forested areas to pasturelands had to contend with re-sprouting hardwoods. Many settlers turned to intensive sheep and goat grazing and fire as the primary means of controlling hardwood re-growth and restoring grass cover. Repeated burning exposed Ozark soils to erosion, which robbed hillsides of nutrients essential for both grass and tree growth (Cunningham and Hauser 1989). The loss of ground and canopy cover was a primary cause of the erosion of the loess mantle (Jacobson and Primm 1994). During this period of settlement, it was estimated that six to eight inches of surface soil had been washed away (Law 1992). From the end of the 1930s to the end of the 1950s, public land managers became concerned with healing eroding lands, ending annual woods burning, and establishing young forests. Open range for livestock did not end until 1969 (Law 1992, Keefe 1987). As a result, many of soils in the analysis area have shallow surface horizons, low available water-holding capacities, and relatively low soil fertility.

Past activities on private lands have included conversion of forested land to pastures, timber harvest, and road building. During the conversion process to pastures, there was an increase in the sedimentation and erosion. Timber harvesting contributed to low soil productivity and increased compaction. It is not known how much additional private land would be cleared or harvested, or the miles of private roads to be constructed in the future, although impacts of these activities are anticipated to be similar to those in the past.

On Forest Service lands, past activities include timber harvesting and associated road building; log landings; temporary haul roads; mining; grazing, and wildlife openings construction and maintenance. The past activities of timber harvesting and wildlife openings conducted by the National Forest have had no documented long-term negative impact on soil productivity when standards and guidelines were applied. There is no evidence of long-term accelerated erosion in the uplands. Areas where timber harvests occurred in the past have re-vegetated and little bare soil is exposed in closed cutting units after a growing season.

There are a number of unclassified, non-system roads present on the Mark Twain NF that could be used for temporary haul roads. This would reduce the amount of new roads construction and the amount of associated sediment moved. No appreciable long-term soil disturbance effects have been identified, primarily because of methods used, and standards and guidelines that are applied. Maintenance of existing roads would continue.

Recent activities on Mark Twain NF system lands are similar to those that occurred in the past, including timber sales associated with approved management projects, grazing, and mineral exploration. Potential for erosion, compaction, and destruction of soil structure remains high in sensitive soils. Strict contract administration has and would continue to limit and avoid when possible long-term detrimental impacts.

Future activities on Mark Twain NF lands would include the completion of current projects and implementation of similar projects. Activities would be located in multiple management units and stands in a number of compartments and over thousands of acres. Activities likely to occur are regeneration harvesting; reforestation; timber stand improvement; hazardous fuel reduction; mineral exploration, grazing and fisheries, watershed, and wildlife improvement projects. Most project areas may contain soils that exhibit perched water tables, and are subject to erosion, compaction, and destruction of soil structure. Adherence to the 2005 Forest Plan standards and guidelines, and site specific mitigation measures developed at the project level, combined with strict contract administration would be critical in minimizing detrimental impacts to soil resources.

Management activities in the 2005 Forest Plan would result in some soil disturbance. This disturbance would result from any management activity that removes ground cover and disturbs the soil surface. Sediment increase associated with roads would be highest during the initial construction and reconstruction and would decrease as roads become stable and the adjacent area re-vegetates. This could take up one full growing season, or less if the re-vegetation and growing season are compatible. Closing and obliterating temporary roads is critical to bringing the erosion rate down to pre-harvest and pre-construction levels. Implementation of 2005 Forest Plan standards and guidelines would reduce sediment leaving a project area and being able to reach local drainage systems.

Regeneration harvest stands seldom have more than five percent bare soil exposed within the cutting units if proper care is taken during the harvest. Hardwood slash acts as a protective cover for soils and can help mitigate compaction if used during harvesting. Areas that have prescribed fire would have potential for soil erosion, which could result from fireline construction and in some instances from the burn unit. The increase in erosion from the burn unit would be a direct result of fire intensity, or the amount of ground cover removed. Burning with a cooler fire usually results in minimal soil erosion due to the protective duff layer that is still present. Any increase in soil erosion is usually of very short duration. In areas where various selection harvests (seed tree, shelterwood, thinning, sanitation cuts, uneven-aged management, overstory removal, etc.) occur, some minor soil erosion would be expected. In these areas there would be enough ground cover or slash to protect any bare mineral soil. Similar management activities would potentially be proposed in the reasonably foreseeable future and would be accompanied by the appropriate standards and guidelines.

Overall the cumulative effects on soil of activities on the Mark Twain NF, if standards and guidelines are implemented, should remain negligible. Due to the fragmented ownership pattern, management that occurs within on National Forest lands is small compared to the ownership and activities that occur on private lands and other public ownerships.

Geologic Features

Introduction

Geologic materials (bedrock) and processes are a factor in determining the areal extent of landforms and associated vegetation; the distribution and composition of soil parent material; wetland characteristics; glades or barrens; riparian and stream substrates; quantity and quality of surface water and ground water. Geologic processes include erosion, transport and deposition of sediment; mass wasting; flooding; changes in stream channels; groundwater flow; faulting, and fracturing. The underlying bedrock in response to these processes has created many geologic features such as high bluff and cliffs; glades; knobs; shut-in creeks, and karst features such as caves, springs, sinkholes and losing streams. These physical geological features provide unique and specialized habitats for many plant and animal species, in addition, to scenic views, recreational opportunities, and cultural significance.

The Forest has a wide variety of bedrock, from the igneous granitic and felsitic rocks to glaciated tills. The dominant bedrock of the Ozark Highlands, where the majority of the Forest is located, is dolomite and limestone. These rocks are composed of calcium carbonate, which is less resistant to weathering processes than the granitic or sandstone rocks which have higher quartz content. Water movement over the surface and within the easily weathered limestone and dolomite has created the most prominent and sensitive geologic features on the Forest, known as karst features. Karst features include caves, sinkholes, losing streams, springs, and some glades, cliffs, bluffs and outcrops.

Proposed Changes

The management direction for Geological features will remain essentially the same. The basic difference between Alternative 5 (1986 Forest Plan) and Alternatives 1-4, is that additional mitigation measures were designed for the latter to further protect unique habitats associated with geological features, such as bluffs, cliffs, and the many karst features. General Forest standards and guidelines will include the following:

- continued inventory of caves,
- protection of cave resources,
- prohibiting mechanical fireline construction within 100 feet of known caves;
- designating 10 acres over a known cave as old growth;
- locating new trails 100 feet from the entrance of a cave;
- designating cliffs and bluffs as management prescription 8.1, when listed or qualified for listing as a significant, exception or notable natural feature by the Missouri Natural Heritage database;
- minimize surface disturbance within 100 feet of cliffs, bluffs or outcrops;
- prohibit or restrict activities within 100 feet of springs or sinkholes;
- do not locate common variety mineral pits (gravel pits) on karst features;
- prohibition of timber harvest within 100 feet of cave entrance.

Affected Environment

The Mark Twain National Forest has numerous unique geologic features on the landscape. Significant geologic features are identified with Special Areas, Natural Areas, Recreational Areas and Wilderness. Many other geologic and karst features are associated with special or unique habitats; many are home to threatened and endangered species. The following are many geologic feature types located on the Mark Twain.

Caves and natural bridges

The Federal Cave Resource Protection Act of 1988 defines caves as "any naturally occurring void, cavity, recess, or system of interconnected passages which occurs beneath the surface of the earth or within a cliff or ledge and which is large enough to permit an individual to enter, whether or not the entrance is naturally formed or human-made", including any natural pit, sinkhole or other feature which is an extension of the surface.

The Mark Twain inventory contains over 500 caves, with the majority on the Eleven-Point District. Caves on the Mark Twain vary in size from those that would just provide shelter to a person to those with miles of passages. Cave resources such as paleontological deposits, sediments, minerals, speleogens, and speleothems may be found in caves. Not only do caves have a wide range of unique geologic features they also support very site specific wildlife.

Natural bridges are typical features of the Ozarks karst terrain. Natural bridges tend to be the remnant roof of an underground cave or tunnel.

Caves and natural bridges are popular recreation destinations on the Mark Twain NF.

Bluffs, Cliffs and Outcrops

Bluffs, large steep-sided rock outcrops, are scenic geological features. Very steep, straight bluffs and cliffs maybe created from natural vertical fractures. The erosion of thickly stratified bedrock contributes greatly to the creation of bluffs. Many of the sheerest bluffs tend to occur on the outside bends of streams where the water is extremely erosive. Bluff coloration is a function of chemical composition of the rocks. Sutton Bluff and Red Bluff recreation areas offer scenic views.

Numerous rock outcrops are found in nearly every corner of the Mark Twain National Forest. The majority of these features have not been mapped. Outcrops of pre-Cambrian rocks can be found at the Silver Mines Recreation Area, and in Bell Mountain and Rockpile Wilderness Areas.

Sinkhole

Sinkholes, like caves, are common features in areas of karst topography. Sinkholes develop as a result of the collapse of surface or near-surface material into underlying cavities. Two types of sinkhole-forming collapses are carbonate rock and overburden collapses. Carbonate rock collapse occur when the enlargement of cave passages in carbonate rock causes the roof above the passage to weaken and eventually collapse. Overburden collapses are more common then carbonate-rock collapses (U.S. Geological Survey 1985) and generally start as soils and residuum is washed into and through underlying solution channels. The remaining overburden bridges the opening as more material is removed, until the resulting overburden arch loses support and collapses. Aley (1975) reports most sinkholes in the Ozark springs study area are developed within the soil and residuum horizons, and bedrock outcrops seldom occur in these sinkholes.

These features are characterized by a rounded depression in the landscape formed by collapsed portion of bedrock above a void. Sinks may be a sheer vertical opening into a cave, or a shallow depression. They vary in size from a few inches to hundreds of feet in diameter. Slaughter Sink and Conical sink are greater than 100’ feet in diameter. The majority of sinks across the Forest are much smaller.

There are over 420 mapped sinkholes in current Mark Twain National Forest ownership. The Eleven Point and the Houston / Rolla Ranger Districts have the highest concentration of known sinkholes. Due to the geology of the areas, the Cassville and Fredericktown units have no mapped sinkholes.

The public has turned many sinkholes located on private lands, and some on Forest Service land into trash dumps. A trash dump located in a sinkhole has a prime opportunity to contaminate subsurface waters because of the nature of sinkholes because of the way they are created by the collapse of surface or near-surface material into underlying cavities. As water passes through trash in the sinkhole, it can pick up large amounts of heavy metals, any other chemicals that maybe present including motor oil, gasoline, freon, etc., and then be transported into the subsurface. The water passing through a landfill has been shown to be a major contributor to groundwater contamination (Qasim 1994).

Environmental Consequences

Geologic features listed here are affected by activities that occur in and on their locations. Management activities can cause direct effects primarily when they occur on the features themselves.

Most activities that would affect these sites are from direct disturbance of the area. Standards and guidelines are proposed that would limit these types of activities. Buffers are additional protection for features that can influence surface and ground water systems.

Standards and guidelines would be the same for Alternatives 1 through 4. These measures go beyond what is in Alternative 5. These features have been recognized as sensitive and unique and additional measures have been created to provide more protection. Additional features, such as cliffs, bluffs, and rock outcrops are protected from direct disturbance in Alternatives 1 through 4.

Direct and Indirect Effects

Effects from Transportation system

Road construction could result in physical changes or structural damage to karst features or other geological features. All alternatives have standards and guidelines designed to protect or minimize any damage to geological features.

Ground disturbance activities associated with the transportation system would have the greatest impacts on sinkholes, cliffs, bluffs, rock outcrops, and caves. Soil disturbance could increase sedimentation and erosion leaving the site. In sinkholes and caves this impact could affect the ground water system as well. New construction near cave entrances and over cave passages could affect the stability of the complex. The placement of roads could direct water flows to or from sinkholes and caves, which would alter the hydrologic regime of the area and could impact the natural communities present.

Alternatives 1 through 4 provide extensive guidance to avoid geological and karst features. These include: avoiding road construction above known cave passages, within 100 feet of known caves, sinkholes and other karst features, bluffs, cliffs, and outcrops and glades or within losing streams. Effects would be minimized in all alternatives, but to a greater degree in Alternatives 1 through 4.

Effects from Timber Management Activities

The ground disturbance activities associated with timber management would have the greatest impacts on sinkholes, cliffs, bluffs, and rock outcrops. Soil disturbance could increase sedimentation and erosion leaving the site. In sink holes this impact could affect the ground water system as well.

The potential would also be there for sedimentation to accumulate in a cave system. This could affect the ground water system as well as conditions in the cave. The micro climate of a cave could also be altered by the removal of the surrounding vegetation.

Alternatives 1 through 4 provide additional standards and guidelines such as prohibiting timber harvest activities within 100 feet of the edge of a sinkhole, cave entrance, bluff, or cliff. Wider buffer zones, if necessary would be identified through site-specific analysis. Effects would be minimized in all alternatives, but to a greater degree in Alternatives 1 through 4.

Effects from Mineral Exploration and Development

All alternatives have standards and guides designed to protect or minimize any damage to geological features during surface disturbing activities associated with mineral exploration and development. Alternatives 1 through 4, however, provide additional guidance to avoid geological and karst features. These include prohibiting surface-disturbing mineral activities within 100 feet of cave entrances, springs, or sinkholes, and restricting the location of common variety mineral areas in karst features. Effects would be minimized in all alternatives, but to a greater degree in Alternatives 1 through 4.

Overall Effects from Management Activities

In general, there would be little difference in the effects to geologic features on the Mark Twain NF by alternatives. Adherence to standards and guidelines would protect caves and abandoned mine areas, springs, wetlands, and sinkholes to some degree in all alternatives. Alternatives 1 through 4 provide additional protection for these habitats as well as recognizing the importance and uniqueness of cliffs, bluff, and rock outcrops.

Impacts to these features from all management activities would be from actual ground disturbance in these locations. When standards and guidelines are implemented, impacts of management activities conducted on the Mark Twain NF would be negligible. Exact impacts are difficult to access at a programmatic level. A site-specific analysis would be done to determine the actual effects to a given feature.

Cumulative Effects

The temporal boundaries for the cumulative effects analysis is the planning period, approximately 10 – 15 years. The spatial boundaries are the proclamation boundary of the Mark Twain NF. The entire Forest is scattered with numerous springs, caves, rock bluffs, outcrops and other geologic features. Impacts on several of the geologic features discussed have effects on the watershed and water systems of area.

On public lands, the past and present timber harvesting and other management activities by the Mark Twain NF has had no documented detrimental long-term effect on the integrity of various geologic features discussed. In the future, similar management activities will most likely continue to take place. With standards and guidelines properly implemented, these activities would have no appreciable long-term negative effects in the area.

Past, present and future land use of privately owned lands in the area is not expected to change. Much of the area is occupied by private homes and small farming operations, with a few urban areas. On private lands, timber harvesting and grazing activities will continue to occur. In the past, much of the private land was overgrazed and over burned to facilitate conversion from forested lands into pastures, or to keep glades open

Privately owned sinkholes as well as some on Forest System lands have been used as trash dumps in the past. This practice will most likely continue into the future. If a hazardous waste did enter one of these conduits, it could have negative impacts on the ground water. This could affect private and public lands due to the transient nature of water. It has been and will continue to be illegal to dump trash on National Forest lands, whether in a sinkhole or not.

The incremental impacts of past, present and future management activities on the Mark Twain NF would have no appreciable cumulative effects to the geologic features of the area, nor would they impair the long-term productivity. However, it could be anticipated that the standards and guidelines and other mitigation measures would provide positive effects through identification and protection of the features.

Range

Introduction

Suitable rangelands are open lands of grasses or shrubs capable of producing forage for livestock. Range management by grazing or haying on the Mark Twain NF is currently done in warm and cool season grass pastures and glades. Wildlife also use pastures and glades for food and shelter.

Management of rangelands requires coordination with other resources and uses. Standards and guidelines have been designed to minimize impacts on soil, water, and other important resources while ensuring that desired structure and species composition of rangeland vegetation is moved toward or attained. Frequent monitoring of range allotments is important to ensure that use is occurring at expected levels and resource quality and function is not impaired.

Proposed Changes

Some editorial changes were made in the 2005 Forest Plan, including removal of current FSM and FSH direction concerning range management.

The need to manage for ecological sustainability and ecosystem health (revision topic 2) resulted in two substantive changes to 1986 Forest Plan standards. One will eliminate livestock grazing in open woodland and glade natural communities so healthy ecological conditions can be achieved. The other ensures that grazing allotments in riparian management zones will be closed at the earliest opportunity. Monitoring will occur to ensure these standards and guidelines are implemented.

Affected Environment

Before European settlement, great numbers of American bison, elk and white-tailed deer roamed freely throughout Missouri. The abundance of food, water, topography, predators, and seasonal migration behaviors were factors affecting the distribution of these native herbivores. These native grazers moved about the landscape and rarely revisited the same plant population during a growing season. Congregating around water sources might have led to localized grazing pressure, but the immense regional scale of high quality native vegetation buffered any lasting significant effects from this behavior. Prior to the introduction of modern exotic plant species, native plants repopulated areas impacted by local grazing pressure.

Following European settlement, humans greatly altered or eliminated bison, elk and deer populations and their grazing patterns through direct harvest or habitat destruction. By 1850, large scale commercial farming and livestock grazing had begun across the state. Large numbers of free ranging cattle, goats, sheep, hogs, and horses foraged across woodlands, savannas, glades, and forests, eventually stripping them of most of their abundant native grasses and wildflowers. This era of resource exploitation, coupled with extensive land clearing, resulted in soil loss and erosion that degraded watersheds and altered forage conditions across the Ozarks.

Much of the Ozarks has now grown back in dense black and red oak forests that have little ground flora, and which have no suitable forage for livestock, and very little for wildlife. After establishment of the Mark Twain NF, range management began to reverse effects of decades of uncontrolled grazing. However, open range grazing was legal in Missouri until 1969; livestock and wildlife shared much of the Forest lands until that time. Recovery of watersheds, soils, and vegetation has progressed since then, but many watersheds still exhibit signs of degradation that can be traced back to overgrazing, over cutting, and other poor management practices that occurred before these lands became National Forest.

Most of the current range allotments on the Mark Twain NF are made up of purchased farms that were originally pastureland, cropland, glade, or open woodlands. Many of these allotments are now primarily cool season pastures consisting of tall fescue, orchard grass, and other annuals and perennials. Nine current allotments include glade and open woodland natural communities.

Between 1980 and today, the number of grazing allotments has declined approximately 39%. The number of animals grazing is also decreasing. These declines have come from the closure of some allotments to meet 1986 Forest Plan Standards and Guidelines or as a result of lower investments in some allotments that have allowed them to revert to woody vegetation.

Table 49 – Mark Twain NF Range Allotments 1980 and 2004

Year	Number of allotments	Acres[1]	Capacity acres[2]	Animal Unit Months (AUM)[3]
1980	184	Not Available	Not Available	Not Available
2004	112	52,092	20,640	26,635

1. Total acres within current active and inactive (vacant) allotment boundaries.
2. Actual acres that could be grazed or hayed in active or inactive allotments. This shows that only about 40% of the area within allotment boundaries are actually being grazed/hayed.
3. A measure of the quantity of forage required to feed one mature cow for one month.

Suitability Analysis

As part of Forest Planning, an analysis of all Mark Twain NF lands was conducted to determine which lands are suitable for grazing and to determine which of these lands are appropriate for grazing. Only areas that are in an open condition (grasses and shrubs and without trees) are considered suitable. Excluded are open areas within Wilderness, the Eleven Point National Scenic River, Greer Springs special management area, roads, and the Van Buren administrative site. Glade and riparian natural communities and some special areas are not appropriate for grazing. The following table shows the acreages for suitability and appropriateness determinations. Total current acres appropriate for grazing are 32,182. Comparing this number to total current capacity acres within allotments (20,640) indicated there are about 11,542 acres of open land that is appropriate for grazing that is not currently within allotments.

Table 50 – Mark Twain NF Lands Suitable and Appropriate for Grazing

	Acres	Total Acres
Lands Suitable for Grazing		
Mark Twain National Forest		1,496,100
Forested Lands with trees, Roads, Water	1,426,270	- 1,426,270
Total Open Lands Suitable for Grazing		69,830
Lands Not Appropriate for Grazing		
Open lands within Wilderness	15,822	
Glades	11,801	
Special Areas (springs, fens, sinkholes)	282	
Riparian Area	9,743	
Total Lands Not Appropriate for Grazing	37,648	-37,648
Total Lands Suitable and Appropriate for Grazing		32,182

Glade, woodland, and riparian natural communities are excluded from lands appropriate for grazing due to concern for their ecological sustainability and ecosystem health. Glades and woodlands are unique natural communities that provide habitat for many sensitive plant and animal species. Past heavy grazing has greatly diminished the original diversity of grasses, sedges and wildflowers on glades and in woodlands. Heavy grazing has accelerated eastern red cedar invasion. Consequently many glades and woodlands are currently degraded and outside their range of natural variability. Around 1969, open range was discontinued and intensive management of some glade communities began using cedar control and prescribed fire. While this has improved the condition of some glade communities, they are far from being productive or sustainable ecosystems. Currently the general ecological condition of glade and woodland natural communities is poor. With few exceptions, existing glades and woodlands do not have sufficient natural integrity to reintroduce or sustain grazing in such a manner that would allow recovery of the natural community. Thus, the determination was made to include standards and guidelines in the 2005 Forest Plan to remove livestock grazing from glades and woodlands entirely in management areas 1.1 and 1.2, where the primary emphasis is restoration of ecosystem health. All other management areas are covered by the forest wide standards and guidelines that provide for the modification or termination of grazing when necessary to ensure glade and open woodland natural communities move toward desired conditions. .

Riparian ecosystems are important habitat for many plant and animal species. Concentration of livestock in or near streams and rivers contributes high levels of nitrogen to the aquatic system causing excessive aquatic plant and algae growth. Ground compaction, sedimentation, destruction of riparian vegetation and introduction of non-native invasive species can also occur in the riparian ecosystem near streams and rivers due to concentrations of livestock. Standards and guidelines have been developed in the 2005 Forest Plan that would help prevent adverse effects from occurring in riparian areas where grazing occurs. These standards and guidelines would also help achieve desired vegetative structure and species composition within riparian areas by controlling livestock grazing. Additionally, grazing within riparian ecosystems would be eliminated at the earliest opportunity during the plan period and riparian community restoration measures would be initiated on grazed areas of allotments.

Environmental Consequences

Current active and inactive allotment capacity acres available (those acres on an allotment that may actually be grazed or hayed) form the basis of effects comparisons between alternatives. Total acres of allotments available are not as good of a measure (as capacity acres) because some current allotments include land unsuitable or not available for grazing.

In many cases, this is due to allotment boundaries falling along topographical features that are well outside the actual open land available for grazing or haying.

Effects by alternative are also described in animal unit months (AUMs). This is a measure of the quantity of forage required to feed one mature cow for one month. Since capacity acres are where the forage is being utilized and counted toward the AUMs calculation, it is appropriate to use capacity acres as a basis for comparison for effects to the range program.

Effects Common to Alternatives 1 Through 4

Forest-wide standards and guidelines do not vary for Alternatives 1 through 4. They incorporate range management direction designed to protect Forest resources and facilitate establishment of healthy ecosystems and restoration of natural communities. Over the long term, the 2005 Forest Plan is expected to improve ecological sustainability and ecosystem health of rangelands on the Mark Twain National Forest.

The amount of grazing occurring on current allotments on the Mark Twain National Forest would decline under Alternatives 1 through 4. This is due to proposed Plan direction that would require closing allotments in some areas in order to move natural communities toward their desired condition. Each alternative will result in different amounts of capacity acres available and potential AUMs from grazing or haying because the alternatives have different land allocation amounts, and each land allocation prescription has specific standards for the range program.

Capacity acres described as available for grazing or haying under each alternative do not include riparian areas. Standards and guidelines ensure grazing in those areas would be foreclosed at the earliest opportunity so these have been removed from the acreage displayed by alternative as well as the AUM estimates for each alternative.

Although Alternatives 1 through 4 result in reductions in capacity acres available and AUM potential in current allotments, there are many acres of open lands on the Forest that could be analyzed and made available for range management under any alternative. The AUM production of the range program would remain stable if additional permits are requested to offset lost AUMs from closed allotments.

Direct and Indirect Effects

Alternative 1

Of the approximately 52,000 acres within current allotment boundaries on the Forest, 7,803 capacity acres would be available for grazing or haying in Alternative 1. Approximately 10,036 AUMs would be produced. This is about a 63% reduction in AUMs produced by the current program. This reduction in AUMs may be offset by the approval of new grazing or haying allotments in ecologically appropriate areas.

Approximately 77% of the Forest would be in Management Prescription 6.2 which limits investments for grassland management to low levels. More importantly, vegetation different than the natural community for a particular site, such as a fescue pasture, would not be maintained. Livestock grazing or haying could occur on native grasslands, such as warm season native grass pastures, as a tool to maintain structural or species diversity. There are approximately 6,226 acres of native grasslands within current allotments that would occur within the 6.2 management area in Alternative 1.

Approximately 8% of the Mark Twain NF would be in Management Prescription 1.1, where grazing or haying is permitted only on existing allotments of improved pastures. Improved pastures are pastures where activities such as fencing, seeding of desired species, herbicide for removal of non-desirable vegetation, or fertilization has occurred. There are approximately 596 acres of improved pasture occurring within MP 1.1 in Alternative 1.

The remaining 13% of Mark Twain NF lands would be in management areas that contain approximately 981 acres both native and non-native grass pasture land in allotments that would continue to be available for grazing.

Alternative 2

Approximately 10,153 capacity acres within current allotments would be available for grazing or haying as follows:

- About 39% of Mark Twain NF lands would be in MP 1.1. There are approximately 1,830 acres of improved pasture in existing allotments that would be available for grazing.
- About 31% of Mark Twain NF lands would be in MP 2.1. This includes 6,984 capacity acres of grassland in existing allotments.
- About 17 % of the Mark Twain NF lands would be in MP 6.1 and 6.2. Currently, existing allotments contain about 40 capacity acres of native grass pastures.
- The remaining 13% of Mark Twain NF lands would be in management prescriptions that contain approximately 1,299 capacity acres of grassland within existing allotments that would remain available.

Approximately 22,660 AUMs would be produced from the current allotments. This would be about a 15% reduction in AUMs produced. This AUM reduction could be offset by the approval of new grazing/haying permits in ecologically appropriate areas.

Alternative 3

Approximately 10,820 capacity acres within current allotments would be available for grazing or haying and would be distributed as follows:

- About 25% of the forest would be in management area 1.1. Approximately 1,321 capacity acres of improved pastures occur in existing allotments and would be available for grazing.
- About 45% of the forest would be in management area 2.1. Approximately 8,160 capacity acres of grassland occurs in existing allotments that would remain available for grazing or haying.
- About 14% of the forest would be in management area 6.1 and 6.2. Approximately 40 capacity acres of native pastures occur within existing allotments and would remain available for grazing.
- The remaining 16% of the Mark Twain NF lands would fall in management areas that would allow approximately 1,299 capacity acres within current allotments to be available for grazing or haying.

Approximately 23,102 AUMs would be produced from the current allotments. This represents a 13% reduction in AUM production for this alternative. This AUM reduction could be offset by approval of new range permits in ecologically appropriate areas if demand warrants.

Alternative 4

Approximately 11,384 capacity acres within current allotments would be available for grazing or haying and would be distributed as follows:

- About 8% of the Forest would be in Management Prescription 1.1. This would allow approximately 596 capacity acres of improved pastures within current allotments to be available for grazing or haying.
- About 62% of the Forest would be in Management Prescription 2.1. This would allow approximately 8,877 capacity acres of grassland in current allotments to remain available for grazing or haying.
- About 17% of the Forest would be in MP 6.1 and 6.2. About 821 capacity acres of native pastures in current allotments would continue to be available for grazing or haying.
- The remaining 13% of the Mark Twain NF lands would fall under management prescriptions that would allow an additional 1,090 capacity acres of grasslands in existing allotments to be available for grazing or haying.

Approximately 22,925 AUMs would be produced from current allotments under this alternative. This represents a 14% reduction in AUMs. This AUM reduction could be offset by the approval of new grazing or haying permits in appropriate areas. .

Alternative 5

This represents a continuation of the 1986 Forest Plan management areas and standards and guidelines. Alternative 5 is less restrictive than the other alternatives, and would not cause a significant decline in the current grazing program. Grazing and haying would be allowed to continue on glades and open woodlands in all management areas. Grazing would be phased out in riparian areas. Of the approximately 20,640 capacity acres that are currently in allotments, approximately 1,547 acres would be closed due to encroachment into riparian areas. A total of 26,635 AUMs would be produced.

Summary of Alternatives 1-5

Table 51 – Effects to Range Program in Capacity Acres and AUM's

Unit of measure	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Capacity Acres	7,803	10,153	10,820	11,384	20,640
AUMs *	10,036	22,660	23,102	22,925	26,635

Cumulative Effects

The cumulative effects are evaluated for the twenty-nine county area in which National Forest lands occur.

The time period for which the past, present, and reasonably foreseeable cumulative effects on the Range Program are being estimated is the plan period for the 1986 Forest plan and the 2005 Forest Plan. Past and current actions have resulted in about 52,000 acres of National Forest lands with current allotment boundaries with about 20,640 capacity acres actually being available for grazing or haying. Reasonable estimates of future actions range from a maximum of about 20,640 capacity acres in Alternative 5 to a minimum of about 7,803 capacity acres in Alternative 2.

Within the twenty-nine county area, about 3,546,000 acres of private rangeland is grazed or hayed. The amount of actual grazing or haying acres on the Mark Twain National Forest (currently 20,640) are insignificant (.6%) compared to the acres of range management occurring on private lands. Any reduction of available range acres or AUM production would not significantly affect the livestock industry in the twenty-nine county area. Some individual permittees may be affected if the selected alternative required an allotment be modified or closed due to new standards in the Forest Plan. The effect on these individuals may be minimized by adjusting their existing allotment or offering additional areas for their use.

There are no known cumulative effects on the Forest Range program at this time, and all cumulative effects that could potentially occur are expected to be minor and manageable with the implementation of the 2005 Forest Plan standards and guidelines. At the site-specific level of analysis, situations where resource conflicts are identified will be addressed using special mitigation measures or management alternatives.

Access and Transportation Management

Introduction

Proposed Changes

The goal of developing minimum permanent road access needed to meet resource management needs would be changed to maintaining a minimum permanent road system. The transportation system of the Mark Twain is largely in place. Management emphasis will be placed on maintaining and reconstructing existing roads, rather than constructing new roads. Other goals and objectives of the 1986 Forest Plan will be continued.

Additional standards and guidelines to be considered during planning and design of roads shall minimize impacts to a variety of natural resources, such as; streams, springs, fens, soil, aquatic and terrestrial plant and animal species, caves and karst features, sinkholes, and glades. During construction or reconstruction of roads, road drainage features will spread, infiltrate, or retain water in a manner that reduces negative environmental effects.

Temporary pools associated with road drainage features will provide habitat for amphibians and other wildlife species. Bat habitat will be considered during bridge design and construction. Re-vegetation will follow soil-disturbing activities. Maintenance activities will focus on safe and efficient travel by motorized vehicles.

Current FSM and FSH direction concerning the transportation system will be followed. References to national direction and policy have been removed, such as signing along roads and designation of Forest Highways.

Use of National Forest System roads by motorized vehicles will be in accordance with State law and closure orders in order to provide for safety of users, the protection of Forest resources, and to meet resource management goals.

Roads may have restricted access to protect natural resources, due to funding shortages for maintenance, to reduce conflicts, or enhance the ROS setting.

Roads under jurisdiction of the Forest Service and determined to be unnecessary will be decommissioned. Unnecessary roads are those that are not needed for long-term access for Forest resource activities, to private property, or for maintenance of utility structures. Priority for decommissioning will be those roads that cause the greatest risk to either public safety or unacceptable resource damage.

Affected Environment

National Forest System roads (system roads) serve a wide variety of resource management and access needs related to ecosystem sustainability, commodity extraction, recreation opportunities, social values, and administrative uses. Some of these roads may also provide access to private property within national forest boundaries. The transportation system of the

Mark Twain is in place, and includes a network of public and private roads, trails, rail-lines, waterways, and utility corridors. Access or the elimination of access is a key concern of the public, whether at site-specific locations or identified as general Forest-wide goals (Road Analysis Report, Maintenance Level 3 and 4 Roads 2003).

Many issues concerning road management on the Mark Twain National Forest involve unclassified, or non-system roads. These are historic roads constructed or developed by users before the land was incorporated into the National Forest System or prior to development of the 1986 Forest Plan. Many of these roads have been identified as not needed for Forest Service management and are not maintained. According to the 1986 Forest Plan, all unclassified roads are to be closed. Normally these closures occur when project-related temporary roads in the area are closed upon completion of management activities.

Activities such as unauthorized use of vehicles in prohibited areas, theft of forest products, trash dumping, arson, poaching, possession of illegal drugs and alcohol, illegal drug manufacturing, growing marijuana and vandalism are some of the problems with the Forest road network. (Road Analysis Report, Maintenance Level 3 and 4 Roads 2003)

Some communities near the Mark Twain NF are experiencing accelerated growth and retirees are moving out of urban areas, resulting in private property in or near the Forest being developed for housing. With this development comes an increase in traffic from individuals commuting to work, visiting friends or relatives, or for leisure activities. This has resulted in increased demand for better road maintenance of system roads. Where the Forest has not been able to provide adequate maintenance on these system roads, the respective county has been contacted to determine if a change in jurisdiction is warranted. During the past decade, more than 100 miles of roads have had a deed of easement granted to counties. It will continue to be national forest policy to pursue turning over jurisdiction of Forest roads that receive non-Forest traffic to the local county, where such an agreement can be made between both agencies.

This development trend has also resulted in an increase in the number of special-use road permits issued, allowing access across national forest to private property. Special-use permit holders are responsible for maintenance of permitted unclassified roads. Currently there are over 250 special use permits for use of unclassified roads to access private property across the Mark Twain NF. Additional requests for road special-use permits are expected to continue.

Due to the Forest’s intermixed ownership, numerous private roads are located within Mark Twain administrative boundaries as well. As shown in Table 52, the Forest manages about 33% of the 7,261 miles of public road within its administrative boundary. Of the 4,604 miles that traverse Forest Service-managed land, 51% are under Forest jurisdiction. Public roads within the Mark Twain NF are maintained by a variety of local and state agencies. In addition to these public roads, the Department of Defense manages roads within Fort Leonard Wood, which is located within the administrative boundary of the Forest. Occasionally, the Forest must coordinate with the Department of Defense for gaining motorized access to portions of Forest-managed land.

Table 52 - Miles of Public Roads on the Mark Twain NF

Route type	Total miles within administrative boundaries	% total miles within administrative boundaries	Total miles on NFS land	% total miles on NFS land
National Forest System Road	*2,364	33	**2,349	51
County	3,206	44	1,559	34
Missouri Dept of Transportation	1,430	20	628	14
US Highway	155	2	58	1
Interstate	31	<1	7	<1
Town or City	60	1	0	0
Missouri Dept of Conservation	15	<1	3	<1
Total	7,261	100	4,604	100

Source: MTNF GIS data

**Two miles of National Forest System road are outside the administrative boundaries.*

***Seventeen miles are located by easement across private land.*

Based on queries from the Forest's GIS road layer, the Mark Twain NF manages 2,366 miles of National Forest System road. Based on queries from the Forest's INFRA Travel Routes database, the Mark Twain NF manages 2,353 miles of National Forest System road. The difference in mileage between GIS and Travel Routes is 13 miles, or less than 1% difference between the spatial and tabular data sources. GIS data will be used for spatial analysis and display of roads. Travel Routes will be used for tabular analysis. The following road information is based on Mark Twain NF Travel Routes road data as of July 22, 2004.

System roads have varying surface materials. There is approximately 46 miles of asphalt, 1454 miles of aggregate, 13 miles of improved surface, and 840 miles of native surface road. Approximately 64% of National Forest System roads have an asphalt, aggregate, or improved surface and have been constructed or reconstructed to provide vehicle access and require periodic maintenance to sustain a safe and efficient travel way. Maintenance also reduces negative impacts to surrounding resources. The remaining 36% of National Forest System roads, with a native surface, may require reconstruction before commercial activities can take place on them.

The function of system roads varies throughout the Forest. Approximately 2,031 miles of National Forest System road serve as local roads, 158 miles as collector roads, and 164 miles as arterial roads. The arterial and collector roads, which compromise roughly 14% of the transportation system, generally receive some of the highest traffic volumes and are designed and maintained for passenger car traffic. Local roads, which make up the majority of the transportation system (86%), are generally dead-end roads designed and maintained for use by high clearance vehicles.

All National Forest System roads have an assigned maintenance level, from 1 to 5. Approximately 16% of the roads have an assigned maintenance level of 3 or 4, make up the backbone of the Forest transportation system, and receive the greatest amount of traffic. Approximately 83% are maintenance level 2, are suitable for high-clearance vehicle travel, and generally dead-end. The remaining 1% is assigned maintenance level 1 and is impassable due to vegetation growth. There are no maintenance level 5 roads on the Mark Twain NF.

In summary, the majorities of National Forest System roads are dead-end local roads, suited for high clearance vehicles, and have an aggregate or native surface.

Environmental Consequences

Direct and Indirect Effects of Alternatives 1 through 4

Road Density

Since the transportation system identified in the 1986 Forest Plan is largely in place, more existing roads are reconstructed rather than the construction of new roads to accomplish resource objectives. The result should be very little change in current road density. The Forest is focusing on maintaining the current transportation system. There is a lack of scientific data and research showing the correlation between road density and effects on biological resources in Missouri. Other factors, such as traffic volume and speed, amount and frequency of road maintenance, and location, may have a greater effect on wildlife, soil, and water. However, there are some social effects from road density. More roads reflect an increase of human presence and their ability to impact the natural environment.

For Alternatives 1 through 4, ROS objectives of each management prescription will be used during project level analysis to determine how roads will be managed. Access and travel management within a management area will complement its ROS classification. During roads analysis, road management recommendations will protect or enhance the ROS of the management area.

Rather than relying on road density standards, all road management proposals will be analyzed in the context of other roads and modes of access in management areas. There would be no direct or indirect effect from removing road density standards from the Forest Plan for Alternatives 1-4.

Woods Roads

The term woods road has led to confusion because the public and many Mark Twain NF employees commonly use it to mean any road in the forest, including unclassified roads that are not part of the Forest's permanent transportation system and are to be decommissioned.

