CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Introduction

This Chapter summarizes the physical, biological, social, and economic environments of the Analysis Area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in the chart above. Specialists considered direct, indirect, and cumulative effects to evaluate both short-term uses and long-term productivity. Appendix F of this document provides further discussion of the biodiversity of the Analysis Area.

The Final Environmental Impact Statement (FEIS) that accompanied the programmatic Forest Plan disclosed the effects, including cumulative effects, of management practices in a forest-wide context. This Environmental Assessment of the Crooked Creek project discloses the effects of implementing the proposed action and its alternatives and is tiered to the Mark Twain National Forest Land and Resource Management Plan FEIS and subsequent amendments, as well as the Oak Decline and Forest Health project FEIS.

The Analysis Area boundaries are delineated by the Sub-Management Areas 3.4-1, 3.4-2, and 3.4-3. The direct and indirect effects would include those identified in the project area and the existing conditions within the MAs boundaries and Land Type Associations (LTAs).

The cumulative effects include "…the impact on the environment which results from the incremental impact of the action when added to past, present, and reasonably foreseeable future actions regardless of what agency (Federal and non-Federal) or person undertakes such other actions." (40 CFR section 1508.7). This includes determining the geographic (spatial) and time (temporal) boundaries for cumulative effects within the Analysis Area. This is to ensure that cumulative effects are measurable and meaningful and that the decision makers will be completely informed about the consequences of their actions (CEQ 1997 – Considering Cumulative Effects under NEPA). Cumulative effects should be evaluated separately for each resource. Therefore the cumulative effects may vary between resources, including the spatial and temporal boundary.

The cumulative effects to be considered in this analysis include areas within the Oak Hickory Hills and Oak Pine Hills LTAs and the Meramec watershed. Information regarding past Forest Service activities in the Crooked Creek Analysis Area can be found on page 1-16 of this document.

The activities identified in Alternatives 2 and 3 (Chapter 1 and 2) are the same or similar to previous activities implemented on the Salem Ranger District (see "Relationships to Other Documents—Site-Specific Projects" in Chapter 1). Therefore, any effects would be the same or very similar to ones which have already been observed.

The Forest Service also developed mitigation measures to be used as part of all the action alternatives. For simplicity, all mitigation measures are compiled from each resource discussion into a listing in Chapter 2 of this document. Like mitigation measures, all monitoring would be compiled from each resource discussion into a listing at the end of this chapter.

Background

Ecological Patterns and Processes

Among the purposes of the National Environmental Policy Act are: to encourage productive and enjoyable harmony between humans and their environment; to promote efforts that would prevent or eliminate damage to the environment, to stimulate the health and welfare of humans, to enrich the understanding of the ecological systems and natural resources important to the United States of America.

Understanding ecological systems, their patterns on the landscape and natural processes is fundamental for understanding challenges in managing healthy natural resources. The current condition of oak decline and mortality is symptomatic of unhealthy forest conditions. These conditions are due, in part, to a history of major disturbances to the landscape including the following:

- Overexploitation of forest resources, especially extensive logging of most of the original virgin timber.
- Overgrazing by cattle, hogs, goats, horses, and sheep allowed to freely range for over a century, resulting in severe soil erosion and damage to woodland forage.
- Suppression of historic fires, both natural and man-made.
- Loss of crop and timber productivity due to topsoil erosion.
- Conversion of timberlands and ecosystems to croplands and pasture.
- Loss of species diversity as a result of overgrazing livestock.

The current Land and Resource Management Plan for the Mark Twain National Forest (Forest Plan) uses the Ecological Land Classification Terrestrial Subsystem (ECS) by Miller (1981) to inventory, identify, categorize, and classify lands. This system provides land capability information in the eight various management/planning levels outlined in the Land and Resource Management Plan for the Mark Twain National Forest. Since 1981, the U.S. Forest Service has participated with experts in federal and state agencies and non-governmental organizations in developing a contemporary national framework for ecological units.

The Ozark-Ouachita Highlands Assessment (Pell, W. F., et al., 1999) examined the terrestrial resources of the Ozark-Ouachita Highlands spanning 20 ecological units and encompassing 41,131,900 acres (64,269 square miles). The Ozark-Ouachita Highlands Section is a unique feature of the North American landscape; the Highlands are the only extended area of substantial local relief, high hills, and low mountains, between the Appalachians and the Rockies. The Salem Ranger District, (Dent, Crawford, Reynolds, Iron, and Shannon counties of southeastern Missouri) bounds 307,084 acres, of which 194,001 are U. S. Forest Service land. The following table summarizes the hierarchical ecological stratification of lands situated in the Analysis Area:

Table 3 - 1: Hierarchical Ecological Classification.

Hierarchy	General Size/Range	Crooked Creek Analysis Area
Sub-region	1,000,000's to 10,000's of square miles, or covering several states	Southern Forest
Province	10,000 square miles or portion of state	Ozark Plateau
Section	1,000 square miles	Salem Plateau
Subsection (from Thom and Wilson; Natural Divisions of Missouri)	1,000 square miles	Upper Ozarks Section
Landtype Association (landscape)	100's to 1,000's of acres	Oak-Pine Hills Oak-Pine Plains Oak-Hickory Hills
Ecological Land Types (ELT) and Natural Plant Communities	10's to 100's of acres	Dry Chert Forest Dry Mesic Chert Forest Dry Forest Mesic Forest Wet Mesic Bottomland Forest Mesic Bottomland Forest

The Ozark Plateau Province described in current ECS is generally equivalent to the Ozark Highlands Section described by Keys (1995). These highlands are characterized by an assemblage of maturely dissected high plateaus and rounded knobs where complex cycles of erosion and uplifts over millions of years created a scenic region of variable topography and relief. High, flat to gently rolling plateau remnants are drained by dendritic and radial drainage patterns with rivers and streams entrenched into the plateau creating deeply dissected hills. Characteristic springs and spring-fed streams cut deeply into the plateaus forming a region of steep to moderately rolling hills with local relief mainly ranging from 200 to 500 feet (60-150 m). Karst features (caves, springs, sinkholes, loosing streams) are common in this province.

The subsections are further divided into Land Type Associations (LTAs). LTAs are based on variations within each subsection in local landform, relief, geologic parent materials, soils, and potential natural vegetation. These are fairly uniform areas of land approximately 5,000 to 100,000 acres in size that seem to harbor similar assemblages of natural vegetation, and possess similar topography and geology.

Ecological Land Type Associations, Ecological Land Types, and Associated Terrestrial Natural Communities in the Ozark Highlands

Within these LTAs are described lower/smaller ecological units called Ecological Land Types (ELTs). Ecological Land Types are delineated based on landform, soils and vegetation. Nine landforms are described on the basis of slope gradients and slope aspect. Soils criteria are used because they play a major role in the historic development of natural vegetation on specific ELTs, and their current condition

(soil loss, damage, alteration) helps to explain why a loss of historic biodiversity occurred in the Ozarks. Soils criteria include: soil depth, texture, drainage, and parent material.

Ecological Land Types are rather constant in terms of their physical slope, aspect, soils, and geology of the land surface. However, historic natural processes (especially fire and native herbivory) influenced the shape and character of terrestrial natural communities occurring on these ELTs. The interaction of historic fires in relationship to the relative position of the landform (ELT) generally determined whether the vegetation structure was open and park-like (open oak woodlands on southwest-facing slopes and flat ridge tops) or dense and closed canopy forests found on north or east slopes and river bottoms. Widespread historic fire crossed arbitrary LTA and ELT lines excepting larger streams and rivers. Understanding the relationship between natural processes, landform, soils, and native vegetation gives a general picture of resource capability, helps predict potential natural community patterns that were historically prevalent, and then helps to set management objectives and strategies in restoring forest health.