For Alternatives 1-4, the term "woods roads" would be removed. Forest Service terminology defined in FSM 7700 would be used throughout the 2005 Forest Plan. All roads under Forest Service jurisdiction needed for long-term access will be referred to as National Forest System roads in the 2005 Forest Plan. The term "National Forest System road" is synonymous with the term "forest development road". Each National Forest System road is assigned a maintenance level of 1 to 5, with 5 being the highest. Non-system roads will now be referred to as unclassified roads.

All National Forest System roads will be managed and classified according to FSM and FSH 7700. There would be no direct or indirect effect from removing woods roads terminology from the 2005 Forest Plan.

Forest Plan Transportation Map

The 1986 Forest Plan transportation map, Alternative 5, shows roads to be constructed, re-constructed, or maintained during the planning period, for each administrative unit. The programmatic map tried to identify site-specific road activities that may or may not have been complimentary to resource management objectives or needs. Some roads were poorly located on the map and could have negative impacts to water, soil, or other resources. Others lacked easements across private property.

Mark Twain NF currently manages 2,353 miles of National Forest System road. This mileage differs from the 2,608 total road miles shown on page IV-85 in the amended 1986 Forest

Plan. It is unclear why there are fewer miles of National Forest System road than those projected in the 1986 Forest Plan, especially since road construction was a small part of the road system. One possible reason is that the Forest has transferred jurisdiction of more than 100 miles to Missouri counties, land exchanges and an interchange with Fort Leonard Wood, have also reduced the number of Forest Service roads. While these transfers and exchanges are reflected on the GIS layers and in the Travel Routes database, only additions were documented in Forest Plan amendments.

During development and maintenance of a Forest transportation atlas the Forest Service Manual (FSM) 7700, Chapter 7710, directs the National Forest to comply with 36 CFR 212.2. Information contained in this atlas, along with the GIS roads layer for each district and the Forest-wide Travel Routes database, is designed to contain adequate information for management of the Forest's transportation system. For The Forest Plan transportation map would be replaced with the required Forest transportation atlas in Alternatives 1-4. The transportation atlas is dynamic with road management objectives based on resource management needs. Changing the transportation atlas does not require forest supervisor approval or a Forest Plan amendment. Rather, changes to the transportation atlas will be based upon roads analysis recommendations during project-level environmental analysis.

Due to current FSM 7700 direction and technology, the transportation atlas will replace the Forest Plan transportation map. There would be no direct or indirect effect from removing the Forest Plan transportation map from the Forest Plan.

Direct Effects on Access for Alternative 1

Alternative 1 allows no commercial timber harvest, which would result in less funding for reconstructing and maintaining National Forest System roads. Road maintenance and reconstruction activities to provide safe and efficient travel ways would be limited to funds appropriated by Congress. In addition, the Forest would have less need for motorized access for commercial timber activities. Many maintenance level 2 roads would no longer be needed for long-term access.

Over time, system roads would deteriorate due to lack of or need for maintenance, resulting in active or passive decommissioning of some routes. The Forest would focus road funding on those roads receiving the highest traffic volumes, generally maintenance level 3 and 4 roads. Fewer maintenance level 2 roads, designed for high clearance vehicles, would be usable or open to the public. Miles of maintained National Forest System road would decrease, resulting in reduced motorized access including motorized recreational activities like viewing scenery and driving for pleasure.

Direct Effects on Access for Alternatives 2 through 5

National Forest System roads are a primary means by which commodities, especially timber, are managed and removed from the Forest. Adequate access is needed to manage timber and other resources for both commercial and non-commercial uses. Road access is also needed for continued improvement and maintenance of wildlife habitat, reforestation, timber stand improvement, noxious and invasive weed control, and open land maintenance. Road access also allows for a variety of recreation activities, such as driving for pleasure and sightseeing, hunting, bird watching, camping, and picnicking.

Because the transportation system on Forest Service-managed land is largely in place, no noticeable changes would be made to the current transportation system in Alternatives 2-5. Rather, current road management objectives will be retained. Some roads may need to be improved to reach their identified road management objective. The public's ability to access the Forest by motorized vehicles should not change significantly in Alternatives 2-5. The ability to access the Forest by National Forest System roads for commercial resource activities is expected to stay the same.

The Forest will continue to manage system roads within the context of other public and private road systems and land ownership patterns. Miles of National Forest System road on Forest for Alternatives 2-5 may change slightly, either because access is needed on acquired property, where demand for new access is identified, the Forest exchanges property and its road, or when roads are decommissioned.

Standards and guidelines for Alternatives 1-4 are designed to protect or minimize negative effects from roads on other resources. Less stringent standards and guidelines exist for Alternative 5. If necessary, additional mitigation measures would be identified at the project level, during site-specific analysis.

Cumulative Effects on Access

Cumulative effects include those activities within the reasonable and foreseeable future that may impact access to the National Forest. This includes, but is not limited to the following road activities, construction, reconstruction, maintenance, decommissioning, and access restrictions. These activities may either help or hinder motorized access on National Forest System roads. Any difference in cumulative effects would be related to variation of an alternative's direct and indirect effects. Cumulative effects on access were considered within the Forest's administrative boundary, which contains a variety of public and private roads.

The Forest will continue to partner with agencies addressing local, state, and regional transportation needs and provide a seamless transportation system between the various agencies. (Road Analysis Report, Maintenance Level 3 and 4 Roads 2003) The incremental effects of other federal, state, and local road actions would not change, regardless of the alternative chosen.

Much like the Forest, the Missouri Department of Transportation's five year Statewide Transportation Improvement Program emphasizes maintenance of its existing road system (MoDOT, 2004a). Within the Forest boundary, visitors are likely to see road improvement projects, such as; highway resurfacing, shoulder widening, and bridge improvements or replacements. Major highway projects planned during the next five years include dual dividing US Highway 60. Access to the Forest by state highways is expected to remain about the same in the future.

The twenty-nine Missouri counties containing Forest-managed land are also expected to continue maintain their existing road network. Some improvements, such as road widening and paving are expected where development for housing and industry demands. Access to the Forest by county roads is expected to increase somewhat in the future, due to increased private and industrial development within or near the Forest.

Management proposed for Alternatives 2-5 has no cumulative effects on motorized access to or use of the National Forest. Commercial resource activities will contribute to maintenance and reconstruction of the current transportation system.

The proposed management in Alternative 1, would have a cumulative effect on motorized access to and use of the National Forest. In the next decade system roads would begin to close due to encroaching vegetation, surfacing material would become displaced, and drainage features would begin to fail. The roads would still be accessible to only high clearance vehicles whose drivers are willing to travel on rough roads. In the long-term, roads would become inaccessible due to vegetation growth and development of ruts and wash- outs from failed drainage features. The Forest would close and decommission maintenance level 2 roads due to safety concerns and negative impacts to surrounding resources, such as soil and water. Remaining road maintenance funds would be devoted to maintenance level 3 and 4 roads. The number of system roads open to motorized access would be reduced and a smaller percentage of Forest-managed lands would be accessible. This would impact the Forest personnel's ability to perform resource activities and the public's ability to enjoy the Forest with motorized vehicles.

On the Mark Twain NF, past, present and reasonably foreseeable road activities have not had any detrimental long-term effect on the integrity of Forest resources. In the future, similar road activities are likely to continue. By implementing standards and guidelines, impacts of roads should have no appreciable long-term negative effects in the area.

Wilderness Study Areas and Roadless Areas

Introduction

Congressionally designated wilderness areas are protected by law and valued for their ecological, historical, scientific and experiential resources. A forest evaluation of potential Wilderness areas is required as part of forest plan revision per 36 CFR 219.17 dated 1982, and revised September 7, 1983.

The first step of an evaluation of potential wilderness is to identify and inventory all roadless, undeveloped areas that satisfy the definition of wilderness found in Section 2 (c) of the 1964 Wilderness Act (FSH 1909.12, Chapter 7, item 7.1). Roadless areas found in the eastern states are places that have retained or are regaining a natural, untrammeled appearance; where any signs of prior human activity are disappearing or being muted by natural forces. Criteria provide for an individual roadless area to qualify for placement on the inventory of potential wilderness **if**, they meet one or more of the criteria listed in 7.11, and then also meet criteria listed in 7.11(a), which lists criteria for including improvements, and 7.11 (b) which lists criteria for Roadless Areas in the East for areas east of the 100th meridian."

A forest roadless area inventory was conducted as a part of the Mark Twain NF Plan revision in accordance with Forest Service policy and guidelines developed by the Eastern Regional Office to facilitate consistent application of the process. The Regional Forester, in his August 1997 letter to forests within Region 9, provides more specific interpretation of the FSH 1909.12 for application within the Eastern Region. Included in this interpretation is direction to "re-inventory" RARE II areas (identified in the RARE II Nation-wide Environmental Impact Statement of January, 1979) to determine if they still qualify for inclusion in the inventory. This direction extends to "all other National Forest lands." The Regional Forester also emphasizes that the inventory should be thorough and free of bias or "data filters". The process and results of the forest evaluation are documented in Appendix C of this EIS.

This process has two parts; the first is an inventory, which consists of data-gathering with five steps to identify roadless areas, the second is the evaluation of resulting roadless areas as potential Wilderness.

The five steps of the first part of the process are outlined below:

1. Mapping exercises using Geographical Information System data to identify potential roadless areas that met criteria 7.11b (5) contain one-half mile or less of improved road within a thousand acres.

2. Sixty-four parcels of land identified in step 1 were reviewed to see if they met FSH1909.12, criteria 7.11(1), (2b) or (2c) and determine the core acreage.
3. All parcels reviewed in step 2 were examined with additional data to verify the density of improved roads within the Forest Service Transportation System in light of criteria 7.11 (3) and 7.11b (5). Parcels of land that did not meet road density criteria were eliminated at this step in the process.
4. Each of the remaining forty-eight parcels was scrutinized using criteria from FSH1909.12, Chapter 7.11 2(a), 7.11(a) and 7.11(b) to determine if they meet the definition for roadless areas within the Eastern United States.
5. Thirteen parcels of land that were identified as part of the forest roadless areas inventory within the Mark Twain NF.

For each area that met the roadless criteria, a report was prepared that evaluates its wilderness potential in accord with 36 CFR 219.17 found in part two of Appendix C. The evaluation reports consider wilderness potential in three main categories:

- Capability — the qualities that make a roadless area suitable or not suitable for wilderness;
- Availability – an assessment of the non-wilderness resources and demand of the area;
- Need — a consideration of the amount of wilderness already in the area and region.

Proposed changes

Currently on the Mark Twain National Forest, there are thirteen parcels of land all adjacent to existing Wilderness areas that exhibit some roadless characteristics. Although these areas are each less than 5,000 acres they met criteria 7.11 2c, each parcel has potential to provide additional acres to adjacent Wilderness areas and may provide additional semi-primitive non-motorized recreational opportunities. The following thirteen areas are proposed as Wilderness Study Areas in the Revised Forest Plan.

Table 53 - Proposed Wilderness Study Areas on the Mark Twain NF

Roadless Area Name	Roadless area Number	Size (acres)	Ozark Highlands Subsection
Hercules Glades Additions	952101	40	White River Hills
	952102	20	
	952103	20	
Piney Creek Additions	952104	20	White River Hills
Irish Excluded Lands* (RACR)	952301	900	Current River Hills
	952302	320	
Rock Pile Additions	950504	80	St. Francois Mountains
	950505	40	
Paddy Creek Additions	950301	40	Gasconade River Hills
	950302	60	
Bell Mountain Additions	950501	200	St. Francois Mountains
	950502	10	
	950503	20	
Total		1,770	

** Lands were studied as part of the Irish Wilderness and are managed in accordance with the Irish Wilderness legislation*

Affected Environment

Wilderness

Currently on the Mark Twain National Forest, there are 7 designated Wilderness areas containing a total of 63,383 acres or 4 percent of the total Forest area (Table 54). The Mark Twain National Forest does not contain any wilderness study areas or recommended wilderness study areas that have not been acted upon by Congress. The 1986 Forest Plan used the results of the Roadless Area Review and Evaluation (RARE II) to address the wilderness/roadless issue. Prior to the Plan analysis, Congress designated all the existing wilderness areas within the Forest. The Paddy Creek Wilderness Act of January 3, 1983 released four areas remaining in the RARE II inventory "to be managed for multiple use". These are Anderson Mountain, Big Creek, Spring Creek and Swan Creek.

Table 54 - Existing Designated Wilderness Areas on Mark Twain NF

Area Name	Net Forest Service Acres	Subsection of the Ozark Highlands Section	Designation Date
Hercules Glades	12,314	White River Hills	10/19/76
Bell Mountain	8,977	St. Francois Knobs and Basins	12/22/80
Piney Creek	8,112	White River Hills	12/22/80
Rock Pile Mountain	4,089	St. Francois Knobs and Basins	12/22/80
Devils Backbone	6,595	White River Hills	12/22/80
Paddy Creek	7,019	Gasconade River Hills	01/03/83
Irish	16,277	Current River Hills	05/21/84
Total	63,383*		

** Source Land Areas of the National Forest System, FS-383, January 2004*

The existing wilderness areas are managed to maintain the areas' natural characteristics as stated in the 1986 Forest Plan under Management Prescription 5.1.

As stated in later in this chapter the primitive Recreation Opportunity Spectrum class is applied to Wilderness areas within the Mark Twain NF. The Wilderness Opportunity Spectrum (WOS) further stratifies each Wilderness into units for application of different management actions to preserve a range of Wilderness opportunities and options for visitors. Use of WOS also recognized that designated lands may be recovering from past use or influences of adjoining ownership. These zones are Transition, Pristine and Remote and described in detail within the Forest Plan Management Prescription 5.1 under Recreation Management. When the ROS inventory mapping exercise was completed, few of the Wilderness areas were inventoried as meeting the primitive criteria, though most areas meet semi-primitive nonmotorized class.

Natural occurrences such as outbreaks of insects or disease are allowed as part of the natural cycle, unless there is a threat to resources on adjacent areas or continued use of the wilderness. Human caused intrusions are not allowed. Under emergency conditions, motorized equipment and mechanical transport may be approved for use to control fire which threatens life, property, or the wilderness resource.

Most of the Ozark Highlands Section subsections that contain Mark Twain NF lands also contain a congressionally designated Wilderness area. The Black River Ozark Border, in which the Poplar Bluff unit is located, is home to the Mingo Wildlife Refuge, a 7,855 acres Wilderness managed by the Fish and Wildlife Service.

Wilderness Use

Outdoor recreation is one of the main benefactors of wilderness and a driver of wilderness demand and wilderness management. According to trend data collected from 1965 to 1994, the trend in recreation visits to National Forest Wilderness has paralleled designations and increased over time.

The Ozark-Ouachita Highlands Assessment (OOHA) describes the demand for many recreation activities throughout its Assessment area; much of the information is taken from the National Survey of Recreation and the Environment (NSRE). "Recreational use of national forest wilderness areas in the Highlands has increased from approximately 94,000 Recreation Visitor Days (RVD) in 1991 to 99,000 RVDs in 1996, about a 5 percent increase in 5 years. Hiking, horseback riding, nature study, photography, and primitive camping are the most popular recreational activities in these areas. The relative unfamiliarity of the public with wilderness areas probably kept use from growing more rapidly" (Cordell and others, 1997b).

In general, Wilderness use on the Mark Twain is concentrated on weekends in spring and fall. Overall use has remained nearly consistent for the past five years, though it may be increasing slightly. Hunting and hiking pressure seems to be about the same. Horseback riding in some Wildernesses has increased. While most use is within predictions from the last planning period, on peak weekends Paddy Creek visitation is exceeding those expectations. Use within all Wilderness areas is within carrying capacity developed in accordance with ROS guidance during the 1986 planning process.

The best available estimate of the economic value of a visit to a Wilderness area equals $41.87 per person per day (Loomis, 2000 and NSRE). This figure and others that relate to expenditures for hunting, fishing and other activities would be used to estimate value of visits to Wilderness areas related to tourism and benefits to local communities. For further discussion of economic impacts refer to the social and economic section of this chapter.

Wilderness Values

In addition to outdoor recreation in wilderness, there is a non-user component that values American wilderness and is important to understand when analyzing wilderness and roadless allocations. Wilderness is valued for preserving representative natural ecosystems and local landscapes. The very existence of wilderness is valued by the American public as part of the natural heritage of the country. In 2000, the National Survey of Recreation and the Environment was conducted to show what Americans value about Wilderness. The following are the results, by percentage, of people surveyed: protecting air quality (58%), protecting water quality (56%), protecting wildlife habitat (53%), protecting endangered species (50%), legacy for future generations (49%), preserving unique ecosystems and genetics (44%), future option to visit (38%), just knowing it is preserved (37%), providing scenic beauty (35%), providing recreation opportunities (28%), providing spiritual inspiration (26%), undisturbed area for scientific study (24%), and providing income for the tourist industry (10%).

Environmental Consequences

Direct and Indirect Effects

Wilderness Areas

Wilderness has many positive effects. As stated above, wilderness can preserve some natural systems and provides places of solitude for visitors. However, there are environmental effects within wilderness from many sources. Recreational use can have negative impacts on the quality, character, and integrity of the wilderness resource. These negative impacts may include soil compaction, vegetation loss, crowding, and loss of solitude both on trails and at campsites caused by heavy recreation use; deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological/ecological processes and biodiversity through replacement of vegetation by non-native species such as noxious weeds with visitor use.

Wilderness recreation use on the Forest is estimated to be approximately 62,000 RVDs, from the National Visitor Use Monitoring (NVUM) survey. In the 1986 Forest Plan, capacity for Primitive ROS class was determined to be 1.6 RVDs per acre per year (Forest Plan, IV-27) for a total of 101,410 RVDs per year. Even though current use exceeds the 2002 projection of 32,000 RVDs (Forest Plan, B-30), this is only 60% of Wilderness capacity. Though current use is almost double that projection, few areas are experiencing negative effects from visitors. Many visitors to the Wilderness are participating in activities that are better suited to other areas of the Forest, evidenced by visitor's complaints about the lack of facilities in the Paddy Creek Wilderness. Hunting is one of the more popular activities, which could take place outside of a Wilderness.

According to Forest Service research, fire exclusion policies of recent decades threaten Wilderness preservation by interfering with the free play of natural processes specified in the 1964 Wilderness Act. When fire is excluded, fuels accumulate and Wilderness ecosystems become unnaturally dense and dominated by species different from those present under historical fire regimes. These synthetic plant communities are easily damaged by droughts, insects, disease, and [wildland] fire. (Cordell, et al 1991)

Forest Service tools for management of fire in Wilderness are to permit lightning-caused fires to play their natural role, yet reduce to an acceptable level the risks and consequences of these wildfires. Under these goals, fires in Wilderness must be prescribed. It may be ignited by nature for example, by lightning or management. All other fires are wildfires. Prescribed Natural Fires (PNF) are the preferred means of assuring the role of fire as a natural ecosystem process. PNFs are the preferred means of assuring the role of fire as a natural ecosystem process. Where PNF occurrences are not adequate to accomplish these goals, a Management Ignited Prescribed Fire may be needed to supplement the PNF within Wilderness and on adjacent lands. The total land area burned by PNFs has been highly variable in recent years, but remains tiny portions of that needed to maintain understood natural and historical fire regimes.

Lightning-ignited fires, if allowed to burn, enhance the natural systems that are fire dependent. It would benefit recreation by opening up the Forest, reducing fuel loading to acceptable levels, and maintaining the vegetation. There could be a short-term negative impact to air quality, visual aesthetics and possibly water quality.

Management-ignited fires, if approved, can benefit Wilderness by reducing fuel loadings to acceptable levels or re-introducing fire within natural systems that are fire dependant. This is especially true for specific natural communities and for species viability. Fire prevention strategies applied in the urban interface area on private land can reduce the need for management-ignited fires.

Other environmental effects, which influence the integrity of natural systems in wilderness, include air pollution from outside sources, interruption of natural functioning ecosystems by the exclusion of fire, loss of habitat for species protected under the Endangered Species Act, and threats to native plant species from the spread of noxious weeds.

No new management direction is being proposed for any of the existing designated Wilderness areas on the Forest under any of the alternatives, so there are no significant direct, indirect, or cumulative effects to the existing Wilderness resource. Expansion of existing Wilderness is proposed by allocating adjacent lands (see Table 53). Proposed Study Areas) to wilderness study areas. See Forest Roadless Inventory Areas discussion below.

Forest Roadless Inventory Areas

A web of old road corridors that have been in use since the late 1800s crisscrosses National Forests of the Ozark Highlands and southern Missouri. Many routes are still in use today by motorized or non-motorized recreationists. Though many open system roads are unimproved, use by motorized vehicles is allowed. Temporary logging roads and access both on roads and trails have also been added to the Forest's transportation system through the years. Second, inter-mingled ownership of other public and private lands as well as man-made improvements further affect the roadless character of most lands within the Mark Twain NF.

Therefore, few areas on Forest met the criteria of the 1975 Eastern Wilderness Act as interpreted in FSH 1909.12, Chapter 7.11a and 7.11b. Appendix C – Roadless Area Inventory and Evaluation for Potential Wilderness includes a more detailed assessment of the criteria used to inventory roadless areas within the Mark Twain National Forest.

Three categories are used to summarize how each identified potential roadless area is allocated in the alternatives. These categories are:

- Recommended Wilderness Study/Forest Inventoried Roadless Areas.
- Areas Managed for Semi-Primitive Objectives (Management Prescriptions 6.1, 6.2, and 1.2)
- Areas Not Managed for Semi-Primitive Objectives (Management Prescriptions 1.1, 2.1 3.3, 3.4 and 8.1)

Of the forty-eight areas examined in step 4 of the Forest Roadless Inventory, thirty-six would continue under current ROS objectives. Eleven areas (totaling 650 acres) would change to more restrictive ROS objectives as potential wilderness and part of one other area (G05F-8a, 1,830 acres) would change from semi-primitive nonmotorized to semi-primitive motorized ROS objectives Further analysis of ROS management can be found later in this chapter under the Recreation section and in Appendix F of the FEIS. Specific characteristics of each part of the spectrum are described in Appendix F of the revised Forest Plan.

Recommended Wilderness Study Areas

Roadless areas recommended for wilderness study are set aside for future designation as Wilderness and are not available for activities such as vegetative management or road construction. These areas are managed much the same as designated Wilderness under management prescription 8.1 with primitive ROS objectives until a final determination is made by Congress about whether they will be added to the National Wilderness Preservation system.

Additions to six of the seven designated Wilderness areas on the Forest are recommended for study (Table 53). These include land adjacent to the Bell Mountain, Hercules Glades, Irish, Paddy Creek, Piney Creek and Rock Pile Wilderness areas, and total 1,770 acres.

Designation as wilderness study areas would preserve additional areas that would be managed to allow natural processes to continue, provide areas for solitude and primitive recreation, and minimize the impacts of man and his activities on the land. These areas would add to the naturalness, uniqueness, and representative ecosystems of the adjacent designated areas. The highest priority for management would be the naturalness of the area.

Direct effects of managing wilderness study areas include maintaining soil, hydrologic, and atmospheric conditions prevailing within the areas. Water quality and air quality should remain high and the imprint of man's influence should diminish over time.

Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, fishing, and hunting would continue and use levels would be expected to remain about the same as current levels. Visual and experiential contrasts between roadless areas and other timbered lands could increase. Additional acreage for wilderness study would increase the carrying capacity and allow for user impacts to be dispersed across a larger area providing an increase in visitor satisfaction.

There are no existing Federal oil or gas leases or other Federal mineral leases in effect in any of the areas recommended for wilderness study. Potential for development of energy minerals and other leasable and common minerals is estimated to be low. Eleven of the areas would be administratively unavailable for federal oil and gas and other federal mineral leases, pending final Congressional action. Two of the areas known as the Irish Wilderness Excluded Lands are currently set aside by Congress from the adjacent Wilderness to permit mineral exploration. Records show that there are no valid permits within these areas.

The naturalness, uniqueness, and representative ecosystems of the designated areas may be maintained to some extent (see wilderness discussion under ecosystem sustainability). Use of Wilderness areas for educational opportunities, for the scientific study of natural ecological processes, as a gene pool, or as an indicator of how communities respond under natural processes has been rather limited in the past. It is likely these uses could increase as the Forest implements the draft Revised Forest Plan.

Naturally occurring disturbance processes will continue including plant succession. Larger blocks of undeveloped land will favor area- and disturbance-sensitive species. These factors will reduce habitat for early successional and fire dependant species. Rare communities and threatened and endangered species would be managed within the limitation of activities allowed in wilderness study areas.

Due to the size and location of the areas, fire management should not be affected by designation of these additions to existing wilderness areas. Suppression of all human-caused wildfires would minimize potential effects on wilderness values of a natural community dependant upon a fire regime. Under emergency situations, the Forest Supervisor or Regional Forester may approve use of motorized equipment and mechanized transport, helicopters, air tankers, and other aircraft. These actions would impact wilderness character and visitor experiences and leave evidence of man, although rehabilitation should help to reduce those impacts.

Since the thirteen roadless areas recommended for Wilderness study do not contain any roads, designating areas for Wilderness study will have no effect on vehicle access. The Revised Forest Plan would expand the Forest wilderness system, provide more opportunities, and improve experiences for those who enjoy the isolation, seclusion and challenge of a wilderness experience.

Additional effects to wilderness study areas are similar to those found in wilderness such as soil compaction, vegetation loss, crowding, and loss of solitude both on trails and at campsites caused by heavy recreation use; deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological/ecological processes and biodiversity through replacement of vegetation by non-native species such as noxious weeds with visitor use.

The effects are minimal due to the size and location of the areas proposed for study. For the same reason the effects will not differ much by actions in Alternatives 1-4. Under Alternative 5 there would be little to no change from current management Since roadless areas would not be recommended as potential wilderness. Most of the proposed acres (1,430) are currently under management prescription 6.1, 6.2, or 8.1 which emphasize semi-primitive or primitive recreation opportunities. Parcels of land adjacent to the Paddy Creek, Piney Creek, and Rock Pile Mountain Wilderness are currently managed with roaded natural ROS objectives.

Table 55 - Forest Roadless Inventory Area Management by Alternative

Forest Roadless Inventory Number	Area or Unit Name	Management Prescription by Alternative				
		1	2	3	4	5
G21A-5	Ava	8.1	8.1	8.1	8.1	6.2
G21A-6	Ava	8.1	8.1	8.1	8.1	6.2
G21A-7	Ava	8.1	8.1	8.1	8.1	6.2
G21C-8	Cassville	8.1	8.1	8.1	8.1	3.4
G23-2	Irish Excluded Lands	8.1	8.1	8.1	8.1	8.1
G23-3	Irish Excluded Lands	8.1	8.1	8.1	8.1	8.1
G05F-2	Fredericktown	8.1	8.1	8.1	8.1	4.1
G05F-2b	Fredericktown	8.1	8.1	8.1	8.1	4.1
G03-8	Houston/Rolla	8.1	8.1	8.1	8.1	4.1
G03-9	Houston/Rolla	8.1	8.1	8.1	8.1	3.4
G05P-3a	Potosi	8.1	8.1	8.1	8.1	6.1
G05P-3b	Potosi	8.1	8.1	8.1	8.1	6.1
G05P-3c	Potosi	8.1	8.1	8.1	8.1	6.1

Areas Managed for Semi-Primitive Objectives

Prescriptions with semi-primitive objectives strive to regain naturalness and minimize impacts of humans influence on the land. Recreation facilities are designed to meet resource protection needs rather than visitor expectations, and may be maintained or constructed with minimum investment. Timber management and road access are allowed on a limited basis. However, in semi-primitive motorized (SPM), sights and sounds of man's activities could increase because a broader range of activities would be allowed. While the semi-primitive component of SPM still strives for minimal impacts of humans, some opportunity for solitude may be diminished because roads and motorized trails are allowed. Under semi-primitive non-motorized (SPNM), permanent open motorized access as well as surface occupancy for minerals development is prohibited. Also, the SPNM 6.1 management prescription has the most limited timber harvest of the semi-primitive areas.

Areas to be managed for semi-primitive ROS objectives are assigned to Management Prescription 6.1 (SPNM), 6.2 (SPM), or 1.2 (normally SPM). Table 56 lists the parcels of land examined in the roadless inventory process (see FEIS Appendix C) and displays management prescription by alternative. Alternatives 1, 4, and 5 do not change management prescriptions of the semi-primitive areas, both motorized and non-motorized, listed in Table 56. Alternatives 2 and 3 do change some allocation of lands to Management Prescription 1.2. This would change the emphasis from semi-primitive recreation to ecological restoration in these parts of the Forest, because they have been identified as important to maintain the range of natural variability of the natural communities represented there. Most acres of land within the 1.2 prescription have been previously managed under the 6.2 SPM prescription and would still be managed for semi-primitive motorized objectives in the 2005 Forest Plan. One exception is the Lower Rock Creek area, which has a 6.1 SPNM prescription in the 1986 Plan.

The Lower Rock Creek area (parcels G05F-7, 8a, 8b, 9, 10 of the roadless inventory) on the Fredericktown Unit is an important area for conservation and restoration of glades and post oak dominated woodlands on the steep igneous domes found there. This area has stimulated public interest since the 1970s. The Lower Rock Creek Area totals 14,230 acres with 11,545 acres National Forest System lands and 2,685 acres in private ownership.

Alternative 2 maximizes the areas of ecosystem restoration and allocates 10,200 acres of the Lower Rock Creek area (primarily parcels G05F-8a, 8b, 9, and 10 of the roadless inventory) as 1.2 SPM Management Prescription. (The northeastern most portion of the Lower Rock Creek area was not included in the 1.2 SPM Management Prescription.) 1,345 acres remained in 6.1 SPNM Management Prescription. Alternative 2 reduces the current SPNM allocation by approximately 12% across the forest.

In the Draft EIS, Alternative 3 allocated the Lower Rock Creek area differently. Approximately 4,995 acres (G05F-8a and 8b) were proposed as 1.2 SPM Management Prescription and 6,550 acres (G05F-7, 9, and 10) as 6.1 SPNM Management Prescription. In response to public comments, Alternative 3 now allocates the 1,830-acre Wolf Hollow Area (part of G05F-8a) as 1.2 SPM Management Prescription (see Alternative 3 map for the Fredericktown Unit). The remaining portion of the 1.2 Management Prescription (3,165 acres) is designated as SPNM, and the 6,500 acres of 6.1 SPNM is unchanged. Alternative 3 reduces the current SPNM allocation by approximately 2% across the forest.

Changing the ROS objectives for the Wolf Hollow area is not expected to significantly diminish the recreational experience in the Lower Rock Creek area. It is important to note that, based upon the ROS inventory, the majority of this area does not meet criteria for providing SPNM opportunities. It does meet SPM criteria (see Recreation section and Appendix F of FEIS for information on the ROS inventory process and results). Significant parcels of private ownership (totaling 2,690 acres) within the boundaries of the Lower Rock Creek area affect the remoteness and naturalness of the Lower Rock Creek area. Currently solitude within the Wolf Hollow Area is affected by motorized use on adjacent lands.

It is uncertain what, if any, motorized access will be needed in the future. No new road development is currently proposed for the Wolf Hollow area. There is currently a non-system road in the area. Any proposal for action will require site-specific analysis, including public involvement, to address the effects of proposed activities. The effects to solitude and remoteness due to motorized access would vary depending on many factors such as the development level, whether the access is permanent or temporary, and whether it is open to the public or gated. Solitude could be diminished as a result of a site-specific decision for a road open to most types of motorized vehicles. On the other hand, a gated, temporary road would have negligible effects to solitude.

Table 56 - Alternative Comparison for Selected Areas from the Mark Twain NF Roadless Inventory

Forest Roadless Inventory Number	Area Name or Unit Name	Management Prescription by Alternative 1	2	3	4	5
9224	Swan Creek*	6.1	6.1	6.1	6.1	6.1
G21A-1	Ava	6.2	1.2	1.2	6.2	6.2
G21C-1	Cassville	6.2	6.2	6.2	6.2	6.2
G21C-2	Cassville	6.2	6.2	6.2	6.2	6.2
G08-1	Smith Creek*	6.1	6.1	6.1	6.1	6.1
G23-1	Doniphan/Eleven Point	6.1	6.1	6.1	6.1	6.1
G23-5	Big Springs Addition*	6.1	6.1	6.1	6.1	6.1

Forest Roadless Inventory Number	Area Name or Unit Name	Management Prescription by Alternative 1	2	3	4	5
9222	Anderson Mountain	6.1	6.1	6.1	6.1	3.5/6.1
G05F-1a	Fredericktown	6.1	6.1	6.1	6.1	6.1
G05F-1b	Fredericktown	6.1	6.1	6.1	6.1	6.1
G05F-5	Fredericktown	6.1	6.1	6.1	6.1	6.1
G05F-6	Van East Mountain *	6.1	6.1	6.1	6.1	6.1
G05F-7	Fredericktown	6.1	6.1	6.1	6.1	6.1
G05F-8a	Lower Rock Creek (N)	6.1	1.2	1.2+	6.1	6.1
G05F-8b	Lower Rock Creek (S)	6.1	1.2	1.2++	6.1	6.1
G05F-9	West Lower Rock Creek (N)*	6.1	1.2	6.1	6.1	6.1
G05F-10	West Lower Rock Creek (S)*	6.1	1.2	6.1	6.1	6.1
G05P-1	Potosi	6.2	6.2	6.2	6.2	6.2
G05P—2a	Potosi	6.1	6.1	6.1	6.1	6.1
G05P—2b	Potosi	6.1	6.1	6.1	6.1	6.1
G07S-1	Salem	6.1	6.1	6.1	6.1	6.1
9223	Spring Creek*	6.1	6.1	6.1	6.1	6.1
G21W-4	North Fork*	6.1	6.1	6.1	6.1	6.1
G21W-5	Devils Backbone Addition	6.1	6.1	6.1	6.1	6.1

**areas unsuitable for timber management.*
+ part of area will be managed as SPNM, see Forest Plan Alternative 3 map for the Fredericktown Unit and Management Prescription 1.2.
++ area will be managed as SPNM see, Forest Plan Alternative 3 map for the Fredericktown Unit and Management Prescription 1.2.

Areas Managed for other than Semi-Primitive Objectives.

Fourteen areas examined in step 4 of the roadless inventory process do not meet all criteria for roadless areas and are currently managed for roaded natural ROS objectives. In this category, areas are made available for management allocations involving road construction and/or timber harvest. This means that management activities are allowed that may no longer provide primitive or semi-primitive settings. Prescription allocations in this category do not necessarily commit an area to development. Before a decision is made to build roads or harvest timber in an area, a site-specific analysis must be conducted.

Vegetation composition and structure would be manipulated resulting in greater diversity of age-classes among forest types. Opportunities for solitude and remoteness could decrease. Sights and sounds of man's activities could be more obvious or remain the same. Additional roads and trails may be constructed. Noise levels and soil erosion may increase, air and water quality may decrease, but water quality would meet State and Federal standards.

Table 57 - Alternative Comparison for Areas Managed for other than Semi-Primitive Opportunities on the Mark Twain NF

Forest Roadless Inventory Number	Area Name or Unit Name	Management Prescription by Alternative 1	2	3	4	5
9225	Big Creek	1.1	1.1	1.1	1.1	3.4/3.3
G12C-3	Cassville	6.2	1.1	2.1	2.1	3.4
G12C-4	Cassville	6.2	1.1	1.1	2.1	3.4
G12C-5	Cassville	6.2	2.1	2.1	2.1	3.4
G21C-7	Big Piney Add I	6.2	2.1	2.1	2.1	3.4
G23-4	Doniphan/Eleven Point	6.2	1.1	2.1	2.1	3.4
R23-1	Doniphan/Eleven Point	6.2	1.1	2.1	2.1	4.1
G05F-3	Fredericktown	6.2	2.1	2.1	2.1	4.1
G05F-4	Fredericktown	6.2	2.1	2.1	2.1	4.1
G05F-11	Fredericktown	6.2	2.1	2.1	2.1	4.1
G03-1	Houston/Rolla	6.2	2.1	2.1	2.1	3.4

Forest Roadless Inventory Number	Area Name or Unit Name	Management Prescription by Alternative 1	2	3	4	5
G03-3	Houston/Rolla	6.2	2.1	2.1	2.1	3.4
G03-4	Houston/Rolla	6.2	2.1	2.1	2.1	3.4
G03-7	Houston/Rolla	6.2	2.1	2.1	2.1	3.4
G04-5	Mud Creek	8.1	8.1	8.1	8.1	8.1
G21W-6	Carman Springs	1.1/8.1	1.1/8.1	1.1/8.1	1.1/8.1	3.4/8.1

Roadless Area Conservation Rule and the Forest Roadless Inventory for Plan Revision

In May of 2005, the RACR was supplanted by the Special Areas; State Petitions for Inventoried Roadless Area Management Rule. This rule allows the governor to petition the Secretary of Agriculture on the management of roadless areas. This new rule also defines inventoried roadless areas as "areas identified in a set of inventoried roadless area maps, contained in the Forest Service Roadless Areas Conservation, Final Environmental Impact Statement, Volume 2, dated November 2000, and any subsequent update or revision of those maps through the land management planning process. The forest's areas: Anderson Mountain, Big Creek, Spring Creek and Swan Creek, formerly RARE II areas, and part of the RACR, are considered the forest's roadless inventory until the new inventory from this effort is made official with the signing of the Record of Decision for the Revised Plan and Final Environmental Impact Statement.

Each area was considered for appropriate management designation based on its current condition and management history. The management direction proposed for all the alternatives are consistent with the March 23, 2005 interim direction for Management of Inventoried Roadless Areas. Refer to Tables C-1 and C-2 in Appendix C.

Table 58 - Areas on the Mark Twain NF Included in 2001 Roadless Area Conservation Rule

RARE II Area Name	RARE II number	Current Management	Total size (acres*)	Core area size (acres)	Road Density (miles)	Carried forward to Evaluation
Anderson Mountain	9222	6.1/SPN	3,255	2110	0.0/1000ac	N
Big Creek	9225	3.3/RN	10,825	1340	0.3/1000ac	N
Spring Creek	9223	6.1/SPN	5,340	1020	0.3/1000ac	N
Swan Creek	9224	6.1/SPN	8,755	1,220	0.6/1000ac	N

SPN = semi primitive, non motorized; RN = roaded natural
**acres from roadless inventory process*

The only RARE II area that met primary criteria to qualify as a roadless was Anderson Mountain. As noted in Appendix C, it did not meet all the criteria for a roadless area in the Eastern United States. Current ROS management objectives would continue in these all theses areas (see Table 57.)