PHYSICAL ENVIRONMENT

Soils

Existing Condition of Soil

The analysis area lies within the **Southern Forests** subregion of the Mark Twain Ecological Land Classification Terrestrial Subsystem (MT ELCTS). This area is beyond the southern limit of continental glaciation. and is characterized by the stream dissected edges of a series of low plateaus. The result is a combination of ridges and valleys of varying degrees of expression. The **Ozark Plateau** province (MT ELCTS) is located within this dissected upland. Cherty, droughty soils are a conspicuous feature of the Ozark landscape. Within the Ozark province is the **Salem Plateau** region (MT ELCTS), which is underlain by gently dipping lower to middle Paleozoic sedimentary rocks, primarily limestone and dolomite. Much of this land is rough, steep, and forested with oak and pine. The analysis area is within the **Upper Ozark** subsection (MT ELCTS) of the Salem Plateau region, which has soils derived from Ordovician-Cambrian-aged cherty dolomites and sandstones.

According to the *Atlas of Missouri Ecoregions*, the analysis area lies within the Huzzah-Courtois Oak Woodland Dissected Plain and the Huzzah Oak Woodland/Forest Hills Land Type Associations of the Meramec Hills Subsection of the Ozark Highlands Section (Nigh and Schroeder 2002). The Robidoux Formation underlies the uplands and the valleys are cut into the upper Gasconade Formation. Highly leached soils supported pine and pine-oak woodlands with oak on protected slopes. Bottomlands where streams meet the lowlands formerly supported transitional bottomlands of both Ozark and lowlands species. The area is presently timbered with second growth forest and the pine component diminished from the historic condition.

The soils of the area are typically very deep, well-drained mineral soils, which have formed in residuum and colluvium from the local sandstone and dolomite bedrock. Alluvial soils, consisting mainly of stratified silt, sand, and gravel, are usually found on the valley floor floodplains. These soils are usually well-drained, although valley bottoms within the analysis area and areas with perched water tables can have areas of poor drainage. Many of the soils, particularly those on steeper ground, have very gravelly or stony surfaces and are skeletal (more than 35 % rock fragments by volume) throughout the profile.

There are thirty-two soil types that occur in the analysis area for all alternatives. They are described in the tables in Appendix C or can be found in the project file. Management considerations describe soil characteristics that may be affected by implementation of the proposed action or may affect implementation of the proposed action. The primary management considerations are for those soils with a fragipan and consequently perched water tables (Hildebrecht silt loam, Hobson loam, Hogcreek silt loam, Lebanon silt loam, Nixa very gravelly silt loam, Scholten gravelly silt loam, Tonti silt loam, Viraton silt loam). Other soils may also have perched, seasonal, or apparent high water tables without the occurrence of a fragipan in the soil profile (Bendavis and Cedargap gravelly silt loams, Elkins, Fourche, Gravois, Moniteau, Sharon, and Westerville silt loams are in this category). These other soils with high water tables occur because of their position on the landscape. These soils are often mapped in associations with other soils which may or may not have either a fragipan or high water tables but occurred so intricately with these other soils on the landscape that mapping each separately would have proved impractical. The primary example is the Clarksville/Poynor/Scholten mapping unit which occurs on nearly every stand in every compartment in the analysis area. Scholten gravelly silt loam has a fragipan in the profile and exhibits perched water tables in the winter and early spring months. Other soil types in addition to some of those mentioned above are located on stream terraces, floodplains, and some footslopes. Due to their location, these areas may experience frequent, brief flooding during the winter

and early spring months. The soils on these areas are Bloomsdale silt loam, Gladden loam, Midco cherty loam, Relfe very gravelly sandy loam, Riverwash, and Wideman fine sand. Clarksville very cherty silt loam occurs on narrow ridgetops and steep sideslopes. Due to the low available water holding capacity, shallow A horizon, and high rock content throughout the profile, the soil productivity of Clarksville is generally low to moderate. Several other soils occur on hillslopes and/or ridges which have high rock content through the profile (Alred extremely cobbly loam, Bender very cobbly fine sandy loam, Coulstone very gravelly silt loam, Doniphan very gravelly silt loam, Gepp and Goss gravelly silt loams, Poynor gravelly silt loam, Rueter very gravelly silt loam, and Sonsac very cobbly silt loam). Nearly every stand where the proposed actions are to be implemented has a number of soil types and a majority of these will also have high water tables. Their presence does not preclude proposed actions if the mitigation measures outlined in this environmental assessment and in the Forest Plan are employed. The soils tables in Appendix C give their location and are given for all stands in Compartments 19 through 23, 33 through 41, 49 through 53, 57 though 59, 78 through 83, 85 through 92, 99, 100, and 118. This was done to give a landscape picture of where these soils occur.

Ecological land types (ELTs) were also examined in this analysis. The dominant ELTs were 17 and 18, which denote south/west north/east facing slopes respectively, and occur on slopes ranging from 8 – 34 % in the analysis area. These ELTs are present on 73 % of all stands in all compartments in the analysis area. Other ELTs which occur in the analysis area are: ELT 3 (high flood plain, low terrace, neutral aspect, 0 – 4 % slopes); 5 and 6 (upland waterways, neutral aspect, 0 – 4 % slopes); 7 (toe slope, all aspects, 0 – 14 % slopes); 10 and 11 (ridgetops, neutral aspect, 0 – 8 % slopes); 14 and 15 (flats, neutral aspect, 0 – 8 % slopes). These ELTs are further identified as to characteristics and compartment/stand location in Appendix C in the EA. and in the Crooked Creek project file.

The other primary management consideration is soils on steeper slopes. These soils are susceptible to erosion (especially on south facing aspects). When disturbed by harvesting activity, soils in these slope and aspect conditions can be subject to erosion levels in excess of standards of the Forest Plan. Approximately half of the stands identified for all alternatives are on slopes that are less than 15 % in grade and most of the other stands occur on slopes between 15 and 34 % grade. Relatively few stands occur on slopes greater than 35 % and relatively few occur on slopes which are unclassified. Erosion hazard for each of the soils are in the soils table in Appendix C of the EA and in the Crooked Creek project file.

Desired Future Condition for Soils

The purpose of this project is to shift existing conditions of the analysis area towards those that more closely resemble the desired future conditions by maintaining healthy and functioning oak/hickory/pine forest communities in all their successional stages. In the past, fire played an important role in maintaining some of these ecosystems. Prior to European settlement, a mantle of loess of two to five feet blanketed southern Missouri. These loess soils were extremely productive and provided the substrate for a rich and diverse floral community above ground and an even richer and more diverse floral and faunal community below ground (Scrivner 1966). The intensive land-use activities of the late nineteenth and early twentieth centuries have resulted in the erosion of most of this mantle.

The desired future condition of the Crooked Creek Analysis Area includes the restoration of soil productivity potential. It is unrealistic and impossible however to duplicate geologic processes and restore the soil to pre-settlement conditions in the foreseeable future. Soil formation is a long, time-consuming process which could take hundreds to several thousand years to return to that previous condition. (Buol, et al 1997) However, the present project, future projects, other similar project proposals on the Forest, and the mitigation measures employed can be expected to reduce soil erosion in the short term and continue the soil formation process in the long term. In this manner, soil restoration can proceed in the direction towards the desired future condition.

Direct and Indirect Effects on Soils

The stands that are proposed for treatment in this project cover a wide range of landscapes throughout the Salem Ranger District. The soils that would be affected by the proposed alternative are identified and characterized in Appendix C.

Many of the treatments in Alternatives 2 - 3 involve harvesting trees at various intensities. Thinning and tree harvest would leave remaining trees to occupy sites and maintain water budgets and nutrient cycles at current levels.

General Effects of Soil Disturbance

Because soil is eroded off the surface horizon, erosion results in a loss of nutrients for forest productivity (Fisher and Binkley 1987). It also results in a loss of biodiversity of thousands of species of soil micro-organisms, as well as millions of individual specimens (Pierzynski, Sims, and Vance 2000). In addition, erosion also results in a loss of carbon that was sequestered in the surface horizon (Boyle 2002).