In addition to these four areas, the Irish Wilderness Excluded Lands were also identified inventoried roadless areas within Roadless Area Conservation Rule.

Table 59 - Irish Wilderness Excluded Lands on the Mark Twain NF

RARE II Area Name	RARE II number	Forest Roadless number	Total size (acres*)	Road Density (miles)	Carried forward to Evaluation
Irish Excluded Lands I	9221	952301	720	0.0/1,000ac	Y
Irish Excluded Lands II	9221	952302	300	0.0/1,000ac	Y

**acres from roadless inventory process*

Areas of special public interest

The Forest received comments regarding these specific areas in response to the Notice of Intent to revise the Forest Plan. The public felt that these areas should be recommended for and protected as Wilderness. All of these areas, regardless of size, were carried through the roadless inventory process in order to respond to public concerns. Two of these areas, Swan Creek and Spring Creek, are also RACR areas discussed earlier.

Seven areas within the Forest boundary were part of an appeal by two organizations during the RARE II process in the 1970s. In the 1986 Forest Plan, these seven areas were allocated to management prescriptions with a semi-primitive non-motorized ROS class objective to insure that land management activities would not reduce their roadless character, if present.

Only one area (G05F-10) met the primary criteria for roadless (core area size and road density) though it does not meet all the criteria for a roadless area in the Eastern United States (see Appendix C, step 4). Current management would continue in all of these areas under all alternatives, except for part of Lower Rock Creek which was discussed previously (See Table 56).

Table 60 - Areas on the Mark Twain National Forest of Special Public Interest

RARE II Area Name	Forest Roadless number	Current Management	Total size (acres*)	Core area size (acres)	Road Density (miles)	Carried forward to Evaluation
Big Springs Addition	G23-5	6.1/SPN	3,715	970	0.9/1,000 ac	N
Lower Rock Creek	G05F-9	6.1/SPN	2,320	880	0.0/1,000 ac	N
	G05F-10	6.1/SPN	4,210	2,450	0.0/1,000 ac	N
North Fork	G21W-4	6.1/SPN	5,810	1,630	0.2/1,000 ac	N
Smith Creek	G08-1	6.1/SPN	1,685	430	0.3/1,000 ac	N
Van East Mountain	G05F-5	6.1/SPN	2,430	1,600	0.0/1,000 ac	N

**acres from roadless inventory process*

Cumulative Effects

The Ozark Highlands Section will be considered the cumulative effects analysis area for Wilderness, though visitors to the Wilderness may come from as far away as 250 miles to recreate in these areas. For this reason, the entire acreage of a wilderness area will be counted even though part falls into another ecological section. For example, portions of Wilderness areas on the Mark Twain NF fall within the Black River Ozark Border and Upper Boston Mountains section.

More than 185,000 acres in Missouri and northern Arkansas are managed for wilderness characteristics in National Forests, State Forests, National Parks and National Wildlife Refuges (OOHA 1999; MDNR 2003). The Mark Twain National Forest, with 64,000 acres, provides about 77% of the total for Missouri and 37% for the twenty-nine county cumulative effects area.

Cumulative effects to existing wilderness resources are mostly directed at the visitor use on peak weekends of certain, favorite destinations, such as the Paddy Creek Wilderness. As recent visitor studies indicate, many people using this particular area are actually seeking a less challenging recreation opportunity. As visitors are directed to more developed recreation areas, use of Paddy Creek should decrease.

Though the Forest Plan Revision would recommend an increase of 3% wilderness, there are no expected cumulative effects. The major reason for this determination is that over 50% of the acreage is within the Irish Wilderness Excluded Lands, which are currently managed under similar direction.

The analysis area for other than Wilderness includes National Forest System Lands in the Mark Twain National Forest and its draw area. Further analysis of ROS management can be found in this chapter under the Recreation section.

Currently 20% of the Fredericktown unit is managed for SPNM objectives. Alternatives 1, 4, and 5 do not change this. Alternatives 2 and 3 would result in a reduction of either 12% or 2% respectively Forestwide from SPNM to SPM ROS class objectives. There are no cumulative effects across the analysis area due to this small acreage change

Private development adjacent to National Forest System lands would affect recreational experiences within this interface. Persons desiring to get away from human influence, and experience more solitude on National Forest System lands may avoid these areas. Increasing private development adjacent to National Forest System land could lead to more illegal activities such as motorized use outside of designated systems.

The primary challenge for National Forest recreation managers is how to maintain the unique high quality natural settings and remote recreation experiences that visitors seek on federal land. In the future, supply and demand for kinds of recreation may shift, but the variety that can be accommodated on National Forest system lands, with their large land bases, would ensure some level of user satisfaction. Maintaining an array of Forest settings and opportunities helps level fluctuating responses to weather, travel distance, or societal values

Wild and Scenic Rivers

Introduction

Proposed Changes

There is no change planned in current Forest direction or in how the streams will be managed. Standards and guidelines have been clarified to make them consistent with other parts of the 1986 Forest Plan. An example of the clarification is when and why vegetation management may be planned within the riparian management zone of Candidate Rivers.

One change is the addition of the Black River located within the Poplar Bluff Ranger District boundary. Though the river corridor is almost 17 miles long land managed by the Forest is less than 700 acres, any new acquisitions within the river corridor would be allocated to MP 6.3.

Scope of Analysis

The analysis area includes National Forest System Lands in the Mark Twain NF.

Congress enacted the Wild and Scenic Rivers Act (WSRA) in 1968 to preserve select river's free-flowing condition, water quality and outstandingly remarkable values. The most important provision of the WSRA is protecting rivers from the harmful effects of water resources projects. To protect free-flowing character the Federal Energy Regulatory Commission, which licenses nonfederal hydropower projects, is not allowed to license construction of dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works on or directly affecting wild and scenic rivers (WSR). Other federal agencies may not assist by loan, grant, license, or otherwise any water resources project that would have a direct and adverse effect on the values for which a river was designated.

The WSRA also directs that each river in the National Wild and Scenic Rivers System be administered in a manner to protect and enhance a river's outstanding natural and cultural values. It allows existing uses of a river to continue and future uses to be considered, so long as existing or proposed use does not conflict with protecting river values. The WSRA also directs building partnerships among landowners, river users, tribal nations, and all levels of government.

Beyond the immediate protection afforded the eight rivers in the enabling legislation, the WSRA established a process for building a legacy of protected rivers. Rivers may be identified for study by an act of Congress under Section 5(a), or through federal agency initiated study under Section 5(d) (1). By the end of 2002, Congress had authorized 138 rivers for study. Section 5(d)(1) directs federal agencies to consider the potential of wild and scenic rivers in their planning processes, and its application has resulted in numerous individual river designations, and state and area-specific legislation.

Both Sections 5(a) and 5(d) (1) studies require determinations be made regarding a river's eligibility, classification and suitability. Eligibility and classification represent an inventory of existing conditions. Eligibility is an evaluation of whether a river is free-flowing and possesses one or more outstandingly remarkable values. If found eligible, a river is analyzed about its current level of development (water resources projects, shoreline development, and accessibility), and a recommendation is made too place it into one or more of three classes—wild, scenic or recreational.

The final procedural step, suitability, provides the basis for determining whether to recommend a river as part of the National System. A suitability analysis is designed to answer the following questions:

- Should the river's free-flowing character, water quality, and outstandingly remarkable values be protected, or are one or more other uses important enough to warrant doing otherwise?
- Will the river's free-flowing character, water quality, and outstandingly remarkable values be protected through designation? Is it the best method for protecting the river corridor? In answering these questions, the benefits and impacts of WSR designation must be evaluated and alternative protection methods considered.
- Is there a demonstrated commitment to protect the river by any nonfederal entities that may be partially responsible for implementing protective management?

Rivers authorized for study by Congress are protected under the WSRA; specifically, Sections 7(b)—prevents the harmful effects of water resources projects: 8(b)—withdraws public lands from disposition under public land laws: 9(b)—withdraws locatable minerals from appropriation under mining laws; and 12(a)—directs actions of other federal agencies to protect river values. These protections last through the study process, including a three-year period following transmittal of the final study report by the President to Congress. The integrity of the identified classification must also be maintained during the protection period.

The identification of a river for study through the forest planning process does not trigger any protections under the WSRA. To manage the river for its potential inclusion into the National System, the Forest Plan should provide direction using other authorities to protect its free-flowing character, water quality, outstandingly remarkable values, and preliminary or recommended classification.

Rivers are added to the National System by act of Congress or by the Secretary of the Interior. Secretarial designation requires that a river be a part of a state river protection system and the state governor to make application to the Secretary.

Wild and Scenic River Study Process on Mark Twain National Forest

The 1986 Forest Plan assigned segments of seven rivers to a management area prescription in an effort to protect their integrity as potential wild and scenic rivers, pending additional analysis and decision (Record of Decision, June 23, 1986). Identified rivers included those listed on the Nationwide Rivers Inventory (NRI) and as identified by the Secretaries of the Interior and Agriculture in response to (then) Section 5(d)[*] of the WSRA. Three rivers (Meramec River, Black River, Bryant Creek) located near the National Forest were also included in the summary table for the 1986 Forest Plan.

The 1986 Mark Twain NF Plan and other forests in the Eastern Region received an administrative appeal by American Rivers, Inc., a national nonprofit river conservation organization (September 12, 1986). Specific to the Mark Twain NF, the appeal challenged the rigor of eligibility and classification steps of the study process and failure to conduct suitability of rivers identified on the NRI; lack of protective standards and guidelines; management of all rivers at a scenic classification; and failure to comply with the National Environmental Policy Act.

The Eastern Region reached an agreement with American Rivers and interveners to the appeal in July 1987. Affected forests agreed to conduct eligibility and classification for rivers on the NRI or any other rivers they might identify as potentially eligible within national forest boundaries. They also agreed to amend the Forest Plan to include standards and guidelines by river classification, and develop a process to complete suitability.

The 1986 Forest Plan was amended to effect the settlement agreement, June 16, 1988. Seven rivers were identified as “directly influenced by the Mark Twain NF management.” Each of these rivers was found eligible and provided a “best potential classification.” All or portions of Cedar, Courtois and Huzzah Creeks, and the North Fork White River were identified as too developed to meet recreational classification. These rivers, however, were placed in protective management at recreational classification to maintain their future consideration. This process approach is inconsistent with the wild and scenic rivers study process. Eligibility and classification have been reconsidered in this planning effort.

Table 61 - Wild and Scenic River Original Study Process Summary for the Mark Twain NF

Rivers	Wild and Scenic River Act Authority	1986 FP (miles w/in Forest boundary)	1988 FP Amendment (miles and classification)
Cedar Creek	5(d)	32 miles	29 miles recreational
Big Piney (Gasconade study)	5(a)†	74 miles	63 miles scenic
Gasconade	5(a)	43 miles	66 miles scenic
Black River	5(d)	0 miles	NI
Bryant Creek	5(d)	0 miles	NI
Courtois Creek	5(d)	21 miles	18 miles recreational
Huzzah Creek	5(d)	28 miles	28 miles recreational
Meramec River	5(d)	0 miles	NI
North Fork White River	5(d)	38 miles	30 miles recreational
St. Francis River	5(d)	14 miles	17 miles scenic

NI – not included

[*] The WSRA was amended October 28, 1988; the direction to consider potential additions to the National System in agency planning processes is now in Section 5(d) (1).

[†] Gasconade and its tributary, Big Piney, authorized for study by Congress under Section 5(a) of WSRA. The revised Appendix incorrectly states that 66 and 52 miles of the Gasconade and Big Piney, respectively, be added to the National System per a study completed by the Bureau of Outdoor Recreation (BOR) in 1975. The BOR study recommended river values be conserved by the State; it did not recommend addition to the National System).

Wild and Scenic River Study Process on Mark Twain National Forest—2004 Revision

In order to meet requirements for Forest Plan revision under the current Forest Service Planning Rule (FSH 199.12, chapter 8, “WSR Evaluation”) and to respond to comments made by the public on the Notice of Intent (NOI) to revise the Forest Plan, the following process was developed to evaluate the status of WSR designation on the forest.

A two-pronged inventory, first to consider new information for rivers presently listed and managed as Candidate Rivers MP 6.3 and secondly to inventory information gathered from state agencies and other sources for inclusions of other waters to the list.

The first step is to validate previous candidates for national river status listed in the 1986 Forest Plan and update their classification after reviewing any changed conditions such as land acquisitions, river resources, state designations, federal statues and settlement agreements.

Then, identify any new potential rivers. A decision was made not to inventory the rivers within the Gasconade Watershed that had been included in the previous study.

Use of the following information will complete a systematic analysis to identify the potential of all rivers for eligibility and classification based upon criteria defined for the Mark Twain NF.

- Missouri Department of Natural Resources which include outstanding state resource waters, outstanding national resource waters, lake classification and use designations, and stream classification and use designations;
- Missouri Department of Conservation Watershed Inventory and Assessments for watersheds within the Forest;
- Nationwide Rivers , and
- The Nature Conservancy Ozark Eco-regional Conservation Assessment

Public concerns regarding designating high quality rivers for inclusion in the wild and scenic rivers system with the effect of protecting water quality and riparian corridors listed specific streams North Fork, Gasconade, Courtois, Huzzah and lower Current. Another concern expanded this list to include tributaries of the Gasconade, Little Piney and Big Piney Rivers, and possibly others that have qualities that should be protected through restricted management activities so future designation would not be precluded.

The following list of rivers was compiled from the above sources, and then inventoried to identify any outstandingly remarkable values found within the quarter mile river corridors. Black River (Poplar Bluff RD), Cedar Creek, Courtois Creek, Huzzah Creek, Indian Creek, Mill Creek, Neal’s Creek, Noblett Creek, North Fork of the White River, Spring Creek (Houston/Rolla RD), Spring Creek (Willow Springs RD), St. Francis River and Swan Creek.

Some streams that were listed above were studied as tributaries of the Gasconade River and found not eligible for WSRA designation; these are Little Piney Creek, Roubidoux Creek, and the Osage River. Because of that suitability study, these streams were not included in this 2005 Forest Plan inventory.

In determining the outstanding remarkable values of a stream, the primary consideration is if the feature is river-related.

To be river-related, a feature should:

- Be located within the river or on its immediate shore lands (generally within ¼ mile of either side of the river);
- Contribute substantially to the functioning of the river ecosystem; and/or
- Owe its location or existence to the presence of the river.

For example, some species, such as Indiana bat, may use the riparian corridor for foraging, but can also use uplands. Species that use rivers or riparian corridors opportunistically are not river-related for this evaluation. However, species such as gray bat, which feed almost exclusively over rivers and streams, and occupy caves connected to river systems, are considered river-related.

The Forest Plan Team conducted the eligibility evaluation to determine outstandingly remarkable values for each stream, and each identified feature was rated within the context of the Ozark Highlands ecological section. For example, Ozark hellbender meets the criteria for outstandingly remarkable value due to its dependence on the aquatic environment, scarcity within the Ozark Highlands, and endemism[‡].

In order to be assessed as outstandingly remarkable, a river-related value must be a unique, rare, or exemplary feature for the river in question, as well as being significant at a comparative regional or national scale. Evaluation criteria were established to rate values that are conspicuous examples from among a number of similar values that are themselves uncommon or extraordinary. For example, gray bats are a federally endangered species, making them significant at a national scale. Gray bats have known occurrences along many Ozark rivers, making them a unique, but somewhat common resident. However, when comparing rivers with gray bat occurrences, it is quite obvious that the Eleven Point National Scenic River is remarkable for the number of gray bat caves associated with it. Therefore, gray bats meet the criteria for outstandingly remarkable values for the Eleven Point River, but may not at the same scale for other rivers.

Features were evaluated for outstandingly remarkable values following criteria developed by Interagency Wild and Scenic River Coordinating Council in December 1999. Types of features fall into at least one of the following the eight categories:

- Scenery (S) which includes landform, vegetation, and water features; these landscape elements should result in notable or exemplary visual features or attractiveness;
- Recreation (R) includes recreational opportunities that attract visitors throughout or beyond the region, national or regional competitive events, type and number of water sports or activities which are available, and the type and amount of sport fishing found within the stream;
- Geology (G) which is a feature, process, or phenomenon that is unique or rare within the region of comparison;
- Fish and Aquatic communities (F) which consist of fish population or habitat, or a combination of the two which are nationally or regionally an important producer of resident or unique fish species, contains an exceptionally high quality habitat for fish or aquatic species indigenous to the region of comparison, and the diversity of both species and habitat of the stream;

[‡] Species occur only in a few river drainages in the Missouri and Arkansas Ozarks.

- Wildlife (W) values are judged on terrestrial populations and habitats in the same manner as aquatic communities.
- Prehistory (H) is evidence of use or occupation by Native Americans. Sites must have unique or rare characteristics or exceptional human-interest value(s), may have national or regional importance for interpretation, and represent a culture or cultural period where it was first identified, may have been used at the same time by two or more cultural groups, and may have been used by cultural groups for sacred purposes. Many sites are listed on the National Register of Historic Places;
- History (H) within the river corridor contains a site or feature associated with a significant event, an important person, or a cultural activity of the past that was rare or one-of-a-kind in the region. Many such sites are listed on the National Register of Historic Places and are at least 50 years old;
- Other values on the Mark Twain National Forest are botanical (B) features. These terrestrial features were evaluated in a manner similar to wildlife and aquatic communities, concentrating on significant plant communities, the amount of land conversion, and remnants of natural communities found within the river corridor.

Results of this inventory and eligibility evaluation and classification are in Table 62. Some values listed in the National Rivers Inventory were not remarkable or outstanding, while other values not listed were outstandingly remarkable. The result of the evaluation for each stream was documented on an evaluation form and a copy of each is found in Appendix E of this document. Only values found to be outstandingly remarkable during this inventory and evaluation will be listed in the 2005 Forest Plan.

The preliminary classification for each eligible stream also followed interagency guidelines. None of the streams on the Forest fit the wild rivers category due to the number of road accesses and amount of land conversion within the stream corridors. Scenic rivers are those with shorelines or watersheds still largely primitive and shorelines undeveloped, but are accessible in places by roads. Recreation rivers are readily accessible by roads or railroad, have some development along their shorelines, contain low water crossings, and water may have been impounded or diverted in the past.

Table 62 – 2004 Wild and Scenic River Study Process Summary for the Mark Twain National Forest

Rivers	WSRA Authority	Original 1986 Forest Plan	1988 Forest Plan Amendment	2005 Forest Plan
Cedar Creek	5(d)	32 miles	29 miles recreational	29 miles Not eligible
Big Piney (Gasconade tributary)	5(a)§	74 miles	63 miles scenic	63 miles scenic Two segments separated by Ft. Leonard Wood
Gasconade	5(a)	43 miles	66 miles scenic	66 miles scenic
Black River		NI	NI	15.7 miles recreational
Courtois Creek	5(d)	21 miles	18 miles recreational	18 miles Not eligible
Huzzah Creek	5(d)	28 miles	28 miles	28 miles

§ Gasconade and its tributary, Big Piney, authorized for study by Congress under Section 5(a) of WSRA. The revised Appendix incorrectly states that 66 and 52 miles of the Gasconade and Big Piney, respectively, be added to the National System per a study completed by the Bureau of Outdoor Recreation (BOR) in 1975. The BOR study recommended river values be conserved by the State (i.e., did not recommend the river be added to the National System).

Rivers	WSRA Authority	Original 1986 Forest Plan	1988 Forest Plan Amendment	2005 Forest Plan
			recreational	recreational
North Fork White River	5(d)	38 miles	30 miles recreational	Miles 1-18 Not eligible Miles 18-30 recreational
St. Francis River	5(d)	14 miles	17 miles scenic	17 miles scenic
Indian Creek	5(d)	NI	NI	20 miles Not eligible
Mill Creek		NI	NI	7.7 miles Not eligible
Neal's Creek		NI	NI	8.25 miles Not eligible
Noblett Creek		NI	NI	1.3 miles Not eligible
Spring Creek (WS)	5(d)	NI	NI	20 miles Not eligible
Spring Creek (H/R)		NI	NI	6.5 miles Not eligible
Swan Creek	5(d)	NI	NI	19 miles Not eligible

NI – not included, WS – Willow Springs, HR – Houston Rolla

Non-eligible Rivers

The following rivers were found not to be eligible for classification under the WSRA due to the lack of at least one outstandingly remarkable river-related value: Cedar Creek, Courtois Creek, the first eighteen miles of the North Fork of the White River, Indian Creek, Mill Creek, Noblett Creek, both Spring Creeks and Swan Creek. See Appendix E for a detailed list of features or values and the result of the eligibility evaluation for each.

Management direction for non-eligible rivers under Section 5(d) will be determined by Forest wide recreation, aquatic, riparian management and streamside protection zone standards and guidelines and the specific management prescription within in which the stream is found such as 1.1 or 6.2. In addition to these standards and guidelines, other management may apply. Cedar Creek, Courtois Creek and the north segment of the North Fork of the White River will remain under Management Prescription 6.3.

Three of the rivers found to be ineligible are currently under Management Prescription 8.1 and classified as Forest Special Areas and as such they are protected from any disrupting activities. All three are on the Willow Springs unit Indian, Noblett, and Spring Creeks.

The above allocations are the same in all Forest Plan alternatives. Though outstandingly or remarkable values may be found along these streams, current management should not negatively affect these values.

Eligible Rivers

The identification of a river for study through the Forest planning process does not trigger any protection under the Act until designation by Congress. Importantly, identifying rivers as eligible, or eligible and suitable does not create any new agency authority; rather, it focuses management actions to the discretion of the Forest Service on protecting identified river values. For agency-identified study rivers, the preliminary (inventoried) classification is to be maintained even without a suitability determination. The recommended classification should be maintained through the duration of the Forest Plan. Tables 62 and 63 describe the eligible river segments and their classifications.

Rivers eligible for WSR designation will be in Management Prescription 6.3 under Alternatives 1-4. Effects of forest management on eligible rivers are determined by the recommended classifications.

Table 63 - Eligible Rivers and their Outstandingly Remarkable Values on the Mark Twain National Forest

River	Best Potential Classification	Segment Reach Description	Outstandingly Remarkable Values	Length (Miles)
Black River	Recreation	Markham Springs recreation area to south District boundary	H,F	16
Huzzah Creek	Recreation	Entire Creek within MTNF proclamation boundary	H	28
North Fork of White River	Recreation	Mile Post 18 to 30	F,W	12
St. Francis	Scenic	Entire Creek between North and South proclamation boundary	S,R,G,H	17

S – Scenery, R – Recreation, G – Geology, H – History, F-Fisheries

Increasing human population density and resulting intensive uses of the landscape put high stresses on aquatic systems in many areas through non-point source pollution and habitat degradation. Human population density in the Forest ranges from a low of 14 people per square mile in the area around the Eleven Point River to 122 in the Cedar Creek District. Throughout the Forest, populations have increased and are expected to continue to grow. The Mark Twain NF is not able to adequately estimate the impacts of increasing population on aquatic resources, however the effects of land uses is discussed in the Riparian and Water Quality section of this chapter. Historically, about 55 percent of riparian zones were forested, but human activities have altered Forest land cover. Today the appropriate type of riverine vegetation may not be found where it once thrived. Development along rivers and streams is not only reducing water quality and habitat on many rivers, but limiting public access for fishing and other river- related activities. Protection of rivers and streams through the Forest planning process helps assure high quality, free flowing rivers and streams, as well as river-related recreation opportunities.

River sections classified as scenic or recreational are managed with a variety of activities allowed within the river corridor. However Forest management would be subordinate to recreational and protecting the river’s outstandingly remarkable values. Classification as scenic or recreational would therefore be expected to have a wider range of effects from activities outside and within the river corridor. Visual quality, while preserved at a higher level of visual quality objectives than in those alternatives where rivers are not eligible for WSRA designation, would be less than for wild rivers. Sights and sounds of man’s activities would be more apparent. Management activities having the greatest potential of affecting rivers and their potential suitability for WSRA designation are road construction, vegetation management, insect and disease control, special use utility right-of-ways, and mineral extraction. Other management activities that also can affect river resources to a lesser degree are threatened and endangered species habitat management, range management, recreation, and fisheries management.

Management activities within the river corridors will be planned to compliment the outstandingly remarkable values found along these streams, restore a riparian natural community that would have been found there previously, protect water quality, and keep streams free-flowing.

Two rivers managed as candidates, are part of a completed suitability study are found within the Gasconade River Watershed. Specifics about these rivers are shown in Table 64. Both the Gasconade and Big Piney are managed as scenic rivers. Other rivers within the watershed determined not suitable were the Little Piney Creek, Osage Fork River, and Roubidoux Creek. A decision was made not to inventory or evaluate any of these rivers due to the completed study. It should be noted that the description of the beginning and termini of Big Piney river segments have changed to reflect actual locations rather than reference the boundaries of Fort Leonard Wood, this is due to land interchanges, which have changed those boundaries. There will be no change in the management of these streams under any of the proposed alternatives.

Table 64 - Rivers with Suitability Studies Completed on the Mark Twain National Forest

River	Classification	Segment Reach Description	Outstandingly Remarkable Values	Length (Miles)
Gasconade	Scenic	State Hwy O to Ozark Springs	S,R,G,F,W	66
Big Piney	Scenic	State Hwy 17 to S31, T35N, R10W	S,R,G,F,W	52
	Scenic	River access in the southeast of Sec. 17, T36W, R10W to southeast Sec. 31, T36W, R10W	S,R,G,F,W	11

S – Scenery, R – Recreation, G – Geology, H – History, W - Wildlife

Use of rivers

Rivers and stream corridors accommodate many different uses such as picnicking, fishing, day hiking and walking for pleasure, primitive camping, canoeing, kayaking, rafting, tubing, swimming and nature study. The National Survey on Recreation and the Environment 2000 interviewed over 15,000 people to determine participation in a variety of activities. According to the results, 76 million reported participating in boating, including rafting, kayaking and canoeing, and 20 million participated in rafting, tubing or any other type of floating on flowing waters. Over 27 million reported fishing in cold water streams, rivers and lakes for trout. The largest projected increases in participation are picnicking (21%), visiting beaches or water sites (20%) and visiting historic sites (13%) within the North Region. Other activities that could be river-related and are expected to increase less than 10 percent are canoeing, floating, rafting, fishing, and swimming. These increases are primarily based upon population increases by 2010; local conditions could be different.

Environmental Consequences

Direct and Indirect effects

Standards and guidelines would be the same for Alternatives 1-4. These measures go beyond what is found in Alternative 5 in protecting values of the candidate rivers. Outstandingly remarkable values identified for each stream in Tables 59 and 60 would be enhanced or protected under MP 6.3.

Management would be the same for all candidate rivers under all alternatives except for Alternative 5, where the Black River corridor would remain under its current management.

The amount of vegetation management within the riparian management zone of Candidate Rivers would be the same in all alternatives except Alternative 1, in which removal of timber would not occur, thereby delaying any restoration of natural riverine communities that might be part of or enhance a stream’s outstandingly remarkable value.

Cumulative effects

The Ozark Highlands ecological section will be considered the base cumulative effects area for candidate rivers, even though visitors to these rivers may come from other states to recreate.

Demand for WSRA designation is expressed primarily through public comment and responses to agency proposals. The degree to which public input favors designation indicates demand for a wide range of uses, activities, and resources qualities associated with wild and scenic river management. Although demand is closely related to current populations and projected growth of the local area, WSRA designation would likely produce increased levels of recreation use in designated and potential wild and scenic corridors.

The Nature Conservancy and Missouri Department of Conservation have identified a number of activities that could be considered threats to aquatic communities. These include conversion of forest to pastures and row crops, the change in vegetation to non-native grass species like fescue, and commercial or residential developments, all of which result in a reduction in the amount of riparian vegetation and flood plain protection. The amount of these activities that take place within a rivers' corridor increases the threat to or actual change in water quality. Streams on the Forest with the highest threat ranking by The Nature Conservancy are Courtois and Huzzah Creek

A change in water quality would affect fishing success, diversity of all species whether aquatic or terrestrial, and recreational experience of other water users.

Private development adjacent to or within the rivers' corridors could affect the recreation opportunity setting, and thus the recreation experience. Persons desiring less interaction with other users of the river, such as anglers, nature watchers, and canoeists may avoid such areas thereby concentrating use on specific sections of the stream or river. In Missouri, the Forest manages very little land along the Candidate Rivers, and private influences greatly contribute to the recreation quality for visitors and water quality.

Recreation

Introduction

Proposed Changes

In March of 2002, Forest Plan Amendment #27 was signed, which included the designation of higher development campgrounds into Management Prescription 7.1. Due to this amendment, the only changes in Forest-wide and Management Prescription 7.1 standard and guidelines are removal of the ones that repeat national or regional direction, edits to clarify current direction or removal of permissive direction.

The amount and allocation of land to different management prescription under alternatives may result in minor changes for land managed for a specific ROS objective depending on the alternative selected. This is displayed in Table 69.

Key Indicators

Acres with semi-primitive ROS classification

This indicator highlights differences between alternatives and discusses the potential increase or decreases in semi-primitive opportunities on the Forest. Public comment has identified changes in access and uses on the Forest as important to many residents.

Scope of Analysis

The analysis area includes National Forest System Lands in the Mark Twain National Forest and its draw area.

Affected Environment

National Forests provide over 191 million acres of public land within the United States. National Forest lands in Missouri contributes approximately 1.5 million acres to the national total and provide unique settings for a variety of outdoor recreation activities such as camping, hunting, fishing, hiking, backpacking, horseback riding, use of motorized trails, canoeing, as well as picnicking, sightseeing, nature watching, and driving for pleasure.

Mark Twain NF is currently managed to provide a wide spectrum of recreation opportunities for the public to enjoy. These range from primitive conditions in seven Congressionally designated Wilderness to more highly developed recreation areas that include paved camping spurs, flush toilets, showers, and picnic pavilions with electricity. The National Forest also provides small, rustic campgrounds that only accommodate a few people at a time, river accesses, scenic overlooks, trailheads, and parking.

A variety of dispersed recreation experience opportunities are offered through management of approximately 750 miles of trails, and a road system that provides access. Approximately 99% of the 1.5 million acres of Mark Twain NF is open to dispersed recreation, and less than 1% is included in developed recreation areas. A key function of the developed recreation areas is to provide a base from which recreationists can enjoy the many dispersed recreation opportunities on the Forest. Some developed recreation areas provide facilities and activities for a complete recreational experience.

Draw Area

Draw areas have been established to better evaluate public demand for recreation opportunities. Past research has demonstrated that most national forest visits originate from within a 300-mile, or one days driving time radius. Therefore, for this analysis, the draw area has been defined as all counties falling within a 300-mile straight-line radius from the Forest border (USDA Forest Service 1999d).

The largest cities within the draw area for the Mark Twain NF include Kansas City, Springfield, and St. Louis in Missouri; Memphis and Nashville in Tennessee; Little Rock, Arkansas; Wichita, Kansas; Tulsa, Oklahoma; Omaha, Nebraska; Chicago, Illinois; Louisville, Kentucky and Indianapolis, Indiana.

Opportunities for outdoor recreation are not limited to the National Forest within the draw area. In addition to many private providers, several agencies manage lands including the Missouri Department of Conservation, Missouri Department of Natural Resources, Corps of Engineers and National Park Service

Recreation Demand and Trends

Recreation demand is a complex mix of people’s desires and preferences, availability of time, price, and availability of facilities. The evaluation of current and future demand for recreation on the Mark Twain NF is based on recent surveys that identify and quantify:

- Estimated number of current recreation visits
- Participation rates for recreation activities within the Forest draw area
- Future activity demand based on projected trends from research

- Activity demand by demographic strata

The recent National Visitor Use Monitoring (NVUM) effort by the Forest Service has provided baselines for estimating current use of recreation sites. These numbers only account for people visiting developed or dispersed sites for the purpose of engaging in a recreation activity. They do not include people that drive through or hunt within the National Forest. For this reason total number of users may not be reported on a Forest level, though the percentage of participation and amount of spending may be accurate.

People within the defined draw area for the Mark Twain NF engage in a variety of recreation activities. The five most used facilities were picnic grounds, other forest roads, developed campgrounds, non-motorized trails and swimming areas according to NVUM results. This survey also showed the most popular activities and percentage of people participating, as shown below.

Table 65 - Popular Recreation Activities on the Mark Twain National Forest

General Activity	Percent	Primary Activity	Percent
Relaxing	57	Relaxing	19
Viewing wildlife	45	Hunting	17
Viewing natural features	41	Hiking or walking	15
Hiking or walking	30	Picnicking	14
Picnicking	29	Non-motorized activities (swimming, games, sports)	10

The 1999-2000 National Survey on Recreation and the Environment (USDA Forest Service and UT 2000), shows over 97% of Americans participated in at least one outdoor activity during the year 2000. Walking continues to be by far the single most popular outdoor activity, although viewing and learning activities such as birding or visiting a historic site are growing rapidly and joining the ranks of activities Americans most favor. Family gatherings outdoors, and viewing a beach or waterside are also among the top five most popular outdoors activities in the U.S. Results of this survey indicate a rapid rise in popularity of viewing and learning about nature, trail use, camping, and motorized recreation activities.

Residents of the Highlands' draw area exceed the national average in percent of population participating in every major category of outdoor recreation available in the Highlands. More than 90% of the draw area population participates in activities associated with viewing and learning about nature and human history, such as sightseeing, bird watching, and visiting historic sites, compared with 76% nationwide. Approximately 40% participate in fishing, 41% participate in boating, 31% participate in camping, and 14% participate in hunting, compared with nationwide participation rates of 29% in fishing, 29% in boating, 26% in camping, and 9% in hunting.

Tables found in OOHA, Volume 4, pages 157 – 163, show participation rates and trends of the population within the assessment area by activity. "Results of NSRE show that, for the Nation as a whole, the number of people participating in outdoor recreation is increasing due both to a growing population and to an increase in the percentage of the population participating in activities" (USDA Forest Service 1999d). "Activities in the Northern Region with the greatest projected percent increase in participation are picnicking (21%), visiting beaches or other water sites (20%), visiting historic sites (13%), developed camping (11%), and biking (10%)" (USDA Forest Service 1999d) all of which are available on the Mark Twain NF.

Recreation Opportunity Spectrum (ROS)

Recreation Supply

For planning purposes, recreation supply is defined as the opportunity to participate in a desired recreation activity in a preferred setting to realize desired and expected experiences. Recreationists choose a setting and activity to create a desired experience.

Three components of supply are settings, activities, and facilities. The Forest Service manages a supply of settings and facilities.

The Recreation Opportunity Spectrum (ROS) is a planning tool used to identify, evaluate, and define the supply of recreation settings on national forests. Five ROS classes have been inventoried on the Mark Twain NF. These settings are Primitive (P), Semi-Primitive Non-Motorized (SPN), Semi-Primitive Motorized (SPM), Roaded Natural (RN) and Rural (R).

Primitive (P) is the most remote, undeveloped recreation setting on the Forest. These settings are generally located at least three miles from any open managed road and are 5,000 acres or larger in size. The Primitive ROS class is limited on the Mark Twain NF to areas managed under the Wilderness Act. Wilderness are assigned Primitive management objective even though they may not meet the requirements for Primitive. On the Mark Twain, these areas are further described by the Wilderness Opportunity Spectrum. This spectrum addresses three zones that fit well with Wilderness in the eastern part of the United States. These further delineations are named transition, pristine and remote. See Management Prescription 5.1 in the 2005 Forest Plan.

Designated wilderness areas currently range in size from four to sixteen thousand acres and do not contain any open managed roads. A few Wilderness areas do contain gated roads that allow access to private property. With few exceptions, the Wilderness Act prohibits the use of mechanized equipment and motorized transport for recreational use, search and rescue, resource protection, trail construction, and maintenance. Groups of visitors are often limited to a specific size to retain a sense of isolation and solitude. For detailed information on the Wilderness resource on the Forest see the Wilderness and roadless discussion.

Semi-Primitive Non-Motorized areas are less remote and can be as small as 2,500 acres in size and only a half-mile or greater from any open road. These settings accommodate dispersed, non-motorized recreation.

Semi-Primitive Motorized settings are within a half mile of a maintenance level 2 Forest System road and can accommodate dispersed or developed recreation.

Roaded Natural settings are located within a half mile of a state, county, or maintenance level 3 Forest System road and usually provide higher levels of development such as campgrounds, picnic areas and river access points.

Rural settings have the most developed sites and modified natural settings on the Forest, such as those under Management Prescription 7.1.

ROS is used in two different ways. The first is as an inventory tool to describe the existing array of recreation settings. This application describes the current condition of the Mark Twain NF and is referred to as the ROS inventory. The process to conduct this inventory followed national direction; housing density maps were used to further delineate the SPM and RN settings.

Table 66 - Inventory of ROS Classes on the Mark Twain NF

Recreation Opportunity Spectrum (ROS) Class	% of NF	Inventoried Acres
Primitive (Wilderness) (P)	4%	64,000
Semi-Primitive Non-Motorized (SPN)	12%	187,000
Semi-Primitive Motorized (SPM)	22%	323,000
Roaded Natural (RN)	61%	911,000
Rural (R)	1%	11,000
Total	100%	1,496,000

The second way to use ROS is to set ROS class objectives for land allocations across the National Forest to integrate a variety of recreation opportunities. On the Mark Twain NF, these objectives are set by management prescriptions.

Table 67 - ROS Objectives by Management Prescription for 2005 Forest Plan

Management Prescription	ROS objective
1.1	RN
1.2	SPM
2.1	RN
5.1	P
6.1	SPN
6.2	SPM
6.3	SPM/RN
7.1	R
8.1	RN*

**ROS objectives vary by specific management areas; generally, areas are roaded natural unless otherwise noted in the 1986 Forest Pan.*

Dispersed Recreation

Dispersed recreation is defined as those activities, such as boating, hunting, fishing, hiking and biking, that occur outside of developed recreation areas, which may need little or no investment in facilities. The supply of dispersed recreation opportunities on the Forest has remained constant since implementation of the 1986 Forest Plan. The availability of some opportunities has increased, such as those depending upon motorized and non-motorized trail systems. The Mark Twain's trail system has increased from approximately 75 miles of motorized trails and 225 miles of non-motorized trails to approximately 150 miles of motorized and 600 miles of non-motorized trails.

While there are fewer minimally developed sites available for camping and day use, opportunities for camping and day use in undeveloped parts of the Forest are even greater than before. Cedar Creek has a number of parking areas to provide users access to many scattered tracts of Forest Service lands throughout the District. These are needed due to the management of grazing allotments and lack of Forest Service system roads.

The Forest also has 3 designated Forest Service Scenic Byways, all of which are on the Ava/Cassville/Willow Springs Ranger Districts. They are Sugar Camp (Cassville), Glade Top Trail (Ava), and Blue Buck (Willow Springs). All are located in the southwest part of Missouri.

Developed Recreation

A developed recreation area is a discrete place containing a concentration of facilities and services with a significant investment in facilities and management. These areas include such facilities as campgrounds, picnic areas, swimming beaches, and historic sites. Developed recreation areas provide different levels of user comfort and convenience based on the assigned ROS setting. Development Levels range from 1 to 5, with Level 1 representing the most primitive, natural settings with minimal or no site amenities. Level 5 represents the highest level of development and is usually fully accessible for people with disabilities in accordance with agency direction.

Supply

Within the Mark Twain NF, there are 27 developed campgrounds with more than 5 campsites. Many smaller camping areas only accommodate a few people at a time. Most of the larger campgrounds have picnic areas, trailheads, or other day use facilities associated with them, and may include beaches and/or boat launches. The Forest also manages at least 65 other developed areas not associated with campgrounds for day use; these are picnic areas, beaches, and boat launches. In addition to these, there are dozens of trailheads and other less-developed sites on the Forest managed to provide other recreation opportunities.

The supply of developed recreation opportunities on Mark Twain NF has decreased slightly since the development of the 1986 Forest Plan, but the spectrum of opportunities has increased. Some smaller, less-used sites are closed; others have been reduced in size or number of facilities. As older campgrounds are being reconstructed, electric and water hook-ups are being provided in response to demand. Consequently, use should increase in updated and upgraded existing campgrounds.

National Forests provide only a small percentage (6%) of the public, developed campsites in the Ozark Highlands, but offer a high percentage of the dispersed recreation opportunities, including 63% of the total miles of trails.

Capacity based on Person-at-one-Time (PAOT) for the Forest is listed by District is shown in Table 68. These capacity numbers include developed and dispersed recreation areas as reported in the developed recreation section of 2002 INFRA. This does not include all parking areas or trailheads with minimum development.

Table 68 - Number of PAOTS by Unit on the Mark Twain National Forest

Unit	Number of PAOTS
Ava/Cassville/Willow Springs	2,976
Eleven Point	2,901
Houston/Rolla/Cedar Creek	1,044
Poplar Bluff	1,966
Potosi/Fredericktown	3,148
Salem	768
Total	12,803

Environmental Consequences

General themes were developed for each alternative that emphasize different resource management objectives. Alternative 5 is based on current management, and will provide the baseline for evaluating other alternatives. Road management direction and the emphasis placed on recreational use, either dispersed or developed, were major factors in determining the effects of each alternative on recreation.

Existing recreation demand is expected to grow for a variety of activities including dispersed and developed recreation. Existing use on National Forest will increase as recreation demand and population grows over the next ten years.

National Forest management could affect recreation by constructing or removing recreation facilities and improvements; changing their development level; restricting, prohibiting or encouraging use; altering the land to make it suitable or unsuitable for use; and changing the landscape setting. Evaluation of potential recreation effects requires that these elements be considered including activities, setting, and experiences.

Environmental effects within these areas will be reduced if 2005 Forest Plan standards and guidelines are followed.

Recreation Opportunity Spectrum

Table 69 - Estimated Distribution of ROS Classes by Alternative for the Mark Twain National Forest

		P	SPNM	SPM	RN	R	Total
ALT 1	Acres	64,000	118,000	1,178,000	132,000	3,000	1,496,000
	% of NF	4	8	79	9	<1	100
ALT 2	Acres	64,000	110,000	261,000	1,058,000	3,000	1,496,000
	% of NF	4	8	17	71	<1	100
ALT 3	Acres	64,000	86,000	285,000	1,058,000	3,000	1,496,000
	% of NF	4	6	19	70	<1	100
ALT 4	Acres	64,000	91,000	277,000	1,060,000	3,000	1,496,000
	% of NF	4	6	19	71	<1	100
ALT 5*	Acres	64,000	88,000	348,000	981,000	16,000	1,496,000
	% of NF	4	6	23	66	1	100
2004 Inventory	Acres	64,000	187,000	323,000	911,000	11,000	1,496,000
	% of NF	4	12	22	61	<1	100

Baseline = Alternative 5, Existing Forest Plan

Table 69 compares the estimated distribution of acres of each ROS Class by alternative, and how distribution for each alternative compares to the current inventory. Alternative 5 contains a variety of ROS settings from primitive to the most developed. However, emphasis in Alternative 5 is to provide recreation opportunities in settings that are dispersed, such as roaded natural. The acres of semi-primitive or more remote settings increase 58% in Alternative 1, which emphasizes less management across the Forest. In other alternatives, there is a decrease of 5% in semi-primitive motorized opportunities from current management. Change in settings will be positive for those visitors seeking a more remote experience under Alternative 1 and less positive for those visitors who prefer a more developed experience.

Increasing the number of remote settings may be associated with road closures in some areas, both seasonal and permanent. The effects of road closure and decommissioning decreases access by motorized vehicles. Closing roads increases visitor satisfaction for those that prefer solitude and fewer disturbances by motorized vehicles. Road closures often reduce wildlife poaching, trash dumping, and litter, but may also restrict use by those who drive for hunting and wildlife viewing. About 2,000 acres of proposed wilderness study areas would increase the primitive setting by about 1% in Alternatives 1, 2, and 3.

The alternatives, to varying degrees, provide remote recreation experiences that provide a unique experience in Missouri. Societal expectations of finding a recreation experience that relies on large remote land bases on National Forest lands would be met.

The objectives for all alternatives favor meeting the National Forests' desired condition to provide a range of quality recreation opportunities to satisfy diverse public interests. Alternatives 2 through 4 would provide more roaded natural motorized forms of recreation and Alternative 1 would provide more semi-primitive motorized forms of recreation. In all alternatives, almost 99% of the Forest is available for a variety of dispersed recreation opportunities whether motorized or not.

Developed Recreation

Generally, the number of developed campgrounds will not change in the amount, capacity, or development level, under any alternative. Visits will likely increase as developed recreation areas meet the needs of visitors and potential visitors. Many areas will continue to offer the same type of facilities and levels of development that are present today. Campgrounds offering shower houses and individual electrical hook-ups are likely to have a greater occupancy rate, and some campers may extend their stay.

Some management activities will effect developed recreation and those effects will depend on the proximity and magnitude of the activity to recreation areas. These activities include management of roads and trails, prescribed fire, vegetation management and mineral exploration. Some activities have short term effects such as prescribed burning that may decrease the satisfaction of visitors in the area for a season. Other activities such as road construction or insect and disease control may influence satisfaction for a few years. Other natural causes such as wildfires or tornadoes can greatly affect developed recreation areas for many years, even permanently.

Dispersed Recreation

In Alternative 5 the Forest is managed to reach and maintain a balanced age class which effects the type of habitats and recreation opportunities. Potential for roaded natural experiences could increase as access roads are built or improved to accommodate management activities. Dispersed activities such as hunting, fishing, and wildlife viewing remain at current levels with changes in use resulting from management activities.

Alternative 2 emphasizes ecosystem restoration activities under which hunting and non-consumptive wildlife opportunities should increase the most. Effects of this emphasis will include increased opportunities for hunting and wildlife viewing on some parts of the Forest. Management acres for ecosystem restoration would be the highest at 44% in Alternative 2. Under Alternative 3, 29% of the Forest would be managed in the same manner. Alternatives 1 and 4 have the lowest increase in areas of restoration at 8% and Alternative 5 has no management that emphasizes restoration, although this work could occur under current management direction.

As a blend of Alternatives 3 and 5, Alternative 4 should have little change in hunter satisfaction, type of game species present or hunter success ratios. There may be an increase in people viewing wildlife or nature in ecosystem restoration areas.

Under Alternative 1 most of the Forest will be managed for semi-primitive recreation objectives, since late-successional wildlife species will dominate, hunter satisfaction will decrease due to changes in their success ratio and having fewer game species. Hunter satisfaction may increase in areas of ecosystem restoration, if proposed management is different from in the past. Road network mileage would be reduced through closure and obliteration of roads not needed for management activities, thereby reducing access to some parts of the Forest for a variety of recreation activities.

Cumulative Effects

The analysis area includes National Forest System Lands in the Mark Twain NF and its draw area.

In general, the National Forest has the greatest ability to provide more semi-primitive forms of recreation due to its large land bases. Where federal and state lands are adjacent, semi-primitive recreation opportunities are enhanced with the combined acreage. State parks generally provide a higher level of development in the rural and urban opportunity of the ROS spectrum than federal developed camping and recreation facilities.

State and private recreation management is complementary to Forest Service facilities rather than adversely competitive.

Private development adjacent to National Forest System land would affect recreational experiences in the interface. Persons desiring to get away from human influence, and experience more solitude on National Forest System lands may avoid these areas. Increasing private development adjacent to National Forest System land could lead to more illegal activities such as motorized use outside of designated systems.

The primary challenge for National Forest recreation managers is how to maintain the unique high quality natural settings and remote recreation experiences that visitors seek on federal land. In the future, supply and demand for kinds of recreation may shift, but the variety that can be accommodated on National Forest system lands, with their large land bases, would ensure some level of user satisfaction. Maintaining an array of Forest settings and opportunities helps level fluctuating responses to weather, travel distance, or societal values.

Heritage Resources

Introduction

Heritage resource is an umbrella term for many kinds of heritage-related resources including:

- Historic sites, buildings, districts, structures, and objects with historical, archaeological, engineering, and cultural values;
- Historical objects found or excavated from an archaeological site or associated with the history and cultural of an American Indian tribe;
- Documents with historic, folkloric or archaeological significance;
- Places of traditional religious or cultural importance to an American Indian tribe;
- Locations regarded by a community or others, as contributing to its “sense of place.”

Proposed Changes

In March of 2002, an amendment was made to the Forest Plan in this resource area. This amendment addresses current federal mandates and compliance requirements for the Heritage Resource program. Due to this amendment, the only changes in Forest-wide and management prescription standard and guidelines are removal of those that repeat national or regional direction, edits to clarify current direction, removal of permissive direction, and the removal of direction under MP 8.1specific to Fort Davidson, which is no longer in Forest Service ownership.

Affected Environment

Forest heritage resources range in age from over 10,000 years to historic European exploration and settlement eras and, in more recent years, Forest Service land management and facilities in the Missouri Ozarks. Evidence of past human activities can be found through archaeological and historical investigations of sites inhabited by groups such as Paleo-

Indians, later Native American hunters and gatherers, and Euro-American settlers of the region. Heritage resources spanning the length of human occupation in the Ozarks provide invaluable information about human adaptation to and interaction with the natural environment. From locating and studying such diverse resources as prehistoric rock shelters, campsites, and quarries to historic settlements, Civil War encampments, and Civilian Conservation Corps construction projects, the story of past human life in the Ozarks of Missouri is being pieced together for future generations.

Approximately 6,000 heritage resource sites have been documented to date on the Mark Twain NF. This is an increase from the 2,211 known sites identified in 1979. Just over 400,000 acres have been surveyed across the Forest preceding earth-disturbing management activities.

Survey and evaluation of acres are conducted in conjunction with site-specific project analysis for timber, wildlife, recreation, roads, land exchange or other management activities. Targets are based upon these projects. In 2002, 63,755 acres were surveyed, and 356 historic and prehistoric sites were identified for preservation and protection. In 2001, volunteers contributed 11,000 hours as part of the Passport in Time project, this included surveying and mapping cultural sites, collection and cataloging of artifacts and site interpretation.

There are currently nine Forest sites on the National Register these include buildings, historic districts and undisclosed sites. In 1979, there were only two sites designated: these were Decker Cave and Fort Davidson. Fort Davidson is no longer under Forest Service management, but is managed by Missouri Department of Natural Resources – State Parks Division. Presently there are five sites and one archaeological district being evaluated for listing.

A list of heritage resource survey sites on the Mark Twain is found in report 4 of 5 of OOHA. This listing totals both prehistoric and historic sites by type and components (USDA Forest Service 1999d).

Environmental Consequences

The identification, protection, and evaluation of historic properties on the Mark Twain National Forest is implemented programmatically under the terms and conditions of the Memorandum of Understanding with the State Historic and Preservation Office as stipulated in 36 CFR 800. Therefore, the degree of direct, indirect and cumulative affects to known properties should be the same under any alternative, regardless of project.

Historic properties may be directly and indirectly affected by heat damage to artifacts and sites and erosion from fire. High-temperature wildfire could pose direct affects to historic properties by damaging surface or shallow archeological sites, standing structures, and cemetery markers. Sites of the historic period are most subject to direct affects from these events because many of these properties are more likely to exhibit surface artifacts. Wildfire, and in some cases higher temperature prescribed burns, may alter the character and condition of surface artifacts such as melting glass, “crazing” lithic and ceramic artifacts, and scorching or burning wood structures.

Fire lines installed with tractor-plow units for wildfires could directly affect historic or prehistoric properties by physically displacing artifacts located at shallow levels or on the ground. Fire lines established using a disc harrow would have less impact than those made with a tractor plow. Under normal conditions, however, heritage surveys do not precede emergency fire line construction. Thus, there is a potential for unknown properties to be affected by wildfire suppression. Indirect affects following the installation of fire lines and burning may include erosion losses due to the removal or burning of vegetation cover or further deterioration of artifact or feature condition following damage by high temperatures.

Indirect effects could include soil erosion and compaction of historic properties due to visitor use, and access to given locales could result in archeological site vandalism. These indirect effects could especially occur with illegal expansion or establishment of motorized trails.

The amount of these effects for each alternative is best discussed in project level analysis, though general conclusions can be stated here. Under all alternatives effects will be dependant upon the activities that take place upon any specific part of the Forest.

With increased prescribed burning more heritage resources artifacts or features will need protection. The least amount of planned fire will be in Alternative 5; the most under Alternative 2, though the total difference is about 9 % overall. The amount of fireline needed would also vary by alternative and layout of areas to be burned. Fuel treatment by mechanical methods would affect heritage resource areas in a manner similar to the use of tractor plows and discs. Projected activities would be the greatest under Alternative 5 and the least in Alternative 1; a difference of about 8 %.

Another activity with effects on heritage resources is the amount of access to an area due to management. Since system road mileage needs should be the same under most alternatives, except Alternative 1, the greater impact will be miles of temporary roads needed for timber management. There is a wide variance for this activity from lowest estimated miles of temporary road under Alternative 1 to highest in Alternative 5, all other alternatives show a projected need in the middle. Unauthorized use of these roads by the public could increase soil compaction and vandalism to heritage resource sites.

Vandalism and illicit collection is influenced by visitor use. Greater visitor use in some areas will lead to the increase of vandalism, illicit collection, littering and disturbance to cultural sites under all alternatives. Opening areas to timber production and timber manipulation, recreation use, and roads and trails will result in an increase in site disturbance and vandalism in previously inaccessible areas. While cultural properties situated in recreation areas and along designated trails and road corridors can be signed, monitored, patrolled and protected, impacts outside of these areas are largely uncontrolled and the extent of impact unknown.

In all activities, except for wildfire, areas will be protected under the standards and guidelines found in the Forest Plan. For known heritage resource sites some protection can be built into fire responses based upon local knowledge and the fire risk assessment.

Cumulative Effects

The scope of analysis for cumulative effects will be lands managed by the Mark Twain National Forest in Missouri.

Natural affects (weathering, erosion, wildfires, etc.) will inevitably result, over time, in degradation of historic properties and fewer intact significant historic resources.

Forest management is not always adequate to protect heritage resources from adverse effects of human undertakings or from illegal activities such as looting or vandalism. Increased public access could result in increased degradation of historic sites through an acceleration of erosion and vandalism.

Social Effects

Introduction

The relationship between the Mark Twain National Forest and local lifestyles and economies is interdependent and complex. Outdoor recreation, seven Wilderness areas, an exceptional wild and scenic river, and unique ecosystems all provide a stunning backdrop to communities that are growing at a fast pace. This section contains information on the affected social environment which describes its current condition and the people who reside in the vicinity of the Forest, followed by an examination of potential effects resulting from changes in the 2005 Forest Plan..

Social attitudes, values, and beliefs are elements used to describe and understand the human dimension of natural resource management. Attitudes, beliefs, and feelings about proposed revision topics were gathered through the scoping process described in Chapter 1 of this Final Environmental Impact Statement (FEIS). Analysis will focus on the areas of concern expressed. This information will be used to predict possible effects on local communities, which may include acceptance of or resistance to future decisions. Social analysis, coupled with economic and demographic information, forms the human dimension of ecosystem management. This information is used in conjunction with biological and physical analyses to better understand potential effects on the land as well as on human communities.

Key Indicators

Decisions made in the Forest planning process may result in changes to the quality of life in local communities. The key indicators and social implications have been listed and discussed in the fire, timber, ecosystem health, water quality, economics and environmental justice sections of this chapter. All of the key indicators have potential impacts on community quality of life values that include, but are not limited to clean air and water, recreation opportunities, employment opportunities, forest access and transportation, and safety. Detailed discussion of key indicators and effects can be found in the section of interest.

Affected Environment

The following summary provides a description of conditions and trends in the area. People living in the area, outside the area, and those making management decisions about resources of the Forest should understand the social and economic context of the area most likely to be affected, positively or negatively, by these resource decisions. For a more comprehensive look at the social and economic information summarized here, readers are referred to Pell's Ozark-Ouachita Highlands Assessment (OOHA).

Historical Background

The Mark Twain National Forest has cultural resources dating back to Paleo-Indian times, prior to 10,000 B.C.

The primary and dominant indigenous Indian tribe in Missouri area was the Osage. By 1700, they were an organized tribe and when they encountered French explorers and settlers, the influence was great. Osage settlements were permanent villages, organized according to the political affiliation of each clan present. Agriculture and farming were developed while gathering still occurred. Hunting seemed to be the most important means of getting food for the Osage. Immigrant Indian groups from the East moved to and through Missouri as

European settlers claimed more and more land. Eventually, the Osage and the immigrant Indians ceded their Missouri lands and moved further west. The Osage left in 1923.

The people who moved into Missouri in the late 18th and early 19th centuries were attracted by opportunities to acquire timberland and by the availability of free open range on unclaimed public land. Land acquisition records indicate that much of the area was settled between the 1880’s and 1930’s.

Around 1870, the citizens of Missouri had begun to use natural resources for profit. Timber mills flourished and vast forests of pine and oak were leveled, sawed, sold and shipped. Over fishing of streams was common; dynamite became a new fishing tool; and an almost total annihilation of game turned the land lean. By the 1930’s, the lumber mills were gone as were the forests and game. Soil erosion and water pollution had begun due to clear-cutting, slash-burning, and continued cropping of slopes. This was the condition of the land when the Forest Service began restoration in 1939.

The connecting ridges, deep hollows, rocky knobs, and cedar glades of the Mark Twain NF today scarcely reveal the hard times of the past that affected both the land and its people. Historically, the area consisted of open woodlands managed by large-scale use of fire by the Native Americans (Mississippian and Osage) that had lived here for centuries. Once the settlers arrived, the ecological structure of the area changed due to heavy agricultural activities that supported mining and westward expansion. By 1927, heavily harvested woodlands, bare hillsides, failing soils, eroded farmland, and streams full of gravel and sediment made up the Southern Missouri landscape. It was in this abused condition that the Mark Twain NF had its beginnings (Pinkerton 1981).

Current Social Environment

The social environment comprises the people living in and adjacent to the Mark Twain NF, and includes lifestyles and attitudes of people toward the area’s resources and ways in which these resources are used. In the Notice of Intent (NOI), five areas of forest management were identified as major revision topics. Proposed changes to the 1986 Forest Plan in areas of vegetation and timber management, ecological sustainability and ecosystem health, fire management, management area allocation, riparian areas, and water quality were published. The Plan also includes intent to clarify access and transportation management language. Response to our consideration of these areas during plan revision was significant. Written comments and statements made at public meetings, as well as attitudes, beliefs, and values published in assessments, survey reports, and research papers concerning these issues are outlined in the following paragraphs.

As open space becomes scarce, demand for openness and solitude offered by the National Forest System will become more and more important to residents seeking a break from their urban surroundings. Forest resources play an important role now, and will continue to do so in the future for many people. One purpose of scoping is to allow interested individuals and groups an opportunity to express their concerns about the proposed revision and its potential effects on their lives. Concerns were expressed from a wide range of viewpoints.

Concerns of Residents and Non-residents

The importance and extent of social and economic impacts vary based on the perspective of the individual. On one extreme, there are those who would make social and economic needs of the local community of paramount importance. Others would advocate that social and economic factors are of no importance and should be completely disregarded in favor of environmental concerns. The challenge is to find an acceptable balance.

Long-time residents often have strong traditional and emotional ties to the Forest. They want assurances that resources will be protected, traditional uses will continue to be accommodated, favored areas are protected, and changes in management will not have an unacceptable impact on their lifestyles and customs.

Many people expressed concern that a reduction in dispersed camping opportunities would adversely affect their lifestyle. Dispersed camping and picnicking is a popular activity for family gatherings in the area. Reductions in opportunities for these activities would adversely affect many area families who make such activities a regular element of family custom and tradition.

Additionally, many residents are concerned about the kind of impact changes in management will have on their economic well being. Water originating on National Forest System lands serves agricultural, industrial, business, and residential uses. Grazing permittees rely on the availability of allotments and suitable forage for grazing livestock. Outfitters and guides for various recreation-related uses make all or part of their living from National Forest resources. Many local communities rely on employment and income generated from the use of Forest resources.

Non-local interested parties have concerns with how changes in management activities will affect their lives. Many of these people may never actually visit the Mark Twain NF, but draw comfort and satisfaction from the knowledge that the Forest and its resources exist. They want assurance that these resources are maintained in a natural, unaltered state into the future. These individuals and groups are generally less concerned about potential changes to local economies or lifestyles than they are about limiting the environmental effects of management activities and forest uses.

Many residents believe that Missourians should have greater influence on local Forest management decisions. There is a belief among local individuals, groups, and governments that their lifestyles are being threatened by the influence and power of well-financed, non-local environmental organizations with little or no interest in or concern for local communities and their welfare. The belief was frequently expressed during the scoping process that non-local organizations and “eastern” interests, both within and outside government, were the primary force behind efforts to increase wilderness designations and roadless protections.

Other groups and individuals believe that local communities have had too much influence on Forest management decisions to the detriment of the environment. They believe that there has been too much emphasis on local economies, resulting in the perpetuation of commodity uses, which they view as shortsighted and damaging to the environment.

Attitudes, Beliefs, and Values

In 1999, the Ozark-Ouachita Highlands Assessment (OOHA) sought to answer the question ‘What are the attitudes, values, and opinions of people in the Highlands (including interest groups and forest in-holders) regarding national forests and the Forest Service?’ The answer to this question helps managers better understand public interests and perceptions concerning national forest management. A poll was taken to ascertain the values of the general public and both national and local surveys are used to understand the public’s views on forests and the environment in general.

One key finding of OOHA (USDA Forest Service 1999d) was that there is a high level of public support for maintaining healthy forests and environmental quality, although the concept of a healthy forest is subject to a variety of interpretations. In general, the public agrees that the Forest should fulfill a variety of roles, and that multiple use management is important. Most respondents in public opinion surveys support the following:

- Forests should be managed for multiple uses
- Forests should provide a range of goods, services, experiences, and values
- Public forests should not provide goods and services at the expense of long-term forest health and environmental quality

There is widespread agreement that different uses of national forests should be balanced. In various surveys, 40 to 50 percent of the respondents disapproved of timber cutting for wood products on public lands. On the other hand, if environmental protection measures were listed as conditions, or the management objective included benefits to wildlife and/or scenery, as many as 70 percent of respondents were in favor of such timber harvests.

The public expects the Mark Twain NF to take a scientific approach to forest management, but they also want the agency to encourage public participation in decision-making and monitoring. The public has generally not understood land management principles or which agencies are responsible for managing specific tracts of public land. Public opinions voiced most often during OOHA meeting were those having to do with perceived threats to private property and United States sovereignty.

One great source of information about attitudes and opinions is Missouri's "Conservation Monitor" 2000 edition. This report is extremely valuable because of its quality, scope, and time depth. The report is compiled once every two to four years based on telephone interviews by the Gallup Organization. Interviewees are selected randomly and distributed evenly across Missouri. The sample was asked a variety of questions on topics such as environmentalism, conservation, landownership, recreation, and environmental practices.

Citizen values, attitudes, and beliefs as they relate to forests and forest practices are important to know if we intend to manage for these values. Missourians rank oxygen production and carbon storage, wildlife habitat, water quality, scenic beauty, lumber production, and outdoor recreation as the most important benefits from our forests. Similar to the results found in OOHA, the majority of Missourians feel that environmental protection and economic development can go hand in hand, but will side with the environment when a choice must be made between the two.

The following data shows that respondents from a wide variety of backgrounds and values took part in the survey. The sample was split evenly by gender. Six percent (6%) of respondents indicate their race is African-American and 4% chose other. The rest of the sample is Caucasian. The sample age is 18 years of age and above. Twenty-five percent (25%) of those surveyed live in rural areas while another 21% live in an urban area. The remainder lives in suburbs or small towns.

The most popular source of information on conservation and the environment in 2001 was the Missouri Conservationist magazine, which was also true from 1994 through 1997. Most people get their environmental information from some combination of TV news (77%), newspapers (70%) and the Missouri Outdoors TV Show (57%). The sample largely indicated that they pay attention to environmental information and value being informed about management activities.

Sixty-two percent (62%) of Missourians consider themselves environmentalists, declining from 1994 where seventy percent considered themselves as such. Of those respondents who consider themselves environmentalists, 48% said they are strong environmentalists, which has been the norm for several years. Missourians overwhelmingly (85%) view resource restoration as a key issue, and believe that an effort should be made to restore animals and ecosystems that once thrived in or are currently very rare in Missouri. Over 70% of respondents favor wildlife restoration programs, especially ones involving elk.

The same study showed that rural land ownership in Missouri has declined significantly since 1997. Then, almost 50% of Missouri families owned rural land. Today, just under one-third of Missourians are rural landowners. Of those who do own rural land, 81% utilize the land for walking, watching wildlife, and fishing. Another 45% of those who own rural land allow hunting or hunt on the land, which is down significantly from previous years. Almost half (47%) of Missourians approve of the cutting of timber for lumber, furniture, or wood products, which is a decline from 55% approval in 1997.

Twenty-five percent of Missourians consider themselves hunters. Higher percentages approve of hunting for food (88%), and outdoor experience (56%). These numbers have remained fairly consistent over the past eight years. Over half of the sample (67%) participates in outdoor use of conservation areas. The other popular outdoor activities for Missourians are fishing (57%), boating (48%), hunting (35%) and, target shooting (34%).

What people consider to be “natural” varies widely, even among land management agencies. At least three broad definitions of naturalness exist (Hull and Robertson 2000):

- naturalness is associated with a state of the environment that existed at some previous point in time (i.e., authentic or original nature),
- it is a state of the environment that exists in the absence of human modification (i.e. pristine or wild nature), and
- it is associated with a slow, or ‘natural’, rate of change

The first concept of natural as the state of the environment at a previous point in time corresponds to the range of natural variability of a natural community as discussed and used in this document. It is also the perspective of disturbance ecology and geological time, in which the only thing constant about nature is change. This definition of nature fits with the history of vegetation management in Missouri, which includes the Native Americans’ use of wildland fire as one of the most effective tools available to manipulate their environment in an effort to survive.

The second concept can describe Forest Service management of wilderness and other areas where minimal modification or management of resources is prescribed. In a fire- or disturbance-dependant natural community, the very wilderness character that is valued may not be preserved if there is no human intervention to provide the disturbance process. In the same manner, a habitat for threatened or endangered species may be at risk without some sort of disturbance beyond what nature can provide.

The last concept could be considered natural succession, letting nature take over what man has changed. It can be an attempt to mask modifications man, from whatever era, has made to the area. This is the concept behind the term “untrammeled” as used in the Eastern Wilderness Act, which assumes that human-caused modifications in the environment become muted and disappear as an area is affected by the forces of nature.

It is easy to see that there can be conflict in what nature means to different people and in land management decisions. “What nature is and what it should be are questions that touch the heat of ecological restoration and management. The goals of a restoration project are often based upon a decision makers’ idea (or ideals) of what is natural, healthy, or otherwise best for nature.” (Hull and Robertson 2000)

Based upon these various definitions, human-made influences can be considered unnatural in one context, while the exclusion of man's influence in some ecosystems can be considered unnatural if results are outside the historical conditions once found in an area.

Access and Transportation Management

Because of the announcement that an off-road vehicle (ORV) study was being developed during the Forest Plan revision, concerns about non-motorized area management dominated the public response. Some groups and individuals expressed a desire to protect these areas from motorized development through wilderness designation or other protective measures. For many people, the attributes of semi-primitive non-motorized recreation, such as wildness and solitude, are vital to their use and enjoyment of the Forest. Others expressed concern about potential for environmental damage resulting from ORV uses. Still others believe that there has already been sufficient development and that protection is needed and important for the sake of preserving wildness.

Conversely, many other Forest users expressed concern that their favored recreational activities, such as use of all-terrain vehicles (ATVs), motorcycles, and four-wheel drive vehicles, were under attack. These individuals and groups expressed the belief that they had already lost too many recreation opportunities to wilderness designation or other restrictions, and that an important element of their lifestyle could be lost because of changes in the Forest Plan. They expressed concern that restrictions on access will prevent many individuals, such as the handicapped and elderly, from accessing and enjoying the Forest. These individuals believe that wilderness designations or other restrictions on access remove the opportunity to seek solitude and wildness from all, but the most physically fit. Many of these groups and individuals advocate development of additional trailheads and trails in order to increase motorized opportunities for a growing population.

Forest users with economic dependencies on Forest resources are concerned about potential economic impacts. Those who hold grazing permits are concerned about the potential for reductions in lands available for grazing and the resulting economic consequences and potential loss of lifestyle. Still others view grazing as environmentally and aesthetically damaging and would like all grazing eliminated from National Forest System lands. Those dependent on National Forest timber are concerned that potential reductions in the amount of timber harvested could threaten their livelihood. Outfitter guides are concerned that their opportunities and livelihood may be threatened by changes in Forest Plan direction.

Local county governments expressed concern that reductions in uses such as recreation, grazing, mineral development, timber, and others would have a detrimental effect on local economies. Others expressed concern that too much emphasis may be placed on the local economic effects of consumptive uses rather than on maintaining healthy ecosystems.

The diverse range of beliefs and attitudes about what constitutes appropriate Forest management places groups and individuals in the position of opposing each other's goals. This wide range of viewpoints means, that regardless of the decision, some, if not most, stakeholders will experience some degree of dissatisfaction with the final decision. Strains between opposing interests are likely to be heightened throughout the analysis process as well as after final decisions are made.

For the purposes of socioeconomic analysis, the study area has been divided into regions by geographic unit. Each unit has a unique configuration of socioeconomic conditions that influence its social and cultural character and contribute to the definition of and public response to natural resource issues. Table 70 shows the seven units and counties they contain.

Table 70 – Socioeconomic Study Regions and Counties for the Mark Twain National Forest

Unit	Counties	Total Acreage
Ava-Cassville-Willow Springs	Christian, Ozark, Taney, Barry, Stone, Douglas, Howell (7)	311,764
Cedar Creek	Boone, Callaway (2)	16,310
Eleven Point	Carter, Oregon, Ripley, Shannon (4)	376,639
Fredericktown	Bollinger, Iron, Madison, Saint Francois, Sainte Genevieve (5)	159,193
Houston-Rolla	Laclede, Phelps, Pulaski, Texas, Wright (5)	191,236
Poplar Bluff	Butler, Wayne(2)	136,704
Salem-Potosi	Crawford, Dent, Reynolds, Washington(4)	272,419
TOTALS	29 Counties	1,464,265

Source: www.census.gov

Population and Demographics

Population size is a significant issue in Missouri at both ends of the growth continuum. Only two counties, Iron and Pulaski, that experienced a population decrease from the 1990 to 2000 census. Pulaski County in the Houston-Rolla unit and Iron County in the Salem-Potosi region, both lost less than 1% of their populations over a 10 year period. Regional growth ranges from 7% for Poplar Bluff, to 38% for Ava-Cassville-Willow Springs region. Overall, the population of the twenty-nine county area grew an average of 18.7% from 1990 to 2000. Even so, counties that make up the study area continue to be the least densely populated areas of the state. Table 71 shows the regions ranked by their growth and average population density. Districts near urban areas such as Cedar Creek and Ava/Cassville/Willow Springs experienced a good deal of population growth due to urban sprawl and suburban growth.

The largest population group in the 29 county study area, as well as in the state, is the 35 – 44 age group. This age group has had the most growth of any group in each decade since 1980. The 45 – 54 age group is the second largest in the study area (and the largest in 5 of the 29 counties) except for Boone and Callaway, where the 25 – 29 year olds made up the largest percentage of the population.

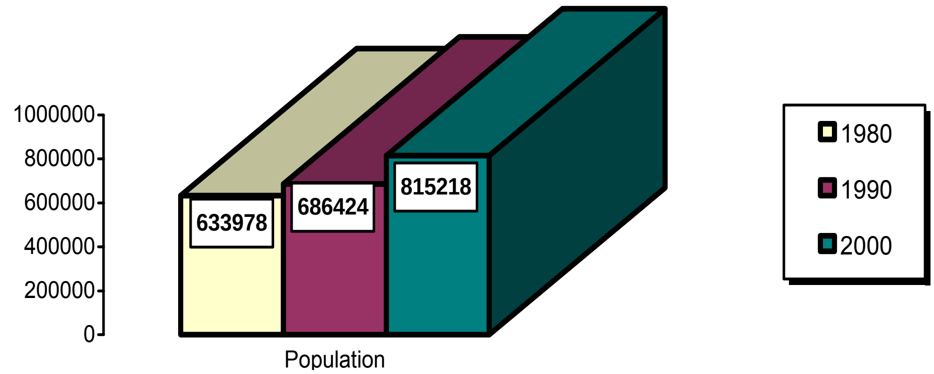
Table 71 – Mark Twain National Forest Unit Population Growth 1990 - 2000

Unit	2000 Population	1990 Population	Percent Growth	Average Population Density
Ava-Cassville-Willow Springs	216,520	156,861	38%	46
Cedar Creek	176,220	145,188	21%	122
Salem-Potosi	67,764	59,916	13%	22.3
Fredericktown	108,009	97,413	11%	44
Eleven Point	38,118	34,901	9%	13.5
Houston-Rolla	154,461	141,947	9%	44
Poplar Bluff	54,126	50,308	7%	37.7
TOTAL	815,218	686,534	19%	42

Source: www.census.gov
Population Density is people per square mile.

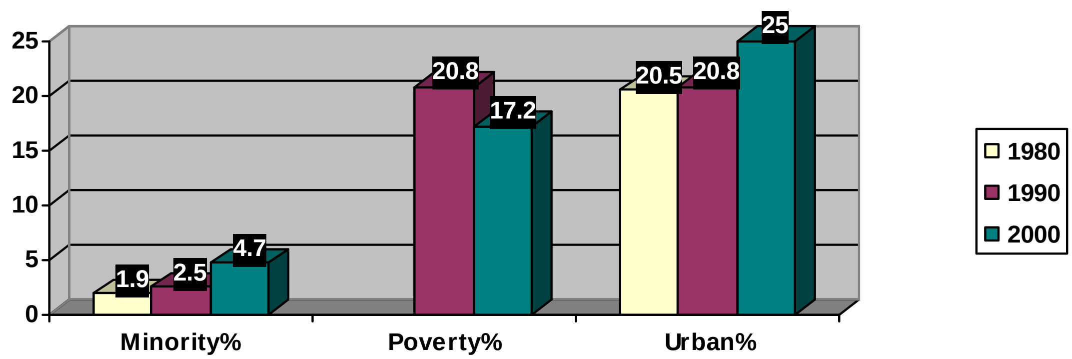
Overall, the Forest has grown tremendously over the past thirty years. Figure 34 shows that the population in and near the Mark Twain National Forest has increased steadily since 1980. Social indicators in Figure 35 show that minority populations have grown from 1.9% in 1980 to almost 5% in 2000. Similarly, urban populations around Mark Twain NF have increased from 20.5% in 1980 to 25% in 2000. The percentage of persons living below the poverty threshold in and around the Forest has decreased about 3.5% since 1990 to 17.2%.

Figure 34 - MTNF Population Changes 1980 - 2000



Source: www.census.gov

Figure 35 - MTNF Social Indicator Changes 1980 - 2000



Source: www.census.gov

Tables 72 and 73 display housing units and median housing values for 1990 and 2000, changes in housing density are shown in Table 71. Housing values in and around the Mark Twain analysis area has increased more than Missouri or the nation because influences of urban areas, population, and economic growth has supported higher priced housing. Housing values are determined principally by demand. The greater the demand, the higher prices are rise. Median housing values in MTNF counties range from $107,000 in Boone County near urban centers of Columbia, to a low of $41,000 in Shannon County. Population changes, the movement of people, and job changes play a factor in housing demand. Populations began to increase at a significant rate in the 1980s. In response to demand, housing units also increased at a significant rate in the 1990s.

Table 72 - Housing Units 1990 - 2000

Area	Units 1990	% Change 1990 - 2000	Units 2000
Mark Twain NF Counties	295,629	23%	364,419
Missouri	2,199,129	11%	2,440,127
United States	102,263,678	13%	115,904,641

Source: www.census.gov

Table 73 - Housing Values 1990 - 2000

Area	Housing Units Median Value 1990	% Change 1990 - 2000	Housing Units Median Value 2000
Mark Twain NF Counties	$36,300	68%	$61,000
Missouri	$59,800	50%	$89,900
United States	$79,100	51%	$119,600

Source: www.census.gov

Racial Diversity, Education, and Age

Age distribution gives an indication of whether the population of a community is generally growing or declining. A notable characteristic of population composition for both the state and study counties is the aging of the population relative to the U.S. The median age in Missouri is 37.5 compared to 35.3 for the United States.