Erosion Hazard is rated according to risk of erosion on forestland where normal practices are used in managing and harvesting trees. A rating of **slight** indicates that soil loss is not an important concern; a **moderate** rating indicates that some attention to soil loss is required; and a **severe** rating indicates that intensive treatments (such as seeding and mulching disturbed areas, water bars, etc.) or special equipment and method of operation are required to minimize erosion. Potential erosion hazard is primarily based on slope and erodability as well as on soil depth. Soils in ELTs Number 17 and 18 are most susceptible to erosion and make up nearly 84 % of the analysis area.

There are various prediction models for soil erosion, and more specifically, rill and sheet erosion. The Water Erosion Prediction Project (WEPP) model has recently been used to predict erosion levels from harvesting activities. These erosion levels would be significantly reduced by implementing the mitigation measures detailed in Chapter 2 of this EA.

Equipment Limitations are rated according to the degree to which soil characteristics restrict or prohibit tree-harvesting equipment. A rating of **slight** indicates little or no restriction on the type of equipment that can be used; a **moderate** rating indicates the use of equipment is seasonally limited, or that modified equipment (rubber tired skidders rather than crawler-type tractors) are needed; and **severe** rating indicates that special equipment is needed or that use of such equipment is severely restricted by unfavorable soil characteristics. Steep slopes present a safety hazard for equipment.

Potential of Damage to Soil From Fire is rated according to the degree to which soil characteristics are reduced in productive capacity from fire. The ratings (low, moderate, high) are made on the basis of texture, amount of coarse fragments, slope, and surface soil. Most of the soils associated with this proposal have a rating of low to moderate potential.

Suitability for Pond Development is rated according to the degree soil characteristics affect or have limitations for the development of pond reservoir areas. The limitations are considered **slight** if soil properties and site features are generally favorable for this use and limitations are minor or easily overcome. Limitations are considered **moderate** if soil properties or site features are not favorable for this use and special planning, design, or maintenance is needed to overcome or minimize the limitations. Limitations are considered **severe** if soil properties or site features are so unfavorable that special design, significant increase in construction costs, and possibly increased maintenance are required. Soils best suited to this have low seepage potential in the top sixty inches. The seepage potential is determined by permeability in the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir areas.

Soil surface disturbance is one of the effects of the activities proposed. Management activities associated with timber harvest, regeneration, and timber stand improvement (TSI) in Alternatives 2 and 3 would cause some soil disturbance. Potential exists for soil compaction, soil puddling, soil displacement and soil surface erosion, as a result of heavy equipment operation on sites where management activities would occur. There would be little loss of landform from road reconstruction as these areas have already been disturbed. Soil surface disturbance is important because it has an impact on soil quality, maintenance, and sustainability. This disturbance would be expected to occur on or adjacent to skid trails and landings both during and after the activities take place. The Standards and Guidelines (S&G) of the Forest Plan are designed to minimize the amount of disturbance from management activities. Assessment of proposed activities on specific sites would determine if the degree and extent of soil disturbance would cause appreciable change in soil properties to be considered detrimental to the long-term productivity of the land. Determination of effects is based on available research, the completed soil surveys for Crawford, Dent, Reynolds, and Iron Counties, and professional judgment. Adherence to Forest Plan Standards and Guidelines and site-specific mitigation measures that follow could be expected to result in no appreciable changes in the inherent long-term productivity of the land.

Soil limitations for the stands in the proposed alternatives range from slight to severe. Slope percentage and depth to water table are dominant factors that impose limitations. Erosion hazards are slight to moderate in most stands, although the hazard can be rated as severe when slope percentages increase. The potential of damage to soil from fire ranges from slight to moderate for most soils in most stands, though the hazard can become severe on steep slopes.

Alternatives were evaluated to assess whether implementation of the proposed project would result in any detrimental or beneficial effects to the soil resource. Harvesting, prescribed burning, timber stand improvement, and wildlife projects can affect soil productivity and soil quality. Alternatives can be compared based on the relative effects of soil disturbance.

The Forest Service Internet-based interface to the Water Erosion Prediction Model (WEPP; Elliot et al 2000) was used as part of this analysis. Climate was simulated for ten years at Doniphan, Missouri to obtain a range of wet and dry conditions. Erosion and sedimentation predictions must be evaluated with a full understanding of the uncertainties.

> At best, any predicted runoff or erosion value, by any model, will be within only plus or minus 50 % of the true value. Erosion rates are highly variable, and most models can only predict a single value. Replicated research has shown that observed values vary widely for identical plots, or the same plot from year to year (Elliot et al 1994; Elliot et al 1995). Also, spatial variability and variability of soil properties add to the complexity of erosion prediction (Elliot et al 2000).

WEPP provides relative versus absolute results to estimate and compare the magnitude of effects of alternatives. The analysis allows a comparison of alternatives but does not predict the effects for a specific stand. The outputs are given in tons per acre. One ton of soil loss is approximately equal in weight to a uniform depth of 0.007 inches of soil over one acre (Troeh et al.1991).

Alternative 1: No Action Alternative

No new management activities would take place, nor any associated activities with the proposed action. Therefore, no appreciable management-related changes in productivity of the land would occur. Soils would be impacted by regular maintenance and use of roads, as well as planned and ongoing natural resource management activities. In the absence of wildland fire, current runoff and erosion pattern would be maintained. An upland erosion rate of less than one ton per acre per year is predicted by FSWEPP for stands on steep slopes in the absence of fire. Natural processes and functions would continue to occur as dead material decomposes. Actual soil organic matter may increase with an accompanying increase in microorganisms and fungi. Since there is no harvest, no carbon would be removed from the forest. Dead

and dying trees would decay with carbon released to the atmosphere. Management activities in and adjacent to the project areas already planned would be carried out.

Under this alternative, fuels will not be reduced nor will biomass be removed through silvicultural treatments including but not limited to prescribed burning. Fire suppression has resulted in increased fuel loading and possible loss of savanna and glade environments present during pre-settlement times (Heikens 1999). Wildland fires that could occur under conditions of increased fuel loading can be expected to burn at a higher intensity and over a larger area than would have occurred if fires had burned at historical fire frequencies. The probability of stand replacement wildland fires could be expected to increase in the absence of fuel reduction through silvicultural treatments in this proposal. The stands in other alternatives where wildland fire does not occur would maintain current runoff and erosion pattern. An upland erosion rate of less than one ton per acre per year (T/A/Y) is expected for stands on steeper slopes and near drainages if fire is excluded. Fire exclusion would result in accumulation of substantial amounts of hazardous fuels.

Lack of fuel reduction could result in stand replacement wildland fires and increase the probability and levels of erosion and sedimentation from lands where these fires occur. FSWEPP modeling indicates that a high severity fire for conditions similar to those described above would produce a ten to fifteen fold increase in erosion (depending on slope) and a like increase in sedimentation. Predicted erosion and sediment quantities are listed in the Appendix C . According to the model, wildland fire produces many times more erosion than do prescribed burns.

Wildland fire control would more likely involve bulldozer constructed firelines. Overland flow in firelines would further erode soils and be a source of sediment. A twelve foot fireline constructed by dozer along a 5,500 foot perimeter of the average 25 acre stand (the area affected by the wildland fire may well be far above 25 acres) would total approximately 1.5 acres (about 6.0 % of a 25 acres steep stand could become an erosive fireline in the event of a wildland fire). If the dozer lines are constructed on soils with fragipans, especially during periods of wet weather, the erosive potential would be increased and the some of the soil structure would be destroyed. Predicted erosion rates for various scenarios are given in the Appendix C.