The study area is broken down into the same race and origin categories as those used by the U.S. Bureau of the Census during the 2000 Census. In 2000, study units were comprised of 86.9% to 96.7% Caucasians, 1.1% to 7.8% African Americans, and 0.1% to 2.4% persons of Asian descent. The areas with the greatest diversity are the more densely populated areas of Columbia and Rolla. Persons in the study area who indicated they are of Hispanic origin range from 13.8% in the Fredericktown unit to less than 1% in the Poplar Bluff unit.

Educational achievement is one indicator of the human resources available in a community and the level of workforce preparation generated. This has implications for community sustainability and resilience, and tends to correlate with income and poverty. All units have a low to medium proportion of the population 25 years and older with a high school diploma or above; the lowest at 65% in Poplar Bluff and Salem-Potosi, and the highest at 84% in the Cedar Creek unit. The highest percentage of adults ages 25 years and older with a bachelor's degree or higher is in the Cedar Creek unit (29%). Residents with the lowest levels of education are located primarily in rural counties. Overall the Cedar Creek unit percentages are comparable to the Missouri average of 81% with a high school diploma or higher and 21.6% with a bachelor's degree or higher.

Social Effects

Direct and Indirect Effects

This section covers social impacts of those management activities that the public has indicated are important to them. More often than not, these impacts occur off National Forest lands. Effects of alternatives to recreationists and other users that occur directly on the Forest, in recreation, from other commodity development activities, through wilderness designation, vegetation management, wildlife habitat management, fire management, and water quality management, are described in sections devoted to these topics.

Ecological Sustainability and Ecosystem Health

People have very different values concerning the restoration of nature and to a certain extent how to define nature. These differences are present in arguments people make, whether in favor of active management for restoration to the range of natural variability of a natural community, or the preference to allow for a slower rate of change, which is evident in the current non-management of many areas under MP 6.1 or 5.1. In some cases, character of the area, which is to be protected is lost with the absence of fire or other recurring disturbance to maintain a specific habitat whether open or forested. In this case trade-offs may have to be made by the decision maker

The results of most values and attitude surveys, whether at a national, state, or local level, seem to echo a similar response. The majority of people who answered the surveys felt that commodity production should benefit long-term forest health and improve quality of the environment, not just for profit and personal gain.

In all alternatives, there would be varying amount of restoring natural communities within their range of natural variability. The amount of management and type of restoration activities allowed would vary by allocation of land to a specific management prescription such as 1.1, 2.1, 3.4, 4.1, or 6.2 under each of the alternatives. The largest difference is in Alternative 1 where efforts to achieve successful restoration of a natural community would be without commercial harvest and cost could be a controlling factor. In all other alternatives restoration activities and commodity production would be balanced to achieve the desired condition. In Alternatives 2 through 5, funds generated from commodity production would help finance restoration activities.

Roads and Transportation Management

Different individuals and groups of people experience solitude, serenity, spiritual renewal, and other positive emotions in different ways. The Forest provides this for some of them, so the need to transport them to and around the Forest is important. The kind of settings that some people find pleasing are not fulfilling to others. Families and groups with differing traditions about how they recreate, use, or otherwise see value in public lands are fervent about their desires to preserve those values they see as shrinking or threatened. This section will disclose how the alternatives may affect or be perceived by groups with differing personal/social values.

At the local level, people use Forest Service roads for recreation opportunities, social values, and economic sustainability. At the national level, the road system is touted to be extensive and costly. Public debate on the need for fewer roads at the national level has been ongoing and polarized.

Those who use roads that have been closed to enter hunting areas would be negatively affected by the closure of what the public views as “woods roads”. People who use roads to traverse the Forest have expressed that they feel their experience is being diminished by road closures. Using gates to prevent entrance onto roads is not appealing to this group.

Under all other alternatives, a project level roads analysis could recommend closure and decommissioning of unclassified roads. The majority of classified, and some unclassified roads would remain open, either permanently or temporarily, until all management activities in the area are completed. In all alternatives, unclassified roads under special use permit would most likely be gated.

Under Alternative 1 there would be less access to the Forest and more visitors would be affected by reduced maintenance on Forest Service classified roads. There would also be fewer temporary roads than under any other alternative.

Vegetation and timber management

Projections for timber harvest levels vary by alternative as presented in the Timber Supply section. Alternative 5 would supply the most timber products, and would most likely support continued employment in the timber industry. Alternative 1 prohibits commercial timber harvest in an effort to minimize direct human influence. While most local mills have adapted to intermittent supply from federal lands by increasing purchases from other sources, further adaptation would be required under Alternative 1 because timber that is cut would not be sold. Similarly, if supply projections equate to some effect on social patterns associated with those people employed by mills or in logging, Alternative 1 may have the greatest effect on related social patterns.

Prescribed Fire and Fuels management

Fire management actions have the potential to greatly influence social conditions. Since most communities surrounding Mark Twain NF do not rely heavily on timber production from federal lands, the impact of wildland fire burning suitable timber stands would be minimal. However, many residents surrounding the Forest choose that location because of the scenic and remote qualities.

Although the overall impact is minimal, alternatives that have more opportunities and acres identified for mechanical fuel treatment, such as Alternative 5, would have more of an impact on social conditions. Residents in the high-risk fire areas would be impacted by mechanical fuel treatment designed to mitigate fire behavior. Some residents may not support fuels reduction actions because of perceived reduced scenic quality resulting from more open-growing vegetation. Other effects on social conditions from fuel treatment in high-risk fire areas are the reduced risk of wildland fire burning homes where treatments have been accomplished.

Alternatives that have more opportunities for prescribed fire used to influence ecological processes and attain a high diversity of habitats and species, such as Alternative 2, would also have more of an impact on social conditions. Residents living on private land in areas adjacent to where this activity will occur may not be supportive of prescribed burning because of perceived danger to their own land if the burn escapes.

Native Americans

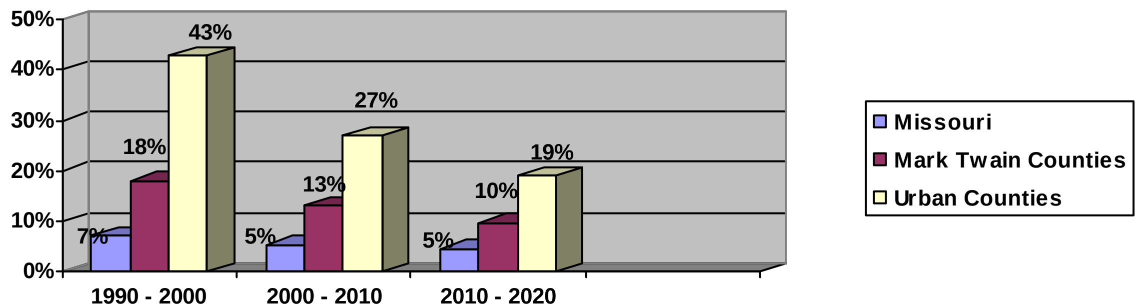
During scoping, no specific issues related to forest planning were raised by the Native Americans described in the Affected Environment.

Cumulative Effects

Population

The rapidly expanding population will create more demands on the Mark Twain National Forest over the next two decades. Population growth will further reduce the available open space in areas adjoining the Forest, increasing demand for opportunities to recreate and to escape densely populated environments. Population growth may also expand urban influences in counties near Branson and Springfield (Ava, Cassville, and Willow Springs), where residents would be likely to experience higher levels of government influence in their lives, further exacerbating some current resistance toward governmental restrictions and their impacts. In Christian county, near Springfield, the population is projected to increase between 10% and 18% every five years between now and 2020. In Stone and Taney counties, near Branson, increases of at least 24% are expected for the same period. Missouri as a whole will not grow as fast at the counties containing Mark Twain lands, as shown in Figure 36. Urban counties are Barry, Stone, and Taney (near Branson), Christian and Wright (near Springfield). The growing list of management actions and restrictions on activities and uses within the Forest required by the National Environmental Policy Act (NEPA), the Endangered Species Act, the Clean Water Act, and other Federal legislation might also serve to agitate those who believe that local control has been lost.

Figure 36 - Population Projections for Missouri, Mark Twain NF, and Urban Counties



Source: www.census.gov

Demography

Newcomers to the region feel differently than long-time residents about natural resources. Often, the latter's livelihood is dependent upon manufacturing from natural resources. Managers of natural resources have had to respond to new sets of values and preferences, particularly increased demand for land, water resources, scenery, recreation, and tourism. Population in and around the Mark Twain NF area is projected to grow by 13 percent by 2010. As shown in Figure 35, this is almost triple the expected growth for the state (5%) and the same growth rate expected for the nation (13%). The increase in population density across all counties in the state has affected farms, forests, and pastures, and has removed habitat for most species of wildlife and fish. More people entering the area has resulted in greater amounts of land conversion and impacts to water quantities, quality, and use.

Population growth is the current leading social trend. Increases in population will increase fragmentation of land, which will place added stress on the continuous character of the land. This means that land will be converted from primarily rural uses to developed uses. A higher demand for recreation may also result because people in developed areas will seek a spectrum of recreation opportunities afforded to them by public lands, such as the Mark Twain NF (Cordell et al. 2004).

At higher elevations, development has affected visual qualities. As certain areas of the region have been developed, more urban pressures have affected the land. Private lands have been posted "off limits," causing public lands to become more crowded. This greater private land restriction has put more pressures on public land to accommodate increased demand for tourism and recreation. The movement of people nearer to Mark Twain NF land has been primarily along the fringe of the area. New arrivals to the area expect basic services experienced elsewhere such as hospitals, retail centers, public water, sewage treatment, and garbage disposal. They also arrive from a suburban or urban culture where needs are derived from institutions rather than from the land, extended family, and community.

Long time residents of the area have watched major changes in farming, plants, animals, and forestland as it has occurred. They expect changes to some degree and anticipate the changes that commonly occur in rural farm and forestland. New arrivals expect change in suburban or urban settings, but have little experience with rural changes.

Diversity

Ethnic diversity will increase if current trends continue, and perhaps at an even faster rate. Different ethnic groups have been shown to have preferences for different types of recreation and use. However, diversity in user demand, not ethnically related, will also affect the Mark Twain. Just as the 1986 Forest Plan did not anticipate ATVs or geocaching; we can be sure that new technology will develop that will increase the diversity of demands on the Forest. Legally and correctly, a responsive attitude will exist in the Forest Service in the near future to try to provide for a variety of cultural and use preferences stated by our public, while still sustaining underlying resources.

Economic Effects

Introduction

Issue - Economic Sustainability of Local Communities

Forest Plan decisions contribute to economic sustainability by providing for a range of uses, values, products and services. At the same time, Forest Plan direction must be consistent with ecological sustainability. Forest Plan revision will determine the mix of uses, values, products, and services that the Mark Twain NF could provide over time.

Key Indicators

Income and Employment (by Resource Program)

This indicator displays the income and employment that can be generated from the Forests' resource programs. The IMPLAN model generates estimates to better understand the economic effects alternatives might have on local communities.

Income and Employment (by major Industry and Sector)

This indicator uses the same economic analysis model described above to understand the effects that alternatives could have on local communities. However, the income and employment that can be generated from the Forests' resources are analyzed in terms of effects by local major industries.

Payments to Counties

Laws passed by Congress require the Forest Service to compensate counties with National Forests or Grasslands within their boundaries for lost tax revenue. This indicator consists of the payments made by the Forest Service in compliance with these laws and regulations. Payments are analyzed by alternative and effects on the payments to counties are illustrated.

			Alternative				
Key Indicator	Units	Current Condition	1	2	3	4	5
Potential jobs as result of forest management	Number of jobs	n/a	4,795	4,563	4,951	4,990	5,081
Potential labor income as result of forest management	Millions of dollars	168.2	160.7	174.6	175.5	177.8	178.1
Payments to counties based on 25% funds	Millions of dollars	1.4	1.0	2.2	2.3	2.3	2.4
Area in semi-primitive management	Percent of Forest	34%	87%	25%	25%	29%	26%

Affected Environment

Current Economic Environment

Employment

Highway systems in southern Missouri easily connect to other regions in Missouri and Arkansas, providing a central, economic means to transport products.

Southern Missouri's economic growth generally keeps pace with, or outpaces the economic growth of the state. The growth of both personal and per capita income in this region has remained just below growth of the state as a whole in the past decade. Industries that drive the region's economy and are poised for future growth include logging, concrete manufacturing, household furniture fabrication, and construction machinery manufacturing, and trucking and refrigeration machinery. The core counties of the South Central area are Texas, Wright, Shannon, Douglas, Oregon, Ripley, Carter, and Ozark. Major employers in South Central area include: Bruce Hardwood Flooring, Dairy Farmers of America, Emerson Motor Division, Hutchens Industries, Lee's Curtain Company, Mountain View Fabricating and Wal-Mart Associates (MO DED)

Forest Resource Related Industries and/or Industries

Industries that use forest-related resources, such as tourism and recreation, wood products, and minerals, are secondary industries in Missouri. These industries are dependent on forest-related resources outputs and are the most likely to be affected (positively or negatively) by Mark Twain NF management. These industries' production activities occur inside and outside the Forest, and in many cases, the Forest is not the only source of resources upon which they rely (MO DED).

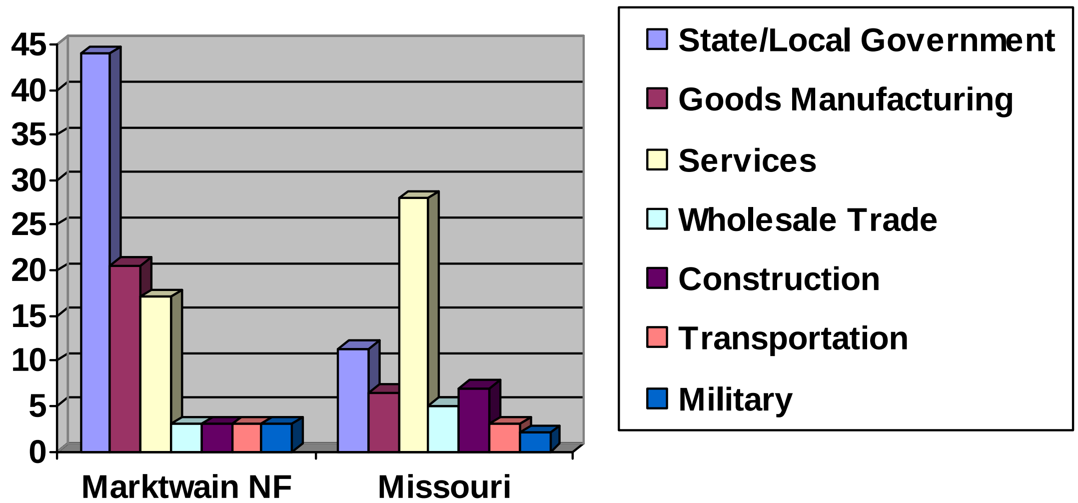
Of the 10 major industries in the study area, state and local government has the largest share of jobs. Thirteen counties in the study area report state and local government as the major industry in their county. The largest industry in the Mark Twain NF study area, government accounts for over 40% of earnings. Six counties report goods manufacturing as the dominant industry in their area, with 20% of earnings. Services come in last with five counties reporting trade and services as their biggest earnings sector (17%). Wholesale trade, transportation, and military jobs are also a large industry in single counties, each with less than 5% of the earnings for the study area. Table 74 shows the major industry by unit for the Mark Twain NF. Figure 37 details the comparison of Mark Twain NF industry earnings with Missouri State as a whole.

Table 74 - Major Industry by Unit on the Mark Twain National Forest

Units	Major Industry
Cedar Creek	Trade and Services
Houston-Rolla	State and Local Government/ Goods Manufacturing
Ava-Cassville-Willow Springs	Goods Manufacturing
Poplar Bluff	Trade and Services/ Goods Manufacturing
Fredericktown	State and Local Government
Salem-Potosi	State and Local Government
Eleven Point	State and Local Government

Source: http://www.ecodev.state.mo.us

Figure 37 - Comparison of Mark Twain NF Counties and Missouri Industry Composition



Source: http://www.ecodev.state.mo.us

Income and Poverty

While employment statistics help us understand overall growth in economic activity and job opportunities this growth creates, personal income statistics more directly measure the economic benefits residents receive. Personal income can be divided into two main categories. Earned income, the first category, includes all wage and salary earnings, including wages paid by self-proprietors to themselves. The second category, unearned income, includes all government transfer payments to individuals, social security, for example, and income from property or other investments. Capital gains, however, are not included.

For 2001, Missouri's per capita personal income was $28,226, which places it 30th out of 50 states. This was a 2.8% increase from 2000. This places Missouri approximately 7% below the national average. Per capita income for the study units ranges from a low of $16,009 in Eleven Point to a high of $23,802 in Cedar Creek. The Mark Twain NF average per capita income is almost $9,000 less than the state average (Table 75).

As the per capita income for a unit goes up, unemployment rates decrease. Cedar Creek unit boasts the lowest unemployment rate (2.6%) as well as the highest per capita income for the study area. Poplar Bluff unit has the highest unemployment rate (8.8%) and the second highest percent living below the poverty level.

The poverty rate is a commonly used indicator of the level of economic need in a community. The Economic Research Service classifies 15 non-metropolitan counties in the study area as having "persistent poverty", or high rates of poverty in 1960, 1970, 1980, and 1990. Nearly half of the 26 non-metropolitan counties that contain National Forest lands are persistent poverty counties. In 2000, the Eleven Point unit has the highest level of poverty in the study area (24%). The Cedar Creek and Fredericktown units had the lowest percent of residents living in poverty (11%). As a whole, the Mark Twain NF study area has 17% (138,400 persons) living below the poverty level. This is higher than Missouri's average of 12%.

Table 75 - Per Capita Income, Unemployment Rate, and Percent Below Poverty for the Mark Twain National Forest

Units	Per Capita Income 2000	Unemployment Rate 2001	Percent Below Poverty 2000
Cedar Creek	$23,802	2.6	11%
Houston-Rolla	$19,635	6.5	17%
Ava-Cassville-Willow Springs	$18,915	6.7	15%
Poplar Bluff	$18,846	8.8	20%
Fredericktown	$18,375	7.2	11%
Salem-Potosi	$17,999	8.2	19%
Eleven Point	$16,009	6.2	24%
Mark Twain National Forest Averages	$18,751	6.7	17%
Missouri State	$27,271	4.7	12%

Source: www.census.gov

Per capita personal income is a measure that includes trends in population and total personal income. This measure is often used as an indicator of economic well being in an area. Over the years, the difference between average incomes in the United States and income in Missouri has decreased, although some areas maintain a larger gap. The United States displays an increasing trend, while Missouri fluctuates more with overall economic trends. More recently, per capita incomes at the state level and in St. Louis have remained stable while the South Central Missouri area's has slightly declining levels.

Methodology for Economics Analysis

Revenue, Values, and Costs Used in Analysis

Forest Plan decisions contribute to economic sustainability by providing for a range of uses, values, products, and services. At the same time, Forest Plan direction must be consistent with ecological sustainability. This revision may affect the mix of uses, values, products, and services that the Forest could provide. This mix provided by each alternative, is measured by representative values indicated by employment, income, industry sectors and Present Net Value (PNV). These indicators are measures within the defined Economic Impact Area (EIA).

This analysis considers potential effects to market-related goods and services traditionally related to the National Forest, for which monetary values are available, and analysis tools are generally accepted. Market benefits can include revenue related to the sale of timber and fees from camping. The Forest also provides revenue to the impact area from expenditures related to management of the Mark Twain NF. Examples of these items are employee salaries and contracting for trail construction.

In an attempt to address some non-market values, this analysis has incorporated 1990 RPA assigned values for the following areas: wilderness, hunting, fishing, non-consumptive wildlife uses, camping, picnicking, swimming, mechanized travel and viewing scenery, hiking, horseback riding, and water travel (USDA Forest Service 1990).

Economic Impact Area

Forest activities affect the economy of twenty-nine counties, which are the Economic Impact Area (EIA). For the purposes of this analysis, the EIA encompasses the area within and including the following counties: Barry, Bollinger, Boone, Butler, Callaway, Carter, Christian, Crawford, Dent, Douglas, Howell, Iron, Laclede, Madison, Oregon, Ozark, Phelps, Pulaski, Reynolds, Ripley, St. Genevieve, St. Francis, Shannon, Stone, Taney, Texas, Washington, Wayne, and Wright. These counties are grouped into several Ranger Districts.

These include Ava, Cassville, Willow Springs, Cedar Creek, Eleven Point, Fredericktown, Houston-Rolla, Poplar Bluff, and Salem-Potosi.

IMPLAN examined how the Forest influences employment and labor incomes within these counties that make up the analysis area. Due to substitution effects from competing non-government sources, these jobs are associated with local economic activity initiated by Forest Service programs and activities rather than caused by these activities.

Computer Models

IMPLAN (IMpact analysis for PLANning) is a static model based on historic data, which provides estimates of economic impacts of activities on the EIA. IMPLAN's primary values are in modeling the relationships between Forest outputs and EIA employment and income, and displaying relative differences in these impacts among the alternatives.

County-level employment data, revenues, and expenditures from timber sales and the recreation program, and other Forest program expenditures and employment data have been incorporated into the IMPLAN model. Economic dependency is analyzed by dividing employment into the three categories - basic industries, indirect basic industries, and local resident service industries. Government services, manufacturing, and retail sales are the leading providers of jobs and income within the counties that make up the Mark Twain NF.

Economic effects to local counties were estimated using an economic input-output model developed with IMPLAN Professional 2.0 (IMPLAN). Economic relationships generated in IMPLAN were extracted and used in the Forest Economic Analysis Spreadsheet Tool (FEAST) models. FEAST/IMPLAN information has been the professionally accepted means of estimating effects of Forest Plan alternatives. It provides for an area-wide view of relative differences for employment, income and revenue. The scope of analysis includes the first decade of the planning horizon. IMPLAN utilizing FEAST estimated the economic effects of forest management based on each alternative's proposed management emphasis. The Present Net Value (PNV) analysis provided from IMPLAN estimates PNV over the 100-year planning horizon.

Data used in IMPLAN is specific to Missouri from the year 2000. Employment and income data came from the US Department of Commerce, Bureau of Economic Analysis (BEA) Regional Economic census from 2000. Cross tabulations of personal income by major source of earnings by industry, and total full and part time timber employment by industry projections were included.

Definitions of terms used in the IMPLAN model followed those provided by the BEA and are standards in economic reporting. The "agricultural sector" includes agriculture, forestry, and fishing as a classification of economic data provided by the BEA and Census Bureau.

Basic assumptions of IMPLAN do not include restructuring the economy, nor does it predict the specific future of industry related to opening or closing businesses. IMPLAN estimates jobs and income related only to National Forest resources and subsequent changes in proposed management of those resources.

IMPLAN estimates direct, indirect and induced effects by sector based on timber volume by product, and specific measurable recreation, wildlife, fisheries related resources values. For additional information about IMPLAN/FEAST, see Appendix B.

This analysis uses the same impact area as was used in the 1986 Forest Plan Final EIS, and includes the twenty-nine counties in Missouri, which contain Forest Service land. The counties and their corresponding District unit are listed in Table 70.

Data Background

Timber Sales Revenue and Expenditure Data

Forest timber sales records yielded information on timber stumpage values. Four different categories of timber products; softwood saw timber, softwood pulpwood, hardwood saw timber, and hardwood pulpwood; are harvested from the Mark Twain NF and processed by various industry sectors. Distribution estimate details are available in Appendix B. Stumpage values were determined for each of these categories. Direct information on the shipped value of finished timber products for all processing sectors was not available. The IMPLAN model derived these production values.

The EIA has a diverse mix of timber processing firms including sawmills, cooperage mills, chip mills, post and pole mills, charcoal plants, handle plants, and mills producing other products. The IMPLAN model estimated employment in the lumber and wood products industries. The model estimated that logging camps and contractors are by far the largest employer based on Forest Service resources.

Recreation & Wildlife/Fish Revenue and Expenditure Data

Visitors to Missouri's National Forest engage in a variety of activities that often cross boundary lines between public and private lands. Consequently, spending patterns for visitors to the Forest can be reliably represented by a general tourism/recreation visitor-spending pattern for southern Missouri.

Recreation use is measured in "recreation visitor days" or RVDs, which is one 12-hour visit by one person. The tourism studies used either days or nights as the unit of measure. RVDs were multiplied by assigned values according to specifications provided in the research paper, "Resource Pricing and Valuation Procedures for the Recommended 1990 RPA Program" This guidance was used to calculate total spending by each alternative.

The recently completed National Use Visitor Monitoring (NUVM) contains information on the number of visitors to the Mark Twain NF; how important the Forest is to the trip; and expenditures of the visitors. A National Forest visit is the entry of one person upon a national forest to participate in recreation activities for an unspecified period of time. The Forest received about 650,000 visits in 2002 (USDA Forest Service 2003e).

Numbers from NVUM do not completely account for many dispersed uses of the Forest such as hunting or wildlife watching where a specific site might not be visited. In order to account for this use, Forest Recreation and Planning staff analyzed data found in the U.S, Fish and Wildlife Survey for Missouri, and based upon the percentage of public land managed by the Forest and number of wildlife users on public land, increased visitor numbers for wildlife visits by 75% or 556,200 RVD over those reported in the initial NVUM survey for the Mark Twain NF.

Other easily counted areas of recreation use on the Forest were not included in the NVUM proxy sites. A proxy site is an area that was not surveyed, but for which an exact tally of use is available and all use is the same, such as a fee campground. As a result, the recreation visit number used for FEAST was 692,160, which along with the number for dispersed use totaled 1,248,360 visits to the Mark Twain NF.

Of the visitors surveyed, 25 percent were asked about the primary destination of their recreation trip to compile economic data. Approximately 78 percent indicated that National Forest recreation was the primary trip destination.

Estimates are used to determine the usage of the Forest in relation to its primary activities. Using the example of hunting, the Forest has estimated how many visitors will hunt in the

Mark Twain NF. The next estimation involves calculating the average expenditure per hunter per visit. This data is based on usage surveys of consumers of forest services. The expenditures include items such as food, lodging, fuel, supplies, and similar items. The expected number or consumers of each activity are multiplied by the average expenditure per user per visit.

Total Expenditures = E (Consumers) x Expenditures/Visit

This methodology is used for each forest-related activity. This allows an estimate of the direct, indirect, and induced impacts of an activity on the areas, towns, cities, and other residential areas in and around the EIA.

In a typical year, visitors to the Forest spend approximately $1,400 on all outdoor recreation activities including equipment, recreation trips, memberships, and licenses. These same people estimated the amount of money spent within the group of people they were traveling with, if any, within a 50-mile radius of the recreation site at which they were interviewed during their trip to the area.

Only non-local recreation expenditures, tourism imports, are considered for impact analysis. For example, a person from Poplar Bluff might recreate on the Ava Ranger District, over 150 miles from home. Since their zip code is found within the Forest, they are counted as a local visitor and the money they spend is not considered an import into the Forest impact area.

Forest Expenditures and Employment Data

Budget constraints helped estimate total Forest expenditures, some of which have local economic effects. Total Forest obligations by budget object code for Fiscal Year 1999 were obtained from the National Finance Center through the agency’s Inventory and Monitoring Institute. Total Forest obligations were used to estimate how the budget would be spent.

Forest Service employment was based on an examination of historical Forest Service obligations. Salary impacts result when Forest employees spend their earnings locally.

Impacts to local economies were estimated by analyzing effects on employment and labor income figures. Employment is the number of jobs, including seasonal, year-round/full-time, or part-time, which is calculated by averaging monthly employment data from state sources over one year. Labor income includes both employee compensation (pay plus benefits) and proprietors’ income (self-employed profits).

Economic Effects

Direct and Indirect Effects

The five alternatives discussed in this analysis are based on one or more changes to various forest management variables. These variables, or potential states of forest management, include recreation, wildlife and fish, rangeland, timber, minerals, payments to counties, and forest service expenditures. These alternatives are realistic long-term management options, with a budget that will allow for full implementation of proposed activities. The activities analyzed are the most common types of activities in which the forest is involved and the business sectors are those that sustain the largest impacts from forest resources and management activities. The analyses detail the expected employment and income over the next decade for each management alternative.

The economic impacts of the MTNF Region for each of five alternatives are measured with the following variables a) total jobs and b) labor income. Developed by the Forest Service, IMPLAN is used by many public and private institutions to assess the impacts of environmental choices and to develop impact studies. The following tables are from the FEAST spreadsheet and display contribution for the EIA for each alternative.

Table 76 - Average Annual Total Jobs and Labor Income from Forest Management by Activity for Decade 1

Forest Management Activity		Current	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Recreation	Jobs	95	93	95	95	95	95
	Income	$2.0	$1.9	$2.0	$2.0	$2.0	$2.0
Wildlife & Fish	Jobs	92	80	113	104	92	92
	Income	$2.0	$1.7	$2.4	$2.2	$2.0	$2.0
Rangeland	Jobs	15	13	13	16	16	19
	Income	$0.2	$0.1	$0.1	$0.2	$0.2	$0.2
Timber	Jobs	105	0	192	232	338	352
	Income	$2.6	0	$4.8	$5.8	$8.2	$8.5
Minerals	Jobs	3,986	3,986	3,986	3,986	3,986	3,986
	Income	$147.3	$147.3	$147.3	$147.3	$147.3	$147.3
Payments to counties	Jobs	46	33	70	74	75	75
	Income	$1.4	$1.0	$2.2	$2.3	$2.3	$2.4
Forest Service Expenditures	Jobs	455	358	483	483	478	478
	Income	$12.7	$8.6	$15.8	$15.8	$15.8	$15.8
Total Jobs and Labor Income	Jobs	4,795	4,563	4,951	4,990	5,081	5,097
	Income	$168.2	$160.1	$174.6	$175.5	$177.8	$178.1
Percent Change from Current Condition	Jobs		-4.8	3.3	4.1	6.0	6.3
	Income		-4.5	3.8	4.3	5.7	5.9

Labor income expressed in millions of dollars

It is important to note that in all of the alternatives, jobs and income from the minerals program and mining industry remain constant. This is a result of the static nature of mining in the Mark Twain NF. The mining in the Forest primarily occurs in only part of the EIA within the Fredericktown, Potosi and Salem units. Given that mining only occurs in such a focused portion of the Forest as well as the unpredictable nature of mineral prices and resulting outputs, the expectation for this industry is to remain at or near current employment and output levels over the next decade.

Alternative 1

The impacts from forest management activities for Alternative 1 are shown in Table 76. The table is broken down into total employment (direct, indirect, and induced jobs) and the labor income. This alternative has the lowest levels of total employment and total labor income, as well as the largest decreases in Forest employment and labor income among all of the alternatives.

Under this alternative, recreation, wildlife and fish, rangeland, and timber usage are all at the lowest levels. In fact, timber production is non-existent. This impact could be significant in specific areas since 92% of the industrial timber harvested in Missouri is processed within the state (Piva and Treiman, 2000). Therefore, any change in timber offered by the Mark Twain NF will impact the supply of raw materials to the region’s mills. Although the majority of timber harvested in the state comes from private, forest industry, or other public lands (North Central Research), any change in Forest timber management will have major effects.

Another important factor is the projected population growth of 6% within the EIA and 3.4% within the State of Missouri between 2000 and 2010 (OSEDA 2004). This growth will create a twofold effect. First more demand for building materials and secondly an increase in the substitution of timberland for residential developments. This makes any changes in commercial timber management by the Mark Twain NF even more significant in the long-term.

The manufacturing and government sectors account for most of the decline in the region's expected decline in labor income under this alternative (Table 77). This is the only alternative that results in an expected decrease in labor and income during the next decade. This is a direct effect of the elimination of commercial timber harvest in the Mark Twain NF and the corresponding elimination of forest service expenditures relating to timber production.

Table 77 - Average Annual Total Jobs and Labor Income from Forest Management by Industry Sector for Decade 1

Industry Sector		Current	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Agriculture	Jobs	62	58	63	65	65	67
	Income	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8
Mining	Jobs	1,752	1,752	1,752	1,752	1,752	1,752
	Income	$86.0	$86.0	$86.0	$86.0	$86.0	$86.0
Construction	Jobs	170	165	177	178	180	180
	Income	$6.2	$6.0	$6.4	$6.4	$6.5	$6.5
Manufacturing	Jobs	143	76	198	233	288	296
	Income	$5.2	$3.7	$6.6	$7.1	$8.5	$8.7
Transportation, Communications	Jobs	128	122	134	135	138	139
& Utilities	Income	$9.4	$9.2	$9.6	$9.7	$9.8	$9.8
Wholesale	Jobs	102	97	107	108	110	110
Trade	Income	$4.4	$4.3	$4.6	$4.6	$4.7	$4.7
Retail Trade	Jobs	583	554	611	610	614	615
	Income	$12.0	$11.5	$12.4	$12.4	$12.5	$12.5
Finance, Insurance,	Jobs	165	158	171	172	175	175
Real Estate	Income	$16.1	$15.9	$16.3	$16.3	$16.4	$16.4
Services	Jobs	767	731	798	802	814	816
	Income	$21.4	$20.5	$22.2	$22.3	$22.6	$22.7
Government	Jobs	901	830	919	922	923	924
(all levels)	Income	$31.6	$27.9	$34.6	$34.7	$34.9	$35.0
Miscellaneous	Jobs	21	20	22	22	23	23
	Income	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2
Total Forest Management	Jobs	4,795	4,563	4,951	4,990	5,081	5,097
Activities	Income	$168.2	$160.7	$174.6	$175.5	$177.8	$178.1
Percent Change	Jobs		-4.8	3.3	4.1	6.0	6.3
from Current	Income		-4.5	3.8	4.3	5.7	5.9

Income expressed in millions of dollars

Alternative 2

The impacts on total direct, indirect, and induced jobs from forest management activities for this Alternative are shown in Table 76. This includes major differences in wildlife and fish, timber, payments to counties, and forest service expenditures relative to Alternative 1. Employment under this alternative is expected to be 3.3 % higher than under the current condition and 8.1% greater than Alternative 1. Restoration of natural communities will increase the availability and quality of these wildlife resources as a result of increase diversity in plant and animal species which can be seen by increase increases in trade and service sectors. Timber production is higher than under alternative 1, but is still limited to accommodate the increase in ecosystem restoration.

All employment sectors are positively affected with agriculture, manufacturing, retail, services, and government reaping the majority of these gains.

Alternative 3

The largest difference between Alternatives 2 and 3 is the amount of timber production (Table 76). This Alternative further increases the production of timber with an increase of lands available for forage production. Wildlife and fish program employment decreases slightly and understandably given the increased utilization for commodity production. The percent change from the current condition for labor is 4.1 and 0.8% higher than Alternative 2.

Labor income is higher by 3 % from the current condition and 0.4 % from Alternative 3 (Table 77). As expected, manufacturing will reap the majority of the benefits under this alternative.

Alternative 3 provides the widest array of labor and income sources, either directly or indirectly, among the five Alternatives. From an economic and social standpoint, the greatest overall benefits tend to result from a diversified base of employment and recreational activities. This mitigates the effects of unforeseen troughs or downturns in one industry or activity by having a wide base of other functional economic sectors.

Alternative 4

Alternative 4 increases timber output relative to the previous alternatives (Table 76). This increase in timber production is expected to produce a corresponding rise in timber industry employment while more than offsetting a small decrease in wildlife and fish program jobs. The resulting 6 % expected increase in employment relative to the current condition is the largest positive effect in job growth among the four “action” alternatives.

As with alternatives other than 1, the manufacturing sector shows the largest increase in jobs, with an increase expected in the services sector as well (Table 77). A total 3.9 % increase in income over the current condition and 0.9 % change over Alternative 3 is shown in Alternative 4

Alternative 5

In this Alternative, nothing would change from the 1986 Forest Plan. All management choices and variables would be kept exactly as they are today. From a job growth and income perspective, this alternative outperforms the first four in terms of expected benefits over the next decade. Alternative 5 results in a 6.3% increase in employment, primarily in timber activities and payments to counties, as shown in Table 76. Manufacturing and service sectors will benefit the most under this alternative.

Total income will increase 4.1 % from the present over the next decade under this alternative, with the majority of the nominal gains coming from the manufacturing and government sectors (Table 77). In terms of the comparative overall economic impacts from all five alternatives, this one provides the greatest benefits in job growth and creation as well as total income from forest management activities.

Cumulative Effects

The scope of analysis for cumulative effects is the Economic Impact Area composed of the 29 counties with land within the Forest boundary.

The towns, cities, and residential areas within the EIA counties have varying degrees of reliance and dependence on the forest for their economic strength and development. Most of the areas receive payments in lieu of taxes, provide labor and services, and have significant amounts of their land located within the borders of the Mark Twain NF. More developed areas like Fredericktown, Ava and Houston tend to have stronger economic ties on a county level than to each other. Economic development, commerce and growth areas exist in a few parts of the region such as West Plains, Branson and Salem.

The most notable change that results in economic impacts is undoubtedly timber output. This sector is economically significant to some of the counties within the EIA, which are considered as timber-significant in OOHA. They are Butler, Carter, Madison, Oregon, Reynolds, Ripley, Shannon, Ste. Genevieve and Wayne. As discussed under Alternative 1 any changes in timber offered for sale from public lands can impact private lands where environmental concerns are not always considered or best management practices used to harvest timber.

Given the limited industrial and commercial development in many areas within the EIA, the economic impacts of forest management activities take on increased importance relative to other parts of the country where National Forest System lands are found. These needs of the residents and economic sectors of the area are important but are not the only factors in Forest Plan decisions

The majority of the gains from forest management activities occur in the manufacturing industry, although government and services are affected throughout the alternatives, as well. In terms of quality of jobs, manufacturing ($40,516 average yearly income) and government ($32,963 average yearly income) have historically provided higher per capita income and benefits that those in the service industry ($32,185 average yearly income) in Missouri (USDL Bureau of Labor Statistics 2003). Within the EIA, service jobs are often seasonal or part-time, at minimum or near-minimum wage. The loss of these higher paying jobs can be significant in counties that are mostly dependant on natural resources such as timber or minerals to sustain the area's economy.

Table 78 shows the current contributions of forest management activities as part of the EIA. This table along with Table 77 show the change based upon the land allocations in the proposed Forest Plan during the first decade of implementation, this contribution will change depending on which alternative is selected though overall the impact of Forest Service related activities would not change significantly.