Effects Common for Alternatives 2 and 3

The direct and indirect effects of the action alternatives on soils tend to be similar, varying by the amount of the activity that would take place with each alternative (See alternative comparison tables in Chapter 2). Any harvest would be by stem removal only. This leaves the nutrient rich branches and leaves to be recycled, whether through decomposition or volatilized from burning. Other treatments, such as pre-commercial thinning and release, would also leave the branches and foliage to be recycled.

All action alternatives would remove carbon from the forest by harvesting and prescribed burning. The differences between the alternatives lie in the type of harvest activity, the volume removed, remaining stocking levels, and the reforestation activities that are planned. All alternatives would remove a large amount of carbon from the forest, mostly from salvage material, but also some live healthy material.

A direct effect of timber harvesting upon the area's soil and water resources would result from the temporary road usage needed to access the stands. In both Alternatives 2 and 3, some road reconstruction, maintenance, spot-surfacing, and road decommissioning would be done. Soil would be exposed, excavated, and displaced during harvest operations. Forest experience with harvesting on similar soils and slopes show some roads re-vegetated within one year after all sale activities have ceased.

During use, roads would intercept and channel overland water flow to dips. This water normally carries suspended sediments from the road prism into undisturbed filter zones below the road where it is filtered through the forest floor. During high intensity rainfall when overland flow exceeds the infiltration rate of the soil, these sediments could reach the ephemeral and intermittent drainages. The primary areas of

concern would be areas which have soils with perched fragipans, areas with slopes exceeding 35 %, and areas adjacent or crossing waterways.

Alternative 2 and 3: Effects from Proposed Actions

Silvicultural Methods

Complete Salvage

Alternative 2 – This alternative includes 931 acres of complete salvage. These treatments occur primarily on gentle slopes. The soils are primarily skeletal silt loams. Erosion is estimated from less than 1 ton to 13.5 tons per acre per year depending on climatic conditions. Prescribed fire is occurring on most of these sites. Erosion values would increase by < 1 to 3 tons/acre/year. Two years after harvesting and prescribed burn, erosion values would decrease to < 1 – 3 tons/acre/year. Three years after harvesting and prescribed burning, erosion levels are expected to return to pre-harvest and pre-burn levels.

Most of the soils are moderately to well-suited to harvesting equipment on gentle slopes and dry soil conditions. Soil compaction from harvesting equipment would be moderate in dry conditions and severe in wet conditions. Compaction can be partially mitigated by harvesting equipment riding on slash to the extent possible.

Alternative 3 – This alternative reduces the acres of complete salvage by 294 acres. Environmental effects are similar to those in Alternative 2 (erosion and compaction) and are decreased in this alternative by the reduction in acres harvested.

Seed Tree Salvage

Alternative 2 and 3 - Twenty-six acres of seed tree cutting are planned for these alternatives. The amount of bare ground after a seed tree operation can be expected to be somewhat less than for a complete salvage, although erosion from precipitation can take place until ground re-vegetation takes place one to five years after harvesting. Ground disturbance during the harvesting process would be similar to a complete salvage operation and greater than for a shelterwood salvage operation.

Assuming a 25 % canopy cover after completion of this treatment, erosion levels that could be expected from this treatment are influenced primarily by slope. A relatively gentle grade of 8 %, silt loam soils, and skeletal conditions were input into a WEPP model run over a 30-year simulation. Erosion levels were negligible ranging from zero to one ton per acre per year which, would be well below soil tolerance levels for any soil on the analysis area. Moderate to moderately steep soils of 15 – 20 % make up a majority of the analysis areas. Simulations at this slope ranged from 0 to 2 tons/acre/year which is also within soil tolerance levels for soils within the analysis area. Steep slopes (35 % and above) occur in the analysis area to a lesser degree than do gentle and moderate grades. Erosion on these areas ranges from zero to three tons/acre/year. Seed tree treatments would occur on stands scheduled for prescribed burning. Hence, erosion levels would increase by <1 – 3 tons/acre/years on these sites. Erosion would decrease in the years following treatment as canopy cover increases and vegetation re-growth takes place.

Harvesting equipment would be moderately well-suited to this ground. Erosion would be moderate off skid roads and trails and severe on skid roads and trails. Soil compaction from harvesting equipment would be moderate in dry conditions and severe in wet conditions. Compaction can be partially mitigated by harvesting equipment riding on slash to the extent possible.

Shelterwood Salvage

Alternative 2 and 3 - Approximately 1,275 acres of shelterwood salvage will be done under both alternatives. The amount of bare ground after a seed tree operation can be expected to be somewhat less than for a seed tree, although erosion and ground disturbance during the salvage operation would depend on the logger, the amount of material extracted, ground based equipment employed, and the contract administration. Shelterwood would achieve crown closure a few years after salvage activity and erosion potential would decrease.

A minimum of 40 % cover is assumed for this treatment. An 8 % slope, silt loam soils, and skeletal conditions were input into a WEPP model simulation (simulation period equals 30 years). Erosion values ranged from zero to less than one ton/acre/year soil loss. At moderate slopes (20 %), values ranged from zero to 1.5 tons/acre/year. At steep slopes (> 35 %), values ranged from near zero to three tons per acre per year. All values are within soil tolerance values for most soils within the analysis area and on the stands where shelterwood is taking place. Many of the stands treated with a shelterwood salvage are scheduled for prescribed burning. Erosion levels would be higher on these areas.

The activity is taking place mainly on Clarksville-Scholten-Poyner soil complex on slopes greater than 15 %. Harvesting equipment would be moderately well-suited to this ground. Erosion would be moderate off of skid roads and trails and severe on skid roads and trails. Soil compaction from harvesting equipment would be moderate in dry conditions and severe in wet conditions.

Uneven-aged Management for Salvage

Alternative 2 and 3 - Under both alternatives, 1, 746 acres of uneven-aged management will be done. At the completion of this treatment, 40 to 50 % cover is assumed. Erosion levels would be expected to be similar to shelterwood treatment areas. Many of the stands treated with uneven-aged management are scheduled for prescribed burning. Erosion levels would be higher on these areas. Crown closure would be achieved in a few years and erosion levels would return to pre-harvest levels. Crown closure would be achieved in a few years and erosion levels would return to pre-harvest levels. Harvesting equipment would be moderately well-suited to this ground. Soil compaction from harvesting equipment would be moderate in dry conditions and severe in wet conditions.

Overstory Removal for Salvage

Alternative 2 and 3 - About 122 acres of over-story removal will be done under both alternatives. A 40 to 50 % canopy cover is estimated upon completion of this treatment. Erosion levels would be expected to be similar to shelterwood and uneven-aged management treatments. Crown closure would be achieved in a few years and erosion levels would return to pre-harvest levels. Harvesting equipment would be moderately well-suited to this ground. Soil compaction from harvesting equipment would be moderate in dry conditions and severe in wet conditions.

Sanitation Cuts for Salvage

Alternative 2 and 3 - Approximately 562 acres of sanitation will be done under both alternatives. A 40 to 50 % canopy cover is estimated upon completion of this treatment. Erosion levels would be expected to be similar to shelterwood and uneven-aged management treatments. Crown closure would be achieved in a few years and erosion levels would return to pre-harvest levels. Harvesting equipment would be moderately well-suited to this ground. Soil compaction from harvesting equipment would be moderate in dry conditions and severe in wet conditions.

Commercial Thinning

Alternatives 2 and 3 - Approximately 1,197 acres of commercial thinning are planned as a part of this alternative. Some of the stands across the analysis area occur on soils with fragipans and perched water tables. Harvesting should be confined to periods of dry soil conditions to reduce compaction and damage on foot slopes. Harvesting in these areas needs to pay special attention to erosion control so that sedimentation in nearby streams does not occur. Some stands include other silt loams which can occur on ridgetops and toeslopes.

Several of the commercial thinning acres occur on ELTs 17 and 18, southwest and northeast facing sideslopes, which have a greater erosion potential than other ELTs. The other thinning acres occur on the other ELTs which occur on relatively neutral aspects and relatively gentle slopes, and have a greater compaction potential than areas on ELTs 17 and 18. The slope gradients for nearly all of these areas are greater than 15 %. The soil mapping units that occur on these areas are generally moderately well-suited to harvesting equipment at these moderate slope gradients. Erosion hazard is moderate off of skid trails and roads and severe on skid trails and roads. Soil compaction on these areas would be moderate in dry soil conditions and moderate to severe in wet soil conditions.

Erosion levels modeled for this treatment range from less than 1 ton to 3 tons per acre per year after completion of harvesting and related activities. Erosion will reduce about 50 % in the second years and return to near pre-harvest levels in the third and fourth years after harvesting.

Reforestation

Natural Regeneration

Alternative 2 - No ground disturbing activity is expected as a result of 2,512 acres of natural regeneration in Alternative 2. Prescribed burning in many of these same stands may allow seeds to reach the soil unimpeded by existing slash. Skeletal soils in these areas may result in lower available water holding capacity, thus limiting seedling establishment.

Alternative 3 - Same as for Alternative 2 except that 294 fewer acres of natural regeneration would be done under this alternative given that 294 fewer acres of complete salvage are planned for this alternative.

Pine Planting

Alternative 2 - No ground disturbing activity is expected as a result of 667 acres pine planting in Alternative 2. Skeletal soils in these areas may result in lower available water holding capacity limiting seedling establishment. Prescribed burning in many of these same stands may allow seedlings to have reduced competition for soil water from ground vegetation.

Alternative 3 - No pine planting would be done under this alternative. Natural functions and processes would be expected to occur as under Alternative 1.

Prescribed Fire

Open Woodland Development and Hazardous Fuel Reduction

Alternatives 2 and 3 - Prescribed burning for open woodland development would take place on 2,445 acres and 5,956 acres are planned for hazardous fuel reduction prescribed burns. The effects

of prescribed burning on soil erosion and nutrient loss are related to the severity of the burn. These effects are complex and depend on a host of factors but certain generalizations seem relatively consistent. Burning has its most pronounced effect on the forest floor where carbon (C), nitrogen (N), and sulfur (S) are volatilized and calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P), and other elements are left as ash. The ash is leached by rains into the mineral soil which increases its base saturation and pH (Alban 1977). Increased nutrient availability at higher pHs may result in positive plant responses following fire (Van Lear and Kapeluck 1989). These coincide with results from a variety of other reviews and studies (see DeBano 1998; Luckow, 2000a, 2000b, 2000c; Godsey 1988; Amelon 1991; and Schlesinger 1997) Erosion can increase as a result of prescribed fire, but WEPP model runs indicate that the erosion levels are generally within soil tolerance guidelines (set up by the Natural Resource Conservation Service (NRCS) and the Agricultural Research Service (ARS) and are much lower than erosion and sedimentation levels after a high severity stand replacement fire.

These alternatives do not preclude wildland fires from occurring within the forest, however, the likelihood of stand replacement fires and the environmental impacts would decrease in the stands that are treated. Even if a wildland fire occurred in areas treated with thinning and/or prescribed burn, these areas would experience less erosion damage after the fire, wildland fires would not burn as hot, and trees may be left with a portion of their foliage (USDA, Forest Service, Rocky Mountain Experimental Station, 2003). Low-intensity prescribed fire used alone or in combination with uneven-aged management would not be expected to have a significant affect on the quantity of water flow, nutrient budgets, or soil quality

In the absence of other treatments scheduled prior to the prescribed burn, erosion levels would be expected to range from 0.5 to 2.5 tons/acre/year for gentle slopes and 1 ton to 6 tons per acre/year for moderate slopes. Prescribed burns will be scheduled at least one year after other project activities have been completed in the burn areas so that erosion levels will not exceed tolerable soil loss values. Soil erosion values from two to five years after harvesting and burning will be reduced to well within soil tolerance values and to pre-harvest/burn levels.

Transportation

Temporary Roads and Reconstruction

Alternative 2 - Roads generally contribute the greatest amount of erosion and sediment in any forest system. The Forest-wide Road Analysis included simulations from the WEPP model to show erosion potentials for various road conditions for the Salem area. Twenty-five miles of temporary construction would be completed under this alternative. This would be accomplished by reopening existing non-system roads with blading and rocking as needed so that soil disturbance will take place primarily on previously disturbed areas and not those that have been rehabilitated or decommissioned. Non-rutted, outsloped roads result in the lowest erosion and sedimentation levels.

Alternative 3 - Two fewer miles of road construction would be completed under this alternative due to reduced need for access as there are 294 fewer acres of complete salvage planned under this alternative.

Soil and Water

Dump Cleanup

Alternative 2 and 3 - This would result in an increase in watershed benefit as a result of the removal of appliances, tires, building materials, and household trash. Clean-up of these dumps will minimize degradation of the soil as chemicals and materials from the dump items degrade and infiltrate in the soil profile.

Non-system Decommission

Alternative 2 and 3 - Non-system road decommissioning in 55 areas would be completed under both alternatives. Non-system roads have been used as networks for ORV and ATV use. This has resulted in the potential for significant amounts of erosion in the past. In the long run, decommissioning these roads can be expected to result in reduced erosion in the future, especially if the decommission includes erosion control measures (Switalski et al 2004). Existing sedimentation due to precipitation on compacted surfaces acting as extensions of the stream system would decrease over time as the road beds seed in from adjacent vegetation.

Range/Wildlife

Mowing, Grazing, and Fertilizing

Alternative 2 and 3 – Approximately 1,375 acres of mowing and hand-cutting would be completed under Alternative 2 and 3. All areas scheduled for this treatment are on relatively gentle slopes and minimal erosion is expected. The soils on these areas are relatively well suited to harvesting equipment under dry soil conditions and this should hold true for mowing equipment as well.

Approximately 345 acres of grazing would be completed under Alternatives 2 and 3. All areas scheduled for this treatment are on relatively gentle slopes. Some erosion and compaction could occur as a result of grazing and large areas could experience severe disturbance if grazing is concentrated in a few areas.

About 345 acres of liming would be completed under Alternatives 2 and 3. All areas scheduled for this treatment are on relatively gentle slopes. No detrimental effects are expected if standard fertilization practices are employed.

Mechanical Hand Cut/Water Hole Maintenance

Alternative 2 and 3 - Minimal or no ground disturbance is expected from hand cutting and water hole maintenance is expected.

Fisheries

Pond Rehab

Alternative 2 and 3 - Sixteen acres of pond rehabilitation would be completed with Alternative 2 and Alternative 3. Most of the areas are on relatively gentle slopes, minimal ground disturbance is expected to occur, and natural processes and functions would continue. The majority of these areas occur on Clarksville gravelly silt loam and Midco cherty silt loam. These soils generally have a limitation to pond development due to seepage.

Fish Stocking

Alternative 2 and 3 - Sixteen acres of fish stocking would be completed with Alternatives 2 and Alternative 3. Most of the areas are on relatively gentle slopes, minimal ground disturbance is expected to occur, and natural processes and functions would continue.

Erosion for Alternatives 2 and 3 are not expected to exceed Forest Plan Standards and Guides or Region 9 Soil Quality Monitoring, Interim Directive No. R9RO 2509.18-2002-1, for any single activity in the proposed action or other alternatives. The only exception is the seed tree treatments which may exceed standards in the short term. Many stands in all alternatives have more than one activity planned (i.e. harvesting and prescribed burning). The cumulative effect of more than one activity could result in erosion exceeding soil tolerances for the soils in these areas.