Table 78 - Current Role of Forest Service Management to the Economic Impact Area

	Employment (Number of Jobs)		Labor Income (Millions of Dollars)	
Industry Sector	**EIA Totals**	**Forest Management**	**EIA Totals**	**Forest Management**
Agriculture	30,909	62	194.3	0.6
Mining	2,539	1,752	107.5	86.0
Construction	30,103	170	904.7	5.7
Manufacturing	53,997	143	1676.7	4.0
Transportation, Communications, Utilities	17,184	128	615.8	5.2
Wholesale Trade	13,015	102	421.8	3.5
Retail Trade	76,094	583	1,204.2	9.7
Finance, Insurance, Real Estate	25,448	165	673.1	4.6
Services	106,204	767	2,482.4	19.1
Government (all levels)	90,610	901	3,170.0	29.5
Miscellaneous	2,477	21	18.4	0.2
Total	448,580	4,795	11,469.1	168.2
Percent of Total		1.1		1.5

Forest service management from 2002 was used to describe the current condition as a comparison to the proposed alternatives. In 2002 Forest service management activities contributed 1.1% of all jobs, the change from this current condition range from -4.8% in alternative 1 to a 6% increase under alternative 5.The overall percentage of FS related jobs will remain the same for all alternative, though actual number of jobs will vary in each.

In 2002 the forest management activities contributed 1.5%. Contributions would range from a negative 4.5% under Alternative 1 to a high of 5.9% under Alternative 5. Once again under any alternative the amount of change will vary but overall effect to across southern Missouri will remain somewhat the same. As noted previously in this discussion certain counties or groups of counties will feel the effects of changes in forest management to a greater degree than other areas that have more economic diversification. This could be related not only to a reduced amount of timber offered for sale but also as a result of a reduction in the payments to counties that fund local government jobs.

Environmental Justice

Introduction

This analysis will evaluate some selected quantitative demographic indicators of minority and low-income populations of communities for purposes of assessing environmental justice. It is not intended to represent a quantitative or qualitative assessment of all circumstances and conditions that may affect environmental justice. Nevertheless, this analysis can reveal useful information about the study area.

Concern for environmental justice stems from Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” signed February 11, 1994 by President Clinton. In this order (Section 1-101), “each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States.”

It is important to note that the following analysis only addresses indicators to determine the presence or absence of minority and/or low-income communities in a study area. This analysis does not attempt to address other key components in questions of environmental justice when a minority and/or low-income community have been identified in a study area such as;

- the extent of environmental impact,
- whether the impact is beneficial or adverse,
- whether the impacts are disproportionate to the selected community, or
- whether there is substantial agreement among community residents about the nature of the project or impact

In addition, such indicators do not necessarily reflect how resilient a community’s population is: that is, their confidence in their collective or individual ability to meet challenge, their confidence in community leadership, etc. These additional considerations must be considered in order to fully address a potential environmental justice concern.

Key Demographic Indicators

This analysis summarizes one key demographic indicator of minority populations and two key demographic indicators of low-income populations. While these indicators or the associated thresholds are not formally identified in federal codes and regulations, they serve as reasonable predictors of minority and low-income population status.

Table 79 highlights key indicators of minority and low-income for the twenty-nine counties containing Mark Twain National Forest land. There is no indication that this area, a community with a population of 815,218 residents in 2000, has a significant minority population. There is some indication that the community has a significant low-income population.

Table 79 - Summary of Key Indicators of Minority and Low-Income Populations 2000 for the Mark Twain National Forest

Community Demographic Characteristic	Mark Twain NF Community	Threshold Percent	Potential Concern
Minority Population			
Race/Ethnicity: Percent non-white residents	6%	>25.0	No
Low-Income Population			
Annual Income: Median household greater than $25,000	$28,940	<$25,000	Maybe
Poverty: Average percent below Federal poverty level	17%	>25.0	Maybe

Source: 2000 Census

Table 80 compares Mark Twain NF community indicators to the State of Missouri . The minority and low-income population indicators for Mark Twain NF community do not exceed threshold percents. Characteristics for this community differ for Missouri as a whole more than 10 percent from the minority and household income indicators.

Table 80 - Summary Comparison Minority and Low-Income Populations 2000 For the State of Missouri and the Mark Twain National Forest

Community Demographic Characteristic	Mark Twain NF Community	More than 10% Difference	State	More than 10% Difference
Minority Population				
Race/Ethnicity: Percent non-white residents	6%	No	15%	No
Low-Income Population				
Annual Income: Median household greater than $25,000	$28,940	No	$37,934	Yes
Poverty: Average percent below Federal poverty level	17%	No	8.6%	No

Source: 2000 Census.

Minority Population

Six and a half percent of the population of the Mark Twain NF community is non-white minority; that is Black, Hispanic, Asian, Native American, Hispanic, or Latino. This is less than the EPA threshold value of 25.0 percent, and slightly less than 10 percent different from the State average of 15 percent. It is unlikely that a project completed in the Mark Twain community would have disproportionate negative impacts on any minority population.

Low-Income Population

The average median household income for the Mark Twain NF community is $28,940. This is more than the EPA Region 7 threshold of $25,000 and within 10 percent of the State average. It is possible that a project completed in the area of the MTNF would have impacts on low-income populations.

Conclusion

Based upon the review of demographic racial characteristics of the population of the Mark Twain NF community and how they compare with suggested threshold levels for concern, there is little reason to suspect that this large-scale community might fall under the provisions of Executive Order 12898. When planning project-level activities, further analysis on a county or zip code scale will be necessary to determine whether there may be disproportionate effects on low-income populations.

Other Considerations

Tribal consultation is required through other federal regulations and executive orders. This analysis should not lead to a conclusion that continued tribal consultation is not required.

Vacation or second ownership within the project area should be considered in the public involvement process, while not an environmental justice population, attempts should be made to ensure absentee homeowners are included in the planning process and their concerns and issues considered.

A specific consideration of equity and fairness in resource decision-making is encompassed in the issue of environmental justice and civil rights. As required by law and Title XI, all federal actions will consider potentially disproportionate effects on minority or low-income communities. Potential affects or changes to low-income or minority communities within the study area due to the proposed action would be considered on a project level basis. Where possible, measures would be taken to avoid negative impacts to these communities or mitigate any adverse affects.

Other Disclosures

Unavoidable Adverse Impacts

The application of Forest-wide standards and guidelines and other resource protection measures would limit the extent and duration of any adverse environmental effects. Nevertheless, some adverse effects are unavoidable. For detailed disclosure of all effects, including unavoidable adverse effects, see the preceding Environmental Consequences discussions for each resource area.

This section describes those adverse effects that cannot be avoided during probable management activities on Mark Twain NF. Implementation of any of the alternatives would generally move the landscape and ecosystem towards greater productivity and improved condition, but adverse environmental effects may occur even with standards and guidelines to control the effects. Most notably, unavoidable effects would be to air quality, plant and animals, water, and soil productivity.

Air Quality

Prescribed burning, timber harvest, road construction, road reconstruction, and some recreational activities would cause temporary and localized reductions in air quality due to dust, exhaust fumes, and smoke. Smoke from wildfires can temporarily reduce air quality and visibility.

Soil Productivity

Development and restoration activities such as constructing parking lots or prescribed burning would adversely affect soil productivity on the occupied site. Where vegetative cover and soils are disturbed, there is some short-term (usually one season) erosion and sedimentation. Activities involving vehicles or heavy equipment cause soil compaction.

Water Resources

When vegetation is removed, or soils are disturbed or compacted, there is a short-term increase in sedimentation. Natural precipitation and flood events also increase sedimentation. Natural occurrences of chemical compounds in surface water may reduce water quality.

Vegetation

Removing vegetation and disturbing soils during forest management activities can result in loss of vegetative productivity. Depending on the duration and intensity of the project, loss may be short- or long-term.

Wildlife

Public use of land may result in unavoidable disturbance of native plants, birds, or other species near travel routes, trails, or recreation facilities. Visitor presence may also contribute to dispersal or increased populations of non-native or invasive plant species, undesirable insect species, or animal species.

Forest management activities, such as timber harvesting and road reconstruction, cause short-term disturbance and displacement of some wildlife species. Continual activity, such as traffic on a highway or hiking on a trail, may cause long-term displacement from local areas. Individual animals are accidentally killed by human activities. Fish habitat can be degraded by sediment or contaminants entering water bodies and by increases in water temperature due to removal of trees shading streams.

Insects and Diseases

Endemic (local) levels of forest insects and diseases will continue. Epidemic (widespread) levels of insect infestations or disease like those associated with mortality of aging red and black oak trees across the Ozark Highlands in Missouri and Arkansas are present.

Heritage Resources

Both human activities and natural events have potential to disturb or destroy heritage resources.

Recreational Opportunities

Activities, such as timber harvest and road reconstruction, temporarily disrupt recreational uses. Other activities, such as road closures, permanently reduce or change the opportunities available. Some kinds of developments, such as hiking trails, or activities like motorized recreation use may displace other recreation uses that are incompatible and create user conflicts.

Income and Employment

Changes in income and employment may result from both human decisions and natural events. Reductions in timber harvest levels may cause corresponding reductions in local and regional timber industry employment and income. Reduction or modifications in recreational opportunities may also result in adjustments within the local service industries and resulting income.

Individual and Community Social Factors

Human decisions or natural events have the potential to alter traditional or cultural practices and activities of local and regional residents. Important settings associated with Forest users may be affected by, but not limited to, changes in Forest access opportunities, natural resource management, or natural events such as fire and windstorms.

Hazardous Materials

The use of motor vehicles and transportation of hazardous materials such as gasoline, other fuels, mining by-products, and building materials on roads and highways carry the potential for accidental spills. Small, localized spills may also occur on project sites, such as motor oil or vehicle fuel. There is also potential for accidental leakage from gas and oil pipelines that cross the Forest.

Unknown practices related to improper disposal of chemicals or other hazardous wastes may result in sites on the National Forest that, when discovered, should be investigated for potential environmental hazards.

Relationship between short-term uses of the environment and long-term productivity

Short-term uses are those expected to occur on the Forest over the next ten years. These uses include, but are not limited to recreation activities, livestock grazing, mineral exploration, timber harvest, and prescribed burning. Long-term productivity refers to the capability of the land to provide resource outputs for a period beyond the next 10 years.

Minimum management requirements established by regulation (36 CFR 219.27) provide for maintenance of long-term productivity of the land. Minimum management requirements, as reflected in the 2005 Forest Plan standards and guidelines, would be met under all alternatives. They assure that long-term productivity of the land would not impaired by short-term uses.

Monitoring, as described in Chapter 4 of the 2005 Forest Plan, applies to all alternatives. Monitoring helps to ensure that the long-term productivity of the land is maintained or improved. If monitoring and subsequent evaluations indicate that Forest-wide standards and guidelines are insufficient to protect long-term productivity, the 2005 Plan would be amended.

Although the alternatives are designed to maintain long-term productivity, there are differences among alternatives in the long-term availability or condition of resources. There may also be differences between alternatives in long-term expenditures necessary to maintain desired conditions. Descriptions of differences between alternatives are in Chapters 2 and 3 of the Final EIS.

Forest management on the Mark Twain NF will involve ground-disturbing activities that can affect the short-term and long-term conditions of soils. The following activities will result in short-term ground disturbance, with long-term loss of soil quality or productivity: construction of camping areas, permanent trails, roads, and other facilities. Other ground-disturbing activities would result in short-term soil dislocation and potential for erosion, but would enable long-term recovery of soil properties and productivity: removing buildings, decommissioning roads, and planting vegetation. Forest-wide standards and guidelines as well as site-specific mitigation measures during implementation will eliminate or reduce short-term impacts of ground-disturbance. Guidance on location and design of roads, trails, and facilities would reduce the potential long-term effects.

Irreversible and irretrievable commitment of resources

Irreversible and irretrievable commitment of resources is defined in Forest Service Handbook 1909.15:

- The irreversible commitment of resources is the consumption or destruction of nonrenewable resources. Examples include mineral extraction, which consumes nonrenewable minerals and potential destruction of such things as heritage resources by other management activities.
- The irretrievable commitment of resources are opportunities foregone; they represent trade-offs in the use and management of Forest resources. Irretrievable commitment of resources can include the expenditure of funds, loss of production, or restriction on resource use. Such situations occur where Wilderness designation or management prescription objectives limit resource development investments.

Decisions made in a Forest Plan do not represent actual irreversible or irretrievable commitment of resources. Forest Plans determine what kind and levels of activities are appropriate to occur on the Forest. A Forest Plan does not make site-specific or project level decisions. The decision to irreversibly or irretrievably commit resources occurs when:

- The Forest Service makes a project or site-specific decision;
- When Congress acts on a recommendation to establish a new wilderness

Examples of irretrievable resources commitments associated with 2005 Forest Plan decisions are as follows:

- Commodity outputs and uses, such as motorized recreation, would be curtailed or eliminated in areas recommended for and subsequently designated as Wilderness Study Areas;
- Opportunities for solitude and primitive or wilderness experiences would be foregone if portions of the Forest are not allocated for non-motorized settings or recommended for wilderness study;
- Commodity outputs would be reduced or foregone on areas allocated to specific uses or purposes, such as developed recreation sites, or old growth habitat;
- To the degree that an alternative minimizes management activities to restore or enhance ecosystems, opportunities to restore or enhance the range of variability of unique natural communities and increase biodiversity are reduced;
- To the degree that an alternative preserves or encourages the development of mature and old growth habitat, opportunities to develop early successional habitat are reduced. The reverse is also true, to the degree that an alternative preserves or

encourages the development of early successional habitat, opportunities to develop mature and old growth habitat are reduced and;

- Non-commodity values, including scenic resources, may be reduced or foregone in areas allocated to commodity uses

Energy requirements for implementing the alternatives

Energy is consumed in the administration and use of natural resources from the Forest. For the purpose of the 2005 Plan, energy resources are gasoline, diesel fuel, liquefied petroleum, natural gas, electricity and wood. Although many activities consume energy, the following are those considered significant in the implementation of any alternative.

- Energy consumed in timber management activities is the amount required for felling, bucking, skidding, loading, hauling, site preparation, planting, and vehicle traffic.
- Energy consumed in utilizing range vegetation is the amount required for hauling stock, range improvements, cutting hay, and herding stock.
- Energy consumption related to recreation is based on the estimated number of recreation visitor days and facility operation, maintenance, and construction.
- Energy consumed in road reconstruction and maintenance activities is that used by contractors or Forest Service crews.
- Energy is consumed during Forest Service administrative activities including vehicle use, lighting, heating and cooling of buildings, and fuel used in small engines.

Relationship to the Plans of Others

The Mark Twain National Forest met with several other government agencies and organizations during the Plan revision effort. Forest staff met with and discussed the Forest planning process and revision topics with federal, state, county and local government agencies. The revision process also considered biological and physical capabilities of the land and the predicted needs of people in the future.

The Mark Twain NF coordinated with various agencies and organizations in the development of goals, desired conditions, objectives, standards and guidelines, formulation of alternatives and other important aspects of the revision process. Within the Forest Service, adjacent Forests in both Southern and Eastern Regions, along with the various North Central Area Research Stations were contributors to the analysis.

Others agencies and organizations contributing included U.S. Geological Survey, Missouri Department of Conservation; Missouri Department of Natural Resources, Missouri Department of Economic Development, Missouri Resource Assessment Partnership, The Nature Conservancy, and all counties within the Forest boundary in collecting and analyzing ecological and human use information within the larger landscape. Many of these agencies participated in meetings throughout the process. The planning record, located at the Forest Supervisor's Office in Rolla, Missouri contains proceedings of each of the coordination efforts.

In addition, consultations have occurred with other federal agencies including the Environmental Protection Agency and U.S. Fish and Wildlife Service.

The alternatives, associated effects, Forest-wide standards and guidelines, and the allowable activities in each management area are generally compatible and complement the goals and objectives of land management agencies and land owners within or adjacent to the Forest.

Effects on Consumers, Civil Rights, Minority Groups, and Women

Forest Service activities must be conducted in a discrimination-free atmosphere. Forest management activities that are contracted will include specific clauses offering civil rights protection. The Forest Service will make a concerted effort to enforce these policies.

Executive Order 12898 of February 11, 1994, Environmental, calls for consideration of the environmental, health, and economic effects on minority and low-income areas including the consumption patterns for fish and wildlife. Consideration of Environmental Justice is given to all federal actions which are subject to analysis under NEPA. It is not anticipated that any of the alternatives would have a negative impact on their use of the National Forests. See the Environmental Justice analysis above for more detail.

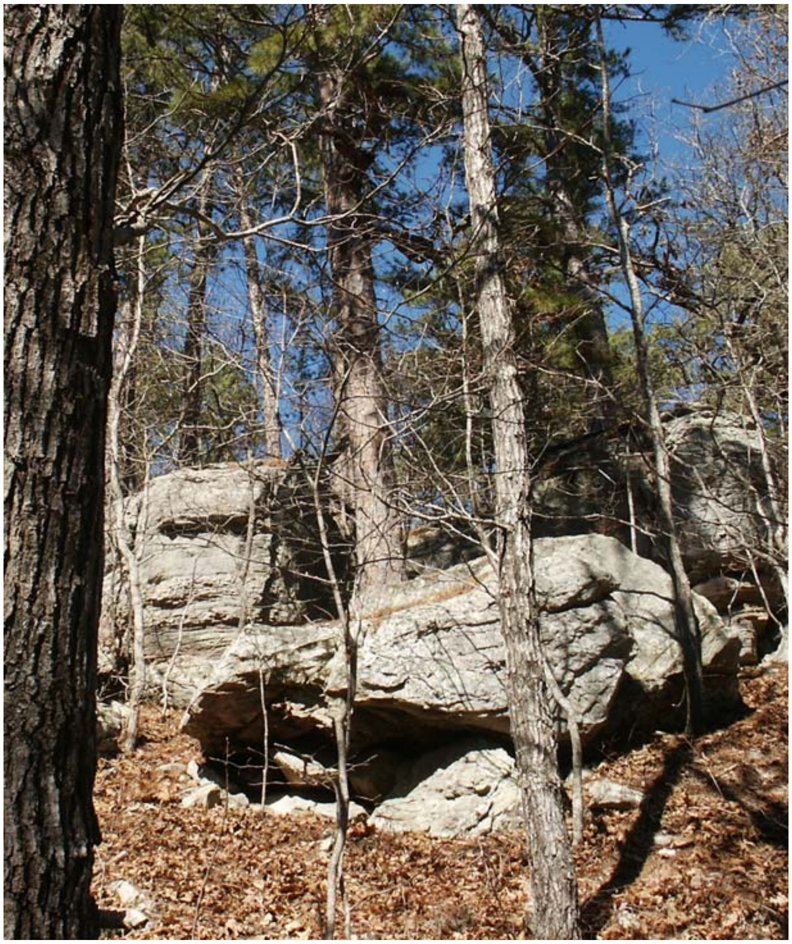
It is not anticipated that implementing the 2005 Forest Plans would adversely affect consumers or women.

Urban Quality and Historic and Heritage Resources

The direct, indirect, and cumulative effects of the alternatives on urban quality as well as historic and heritage resources have been evaluated and discussed under Heritage Resources in this chapter of the Final EIS.

Chapter 4

List of Preparers



Mark Twain
National Forest

Cover image: Rock outcrops in Paddy Creek Wilderness

Photographer: Paul Nelson, Mark Twain NF

Chapter 4

List of Preparers

Introduction

The preparation of the final environmental impact statement (FEIS) and the Proposed Forest Plan has been a major undertaking. This list of preparers is limited to those people who were members of the Interdisciplinary Team working on these documents. Their preparation could not have been completed without the enthusiastic support and assistance of every employee of the Mark Twain NF and our colleagues in the Regional Office. We also recognize the forest leadership team as providing instrumental guidance during this process. In addition, the Content Analysis Team (CAT), a specialized Washington Office unit, along with American Consultants LC, provided the technical support and staff necessary to process, organize, and allow us to consider the large volume of public comment received.

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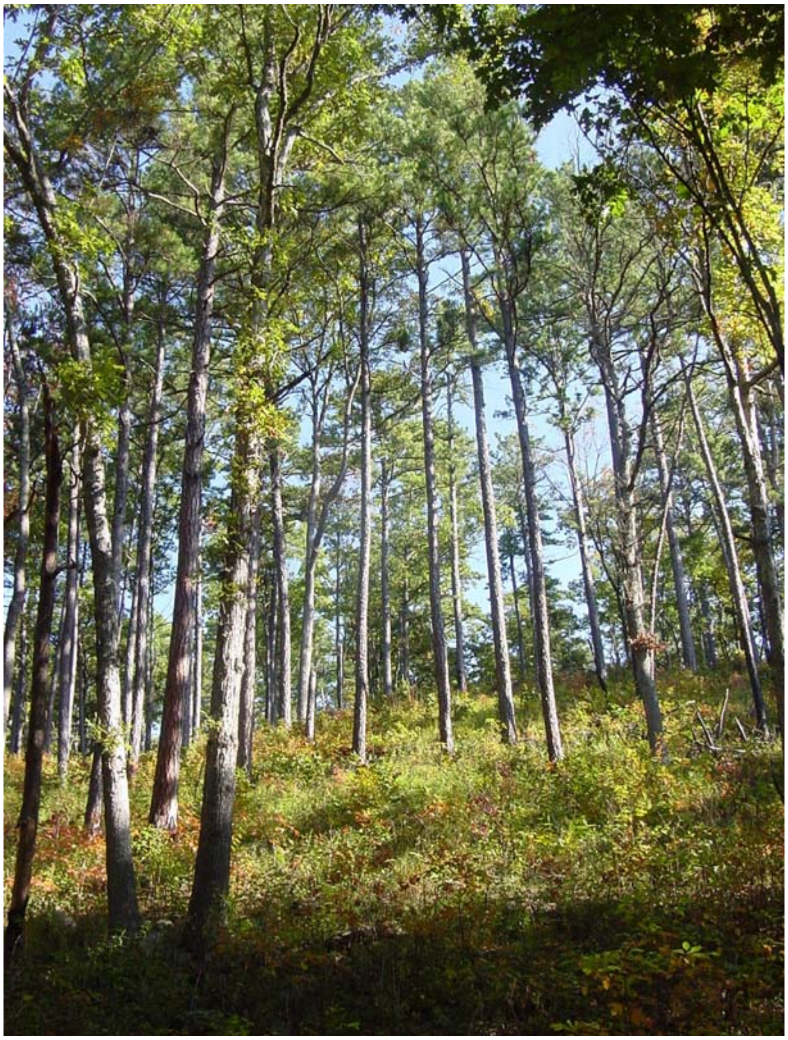
Chapter 5

Glossary and Acronyms



Mark Twain
National Forest

Cover image: Oak-pine woodland

Photographer: Paul Nelson, Mark Twain FS

Chapter 5

Glossary

Access	The opportunity to approach, enter, and make use of public or private land.
Acquisition	Land coming into federal ownership
Activity Fuels	Tree tops, branches, boles, and other woody debris that are created by timber sale activities.
Adaptive Management	A type of natural resource management in which decision making is an on-going process. Monitoring results of actions will provide a flow of information that may indicate the need to change a course of action. Scientific findings and needs of society may also indicate the need to adapt resource management.
Age Class	Grouping of trees originating from a single disturbance event or regeneration activity. Age classes are grouped by an interval of 10 or 20 years, for example 1-10 years, 11-20 years, 21-30 years, etc.
Air Quality	The composition of air with respect to quantities of pollution therein; used most frequently in connection with ‘standards’ of maximum acceptable pollution concentrations.
Air Quality Classes (I, II, or III)	Designation for the level of protection given to geographic areas of the country. This classification denotes the increment above which deterioration of air quality would be regarded as significant and consequently not allowed. Class I allows the least deterioration. Class II is much less restrictive than Class I and includes most of Missouri. Class III is the least restrictive.
Allocations	An assigned portion of land, acreage, production, etc., for a specified purpose in a forest plan.

Allowable Sale Quantity (ASQ)	The quantity of timber that may be sold from the area of suitable land covered by the Forest Plan for a time period specified by the Plan. ASQ is usually expressed on an annual basis as the "average annual allowable sale quantity" (FSM 1900). For timber resource planning purposes, the allowable sale quantity applies to each decade over the planning horizon and includes only chargeable volume. Consistent with the definition of timber production, do not include fuelwood or other non-industrial wood in the allowable sale quantity.
All-terrain Vehicle (ATV)	Any motorized vehicle manufactured and used exclusively for off-highway use which is fifty inches or less in width, with an unladen dry weight of one thousand pounds or less, traveling on three, four or more low pressure tires, with a seat designed to be straddled by the operator, or with a seat designed to carry more than one person, and handlebars for steering control [MO Stat HR 489, 08/28/2004]
Amenity Resources	Non-market resources such as aesthetics, aquatic, old growth, riparian and spiritual values, or wildlife viewing that add to the quality of life.
Amenity Value	Pleasurable or aesthetic features of a plan, project, location, or resource, as contrasted with utilitarian. Typically used in land use planning to describe those resource properties for which market values cannot be established
Analysis	Methods used to determine or separate inventory and resource mapping information into important components and examine them critically (Webster).
Analysis of the Management Situation (AMS)	Forest Plans have a brief summary of the analysis of the management situation, including demand and supply conditions for resource commodities and services, production potentials, and use and development opportunities. (36 CFR 219.11(a))
Angle of Repose	The inclination of a plane at which a body placed on the plane would remain at rest or if in motion would roll or slide down with uniform velocity; the angle at which the various kinds of earth will stand when abandoned to themselves.
Animal Unit Month (AUM)	The quantity of forage required by one mature cow (1,000 lbs.) or the equivalent for one month

Appropriate Management Response	Specific actions taken in response to a wildland fire to implement protection and fire use objectives.
Aquatic	Standing and running water in streams, rivers, lakes, and reservoirs.
Aquatic Ecosystem	The living and non-living components adapted to life in permanent or near permanent water all functioning as a system. Habitats include permanent streams, rivers, lakes, ponds, springs and subterranean water-filled caves.
Aquifer	A permeable stratum or zone below the Earth’s surface through which groundwater can flow.
Aspect	The compass direction toward which the slope of the land surface faces.
Assigned Value	Individual goods and services having an established market value
Background (bg)	The distant part of a landscape located from four miles to infinity from the viewer.
Basal Area	The cross-sectional area of all stems in a stand measured at 4.5 feet above the ground and expressed per unit of land area. Basal area is a way to measure how much of a site is occupied by trees
Bedrock	Solid rock which underlies soil or other unconsolidated materials
Benefit (Value)	Inclusive term used to quantify results of a proposed activity, project, or program expressed in monetary or non-monetary terms.
Best Management Practices (BMP)	Practices that result in attainment of high values for ecological and environmental quality, while providing outputs or outcomes of goods, services or natural resources. Include air, water, soil, wildlife, fish, timber, and aesthetic and biological values.
Biodiversity (Diversity)	Variety of life and its ecological processes; the variety of organisms considered at all levels, from genetic variants belonging to the same species, through arrays of genera, families, and still higher taxonomic levels. Includes the variety of ecosystems, which comprise both natural communities of organisms within particular habitats, and physical conditions under which they live

Biological Assessment (BA)	Determine whether a proposed action will affect a listed species, designated critical habitat, proposed species or proposed critical habitat. Effects determinations for listed species or designated critical habitat include: (1) no effect; (2) not likely to adversely affect; or (3) likely to adversely affect. Effects determinations for proposed species or proposed critical habitat include: (1) no effect; (2) not likely to jeopardize proposed species, or adversely modify proposed critical habitat; or (3) likely to jeopardize proposed species, or adversely modify proposed critical habitat. The outcome of this biological assessment determines whether formal consultation with the US Fish and Wildlife Service or a conference is necessary.
Biological Evaluation (BE)	Review of all planned, funded, executed, or permitted programs and activities for possible effect on endangered, threatened, proposed or sensitive species. A Biological Evaluation is a means for conducting the review and documenting the findings. Effects determinations include those listing for BA (above), as well as the following determinations for sensitive species: (1) no impacts; (2) beneficial impacts; (3) may impact individuals but not likely to cause a trend to federal listing or a loss of viability; or (4) likely to result in a trend to federal listing or a loss of viability.
Biota	Pertaining to any aspect of life, especially to characteristics of entire populations of organisms, including animals, plants, fungi, and micro-organisms, found in a given ecosystem.
Board Foot (BF)	The amount of wood contained in an unfinished board one inch thick, 12 inches long, and 12 inches wide. Expressed as MBF one thousand board feet and MMBF one million board feet.
Buffer	An area designated to block or absorb unwanted impacts to the area beyond the buffer. Buffer strips along a trail could block views that may be unwanted. Buffers may be set aside wildlife habitat to reduce abrupt change to the habitat.
Canopy	Part of any stand of trees represented by the tree crowns. It usually refers to the uppermost layer of foliage, but it can be use to describe lower layers in a multi-storied forest.
Capability	Potential of the land to produce goods and services under a set of management practices at a given level of intensity.

Carrying Capacity	In terms of recreation use, physical carrying capacity is the maximum amount of use that can take place without incurring unacceptable ecological change, soil compaction, erosion, water pollution, littering and destruction of vegetation. Social carrying capacity is the maximum amount of use that can occur without unacceptable conflict and interface among visitors.
Cation exchange capacity	This is the measure of the soil's ability to retain nutrients available to plants.
Cave	A natural underground chamber or series of chambers that may have a surface opening.
Cave Recharge Area	The land area that replenishes a cave's system with water through draining, percolation, and seepage.
Cavity	A hole in a tree often used by wildlife species for nesting, roosting, and reproduction.
Channel Stability	A section of flowing water that maintains a dimension, pattern, and profile without aggrading or degrading in the current climate.
Characteristic Type	An area of land that has common distinguishing visual characteristics of landform, rock formations, water forms, vegetative patterns, and cultural effects. It is used as a frame of reference to classify physical features of an area as to their scenic quality. Two character types have been identified and utilized on the Forest; Dissected Till Plains and Ozark Plateau.
Classified Road	A road wholly or partially within or adjacent to National Forest System lands that are determined to be needed for long-term motor vehicle access, including National Forest system roads, State roads, county and township roads, and other roads authorized by the Forest Service.
Clearcutting	The cutting of essentially all trees in a stand, producing a fully exposed microclimate for the development of a new age class. .
Clearcutting with Reserves	A clearcut harvest in which varying numbers of reserve trees are not harvested to attain goals other than regeneration.

Cliff	A naturally occurring, exposed vertical rock structure that is 10 feet or more in height and a minimum of 50 feet in length. A cliff may have boulders or talus above or below the face, and fissures and openings of various sizes created by rock sloughing or erosion. The cliff is continuous if segments are separated by no more than 200 feet.
Closure	An administrative order prohibiting or restricting either the location, timing, or type of use in a specific area.
Coarse Filter Management	Land management that addresses the needs of all species, communities, environments, and ecological processes in a land area; compare to fine filter management. It is the concept of managing an array of representative ecosystems across the landscape, assuming that such representation will provide habitat for the majority of species. See Ecosystem Management
Cold-water Stream	Cold-water streams maintain water temperatures that are less than approximately 68° F.
Commercial Forest Land	Forest land that is producing or is capable of producing crops of industrial wood; and a) has not been withdrawn by Congress, the Secretary, or the Chief; b) existing technology and knowledge is available to ensure timber production without irreversible damage to soils productivity, or watershed conditions; and c) existing technology and knowledge, as reflected in current research and experience, provides reasonable assurance that adequate restocking can be attained within five years after final harvesting.
Common Variety Class (B)	A landscape architecture term, which refers to prevalent, usual, or widespread landscape variety within a character type. It also refers to ordinary or undistinguished visual variety.
Common Variety Minerals	Earth materials, disposable under USDA authority, that are widespread and abundant; i.e., sand, gravel and clay.
Competitive Use	Events, involving two or more persons, organized for the purpose of a contest, match, or other trial of skill, ability, or machine. (FSM 2355)
Composition	As used in ecology, the mix of species present on a site or landscape or population and the species' relative abundance.

Concern Level	Relative importance to the public of landscape aesthetics viewed from travel routes and use areas. Level 1 routes and areas have significant public use, and scenic quality is a high concern to typical users. Level 2 travel routes and areas have either a high volume of use with the public having a lower degree of concern for scenic quality, or a moderate amount of use with the public having a high degree of concern for scenic quality.
Condition Class	A classification of the amount of departure from the natural fire regime and historical character of vegetation
Confine	The strategy employed in the appropriate management responses where a fire perimeter is managed by a combination of direct and indirect actions and use of natural topographic features, fuel, and weather factors.
Confined Aquifer	An aquifer bounded above and below by impermeable beds, or by beds of distinctly lower permeability than that of the aquifer itself.
Connectivity	The linkage of similar but separated vegetation stands by patches, corridors, or "stepping stones" of like vegetation. Connectivity on the Mark Twain is complicated by the degree to which the forest is fragmented and divided into isolated patches by croplands, pastures, roadways and structural developments due to ownership patterns.?
Conservation Approach	A set of actions that can be taken to remove or minimize adverse impacts to species at risk, and which would result in high quality habitat, well-distributed throughout the planning area for Species at Risk.
Conservative Species	Species that through millennia have become supremely adapted to an environment or natural community determined by a specific set of biotic or abiotic factors. Conservative species tend to exhibit low tolerances to the post-European settlement disruption of otherwise high quality remnant natural communities or habitats.
Consultation (with US Fish and Wildlife Service)	Consultation refers to a requirement under Section 7 of the Endangered Species Act for federal agencies to consult with the U.S. Fish and Wildlife Service with regard to federal actions that may affect listed threatened or endangered species or critical habitat.

Consultation/Consulting Parties (Heritage Resources)	A portion of the review process under Section 106 of the National Historic Preservation Act during which consulting parties consider ways to resolve adverse effects on historic properties. The consulting parties include, at a minimum, the responsible Federal agency and the State Historic Preservation Officer (SHPO). Other interested parties, such as the Advisory Council on Historic Preservation (ACHP), Indian tribes, and local governments, may also be invited to consult.
Consumptive Use	A use of resources that reduces the supply, such as logging and mining.
Contiguous	Used in a geographic sense, the term applies to situations where areas of land physically touch and share substantial common boundaries or have a common border of considerable length. Does not include ‘point to point’ touching or ‘cornering’, or instances where only small portions of land areas touch.
Cool-Season Plant	A plant which generally makes the major portion of its growth during the winter and early spring.
Cool-water Stream	Cool-water streams maintain water temperatures that are between approximately 68 and 84° F.
Cost Efficiency	The usefulness of specified inputs (costs) to produce specified outputs (benefits). In measuring cost-efficiency, some outputs (such as environmental, economic, or social impact) are not assigned monetary values but are achieved at specified levels in a least cost manner.
Cover Type (Forest Cover Type)	Stands of particular vegetation type composed of similar species.
Critical Habitat	An area occupied by threatened or endangered species on which are found physical and biological features essential to the conservation of the species and which may require special management considerations. Critical habitat is formally designated by the U.S. Fish and Wildlife Service for individual species. There is no critical habitat designated for any species on Mark Twain NF.

Culmination of Mean Annual Increment (CMAI) — The age at which the average annual growth is greatest for a stand of trees. Mean annual increment is expressed in cubic feet measure, and is based on expected growth according to the management intensities and utilization standards assumed in accordance with 36 CFR 219.16(a)(2)(i) and (ii). Culmination of mean annual increment (CMAI) includes regeneration harvest yields and any additional yields from planned intermediate harvests.

Cumulative Effects — Effects on the environment that result from past, present, and reasonably foreseeable future actions that, collectively, become significant over time.

Decision Criteria — The rules and standards used to evaluate alternatives to a proposed action on National Forest System land. Decision criteria help a decision-maker identify a preferred choice from the array of alternatives.

Demand — The expected future public need or desire for outputs, services, and uses.

Departure — A sale schedule that deviates from the principle of non-declining flow by exhibiting a planned decrease in the sale schedule at any time during the planning horizon. A departure is characterized by a temporary increase, usually in the beginning decade(s) of the planning horizon, over the base sale schedule originally established. This increase does not impair the future attainment of the long-term sustained yield capacity.

Designated Uses (Clean Water Act) — Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

Desired Character — A statement of the landscape character to be created or maintained over time. It is based on the Adopted VQO, local natural appearing characteristic landscape, biological potential, resource management objectives, and the visual elements desired and obtainable.

Desired Condition (DC) — Land or resource conditions that are expected to result if planning goals and objectives are fully achieved.

Desired Non-native Species — Species of plants or animals that are not indigenous to an area, but wanted for their contribution to social, economic, or cultural value.

Developed Recreation — Recreation that requires facilities that result in concentrated use of the area.

Developed Recreation Sites	Distinctly defined areas where facilities are concentrated for public use, such as campgrounds, picnic areas and swimming beaches.
Diameter at Breast Height (DBH)	The diameter of a tree measured at 4.5 feet above ground level on the uphill side of the tree.
Direct Effects	Results of an action occurring generally at the same time and place as the causal agent (prescribed burn, seeding, cutting vegetation, grazing, choice of plan alternatives).
Direct Employment	Employment in economic sectors directly affected by a proposed action or alternative.
Discharge	Flow in a stream, usually measured in cubic feet per second (CFS).
Dispersed Recreation	Recreation that does not occur in a developed recreation site, such as hunting, backpacking, and scenic driving. Dispersed recreation activities may require facilities for safeguarding visitors, protecting resources, and enhancing the quality of visitor experiences.
Displacement (Soil)	The mechanical movement or removal of the top mineral or organic layers of soil.
Distance Zones	Areas of land divided into near foreground, foreground, middle ground and background that represent relative distance from viewers located on a travelway, in use areas, or on bodies of water.
Distinctive Variety Class (A)	A landscape architecture term, which refers to unusual, outstanding landscape variety that stands out from common features in the character type.
Disturbance	Any event, either natural or human-induced, that alters structure, composition, or functions of an ecosystem or area of vegetation. Examples include forest fires, insect infestations, and timber harvesting.
Early Successional Habitat	Habitat composed primarily of a combination of shrubs and saplings intermixed with dominant or characteristic native herbaceous plants as specified for savanna, woodland and forest natural communities. May be created through regeneration harvest, prescribed fire or through a combination of management activities or natural events.