In addition, the scope of this project includes 5,859 acres of silvicultural treatments and 8,401 acres of prescribed fire. A project involving several thousands of acres could result in erosion and sedimentation over several thousands of acres. The proposal is scheduled to take four to five years to complete implementation. By spreading this project over a minimum of three years, the actions could be spread out over a time period better allowing the landscape and watershed to absorb the erosion and sedimentation occurring as a result.

Cumulative Effects on Soils

Most of the soils in the analysis area developed in loess (a loamy material formed by glaciers and transported by wind) and in residuum from cherty limestone, dolomite, and sandstone. The soils are old, stony, highly-weathered, and acidic, except on some broad ridges and bottomlands (USDA Forest Service, MTNF 2001b).

In the assessment area, the mantle of loess varied in thickness from five feet to less than two feet, the deposits decreasing in depth in the southernmost areas of the Ozarks. Soil conditions were described as ranging from “barrens and prairies …, the soils poor and covered with grass, …” to “the soil rich with a heavy growth of trees” (Nigh 1992, Schoolcraft 1821). In many portions of this area, up to 90 % of this mantle has been eroded away (Scrivner 1966). In addition to occurring from geologic and other natural processes, erosion is a function of past land use.

At the beginning of the twentieth century, the clear-cutting of pines was widespread practice and it continued through the 20s and 30s. Farming, annual burning, and grazing followed this clear-cutting. Those attempting to pasture the cutover lands had to contend with re-sprouting hardwoods. Intensive sheep and goat grazing and fire were the primary means of controlling hardwood re-growth and for restoring grass cover. Repeated burning exposed the thin Ozark soils to erosion, which robbed the hillsides of the nutrients essential for both grass and tree growth (Cunningham and Hauser 1992). 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 the eroding lands, ending annual woods burning, and establishing young forests. Even so, it was 1969 before the period of free-roaming livestock ended (Law 1992, Keefe 1987). As a result, many of the soils in the analysis area have shallow surface horizons, low available water-holding capacities, and relatively low soil fertility.

On Forest Service lands, past activities include timber harvesting and associated road building; landings; haul roads; mining; and wildlife openings construction and maintenance. The past activities of timber harvesting and wildlife openings on National Forest system lands have had no long-term negative impact on the soil productivity with the mitigation measures applied. There is no evidence of accelerated erosion in the uplands. Areas where there have been timber harvests in the past have re-vegetated and there is no bare soil exposed in the closed cutting units. Some of the roads in the analysis area will be reconstructed.

There are a number of unclassified, non-system roads that are present in the area that could be used for temporary haul roads. This will reduce the amount of new roads needed and will reduce the amount of associated sediment movement. No appreciable long-term soil disturbance effects have been identified, primarily because of methods used and mitigation measures applied.

Recent activities within the Salem Ranger District area include the timber sales associated with Oak Decline EIS, which is still in place. The timing of this project resulted in harvest activities during the winter months and moist soil conditions. Soils in these areas were frequently in soil map units with soils that had perched water tables during the winter months due to presence of a fragipan in the soil profile. The potential for erosion, compaction, and destruction of soil structure remains high in these climatic conditions. Strict contract administration was instrumental in limiting or avoiding these detrimental impacts.

Future activities within the Salem Ranger District include the present proposal. These projects are located over multiple management units and stands in a number of compartments and over thousands of acres. Activities in this proposal are regeneration harvesting; reforestation; timber stand improvement; hazardous fuel reduction; and fisheries, watershed, and wildlife projects. Like the timber sales associated with Oak Decline EIS, many of the soils in these areas exhibit perched water tables during winter months due to the presence of fragipans in the soil profile and are subject to erosion, compaction, and destruction of soil structure. Adherence to the Forest Plan Standards and Guidelines, mitigation measures in the EIS, and strict contract administration will be critical in minimizing detrimental impacts to the watershed resources.

On private lands, past activities 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 of streams and creeks and their tributaries. For a more complete description of this sedimentation, refer to the watershed and water resource sections of this document. As is common in the Ozark region, most of the riparian lands in the analysis area consist of floodplains on private lands and surrounding uplands of perennial streams. In areas where the landowners left an adequate woody corridor along the perennial streams, the stream banks along the creek appear to be fairly stable. Other areas without an adequate woody corridor along the streams exhibit signs of accelerated bank erosion. The majority of the land clearing has been the conversion from hardwoods to cool-season grasses. Removing the hardwoods in the uplands and along the stream channel had a major impact on the stability of the channel. It is not known how much additional land will be cleared and what the associated sedimentation of the stream will be as a result of activities on private lands, though it should be similar to the past.

The management activities proposed under this environmental analysis will result in some soil disturbance. This disturbance will be a result of temporary roads, fireline construction, logging, and prescribed burning. The temporary roads (for all types of harvest methods) and firelines that are on the steeper slopes and/or cross the intermittent or ephemeral drainages will be the primary source of sediment in the unlikely event that sedimentation may occur. The sediment increase will be highest during construction and eventually will be reduced as the roads become stable and vegetated. This may take up one full growing season, but can be shorter if the re-vegetation and growing season are compatible. Decommissioning and obliteration of the temporary roads is critical in bringing the erosion rate down to pre-harvest and pre-construction levels. Timber harvesting will have minimal impact on the sedimentation of the streams or drainages. Using the mitigation measures listed at the end of Chapter 2 of this assessment and Forest Plan Standards and Guidelines, there will be adequate filter or buffer strips to help filter any sediment through the forest floor before reaching drainages.

In the stands that will have regeneration harvest, seldom is more than 5 % bare soil exposed within the cutting units if proper care is taken during the harvesting and timber stand improvement process. The hardwood slash acts as a protective cover for the soils and can help mitigate compaction if used during harvesting. The stands that will have prescribed fire will have potential for soil erosion. This erosion will result from the construction of firelines and possibly from the burn unit. The increase in erosion from the

burn unit is a direct result from fire intensity. Burning with a cooler fire, the soil erosion is usually minimal due to the protective duff layer that is still present. If there is an increase in soil erosion, it is usually of very short duration. On the stands that will have various selection harvests (seed tree, shelterwood, thinning, sanitation cuts, uneven-aged management, overstory removal, etc.), some minor soil erosion is expected to occur. In these stands there will be enough ground cover or slash to protect any bare mineral soil. Mitigation measures listed in Chapter 2 are effective in minimizing adverse impacts to the soils. Similar management activities will potentially be proposed in the reasonably foreseeable future and would be accompanied by the appropriate mitigation measures.