Earth Disturbing	A project will be considered earth disturbing when mineral soil mixing or compaction will occur within the project area, or when specific structures such as foundations may be damaged
Eastern Region	The portion of the USDA Forest Service, also referred to as Region Nine, that includes the National Forests and Grasslands in New England, the Mid Atlantic, the Mid-west, and the Lake States.
Ecological Approach to Management	The management of diverse and sustainable natural communities by restoration of their structural vegetative condition, mimicking the historical disturbance processes and functions under which natural communities evolved and to which they are uniquely adapted.
Ecological classification	Categorizing and delineating areas of land and water having similar characteristic combinations of the environment (climate, geology, soils, natural communities, plants and animals). Two primary classification units used by the Mark Twain NF include natural communities and ecological sections.
Ecological Integrity	The degree to which elements of biodiversity and processes that link them together and sustain the entire system are complete and capable of performing desired functions.
Ecological Landtype (ELT)	An ecological map unit with a distinct combination of natural, physical, chemical, and biological properties that cause it to respond in a predictable and relatively uniform manner to the application of given management practices. In a relatively undisturbed state or stage of plant succession, an ELT is usually occupied by a predictable and relatively uniform plant community. Size generally ranges from ten to a few hundred acres.
Ecological Units	The map unit developed for ecological types usually consisting of different biological and physical potentials
Ecology	The interrelationships of living things to one another and to their environment, or the study of these interrelationships.
Economic Dependency	The degree to which a community is dependent upon national forest resources for employment and income.
Economic Impact Area (EIA)	The local area considered to determine the kind of economic affects that could occur due to management of forest resources.

Ecosystem	A community of living plants, animals, and other organisms interacting with each other and with their physical environment.
Ecosystem Enhancement (Forest Health)	An approach to management that prescribes activities to maintain vegetation and natural community structure with the intent to produce productive, healthy vegetation by blending social, economic, physical, and biological needs and values.
Ecosystem Management	The skillful, integrated use of ecological knowledge transformed into management activities that address the needs of all species, communities, environments, and ecological processes in a land area (compare to fine filter management).
Ecosystem Restoration	The repair or re-establishment of natural community complexes of a subsection and containing both common, characteristic, and sensitive populations of plant and animal species that are anticipated to move toward the desired condition with management.
Edge	The margin where two or more vegetation patches meet, such as a fescue pasture opening next to a mature forest stand, a red cedar stand next to an oak stand, or a clearcut stand next to a mature stand.
Endangered Species	Official designation by U.S. Fish & Wildlife Service applied to any species that is in danger of extinction throughout all or a significant portion of its range.
Endemic	Indigenous or confined to a certain area or region, having a comparatively restricted distribution. Example: Found only on a glade, the St. Francois Mountains, the Current River or the Ozarks.
Enhancement (E)	A short term visual management alternative aimed at increasing positive visual variety where little now exists.
Environmental Analysis	The process associated with preparing documents such as environmental assessments and environmental impact statements and the decision whether to prepare an environmental impact statement. It is an analysis of alternative actions and their predictable short-term and long-term effects, which include physical, biological, economic, and social factors and their interactions.

Environmental Assessment (EA)	A concise public document that serves to: 1) briefly provide evidence and analysis for determining whether to prepare an EIS or a Finding of No Significant Impact; and 2) aid in an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary (40 CFR 1508.9a)
Environmental Impact Statement (EIS)	A statement of environmental effects required for major federal actions under Section 102 of the National Environmental Policy Act (NEPA) and released to the public and other agencies for comment and review. It must follow the requirements of NEPA, the Council on Environmental Quality guidelines, and directives of the agency responsible for the project proposal.
Environmental Justice	The fair treatment and meaningful involvement of all people in the development, implementation, and enforcement of environmental laws regardless of race, color, national origin, or income.
Ephemeral Streams	Streams that flow a short time of the year only as the direct result of rainfall and receive none of their flow from groundwater.
Erosion	The wearing away of the land's surface by running water, wind, ice, and other geological agents. It includes detachment and movement of soil or rock fragments by water, wind, ice, or gravity. Rills, gullies, pedestals and soil deposition are indicators of accelerated surface soil erosion, which are considered detrimental erosion.
Evaluation (Heritage Resources)	The process of determining the scientific, social, and historical significance of a cultural resource property by qualified cultural resource professionals. Evaluations also consider the effects proposed actions or undertakings will have on the scientific, social, and historical significance of cultural resources. (FSM 2360)
Even-aged	A term usually used as "even-aged stand" or "even-aged management", which identifies a stand containing a single age class in which the range of tree ages is usually less than 20% of the normal rotation or life span. Clearcut, shelterwood, or seed-tree harvest methods produce even-aged stands.
Existing Rights	Those surface and subsurface land use rights established by ownership, legal conveyance or permit.
Exotic Species	See Non-native Invasive Species

Experimental Forest	An area established for conducting fire, silvicultural, and other forest investigations and experiments.
Extended Rotation	Management at rotation ages that are a minimum of 1.5 times the Culmination of Mean Annual Increment (CMAI).
Extinct Species	Extinct species have disappeared entirely from the planet.
Extirpated Species	Species that formerly occurred regularly in an area but have disappeared and are not expected to return without human assistance.
Facility	Structures needed to support management, protection, and utilization of the National Forests including buildings, utility systems, roads, bridges, dams, communication system components, and other constructed features.
Fauna	The animal life of an area.
Fee Simple Estate	Absolute ownership unencumbered by any other interest or estate.
Fen	A bog-like area of peatland soils kept constantly moist or wet by spring-fed groundwater usually dominated by sedges, forbs and some shrubs. Fens are often located in riparian zones or watercourse protection zones (upper headwaters). In Missouri applied to similar wetlands lacking, or with only superficial, organic soils.
Fifth and Sixth-level Watersheds	Watersheds delineated using the USGS Hydrologic Unit Code delineation system. Fifth level watersheds are larger than sixth level watersheds.
Filter Strip	An area of land adjacent to a body of water that acts to trap and filter out suspended sediment and chemicals attached to sediment before it reaches the surface water. Unless specific management direction in the Forest Plan indicates otherwise, harvesting and other forest management activities are permitted in a filter strip as long as the integrity of the filter strip is maintained and mineral soil exposure is kept to a minimum.
Fine Filter	The concept of managing individual species through individual conservation measures. Individual nests, colonies, and habitats are emphasized. Management that focuses on the welfare of a single or only a few species rather than the broader habitat or ecosystem (compare to coarse filter management).

Fireline	Any natural or constructed barrier used to segregate, stop, and control the spread of fire or to provide a control line from which to work.
Fire Management Plan	A strategic plan that defines a program to manage wildland and prescribed fires, and documents the fire management program.
Fire Regime	A generalized description of the role fire plays in an ecosystem. It is characterized by fire frequency, seasonality, intensity, duration and scale (patch size), as well as regularity or variability. The characteristics of fire in a given ecosystem, such as frequency, predictability, intensity, and seasonality of fire.
Fire Use	A combination of the use of wildland fire and prescribed fire application to meet resource objectives.
Fiscal Year	The fiscal year is the Federal government's accounting period. It begins on October 1 and ends on September 30, and is designated by the calendar year in which it ends. Before 1976, the fiscal year began on July 1, and ended on June 30.
Floodplain	That portion of a river valley, adjacent to the channel typically built from sediments deposited during the present regimen of the stream; covered with water when the river overflows its bank at various flood stages.
Flora	The plant life of an area.
Forb	Any non-woody plant other than grass or grass-like plants.
Foreground (fg)	A tern used in managing visual resources or scenery. It refers to part of the scene or landscape that is nearest the viewer, generally 0 – 3/8 mile away.
Forest	An area dominated by trees forming a closed canopy and interspersed with multi-layered, shade-tolerant, sub-canopy trees, shrubs, vines, ferns and herbs. Trees attain heights of 60 to over 100 feet.
Forest Cover Type (Forest Type)	See Cover Type.
Forest Health	A forest condition that has overall structure, function, and characteristics that allow it to be flexible to disturbance, keep its biodiversity, and meet human needs.

Forest Inventory Assessment	Data collected to monitor the change in absolute abundance, growth and merchantability of forests.
Forest Plan	A forest plan (land and resource management plan) guides all natural resource management activity and establishes management standards and guidelines for a National Forest, embodying the provisions of the National Forest Management Act of 1976.
Forest Plan Revision	A formal modification of an existing forest plan to address changes in the natural, social, and economic environment, new information about resources on and off National Forests, and new scientific knowledge that shed new light on the assumptions of the existing plan and make the predicted impacts of the existing plan less accurate and/or acceptable. Federal planning regulations require the Forest Service to revise a forest plan every 10 to 15 years.
Forest Products	Goods and services resulting from use of the forest. These may include timber, wildlife, water, forage, recreation, and minerals. Also included, are recreational experiences, scenic and spiritual values, etc.
Forest Roadless Area	An area in a National Forest or Grassland that (1) is larger than 5,000 acres, or if smaller, contiguous to a designated wilderness or primitive area, or lies east of the 100th Meridian, and therefore, under the jurisdiction of the Eastern Wilderness Act; and (2) contains no roads; and (3) has been inventoried by the Forest Service for possible inclusion in the Wilderness Preservation System.
Forest Supervisor	The official responsible for administering National Forest System lands on an administrative unit, usually one or more National Forests. The Forest Supervisor reports to the Regional Forester.
Forest-wide	Applying to all areas or acres within a National Forest.
Fragmentation (Ecosytem)	The breaking up of large and continuous ecosystems, natural communities or habitats into smaller areas surrounded by altered or disturbed land (for example cool-season pasture or roads) that often differs from the original in either composition or structure.

Fragmentation (Wildlife)	The breaking up of large contiguous expanses of one vegetation type or age class with other vegetation types or age classes (i.e. a pine plantation in the middle of an oak-hickory forest, or regenerating forest saplings adjacent to mature forest natural communities).
Fuel Treatment	The manipulation of wildland fuel, such as lopping, chipping, crushing, piling and burning, or removal to reduce its flammability or resistance to control.
Fuels	Plants and woody vegetation, both living and dead, capable of sustaining a fire.
Fuels Management	The practice of evaluating, planning, and treating wildland fuel to reduce flammability and its resistance to control through mechanical, chemical, biological, or manual means, including prescribed fire and wildland fire use in support of land management objectives.
Game Species	Those wildlife species commonly hunted, trapped, or fished.
Generalist species	Species that can use a variety of different habitats to meet its life needs; do not depend on one or two particular types of habitat, therefore more adaptable to changing conditions in the landscape (i.e. white-tailed deer is a generalist species; gray bats, which depend on caves for their life needs, are not).
Geographic Unit	Refers to the nine separate Forest units; Ava, Cassville, Willow Springs, Houston-Rolla, Salem-Potosi, Fredericktown, Cedar Creek, Poplar Bluff and the Eleven Point
Geographical Information Systems (GIS)	Computerized method used for inventory and analysis, which can overlay large volumes of spatial data to identify how features interrelate.
Glade	Open, exposed bedrock areas dominated by drought-adapted herbs and grasses in an otherwise woodland or forest matrix.
Goods and Services	Outputs, including on-site uses, produced by forest and rangeland resources.
Grazing Allotment	A designated area of land available for livestock grazing upon which a specified kind and number of livestock may be grazed under a plan of management.

Ground cover — The aerial projection of plants covering the ground generally following these definitions: dense (50-100 percent cover), patchy (30-50 percent), scattered (10-30 percent) and sparse (0-10 percent).

Ground Fire — A fire that burns along the ground surface and does not affect trees with thick bark or high crowns.

Group Selection Harvest — A cutting method in which trees are removed periodically in small groups. This silvicultural treatment results in small openings that form mosaics of age-class groups and leads to the formation of an uneven-aged stand.

Guidelines — Guidelines are preferable limits to management actions that may be followed to achieve desired conditions. Guidelines are generally expected to be carried out. They help the Forest reach the desired conditions and objectives in a way that permits operational flexibility to respond to variations over time. Deviations from guidelines must be analyzed during project-level analysis and documented in a project decision document, but deviations do not require a Forest Plan amendment.

Guiding — Providing services or assistance such as supervision, protection, education, training, packing, touring, subsistence, interpretation, or other assistance to individuals or groups in their pursuit of a natural resource-based outdoor activity for some form of payment. The term “guide” includes the holder’s employees, agents, and instructors.

Habitat — The natural environment of a plant or animal. In wildlife management, major components of habitat are considered to be food, water, cover, and living space.

- **Breeding habitat:** The habitat type or types upon which a wildlife species depends for reproduction.
- **Foraging habitat:** The habitat type or types within which a wildlife species finds the food it needs.
- **Wintering habitat:** Areas where migratory, and particularly airborne (e.g., birds, bats) species find shelter or warmer weather during the winter or non-breeding season.

Hazard Tree — Trees that have an imminent chance of failure and could fall where public use is concentrated.

Headcutting	The upstream movement of a stream or a locally steep channel bottom due to erosion caused by rapidly flowing water.
Headwaters	The source and upper reaches of a stream, may be intermittent or ephemeral in nature.
Herbicide	A substance used to chemically control plants, particularly problematic invasive species.
Heritage Resources	The remains of sites, structures, or objects used by people historically or pre-historically; formerly referred to as cultural resources).
Hibernaculum	A natural or human-made structure (cave, mine, bridge, building,) that bats use to hibernate in winter. Plural = hibernacula
Home Range	The area in which an individual animal finds all its needs for food, cover, shelter and water.
Hydrologic Connectivity	Water-mediated transfer of matter, energy and/or organisms within or between elements of the hydrologic cycle.
Hydrologic Regime (Flooding or Precipitation)	The timing, depth, duration, frequency and source of water input into a wetland system. This can vary daily, seasonally, or over decades.
Hydrology	The study of the amount, flow, and the characteristics of water.
Impaired Waters	Bodies of water that are not fully supporting their designated uses.
IMPLAN	A computer-based system used by the Forest Service to construct non-survey, models to assess the regional economic effects of changes in expenditure and employment. This input-output model is used to estimate economic effects by tracing the interrelationships between producers and consumers in an economy measured by jobs and income.
Indicator (Management Indicator Species)	In effects analysis, a way of measuring effects from management alternatives on a particular resource or issue.
Indigenous (Species)	Any species of plant or animal that naturally occurs in an area and was not introduced by humans; synonymous with native species.

Indirect effect	Those effects occurring later or at some distance from the source action.
Individual Tree Selection Harvest	A cutting method where individual trees are removed from certain size and age classes over an entire stand area. Regeneration is usually natural, and an uneven-aged stand is maintained.
Infiltration	The rate of movement of water from the atmosphere into the soil; that portion of rainfall or surface runoff that moves downward into the subsurface rock and soil; the entry of water from precipitation, irrigation, or runoff into the soil profile.
Inholding	A parcel of land inother ownership (private, state or other federal ownership) surrounded by National Forest System lands.
Intangible Values	Goods, services, uses, and conditions believed to have value to society but have neither market value nor assigned value.
Integrated Pest Management	An ecologically based process for selecting strategies to regulate forest pests to achieve resource management objectives. It is the planned and systematic use of detection, evaluation, and monitoring techniques; and all appropriate silvicultural, biological, chemical, genetic, and mechanical tactics needed to prevent or reduce pest-caused damage and losses to levels that are economically, environmentally, and aesthetically acceptable. (FSH 2109.14-94-1)
Interdisciplinary Team	A group of individuals with different training assembled to perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad enough to adequately solve the problem.
Interior Forest	A contiguous forest with a closed or partially open canopy of relatively mature trees.
Intermediate Harvest	The removal of some trees prior to final harvest, to enhance growth, quality, vigor, and composition of the stand after establishment. Thinning is an intermediate harvest.
Intermittent Stream	A stream that receives base flow from higher water tables during the wetter part of the year but has no base flow during the drier part of the year.

Interpretive Services Visitor information services designed to present inspirational, educational, and recreational values to visitors to improve their understanding, appreciation, and enjoyment from their forest experience.

Intervenor An individual who, or organization that, is interested in or potentially affected by a decision under appeal who has made a timely request to intervene in that appeal (35 CFR 219.2).

Inventory (Heritage Resources) Strategies designed to collect existing information and locate cultural resources. Inventories are divided into the two general categories of overview and survey. (FSM 2360)

Irretrievable A category of impacts mentioned in statements of environmental impacts that applies to losses of production, harvest, or uses of renewable natural resources.

Irreversible A category of impacts mentioned in statements of environmental impacts that applies to non-renewable resources, such as minerals and archaeological sites. Irreversible effects can also refer to effects of actions that can be renewed only after a very long period of time, such as the loss of soil productivity.

Issue A subject or question of wide-spread public or internal discussion or interest regarding management of National Forest System land.

Jurisdiction The legal right to control or regulate use of a facility. Jurisdiction requires authority, but not necessarily ownership. The authority to construct or maintain a facility may be from fee title, an easement, an agreement, or other method.

Karst Landform Terrain with distinctive characteristics of relief and drainage arising primarily from a higher degree of rock solubility in natural waters than is found elsewhere. This topography usually develops over dolomite, limestone and gypsum bedrock. These areas typically exhibit losing streams, caves, sinks, and underground drainages.

Land and Resource Management Plan See Forest Plan.

Land Exchange	A discretionary, voluntary transaction involving mutual transfers of land or interests in land between the Secretary of Agriculture acting by or through the Forest Service and a non-federal entity.
Late Successional Forest	The stage of forest succession in which most of the trees are mature or overmature.
Limits of Acceptable Change (LAC)	The amount of change to be allowed, measured by means of quantitative standards. Appropriate management actions are identified and procedures for monitoring and evaluating management performance are established.
Litter (Forest Litter)	The freshly fallen or only slightly decomposed plant material on the ground, including leaves, bark fragments, twigs, flowers, and fruit.
Long-lived Tree Species	Trees species with a relatively long life span, including post and white oaks, hickories and shortleaf pine.
Losing Stream	A stream that distributes 30% or more of its flow, through natural processes, such as through permeable subsoil or cavernous bedrock, into groundwater.
Male Roost Tree	A tree used by a male bat in summer to rest during the day, or at night between foraging flights.
Management Area (MA)	A portion of a landscape with similar management objectives and a common management prescription. An area of common direction that differs from neighboring areas. The Mark Twain NF is divided into management areas. Specific direction for each management area is described through management practices, standards, and guidelines.
Management Direction	A statement of multiple-use and other goals, objectives, management prescriptions, and standards and guidelines for attaining objectives and desired conditions.
Management Indicator Species (MIS) or Management Indicator	Plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent. (FSH 2620.5)
Management Practices	A specific activity, course of action, or treatment designed to move the forest toward desired conditions.

Management Prescription (MP)	A combination of specific multiple-use directions applicable to one or management areas described in a Forest Plan; generally includes but is not limited to goals, objectives, standards and guidelines and possible management practices.
Market Valued Resources (MVR)	Those natural resources routinely traded in an established market or for which there is a reasonable basis for estimating value. They can be assigned dollar values for benefits and costs associated with them, such as timber.
Marsh	Wetlands dominated by grasses and grass-like plants, including sedges and rushes, maintained by periodic overland flooding.
Maternity Roost Tree	A tree used by reproductively active (pregnant, nursing) female bats as a place to rest and shelter their young.
Mature Tree or Stand	A tree or stand that has attained full development, particularly in height, and is in full seed production.
Maximum Manageable Area (MMA)	The firm limits of management capability to accommodate social, political, and resource impacts of wildland fire. Once established as a part of an approved plan, the general area is fixed and not subject to change. (The Maximum Manageable Area defines the pre-determined limits of a wildland fire for resource benefits). (NWCG IOSWT 1996).
Maximum Modification (MM)	A visual quality objective meaning that evidence of man's activity may dominate the characteristic landscape, but should appear as a natural occurrence when viewed as background.
MBF	Thousand board feet (see board foot.)
Mean Annual Increment of Growth	The total increase in size or volume of individual trees; refers to the increase in size and volume of a stand of trees at a particular age, divided by that age in years (also see culmination mean annual increment).
Mechanical Transport	Includes any wheeled contrivance which constitutes a mechanical advantage to the user, and which IS powered by a living or nonliving source contained on, within, or attached thereto such as bicycles, deer carriers, and wagons.

Median Household Income	The value in an ordered set of household income values below and above which there is an equal number of values. Half of the households in the set earn more and half earn less than the median value.
Memorandum of Understanding	The instrument used as a written plan between the Forest Service and other parties for carrying out their separate activities in a coordinated and mutually beneficial manner and for documenting a framework for cooperation.
Middleground (mg)	A term used in managing visual resources or scenery. It refers to the visible terrain beyond the foreground where individual trees are still visible, but do not stand out distinctly from the stand, generally 3/4 mile to 4 four miles from the observer.
Mineral Exploration	The search for valuable minerals.
Mineral Rights Outstanding	Legal authority to explore, develop and process minerals (including prudent use of land surface) held by someone else other than the party conveying the land to the USA.
Mineral Rights Reserved	Legal authority to explore, develop and process minerals (including the prudent use of the land surface) held by someone who retained the mineral rights when conveying the land to the USA.
Mineral Soil	Soil that consists mainly of inorganic material, such as weathered rock, rather than organic matter.
Mineral, Leasable	Types of minerals whose prospecting and development on public lands under permit or lease was authorized under the Mineral Leasing Act of February 25, 1920, as amended and supplemented. For example: coal, phosphate, sodium, potassium, oil, oil shale, gas, and in some states, sulfur.
Minimal Variety Class (C)	A landscape architecture term, which refers to little or no visual variety in the landscape. It is monotonous or below average compared to the common features in the character type.
Mitigation	Action taken for the purpose of eliminating, reducing, or minimizing negative impacts of management activities on the environment.
Mixed Stand	A stand consisting of two or more tree species.

Model	A computer-based program which attempts to represent some aspect of the real world using mathematics to represent individual elements. Interactions are represented by mathematical computations.
Modification (M)	A visual quality objective meaning that man's activity may dominate the characteristic landscape but must; utilize at the same time naturally established form, line, color, and texture. It should appear as a natural occurrence when viewed in foreground or middleground.
Monitoring	A systematic process of collecting information to evaluate previous changes in actions, conditions, and relationships over time and space relative to a pre-determined standard or expected norm.
Monitoring and Evaluation	The periodic evaluation of Forest Plan management activities to determine how well objectives are met, and how closely management standards and guidelines have been applied.
Mosaic	Areas with a variety of plant communities over a landscape, such as areas with trees and areas without trees occurring over a landscape.
Motor Vehicles	Any vehicle powered by a motor.
Motorboat	A boat propelled by gas or electric motor with a propeller below the water line; does not include hovercraft.
Motorized Equipment	Machines incorporating a motor, engine, or other nonliving power source to accomplish a task. This includes such machines as aircraft, hovercraft, motorboats, automobiles, motor scooters, snowmobiles, bulldozers, duffel carriers, chainsaws, rock drills, and generators. (For administrative guidance, this does not include such things as electric shavers or toothbrushes, portable radios or televisions, Geiger counters, wristwatches, gas stoves, flashlights, and other such small contrivances.)
Multiple-use Management	The management of all renewable surface resources of National Forest land for a variety of purposes such as recreation, range, timber, wildlife and fish habitat, and watershed.

National Environmental Policy Act (NEPA)	Public law that outlines specific procedures for integrating environmental considerations into agency planning. Congress passed NEPA in 1969 to encourage productive and enjoyable harmony between people and their environment. One of the major tenets of NEPA is its emphasis on public disclosure of possible environmental effects of any major action on public land. The Act requires a statement of possible environmental effects to be released to the public and other agencies for review and comment.
National Forest Management Act (NFMA)	Public Law of 1976 that provides for planning and management of National Forests, and requires preparation of forest plans.
National Forest System	All management units, national forests and national grasslands, managed by the USDA Forest Service.
National Forest System Road	A classified road under jurisdiction of the Forest Service and determined to be needed for long-term motor vehicle access. Also referred to as a “system road”.
National Forest Visit	The entry of one person upon a national forest to participate in recreation activities for an unspecified period of time. A national forest visit can be composed of multiple site visits.
National Register of Historic Places (NHRP)	A listing maintained by the U.S.D.I. National Park Service of areas which have been designated as being of historical significance. The Register includes places of local and state significance as well as those of value to the Nation as a whole.
National Trails	Trails designated by the Secretary of the Interior or the Secretary of Agriculture as part of the national system of trails authorized by the National Trails System Act.
National Wild and Scenic River System	Rivers with outstanding scenic, recreational, geological, fish and wildlife, historic, cultural, or other similar values designated by Congress under the Wild and Scenic Rivers Act for preservation of their free-flowing condition (also see wild, scenic, and recreational rivers).
National Wilderness Preservation System	All lands covered by the Wilderness Act and subsequent wilderness designations, regardless of the department or agency having jurisdiction.

Native Species	A species that historically occurred in a particular ecosystem. Native species do not include species introduced by humans.
Natural Area	A natural community that is presumably representative of the pre-European settlement vegetation of the site. Also includes sites that with management and time have a good potential for restoration to a community vegetation and diversity similar to the pre-European settlement condition. The Missouri Natural Areas Committee defines natural areas as "biological communities or geological sites that preserve and are managed to perpetuate the natural character, diversity, and ecological processes of Missouri's native landscapes."
Natural Community	A group of native plants and animals that interact with each other and their environment in ways minimally modified by exotic species and negative human disturbances. A grouping of plants and animals and their physical environment that still contains a semblance of the composition, structure and function that would have occurred in the pre-European settlement era.
Natural Community Types	The consolidation of respective natural communities sharing similar structural and compositional characteristics (forest, open woodland, savanna, glade, prairie, cliff, fen, cave, etc). Types consist of combinations of natural, physical, chemical and biological properties that cause each to respond in a predictable and relatively uniform manner to management practices and which management objectives are specified by ecological subsection.
Natural Disturbance (also ecological disturbance)	Disruption of existing conditions by a single event of wind, tornado, fire, flooding, drought, insects, and disease at a scale from one to thousands of acres.
Natural Ignition	A fire ignition resulting from any natural cause, e.g., lightning.

Natural Opening	A natural community whose vegetation is predominantly contained in the ground-layer or mid-layer, e.g. grasses, forbs, shrubs, or saplings, with few mature trees. Such areas typically are the product of stand-replacing disturbance processes, e.g. fire, wind, or ice storms, and may or may not return to a dominated by canopy-layer and shrub-layer vegetation. Depending upon the natural community and disturbance type, natural openings can vary in size from less than one acre to hundreds or thousands of acres.
Natural Processes Natural Conditions	The regime (frequency, intensity, duration, timing) of a particular disturbance type that shapes a community's structure and composition. Disturbances include fire, flood, elk and bison grazing, insect and disease outbreaks, wind storms, drought, floods, ice storms and tornados.
Natural-appearing	The existing natural character of the landscape integrated into management activities, such as harvesting. The landscape shows few signs of forest management activities; however, the effects of naturally-occurring disturbances may be noticeable.
Near foreground (Nfg)	The portion of the foreground closest to the viewer where fine detail can be observed with clarity. The area within 0 and 300 feet of the observer.
Neo-tropical Migratory Birds	Species that breed mainly in temperate regions of North America and winter from Central Mexico to South America.
No Action (Alternative)	The most likely condition expected to exist if current management practices continue unchanged. The analysis of this alternative is required for federal actions under NEPA.
Non-Consumptive Use	Those uses of resources that do not reduce the supply, such as many types of recreation.
Non-declining Even-flow	A timber sale and harvest schedule formulated on the basis that the quantity of timber planned for any future decade is equal to or greater than the planned sale and harvest for the preceding decade.
Non-market Valued Resources	Those natural resources for which there is no available market transaction evidence and a reasonable basis for estimating a value commensurate with market values does not exist.

Non-native Invasive Species (NNIS)	A species that has been introduced into a particular geographic area in relatively recent times (especially resulting from post-European settlement). Invasive species are any species whose introduction does or is likely to cause economic, ecological or environmental harm or harm to human health. Invasive species are those species that spread from their original native habitat, to one that is not their native habitat.
Non-point Source	Diffuse pollution sources (I.e. Without a single point of origin or not introduced into a receiving stream from a specific outlet)
Non-renewable Resource	A resource whose total quantity does not increase measurably over time, so that each use of the resource diminishes the supply.
Non-system Road	See unclassified road.
Non-volant	Unable to fly; as in young bats during the time they are dependent upon their mothers for movement.
Notice of Intent (NOI)	An announcement to prepare an Environmental Impact Statement in accordance with NEPA regulations. An NOI must be published in the Federal Congressional Register and is intended to solicit public comment about a proposed action.
Noxious Weed	Any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment (definition from the Plant Protection Act, P.L. 106-224).
Nutrient Cycling	Circulation or exchange of elements such as nitrogen and carbon between non-living and living portions of the environment; includes all mineral and nutrient cycles involving mammals and vegetation.
Objective	A concise, time-specific statement of measurable and planned results that respond to pre-established desired condition. An objective forms the basis for further planning by defining both the precise steps to be taken and the resources to be used in achieving identified desired conditions. Objectives identify quantities of items within the 15-year forest plan time frame. Objectives are action oriented and specifically describe measurable results.

Obligate	A species which must have a certain habitat component to survive, i.e. and obligate old growth species will not persist if old growth is not present.
Occupancy Encroachment	Fences, walls, ditches, enclosures, buildings, etc., which illegally intrude on or occupy National Forest System lands or interest in lands.
Off-highway Vehicle (OHV)	An Off Highway Vehicle is any motorized vehicle not registered or lawful for use on all State, county or municipal roads and highways in the State in accordance with State law, except tracked vehicles specifically designed for use over snow. The term off-highway vehicle generally includes all-terrain vehicles, off-highway motorcycles, and off-road vehicles.
Off-road Vehicle (ORV)	Off-road vehicles (ORVs) are motorized, recreational vehicles capable of cross-country travel on natural terrain, such as four-wheel-drive trucks and ATVs. Vehicles not considered ORVs include snowmobiles, motorcycles, watercraft, or aircraft. Farm, logging, military, emergency, law enforcement, utility, and construction vehicles are not considered ORVs when used for their intended purpose.
Old Growth	Old growth is characterized by the later stages of stand development which may include: large trees, wide variation in tree species, sizes and spacing, presence or absence of large-sized dead standing and fallen trees, decadence in the form of broken or deformed tops or boles and root decay, multiple canopy layers, presence or absence of midstory and understory, ground layer, canopy gaps and understory patchiness. Old growth reflects the range of natural variability of forest, woodland and savanna natural communities.
Opportunity Cost	Cost of something in terms of a prospect foregone.
Option Value	Option values refer to the premium risk-adverse individuals would be willing to pay in excess of their personal expected surplus to ensure future availability of the stand in an environment of uncertainty.
Organic matter	Plant and animal residues, or substances made by living organisms. All are based upon carbon.
Outcomes	The impact on a resource or landscape of program activities, for example water quality changes and improved habitat condition.

Outcrop	A portion of bedrock or other stratum protruding through the soil level. Outcrops are considered significant for the purposes of applying the 100 foot buffer when isolated outcrops or a series of outcrops have a minimum exposed surface of 750 square feet. Outcrop complexes should be separated by not more than 50 feet to be included together for the purposes of buffering.
Outfitter/Guide	A special-use permittee that provides all commercial outfitting operations involving services for accommodating guests, transporting persons, and providing equipment, supplies, and materials. The permittee also provides guiding activities wherein the guide furnishes personal services or serves as a leader or teacher.
Outfitting	Providing through rental or livery any saddle or pack animal, vehicle or boat, tents or camp gear, or similar supplies or equipment, for payment or other gain. The term “outfitter” includes the holder’s employees, agents, and instructors.
Outputs	Broadly applied, any result, product, goods or services produced by a process or activity.
Outstandingly Remarkable Values	In the Wild and Scenic Rivers Act, river values identified include scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values..
Out-year (Budget)	The fiscal year beyond the budget year.
Overmature Tree or Stand	A tree or even-aged stand that has attained full development, particularly in height, and is declining in vigor, health, and soundness.
Overstory	The upper canopy layer; the plants below comprise the understory.
Partial Cut Harvest	A harvest system that leaves from 30 ft^2 to 80 ft^2 basal area of trees. This method facilitates reaching desired stand conditions in terms of structure and age while at the same time producing timber volume. Partial cuts with a smaller retention are like shelterwood systems, while partial cuts with more retention are multiple-aged management. Partial cuts can be used with all forest types.

Partial Retention (PR)	A visual quality objective in which management activities may be evident but must remain subordinate to the characteristic landscape.
Patch, or Patch Size	An area of vegetation, a stand, a natural community or a habitat that is internally homogeneous, differing from the larger matrix that surrounds it.
Payments in Lieu of Taxes (PILT)	Payments to local or state governments based on ownership of federal land; not directly dependent upon production of outputs or receipt sharing. Specifically, they include payments made under the Payments in Lieu of Taxes Act of 1976.
Per capita income	Total income for a given area divided by the total population of that area.
Perennial Stream	A stream that maintains water in its channel throughout the year.
Permit	A special-use authorization that provides permission, without conveying an interest in land, to occupy and use National Forest System lands or facilities for specific purposes, and which is both revocable and terminable.
Pesticide	A substance that when applied kills pests that do harm or damage to something of specified value, usually to insects and rodents.
Pests	Insects, diseases, pests, or animals that interfere with objectives for management of forests.
Planning Horizon	In the planning process, the overall time period that spans all activities covered in the analysis or plan, and all future conditions and effects of proposed actions that would influence the planning decisions (FSM 1900).
Pole Size	A tree of a size between a sapling and a mature tree. (Usually 4-8” dbh)
Pre-commercial Thinning	Selectively felling or removing trees in a young stand before they are commercially merchantable. This accelerates diameter growth on remaining trees, maintain a specific stocking density, and improve vigor and quality of remaining trees.

Preferred Alternative	From amongst alternatives developed to address issues, the Regional Forester selects an alternative that he/she believes best resolves management problems within the context of the mission and priorities of the Forest Service for each National Forest. The Preferred Alternative becomes the basis for the Draft Revised Forest Plan.
Permanent Forest Opening	Area of natural grasslands or artificial openings consisting of grass/forbs and shrubs, usually maintained mechanically, with fire or with other management action.
Prescribed Fire **Prescribed Burning** **Management Ignited Fire**	Intentional use of fire to accomplish specific resource objectives, such as preparing sites for natural regeneration of trees, reducing fuels, or controlling unwanted vegetation, under prescribed conditions and circumstances.
Prescription (Fire, Mechanical, Pesticide, Herbicide, or Silvicultural)	Written statement outlining a treatment or series of treatments to achieve predetermined objectives and meet management goals. Examples include changing stand structure, moving toward desired conditions for natural communities, wildlife habitat improvement.
Present Net Value (PNV)	The measure of the economic value of a project when costs and revenues occur in different time periods. Future revenues and costs are "discounted" to the present by an interest rate that reflects the changing value of a dollar over time. PNV is used to compare project alternatives that have different cost and revenue flows.
Preservation (P)	A visual quality objective that provides for ecological change only.
Pre-settlement	The period prior to widespread settlement by Euro-Americans and industrial civilization. In Missouri, European settlement ranges from the late 1700s along the Mississippi River to the early 1800s elsewhere.
Primitive ROS Class	Part of the Recreation Opportunity Spectrum. Area is characterized by an essentially unmodified natural environment of large size. Interaction between users is very low and evidence of other users is minimal. The area is managed to be essentially free from evidence of human-induced restrictions and controls. Motorized use is not permitted within the area.
Program Budget	A plan that allocates annual funds, workforce ceilings, and targets among agency management units.

Project	An organized effort to achieve an objective identified by location, activities, outputs, effects, time , and responsibilities for accomplishment.
Proposed Action	The project, set of activities, or decision that a federal agency intends to implement, as defined in NEPA regulations (compare to 'preferred alternative').
Province	Term used to describe an ecological unit. Province is the largest unit representing the climate zones of North America. For example, the Ozarks of Missouri is contained within the Eastern Broadleaf Forest (Continental) Province. The other provinces in the state are the Prairie Parkland (Temperate) Province and the Lower Mississippi River Riverine Forest Province.
Public Access	Usually refers to a road or trail right-of-way available for public use.
Public Road	Any road under the jurisdiction of and maintained by a public authority and open to public travel.
Puddling	A severe alteration of soil structure that greatly reduces gas exchange and infiltration of water into the soil; associated with fine-textured soils with high water content.
Pulpwood	Trees that yield logs of suitable size and quality for production of pulp.
Purchase	Buying non-federal land for federal ownership.
Rangeland	Lands producing naturalized or native forage for livestock consumption.
Range of Natural Variability (RNV)	Variation of physical and biological conditions and disturbance factors that influenced the composition, structure, distribution and dynamics of natural communities before European settlement.
Rare Natural Resources	Plants, animals, and natural communities that are defined as threatened, endangered, sensitive, special concern, or very uncommon.
Recharge Area	The area that adds water to the zone of saturation of a specific aquifer. This area may or may not correspond to the surface watershed.

Recommended Management Variability	Part of the range of natural variability for ecosystem composition, structure and disturbance regimes from which to select. These selections define conditions that may omit extremes that would prejudice attaining desired results. Example might include prescribed burning mimicking extreme wildland fire burning conditions.
Record of Decision (ROD)	An official document in which a deciding official states the alternative that will be implemented from a prepared environmental impact statement.
Recovery (of federally-listed species)	Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in the Endangered Species act.
Recreation Opportunity Spectrum (ROS)	A system of classifying the range of recreational experiences, opportunities, and settings available on a National Forest. Classifications include: Primitive (P), Semi-primitive Motorized (SPM), Semi-primitive Non-motorized (SPNM), Roaded natural (RN), Rural (R), and Urban (U).
Recreation Visitor Day (RVD)	A unit for measuring recreation use which totals 12 visitor hours. It may consist of any combination of continuous or intermittent recreation use by an individual or groups of individuals. For example, one person camping for 12 hours equals 1 camping RVD; or 12 people picnicking for 1 hour each equals 1 picnicking RVD.
Recreational River	Rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shoreline, and that may have undergone some impoundment or diversion in the past. (Wild and Scenic Rivers Act)
Reforestation	The restocking of an area with forest trees, by either natural or artificial means.
Regeneration	The establishment of a tree crop by either natural or artificial means. The term is also used to refer to the young crop itself.
Regional Forester's Sensitive Species (RFSS)	Plant and animal species designated by a U. S. Forest Service Regional Forester for which population viability is a concern.
Rehabilitation (reh)	A short term visual management alternative used to restore landscapes containing undesirable visual impacts to a desired visual quality.

Release	Removal of competing vegetation to allow desired tree species to grow.
Residual Stand	The trees remaining standing after an event such as harvesting.
Resilient, Resiliency	The ability of a natural community or ecosystem to maintain diversity, integrity and ecological processes following disturbance. An ecosystem well supplied with species adapted to disturbance within the historical range of natural variability will typically be resilient. In human communities, refers to the ability of a community to respond to externally induced changes such as larger economic or social forces.
Resource Mapping	Activities associated with development of a spatial data layer using a geographic information system; development of a spatial map and attributes meeting agency standards.
Responsible Official	The Forest Service employee who has been delegated the authority to carry out a specific planning action.
Retention	A visual quality objective, which means in general man's activities are not evident to the casual forest visitor.
Re-treatment Activities	Management of forest stands such that multiple stands of trees are grown and harvested from the same site.
Revegetation	The re-establishment and development of a plant cover by either natural or artificial means.
Riffle	A shallow area extending across a streambed and causing a "break" in the water surface, usually in the form of a succession of small waves.
Right-of-way (ROW)	Land authorized to be used or occupied for the construction, operation, maintenance and termination of a project or facility passing over, upon, under or through such land; may be temporary or permanent.
Riparian Areas	Riparian areas include aquatic ecosystems, riparian ecosystems, and wetlands. They are three-dimensional: Longitudinal (extending up and down streams and along the shores); lateral (to the estimated boundary of land with direct land-water interactions); and vertical, from below the water table to above the canopy of mature trees.

Riparian Ecosystem A transition zone between aquatic ecosystems and adjacent terrestrial ecosystems, identified by soil characteristics and distinctive vegetation communities that require free or unbound water.

Riparian Management Zone (RMZ) A site-specific area with boundaries established to define limits of management activities, and associated standards and guidelines, within riparian areas. Size and placement of riparian management zones will be determined by management objectives for riparian areas and may not include all of the riparian area.

Riparian Natural Communities Areas adjacent to aquatic ecosystems and extend away from the bank or shore to include lands with direct land-water interactions. As a minimum, this will include all lands adjacent to surface water and which have hydric soils or distinctive vegetative communities that require free or unbound water. This would only include riverfront forest, wet and wet-mesic bottomland forest or woodland, streambank, gravel wash, sandbar (not mesic bottomland forest).

Road A motor vehicle travelway over 50 inches wide, unless designated or managed as a trail. A road may be classified, unclassified, or temporary.

Road Closure Activities that restrict or limit access of motorized vehicles. The road is needed for long-term access, but the amount and timing of vehicle traffic is controlled, such as the use of a gate.

Road Construction Activity that results in the creation of a new road where one did not exist before. The road’s rights-of-way would be cleared of impeding vegetation, drainage features would be installed or created, surface material would be added, and any needed signs would be installed.

Road Decommissioning Activities that result in the stabilization and restoration of unneeded roads to a more natural state. Road decommissioning may involve one or more of the following treatments: blocking access with earthen or rock berms, boulders, or slash piles; restoration of natural drainage features by removing drainage features and re-contouring the area; scarification to remove the road bed; revegetation by seeding, planting, or fertilizing; and signing to discourage motorized use of the road.

Road Functional Classification

Forest system roads are defined on National Forests by three functional classifications to describe their function within the transportation system:
Arterial: Provides service to large land areas, and connects with other arterial routes or public highways. These are usually through-routes.
Collector: Serves smaller land areas than arterials, and connects arterials to local roads or terminal facilities.
Local: Serves as a single purpose road, and connects terminal facilities with collectors or arterials.

Road Maintenance

The ongoing upkeep of a road necessary to retain or restore the road to the approved road management objective. Activities associated with road maintenance may include surface blading, replacement of surface material, mowing and limbing of roadside vegetation, cleaning and restoring drainage features, and replacing signs.

Road Maintenance Level (ML)

All National Forest System roads are assigned a maintenance level. Maintenance level defines the service provided and the maintenance required for the specific road. Factors used to determine a road's maintenance level include, but are not limited to, resource management needs, service life, user safety, volume and type of traffic, surface type, and user comfort and convenience.

ML 1: Assigned to roads that receive basic custodial care in order to minimize damage to adjacent resources. User comfort and convenience are not considered. Roads may be inaccessible at times. Roads generally have a native surface.

ML 2: Assigned to roads suitable for high clearance vehicles. User comfort and convenience are given minimal consideration. Roads have an aggregate or native surface.

ML 3: Assigned to roads suitable for passenger cars and generally have an aggregate surface. User comfort and convenience are considered.

ML 4: Assigned to roads suitable for passenger cars and generally have a paved surface that provides a moderate degree of user comfort and convenience.

ML 5: Assigned to roads suitable for passenger cars and have a paved surface that provides a high degree of user comfort and convenience.

Road Reconstruction	Activity that results in the improvement or realignment of an existing road. Road improvement may increase a road's capacity for traffic, or change its original design function. An example of road improvement would be changing the road's surface from aggregate to asphalt. Road realignment results in a new location of a road or a portion of the road and treatment of the old roadway.
Roaded Natural ROS Class	Part of the Recreation Opportunity Spectrum. The area is characterized by predominantly natural-appearing environments with moderate evidence of sights and sounds of man. Such evidence usually harmonizes with the natural environment. Interactions between users may be moderate to high, with evidence of other users prevalent. Resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is allowed and incorporated into construction standards and design of facilities.
Roadless Area Review and Evaluation (RARE II)	The assessment of areas within National Forests as potential wilderness areas as required by the National Wilderness Act. This refers to the second such assessment which was documented in the final environmental impact statement of the Roadless Area Review and Evaluation, January, 1979.
Rotation	In even-aged systems, the period between regeneration establishment and final cutting. Rotation may be based on many criteria including mean size, age, culmination of mean annual increment, and biological condition
RPA Program	The recommended long-range management of renewable resources of National Forest System lands and resource output targets. Development of this direction was required by Forest and Rangeland Renewable Resources Planning Act of 1974.
Runoff	The part of precipitation, as well as any other flow contributions, that appear in surface streams before it can be absorbed into the subsurface.

Rural ROS Class	An area that is a natural environment, which has been substantially modified by development of structures, vegetative manipulation or pastoral agricultural development. Resource modification and utilization practices may be used to enhance specific recreation activities and maintain vegetative cover and soil. Sights and sounds of humans are readily evident, and interaction between users is often moderate to high. Many facilities are designed for use by a large number of people. Moderate user densities are present away from developed sites. Facilities for intensified motorized use and parking are available.
Rutting	The furrows in soil caused by management or recreation activities that are molded and typically have well defined berms. They severely disrupt soil structure and porosity, can adversely alter local groundwater hydrology and wetland function and provide conduits for runoff. Often associated with clay and organic soils.
Salvage	Removal of dead, damaged, or dying trees to recover value that would otherwise be lost.
Sanitation Harvest	A cutting method in which dead, damaged, or susceptible trees are removed primarily to prevent the spread of pests or disease and promote forest health.
Sapling	A young tree more than a few feet tall and an inch or so in diameter that is typically growing vigorously. A young tree larger than a seedling, but smaller than a pole.
Savanna	Savannas are grasslands interspersed with open-grown, scattered trees or groupings of trees. They are strongly associated with prairies and are dominated by prairie grasses and forbs. Canopy cover is usually < 30 percent.
Sawtimber	Any tree capable of yielding logs of a size and quality suitable for lumber production; usually > or = 9 inches dbh
Scenic Easement	An interest in land of another owner, which allows the easement holder specified uses or rights without actual ownership of the land. e.g., control of the use of land adjacent to public highways, parks, and rivers.
Scenic River	Wild and Scenic Rivers Act usage –Rivers or sections of rivers that are free of impoundments, where shorelines or watersheds are still largely primitive and shorelines largely undeveloped, but accessible by road at places.

Scoping The ongoing processes to determine public opinion, receive comments and suggestions, and determine issues during the environmental analysis process. It may involve public meetings, telephone conversations, or letters.

Secondary Zones The area between 300 feet and 3/8 mile in foreground areas where slash reduction and other mitigating measures are utilized to help assure attainment of visual quality objectives.

Section (ecological) An ecological unit within the U.S. Department of Agriculture, Forest Service hierarchy of ecological units based on regional climate data, geomorphology, major soil groups and potential vegetation patterns. Sections cover parts of a state and are around 1,000 square miles in size. . Missouri consists of four sections: Central Dissected Till Plains, Osage Plains, Ozark Highlands and the Mississippi River Alluvial Basin.

Sediment Solid, fragmented material (soil, sand, minerals, etc.) transported and deposited by wind, water, or ice.

Sedimentation The process or act of depositing sediment.

Seed Tree Harvest A cutting method in which the mature timber crop is removed from an area in one cut, except for a certain number of widely-dispersed trees retained for seed production The seed trees are usually removed after regeneration is established.

Seed Tree Harvest with Reserves Some or all of the seed trees or reserve trees are retained after regeneration is established to attain goals other than regeneration.

Seen Area As used in the visual management system, it is the total area observed by a viewer as limited by landform; measured in terms of distance zones. Example:That portion of the Eleven Point National Scenic River visible from areas of public use such as the river, developed facilities, and access roads.

Seep A small area of groundwater discharge, either non-forested or shaded by trees rooted in adjacent, upland habitats large enough to maintain a gap supported by characteristic herbaceous wetland species. Seeps are often too small or narrow to support woody vegetation that requires waterlogged soil.

Selected Alternative

This is the alternative selected by the Regional Forester, documented in the Record of Decision for the Environmental Impact Statement that will be implemented.

Semi-primitive Motorized ROS Class

The area is characterized predominantly by a natural or natural-appearing environment of moderate to large size. Concentration of users is low, but there is often evidence of other users. Management involves minimum on-site controls, and restrictions may be present, but would be subtle. Use of local, primitive, or collector roads with predominantly natural surfaces and trails suitable for motorbikes is permitted.

Semi-primitive Non-motorized ROS Class

The area is predominantly characterized by a natural or natural-appearing environment of moderate to large size. Interaction between users is low, but there is often evidence of other users. Management involves minimum on-site controls, and restrictions may be present, but would be subtle. Motorized recreation use is not permitted, but local roads used for other resource management may be present on a limited basis. Use of such roads is restricted to minimize impacts on recreational experience opportunities.

Sensitivity Level

A particular measure of viewer interest in the scenic qualities of the landscape:

Level 1 The most sensitive roads and trails (hiking/horse riding) with National or Regional importance, including;

- designated scenic roads (e.g. Glade Top Trail Scenic Byway, Ozark Trail);
- all Interstates;
- U. S. Highways (principal and secondary arterials);
- State numbered roads (principal collectors)
- Roads paved with high design and construction standards and/or primary connector between collector roads
- Roads and trails providing primary access to Level 1 use areas.
- Water bodies with National and Regional (Ozark Highlands) importance; (e.g. Eleven Point National Scenic River, Council Bluff Lake, Table Rock Lake, etc.).
- Water bodies that are floatable and fishable at least 10 months of the year, and receives high to moderate recreation-oriented use.

Level 2 Sensitive Primarily, includes:

- State lettered principal and secondary collectors,
- County and Forest Service System all-weather roads with observed moderate to high recreation-oriented use and moderate non-recreational use. Usually all-weather paved (can be gravel surface) and usually carries through traffic (I.e.not dead-end).
- Roads and Trails providing access to Level 2 use areas.
- All developed trails not designated Level 1.
- Relative large, undeveloped perennial springs that receive moderate recreation use.
- Water bodies that are floatable approximately two months of the year and whose water levels fluctuate moderately with seasons. Fishing and other water enjoyment activities may occur all year; receives moderate use.

Level 3 Less Sensitive Primitive

- County, Forest Service and private, soil and/or gravel surfaced (two-wheel track) roads; usually no through traffic.
- Low recreation-oriented use and high non-recreational use.
- Water bodies only periodically floatable and have no developed public access; i.e., intermittent streams, small farm and wildlife ponds. Receives low recreation-oriented use.

Shelterwood Harvest Method of regenerating an even-aged stand, in which trees are removed to establish a new age class beneath the shelter of residual trees. After the new stand is established, the residual mature trees are removed.

Shelterwood Harvest with Reserves Some or all of the shelter trees or reserve trees are retained after regeneration is established to attain goals other than regeneration.

Short-lived Tree Species Tree species which have a short life span, such as scarlet and black oak (e.g. 60-80 years).

Silvicultural Prescriptions or Treatment Activities prescribed for tending, harvesting, and re-establishing a stand of trees.

Silviculture The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet diverse needs and values of society on a sustainable basis.

Sinkhole	A sinkhole is a surface depression resulting from the solution of underlying carbonate bedrock and possibly the collapse into an underground cavern. Sinkholes shall have delineated protection zones when the sinkhole contains vegetation, natural communities and/or geological features distinguished from the surrounding area
Site (Heritage Resources)	A site is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself maintains historical or archeological value regardless of the value of any existing structure. (36CFR 60.3)
Site appropriate	When a natural community is located on a site to which it historically was adapted and on which that natural community was dominant prior to the late 1800's.
Site Fidelity	The tendency of an individual animal or animals to return to a particular spot, area, or site in successive years.
Site Index	A measure of site class based upon the height of the dominant trees in a stand at an arbitrarily chosen age, most commonly at 50 years in the East and 100 years in the West.
Site Preparation	The general term for removing unwanted vegetation, slash, roots, and stones from a site before reforestation. Naturally occurring wildfire, as well as prescribed fire, can prepare a site for natural regeneration.
Size Class	One of the three intervals of tree stem diameters used to classify timber in the Forest Plan data base. The size classes are: Seedling/sapling (less than five inches in diameter); pole timber (five to seven inches in diameter); sawtimber (greater than seven inches in diameter). Put these sizes in definitions for each class.
Skidding	Hauling logs by sliding it from stump to a collection point.
Skilled event	An activity in which skill or ability is the determining factor to win, rather than shortest amount of time taken to complete the event.
Slash	The residue left on the ground after timber cutting or after a storm, fire, or other event. Slash includes unused logs, uprooted stumps, broken or uprooted stems, branches, bark, etc.

Snag A standing dead tree, with or without cavities, at least 6" in DBH and at least 10' tall.

Social Analysis An analysis of social, as distinct from the economic and environmental, effects of a given plan or proposal for action. Social analysis includes identification and evaluation of all pertinent desirable and undesirable consequences to all segments of society, stated in some measurable terms, such as persons or percent of population in each affected social segment. It also includes a subjective analysis of social factors not expressible in numerical terms.

Soil Compaction A physical change in soil properties that results in a decrease in porosity and an increase in soil-bulk density and strength. Detrimental compaction is the condition with increased soil density and strength that hampers root growth, reduces aeration and slows soil water movement.

Soil Hydrology Movement of water into and through the soil.

Soil Nutrient Capacity The ability of a soil to absorb nutrient ions that can be used by plants later. Related to the cation exchange capacity of a soil.

Soil Productivity Soil potential to produce living matter specifically adapted to an area's distinctive interaction of physical, chemical and climatic characteristics.
The capacity of a soil to produce a specific crop. Productivity depends on adequate moisture and soil nutrients, as well as favorable climate.

Soil Quality The capacity of a specific soil, as determined by its physical, chemical and biological characteristics, to perform its biologic, hydrologic, and ecological functions (FSH 2509.18, 2002).

Special Places Specific locations and outdoor settings that have attractions and features that are identified as unique, different, distinctive, and extraordinary to people. Special places may range from small areas such as a tree, to large areas such as a landscape unit.

Special Use Permit Permits, memorandums of understanding, and easements (excluding road permits and highway easements) authorizing the occupancy and use of National Forest land for a specific period of time by individuals, organizations, or businesses, generally for a fee.

Species at Risk (SAR)	Species for which loss of viability, including reduction in distribution or abundance, is a concern within the Plan area. Species at risk may include, federally listed, RFSS and state listed species, as well as other species
Species Viability Evaluation (SVE)	A process used to determine whether or not implementation of the Forest Plan would directly or indirectly affect the viability of species that may be at risk (see SAR above).
Spring	A place where groundwater flows naturally to the surface, usually to a specific orifice where most of the flow arises.
Stand (of trees)	A community of trees or other vegetation sufficiently uniform in composition, age, spatial arrangement, or condition to be distinguishable from adjacent communities and so form a silvicultural or management group.
Stand Replacement Disturbance	A disturbance that kills or removes trees and creates a new age class of trees; usually by fire, wind, insects, or harvesting.
Standards	Requirements found in a Forest Plan, which impose limits on natural resource management activities, generally for environmental protection. Standards are required limits to activities. These limitations allow the Forest to reach the desired conditions and objectives. Standards also ensure compliance with laws, regulations, executive orders, and policy direction. Deviations from standards must be analyzed and documented in Forest Plan amendments.
Stocking Level	The number of trees in an area compared to the desirable number of trees for best results, such as maximum wood production.
Stream	A channel with a defined bed and a bank that carries enough water flow at some time during the year to flush out leaves.
Stream Geomorphology	The study of water and earth forces that form stream channels, drainage patterns, floodplains, and explain erosion, transportation, and deposition of sediments moved by water.
Stream Order	A classification of the relative position of streams in a channel network, assign each line an integer number determined by the pattern of confluences in the tributary network.

Stream Reach	A specific portion of the length of a stream. It is usually a length with similar characteristics (same gradient, control structures, pool riffle ratios, etc.).
Stream Stability	The tendency of streams to persist relatively unchanged through time. Stable streams have a pattern and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades.
Structural Diversity	The variations in spatial arrangement (vertical heights, differences in canopy openness, open patchiness, spatial distribution) of vegetation that make up distinct natural communities.
Stumpage Price	The value of standing timber.
Subsection (ecological)	Term used to describe an ecological unit. Defined by glacial forming processes, bedrock formations, local climate, topography, soil groups and the distribution of plants. Subsection -- An ecological unit within the U.S. Department of Agriculture Forest Service hierarchy of ecological units based on bio-geographic patterns. Subsections cover portions of a state and are around 10 to hundreds of square miles in size; typically three to five counties in size in Missouri. The same criteria are used to define subsections and sections but at a finer level of resolution for the former. There are 31 subsections in Missouri. See Keys et al. (1995) and Nigh and Schroeder (2002).
Succession	A gradual process of change in structure and composition from one community of plants to another over time.
Suitable Timber Lands	Lands that include timber harvesting as an identified and scheduled management practice.
Surface Fire	A fire that burns litter, debris, and small vegetation along the ground surface.
Surface Rights	Ownership of the surface of the land only; right to use the surface of the land.
Survey (Heritage Resources)	That type of field investigation designed to locate, within certain limits, all cultural resources in a specified area. Limitations to vegetation and topographic factors make some portions of an area unsurveyable with currently accepted techniques. (FSM 2360)

Sustainable (ecological)	The ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time.
Sustainable (human)	Each generation acts in a manner allowing every future generation the option of being as welloff as its predecessors.
Sustained Yield	The yield that a renewable resource can produce continuously at a given management intensity .
Swamps	A nearly continuously flooded wetland dominated by trees.
System Road	See National Forest System road.
Targets	A National Forest's annual goals for accomplishment for natural resource programs. Targets represent commitments the Forest Service has with Congress to accomplish the work Congress has funded. Targets are often used as a measure of the agency's performance. Targets are not the same as objectives.
Temporary Opening	Area of grass/forbs and shrubs usually resulting from timber harvest that will be replaced by tree saplings over a period of a few years: in contrast to permanent non-forested openings.
Temporary Road	A road authorized by contract, permit, lease, other written authorization or emergency operation not intended to be a part of the Forest transportation system and not necessary for long-term resource management.
Tentatively Suitable Forest Land	Forest land that is producing or is capable of producing crops of industrial wood; and a) has not been withdrawn by Congress, the Secretary of Agriculture, or the Chief of the Forest Service; b) existing technology and knowledge is available to ensure timber production without irreversible damage to soils, productivity, or watershed conditions;\ c) existing technology and knowledge, as reflected in current research and experience, provides reasonable assurance that it is possible to restock adequately within five years after final harvest; d) adequate information is available to project responses to timber management activities.

Theme	As used in the public workshops, a broad emphasis or focus for an alternative.
Thinning	Silvicultural treatment where trees are removed to provide improved growing conditions for remaining trees. This method is used to reduce stand density of trees primarily to improve growth and/or form, enhance forest health, or recover potential mortality.
Threatened Species	Official designation by U.S. Fish and Wildlife Service applied to any species which is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.
Threats or risks	Human disturbances that may harm or destroy the structure, composition, or function of a natural community or the habitat of a species at risk.
Timber Production	The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees for cutting into logs, bolts, or other round sections for industrial or consumer use. For purposes of forest planning, timber production does not include fuelwood or harvests from unsuitable lands (FSM 1900).
Timber Stand Improvement (TSI)	Actions to improve growing conditions for trees in a stand by eliminating or suppressing the less desirable vegetation. Methods include thinning, pruning, prescribed fire, and release cutting.
Timed event	An activity in which the shortest amount of time taken to complete the event is the determining factor in winning. Whether measured in segments of a course or as a continuous length.
Total Maximum Daily Load (TMDL)	The maximum amount of a pollutant that a water body can receive and still meet water quality standards. Also refers to the process of allocating pollutant loadings among point and non-point sources. Refers to a written plan and analysis of an impaired water body established to ensure that water quality standards will be attained and maintained throughout the water body in the event of reasonably foreseeable increases in pollutant loads (MPCA).
Trailhead	Parking, signing, or other facilities available at the beginning of a trail.

Trails National Forest System	As defined in 36 CFR 212.1 and 261.2, those trails wholly or partly within or adjacent to and serving, the National Forests and other areas administered by the Forest Service that have been included in the Forest Transportation Atlas. These trails are part of the National Forest Trail Systems and are included in the corporate level Infrastructure databases.
Trails	A commonly used term denoting a pathway for purposes of travel by foot, stock, or trail vehicles. (FSM 2353.05) Linear travelways for purposes of travel by vehicles 50 inches in width or less, pack animals or people.
Transportation Atlas	A transportation atlas displays the system of roads, trails, and airfields on the Forest. The atlas consists of geo-spatial, tabular, and other data to support analysis needs and resource management objectives identified in land management plans. This is a dynamic document, changing with new information. The atlas does contain all classified and unclassified roads, but does not contain inventories of current temporary roads, which are tracked by project or activities authorizing the temporary road.
Two-aged Regeneration Method	Two-aged methods regenerate and maintain stands with two age classes. The resulting stand may be two-aged or tend towards an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes.
Two-aged Stand	An area with trees of two distinct age classes separated in age by more than 20 percent of the rotation age.
Unacceptable Modification (UM)	Excessive and undesirable modification that dominates the local natural appearing characteristic landscape regardless of the distance from the viewer. It is not a visual quality objective.
Unclassified Roads	A road on National Forest System lands that is not managed as part of the Forest transportation system, such as an unplanned road, abandoned travel way, and off-road vehicle track that has not been designated and managed as a trail, and any road that was once under permit or authorization and was not decommissioned upon the termination of the authorization. (FSM 7700)
Understory	Collective term for small trees and shrubs growing beneath the canopy in a forest or woodland.

Uneven-aged A term usually used as "uneven-aged stand" or "uneven-aged management", which identifies a stand containing three or more age classes of trees. A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes. Examples are individual tree and group selection harvests.

Ungulate A mammal with hoofs; i.e. deer or bison

Unneeded Road A road under the jurisdiction of the Forest Service and determined to be not needed for long-term motor vehicle access. The road is not authorized by easement, permit, contract, or other written authorization. (FSM 7700)

Unroaded Area Any area, without the presence of a classified road, of a size and configuration sufficient to protect the inherent characteristics associated with its roadless condition. Unroaded areas do not overlap with inventoried roadless areas.

Unsuitable Lands National Forest System land not managed for timber production, because of policy, ecology, technology, silviculture, or economics.

Urban ROS Class Area is characterized by a very urban environment, although the background may have natural-appearing elements. Renewable resource modification and utilization practices are often used to enhance specific recreation activities. Vegetation cover is often exotic and manicured. Sights and sounds of humans are predominant on site. Large numbers of users are both on site and in nearby areas. Facilities for highly intensified motor use and parking are available with forms of mass transit often available to carry people throughout the site.

Variety Class A particular level of visual variety or diversity of landscape character, described as Distinctive (Class A), Common (Class B), or Minimal (Class C).

Viability Outcomes A rating of the likelihood that suitable habitat would be present and well-distributed through the planning area; and that a particular species at risk (SAR) would be able to persist and/or thrive under conditions created by each Alternative.

Viable Populations The numbers of individuals of a species sufficient to ensure the long-term existence of the species in natural, self-sustaining populations adequately distributed throughout their range.

Viburnum Trend	An area of numerous lead and related ores bodies in the vicinity of Viburnum, Missouri. This Trend extends for approximately 30 miles and ranges in width from a few hundred yards to more than two miles.
Viewshed	Total visible area from a single observer's position or the total visible area from multiple observer positions. Viewsheds are accumulated seen areas from highways, trails, campgrounds, towns, cities, or other view locations. Examples are corridors, feature or basins.
Visual Absorption Capability (VAC)	The ability of the landscape to conceal evidence of human modifications; rated as high, moderate, and low.
Visual Management Suitability	A combination of the Adopted Visual Quality Objectives (AVQO) and the Visual Absorption Capacity (VAC). It provides a measure of a land area's ability to accept management activities and the relative cost in meeting AVQOs.
Visual Management System (VMS)	The Forest Service's system to classify, inventory, and manage its visual resources.
Visual Quality Objective (VQO)	A desired level of excellence based on physical and sociological characteristics of an area. It refers to degree of acceptable alteration of the characteristic landscape.
Visual Resource	A part of the landscape important for its scenic quality. It may include a composite of terrain, geologic features, or vegetation.
Warm Season Grass	A grass or plant which makes most or all of its growth during the spring, summer or fall and is usually dormant in winter.
Warm-water Stream	Warm-water streams have summer water temperatures that are greater than approximately 84° F.
Watercourse	A natural or artificial channel through which water flows.
Watershed	The area that drains water into a lake or stream.
Water Shield	An aquatic plant with oval, floating leaves that spreads rapidly in ponds and lakes.

Watercourse Protection Zone (WPZ)	Watercourse Protection Zones are delineated along all stream channels that have defined banks and streambed, show signs of annual scour, have accumulated sediment and gravel of various sizes within the streambed, and are not included in the RMZ. The WPZ extends 100 feet horizontal distance from each side of the stream channel (measured from the upper break of the stream bank or channel edge), or to the break of the adjacent ridge, whichever is closer.
Wetland	An area that is covered by surface or groundwater often enough to support plants and other aquatic life that require saturated or seasonally saturated soils for growth and reproduction. Wetlands generally include springs, seeps, fens, sinkholes, sinkhole ponds and shrub swamps.
Wetland Feature	Seeps, springs, fens, shrub swamps, some sinkholes and sinkhole ponds. Any other location that is inundated by surface or ground water often enough to alter the plant communities found there.
Whole Tree Logging	Felling and transporting the whole tree with its crown, and sometimes even its roots, for trimming and cross-cutting to a landing or mill.
Wild and Scenic Rivers Act	An Act passed in 1968 which declared that it is a policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess, outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. The Act established a National Wild and Scenic Rivers System. The Eleven Point National Scenic River was one of the original components of the system.

Wild, Scenic and Recreational Rivers Act (WSRA)

Rivers or sections of rivers designated by Congressional actions under the 1968 Wild and Scenic Rivers Act as wild, scenic or recreational by an act of the legislature of the state or states through which they flow. Rivers may be classified and administered under one or more of the following categories:

Wild River: River or section of river free of impoundments with watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads. Scenic River: River or section of river that is free of impoundments, with watersheds still largely undeveloped, but accessible in places by roads.

Recreational River: River or section of river that is readily accessible by road or railroad that may have some development along its shoreline and that may have undergone some impoundment or diversion in the past.

Wilderness

The National Wilderness Preservation Act of 1964 defined a wilderness as an area of undeveloped federal land designated by Congress that has the following characteristics:

1) It is affected primarily by the forces of nature, where people are visitors who do not remain. It may contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

2) It possesses outstanding opportunities for solitude, or a primitive and unconfined type of recreation.

3) It is an area large enough so that continued use will not change its unspoiled natural condition.

Wilderness Opportunity Spectrum (WOS)	The wilderness opportunity spectrum is divided into three strategies each reflecting differences in permitted use, development, and acceptable change. *Transition* is designated for trailhead areas, where concentration of users is high and evidence of past use is readily apparent. *Remote* is designated for trail corridors and popular destination areas where concentration of users is moderate to high and evidence of past use is still apparent. *Pristine* is designated for the more remote areas where concentration of users is low, trails are not provided, and evidence of past use is low or not apparent.
Wildfire	Any unwanted wildland fire.
Wildland	An area with essentially no development, except for roads, railroads, power lines and similar transportation facilities; structures, if they exist, are widely scattered. (NWCG IOSWT 1996).
Wildland fire	Any non-structure fire, other than prescribed fire, that occurs in the wildland. This term encompasses fires previously called both wildfires and prescribed natural fires. (Wildland and Prescribed Fire Management Policy 1998)
Wildland Fire Suppression	An appropriate management response to a wildland fire that results in curtailment of fire spread and elimination of all identified threats of a particular fire. All wildland fire suppression provides for firefighter and public safety as the highest consideration, but minimizes loss to resource values, economic expenditures, and/or the use of critical firefighting resources.
Wildland Fire Use	Prescribed natural fire is a fire burning under specified conditions, to accomplish certain planned objectives; the fire may result from either planned or unplanned ignitions. A prescribed natural fire plan is one that permits certain fires to burn in a manner that duplicates natural conditions as much as possible. Policy allows for fire ignited by lightning to burn under pre-planned, specific conditions and objectives.
Wildland Urban/Rural Interface (WUI)	The line, area or zone where structures and other human development meets or intermingles with undeveloped wildland or vegetative fuels (NWCG IOSWT 1996).

Woodland — A natural community with a canopy of trees ranging from 30-100 percent closure with a sparse understory and a dense ground layer rich in forbs, grasses and sedges. Open woodland: 30-50%; closed woodland: 50-90% canopy.

Woody Debris — Dead, natural woody material greater than 10 cm in diameter and longer than one meter, usually composed of boles and large branches. Various terms, such as large woody debris (LWD), coarse woody debris (CWD), and large organic debris (LOD), have been used to describe this material.

Acronyms

ACOE	Army Corps of Engineers
AHT	Animal Habitat Type
AOI	Area of Influence (Indiana bat)
AMS	Analysis of Management Situation
AQI	Air Quality Index
ASQ	Allowable Sale Quantity
ATV	All Terrain Vehicle
AUM	Animal Unit Months
BA	Basal area (Timber)
BA	Biological Assessment (Wildlife)
BCI	Bat Conservation International
BE	Biological Evaluation
BF	Board Feet
BMP	Best Management Practices
BOR	Bureau of Outdoor Recreation
CAA	Clean Air Act
CDS	Combined Data System
CFM	Conservation Federation of Missouri
CFR	Code of Federal Regulations
CMAI	Culmination of Mean Annual Increment
CR	County Road
CWS	Comprehensive Wildlife Strategy
DBH	Diameter at Breast Height

DC	Desired Condition
DED	Department of Economic Development
DFC	Desired Future Condition
DNR	Missouri Department of Natural Resources
EA	Environmental Assessment
EAM	Even-aged management
EIA	Economic Impact Area
EIS	Environmental Impact Statement
ELT	Ecological Landtype
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
FEAST	Forest Economic Analysis Spreadsheet Tool
FIA	Forest Inventory and Analysis
FIL	Fire Intensity Level
FOFEM	First Order Fire Effects Model
FR	Forest Road
FRA	Forest Risk Assessment
FRCC	Fire Regime Condition Class
FRM	Federal Reference Method
FS	Forest Service
FSH	Forest Service Handbook
FSM	Forest Service Manual
FWS	Fish and Wildlife Service
GIS	Geographic Information System
HED	Hine’s emerald dragonfly
HFI	Healthy Forest Initiative

HFRA	Healthy Forests Restoration Act
HUC	Hydrological Unit Code
IMPLAN	Impact Planning Analysis Model
KV	Knutson-Vandenburgh
LAC	Limits of Acceptable Change
LTA	Landtype Association
LWCF	Land and Water Conservation Fund
LWM	Large Woody Material
MA	Management Area
MBF	Thousand Board Feet
MDC	Missouri Department of Conservation
MIC	Management Indicator Communities
MIS	Management Indicator Species
ML	Maintenance Level
MMA	Maximum Manageable Area
MoRAP	Missouri Resources Assessment Partnership
MP	Management Prescription
MTNF	Mark Twain National Forest
MMBF	Million Board Feet
NAAQS	National Ambient Air Quality Standard
NAWQA	National Water Quality Assessment
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NFS	National Forest System

NHRP	National Register of Historic Places
NMFS	National Marine Fisheries Service
NNIS	Non-native Invasive Species
NOI	Notice of Intent
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRI	Nationwide Rivers Inventory
NSRE	National Survey of Recreation and the Environment
NVUM	National Visitor Use Monitoring
OECA	Ozark Ecoregional Conservation Assessment
OHV	Off Highway Vehicle
ONSR	Ozark National Scenic Riverways
OOHA	Ozark-Ouachita Highlands Assessment
ORV	Off-road Vehicle
OSEDA	Office of Social and Economic Data Analysis
P	Primitive ROS Class
PAOT	Person-at-one-Time
PCT	Pre-commercial Thinning
PIF	Partners in Flight
PILT	Payment in Lieu of Taxes
PM	Particulate Matter
PNF	Prescribed Natural Fires
PNV	Present Net Value
R	Rural ROS Class
RACR	Roadless Area Conservation Rule
RARE II	Roadless Area Review and Evaluation II

RD	Ranger District
RFSS	Regional Forester's Sensitive Species
RGI	Regional Geographic Initiative
RMZ	Riparian Management Zone
RN	Roaded Natural ROS Class
RNV	Range of Natural Variability
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
ROW	Right-of-way
RVD	Recreation Visitor Days
SAF	Society of American Foresters
SAR	Species at risk
SASEM	Simple Approach Smoke Estimation Model
SMP	Smoke Management Plan
SPM	Semi-primitive Motorized ROS Class
SPN	Semi-primitive Non Motorized ROS Class
SVE	Species Viability Evaluation
TCC	Tumbling Creek Cavesnail
TES	Threatened, Endangered and Sensitive
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TSI	Timber Stand Improvement
UE	Union Electric Power Company
UAM	Uneven-aged Management
USDA	United States Department of Agriculture

USDI	United States Department of Interior
USFS	United Stated Forest Service
USGS	United States Geological Survey
VAC	Visual Absorption Capability
VMS	Visual Management System
VOC	Volatile Organic Compounds
VQO	Visual Quality Objective
WOS	Wilderness Opportunity Specturm
WPZ	Watercourse Protection Zone
WRD	Water Resources Division
WSR	Wild and Scenic Rivers
WSRA	Wild and Scenic Rivers Act
WUI	Wildland Urban Interface

Chapter 6

References

Mark Twain
National Forest

Cover image: Igneous glade in Bell Mountain Wilderness

Photographer: Joe Walker, Mark Twain National Forest

Chapter 6

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Chapter 7

FEIS Distribution List

Mark Twain
National Forest

Cover image: Yellow Crownbeard

Photographer: Gary Schmidgall, Retired Mark Twain National Forest

Chapter 7

FEIS Distribution List

Copies of the Final Environmental Impact Statement, 2005 Forest Plan and/or the Record of Decision were sent to the following agencies, organizations and individuals. Copies of these documents are available at all Mark Twain National Forest offices.

Elected Federal Officials

The Honorable Christopher Bond

The Honorable James Talent

The Honorable Roy Blunt

The Honorable Jo Ann Emerson

The Honorable Richard Gephardt

The Honorable Kenny Hulshof

The Honorable Ike Skelton

Federal Agencies

Advisory Council on Historic Preservation

Environmental Protection Agency

Federal Aviation Administration, Central Region, Office of the Regional Director

Federal Highway Administration

Office of Environmental Policy and Compliance

Rural Utilities Service

US Army Corps of Engineers, Mississippi Valley Division

US Army Corps of Engineers, Northwestern Division

US Coast Guard, Environmental Impact Branch, Marine Environment and Protection Division

US Department Of Energy, Office of Environmental Compliance

USDA APHIS PPD EAD

USDA Natural Resources Conservation Service

USDA National Agricultural Library

State Agencies

Missouri Attorney Generals Office – Bryan, Bill

Missouri Department of Conservation, Meramec District – Smith, Mike

Missouri Department of Conservation – Ackerson, John

Missouri Federal Assistance Clearinghouse, Office of Administration

Elected State Officials

Mike Dethrow, Missouri House of Representatives

University Libraries

Central Missouri State University, James C Kirkpatrick Library

Lincoln University, Inman E Page Library

Missouri Southern State University, George A Spiva Library

Northwest Missouri State University, Bd Owens Library

Southeast Missouri State University, Kent Library

Southwest Missouri State University, Duane G Meyer Library

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Public Libraries

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Birch Tree Public Library

Bollinger County Library

Butler Public Library

Carter County Library, Main Library

Daniel Boone Regional Library, Columbia Public Library

Doniphan Ripley County Library, Main Library

Douglas County Library

Eminence Public Library

Farmington Public Library

Joplin Public Library

Kansas City Public Library, Main Library`

Kansas City Public Library

Missouri River Regional Library

Missouri State Library

Newburg Public Library

Oregon County Library

Ozark Regional Library, Main Library

Pulaski County Library

Reynolds County Library

Rolla Public Library

Saint Charles City County Library District, Middendorf Kredell Branch

Salem Public Library

Springfield Greene County Library

St Louis County Library, Main Library

St Louis Public Library

Stone County Library, Main Library

Texas County Library, Main Library

Washington County Library, Main Library

West Plains Public Library

Willow Springs Public Library

Winona Public Library

Wright County Library

Organizations and Businesses

Heartwood – Bensman, Jim

Jim Crouch and Associates – Crouch, Jim

Mark Twain Forest Watchers – Dorst, Hank

Missouri Coalition for the Environment – Heisel, Edward

Missouri Coalition for the Environment – Sherburne, Dan

Missouri Forest Products Association – Presley, Jerry

Reed Lumber Co – Barnes, Carl

Sierra Club, Eastern Missouri Group – Johnson, Delwin

Sierra Club, Ozark Chapter – Dokken, Dee

Timberland Management Consulting – Fris, Frederick

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Brown, Bill

Crain, Tom

Decker, Jerry

Dickson, Dan

Dokken, Dee

Fields, Erin

Flader, Susan

Hall, Fred

Heisel, Edward

Hodges, Dr. Jay

Hutson, Ron

Lewis, Bernard

Moore, Robert

Morse, B Eric

Peters, James

Poleski, Jaime Tarsi & Greg

Pufalt, Caroline

Rafert, Cheryl

Richards, Lynda

Tansil, John

Whitley, Jim

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Mark Twain
National Forest

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