Water Quality

Existing Conditions of Water Quality

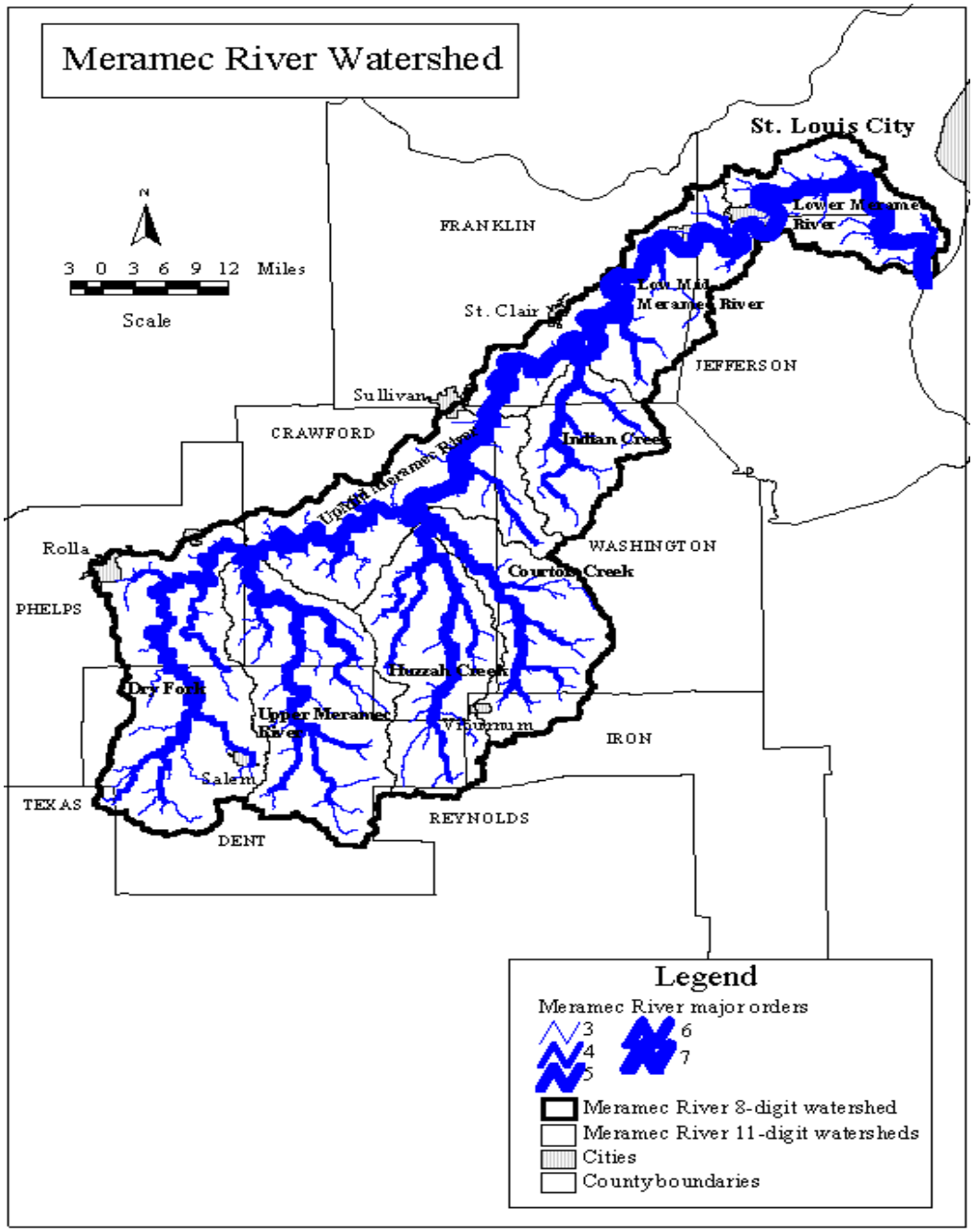
Lakes and Ponds: The Forest Service in partnership with Missouri Department of Conservation maintains the following lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah Cutoff Pond #3, and Gnuse Pond (total 16 acres). The water chemistry in the lake and ponds is not known; however, the water quality is such the lake and ponds support bluegill, largemouth bass, and channel catfish fisheries.

Streams and Rivers: This project lies within the Meramec River Watershed. The Meramec River is unique because it is the second longest free-flowing river in the state of Missouri (228 miles total length and 100 % non-channelized or submerged by large impoundment). The Meramec River basin drains a total of 2,149 square miles and 1,375,493 acres of land. The 8-digit Meramec watershed is divided into seven 11-digit sub-basin watersheds. The analysis area is located in parts of two of these: the 11-digit Huzzah Creek (07140102030) sub-basin watershed and the11-digit Upper Meramec (also called Crooked Creek) (07140102020) sub-basin watershed. For the most part, Forest Road (FR) 2754 divides the watershed between these two sub-basins.

Huzzah Creek (07140102030) watershed: The MTNF's Aquatic Ecological Classification System (AECS) describe Huzzah Creek as RE36G111; which means known upper perennial, warmwater, 7-day 2-year low flow 10-29.9 cfs, known gaining, and sunfish present. There is no National Forest land which borders the Huzzah Creek within the analysis area. At the Dillard Mill Historic site there is a dam, with an eight foot water fall; which impedes upstream aquatic biota movement. The Huzzah Creek flows into the Meramec River.

West Fork of Huzzah Creek - Dent County Road 438 makes up the East boundary of the analysis area; therefore the West Fork of Huzzah Creek lies just outside the analysis area. The MTNF's Aquatic Ecological Classification System (AECS) describes the West Fork of Huzzah Creek near Howes Mill Spring as RE30C111; which means known upper perennial, known coldwater, 7-day 2-year low flow known to be 1-5 cfs, known gaining and sunfish present. The Mark Twain AECS describes West Fork of Huzzah Creek at the junction of the East Fork of Huzzah Creek as RE36D111; which means known upper perennial, warmwater, 7-day 2-year low flow suspected to be 1-5 cfs, known gaining and sunfish present. The West Fork is shallow, full of gravel, void of large woody debris and lacks riparian vegetation. Also there are several concrete low water crossings which impede fish movement and new housing was under construction within the riparian zone. There is approximately one mile of National Forest ownership (all outside the Analysis Area) along the West Fork of Huzzah Creek; therefore there are very little riparian lands along the West Fork of Huzzah Creek in National Forest ownership.

Figure 3 - 1: Missouri Department of Conservation, Fisheries Division. 1998. Meramec River Watershed Inventory and Assessment. Jefferson City, Missouri.
http://www.conservation.state.mo.us/fish/watershed/usgs8.htm



James Branch - The Mark Twain's AECS describes James Branch as RE36A100; which means known upper perennial, warmwater, 7-day 2-year low flow less than 1 cfs, known gaining. Except for the mouth, almost all of James Branch and its tributaries are within National Forest ownership. The James Branch flows into Huzzah Creek.

Indian Creek - The Mark Twain's AECS describes Indian Creek as RF36A200; which means suspected upper perennial, warmwater, 7-day 2-year low flow less than 1 cfs, suspected gaining. There is only a small portion of the upper portion of Indian Creek in National Forest ownership. Indian Creek flows into Huzzah Creek.

Barney Creek – The Mark Twain's AECS describes Barney Creek as RB36A100; which means known suspected intermittent, seasonally dry, warmwater, 7-day 2-year low flow suspected to be less than 1 cfs, known gaining stream. Only the headwaters of Barney Creek are within the Analysis Area. Barney Creek flows into West Fork of Huzzah Creek.

Dry Creek - The Mark Twain's AECS describes Dry Creek as RA36A400; which means known intermittent, seasonally dry, warmwater, 7-day 2-year low flow suspected to be less than 1 cfs, known suspected losing stream. Only the upper most headwaters of Dry Creek are within the Analysis Area. Dry Creek flows into Huzzah Creek.

Upper Meramec (also called Crooked Creek) (07140102020) watershed:

Middle Prong of Crooked Creek - The Mark Twain's AECS describes Middle Prong of Crooked Creek as RA36A100; which means known intermittent, seasonally dry, warmwater, 7-day 2-year low flow suspected to be less than 1 cfs, known gaining. Only the upper most headwaters of the Middle Prong of Crooked Creek are within the Analysis Area. The Middle Prong flows into Crooked Creek, which flows into the Meramec River.

East Prong of Crooked Creek - The Mark Twain's AECS describes Middle Prong of Crooked Creek as RA36A200; which means known intermittent, seasonally dry, warmwater, 7-day 2-year low flow suspected to be less than 1 cfs, suspected gaining. Only the upper most headwaters of the Middle Prong of Crooked Creek are within the Analysis Area. The East Prong flows into Crooked Creek, which flows into the Meramec River.

Watery Forks Creek (also called Hutchings Creek) - The Mark Twain's AECS describes Watery Forks Creek as RA36A200; which means known intermittent, seasonally dry, warmwater, 7-day 2-year low flow suspected to be less than 1 cfs, suspected gaining. The Watery Fork Creek flows into the Meramec River. Only the upper most tributaries of Watery Fork Creek are within National Forest ownership.

Springs and Spring branches: There are several springs on National Forest lands, which contribute to the river flow and are sources of cool water refuge to aquatic biota. Calcium, magnesium, and bicarbonate are the principal dissolved components in the water due to the predominantly dolomite formations in which the water resides and travels. There are fens associated with the springs in Bates Hollow, Fortune Hollow, Thorny Hollow, and James Branch.

Classification and Designated Uses

The Missouri Department of Natural Resources (MDNR) designation of streams within and downstream of the analysis area are as follows: Huzzah Creek is designated for Livestock and Wildlife Watering (LWW), Protection of Warm Water Aquatic Life and Human Health – Fish Consumption (AQL); Cool Water Fishery (CLF); Whole Body Contact Recreation (WBC); and Boating and Canoeing (BTG). West Fork of Huzzah Creek is designated for LWW, AQL, and WBC. The following streams are designated for LWW and AQL: James Branch, Indian Creek, Barney Creek, Dry Creek, the Middle Prong of Crooked Creek, the East Prong of Crooked Creek, and Watery Fork (also called Hutchings Creek). Classification and State of Missouri water quality standards can be found in the Code of State Regulations for the Missouri Department of Natural Resources (MDNR), Division 20, and Chapter 7.

Surface Water Quality Monitoring

The MDNR Water Quality Monitoring Unit staff is currently conducting a Bioassessment Study of Indian and Courtois Creeks using the following four regional reference streams: Shoal Creek, Cub Creek, East Fork Huzzah Creek, and West Fork Huzzah Creek. The East Fork Huzzah Creek is one of four reference

streams for the Ozark/Meramec Ecological Drainage Unit (EDU). An EDU is a region in which one would expect to find similar biological communities. A total of nineteen EDU's were established by MDNR for the State of Missouri. For EDU Ozark/Meramec Drainage, the MDNR maintains a sampling site (01-37069) on West Fork of the Huzzah Creek located in the southwest 1/4 of Section 2, Township 34 North, Range 3 West, Dent County. Results of the biological assessment are summarized by the Macro-invertebrate Stream Condition Index (MSCI), which ranges from 4 (very poor) to 20 (very good). On September 20, 2001, the MSCI scored 20 (very good) and on April 2, 2002, the MSCI scored 14 (fair to good). The West Fork of the Huzzah Creek is considered to be a fully biologically supporting stream segment within the Meramec watershed. The lower score of 14 (fair to good) is most likely related to the small size of the West Fork Huzzah Creek as compared to the other Biocriteria Reference Streams. Surface water grab samples on the West Fork of the Huzzah Creek indicated no State of Missouri water quality standards were being exceeded. A copy of DNR's Biological Assessment for the West Fork of Huzzah Creek can be found in the project file. Also, the data collected is stored in a database at the Missouri Department of Natural Resources, Division of Environmental Quality, Environmental Services Program, Jefferson City, Missouri.

303(d) list

Section 303(d) of the Clean Water Act requires that states identify those waters for which current pollution control measures are inadequate. This is accomplished by comparing data from those waters with water quality criteria established for designated beneficial uses of those waters. Waters that do not meet their criteria are then included in the 303(d) list (MDNR 2003). The state must then conduct Total Maximum Daily Load (TMDL) studies on those waters in order to determine what pollution control measures are required and then insure those measures are implemented (MDNR 2003). Huzzah Creek is not listed on the 303(d) list for 2002; however; the Meramec River is listed for the pollutant Mercury from atmospheric deposition for 75 river miles from Meramec State Park to Township38 North, Range 5 West, Section 22. The MDNR, Water Pollution Control Program, has not completed a TMDL for the Meramec River (see http://www.dnr.mo.gov/wpscd/wpcp/wpcp-about.htm). In July, 2001, the Missouri Department of Health (DOH) issued a fish consumption advisory for all largemouth bass in the State of Missouri because of methylmercury contamination. Sampling and analysis of Largemouth Bass by MDC indicate that mercury is widespread, and present in fish in streams, rivers, ponds and lakes throughout Missouri. The DOH advisory recommends women who are pregnant and children twelve years of age and younger not eat any largemouth bass over twelve inches in length from anywhere in Missouri (Missouri Department of Health and Senior Services 2003).

Potential Nonpoint Source Pollution

Whereas point source pollution can usually be traced to a single discharge point; nonpoint source pollution is much more difficult to detect, as well as remedy. The primary threats from MDNR-designated uses include mercury emissions associated with dumpsites; higher runoff associated with urbanization and county roads in riparian areas; and runoff of nutrients, pesticide, and fertilizer from pastures.

Currently, the Salem Ranger District is a popular area for off-road vehicles (ORV) use. There are approximately 55 miles of non-system roads within the analysis area. The use of ORVs on roads along and near ephemeral and intermittent stream courses can negatively impact water quality. Repeated stream crossing and in-stream operation by ORVs will cause physical disruption of stream substrates. It is possible the stream bottom could destabilize, resulting in the suspension and transport of organic material downstream. Some system roads (approximately 52.5 total miles) are bladed annually and receive regular maintenance work. This helps intercept and retain sediment between the site of its origin and a receiving stream.

There are five known illegal dumpsites on NF lands located adjacent to County and Forest Service roads within the analysis area. These dumps consist mainly of household trash and rubber tires. There are no

known chemical hazards associated with these dumps. None of these dumps are located in perennial stream courses.
There are also three range allotments in the analysis area. The grazing management strategy established by MTNF Forest Plan Standards and Guidelines is to restore the integrity of riparian communities by fencing cattle out of riparian sites.

DIRECT AND INDIRECT EFFECTS ON WATER QUALITY

Alternative 1: No Action Alternative

In this alternative, public health issues, such as dump clean-up, would not be addressed and non-system roads would remain open. This could increase the amount of sediment moving off-site. The term permits for the three existing range allotments would be allowed to expire. This alternative would allow dam inspection and pond and lake maintenance. Maintenance includes keeping trees and large shrubs off the dam (front and back), because decaying root systems can cause leaks. Also, the spillway and outlet pipes would be kept free of obstructions to prevent erosion damage. Major maintenance would include placement of soil and rock along dam and spillway where damage has occurred. Dam maintenance is necessary to prevent a breach of the dam or spillway, which could cause downstream damage to state highways and private lands. This alternative would address these lake and pond maintenance needs; but it would not address any rehabilitation needs.

Table 3 - 2: Alternative 1 - Potential Effects Upon Water Quality

Activity	Units of Measure	Potential Effects upon Water Quality
Silvicultural treatments, and associated temporary roads, reconstructed roads, and newly constructed roads.	0 acres Complete Salvage; 0 acres Seed Tree; 0 acres Shelterwood; 0 acres Uneven Aged; 0 acres Over-Story Removal; 0 acres Sanitation; 0 acres Thinnings. 0 miles of temp. roads. 0 miles of reconstruction. 0 miles new construction.	There would be no effect on MDNR designated beneficial water uses.
Prescribed burn and fire line construction.	0 acres to be burned and 0 miles of dozer line to be constructed.	There would be no effect on MDNR-designated beneficial water uses.
Continue grazing allotments until term grazing permits expire.	Allotments total 345 acres.	Allotment will comply with Forest Plan Standard and Guidelines and will involve fencing out riparian area. This action will help maintain MDNR-designated beneficial water uses.
Pond and Lake Rehabilitation	0 acres	There would be no effect on MDNR-designated beneficial water uses.
Miles of non-system roads (abandoned roads) to be decommissioned.	0 miles	Abandoned roads contribute sediment to streams, which could alter natural relationships between the biota and the stream substrate by changing the condition of the substrate; however, this action by itself would not likely effect MDNR-designated beneficial water uses.
Illegal dump sites to be cleaned-up	0 sites	Existing dumpsites invite oil, chemical and dead animal disposal which may pollute streams. Failure to remove dumps could adversely affect water quality.

Alternative 2 (Proposed Action)

In this alternative, forest health would be accomplished with the use of commercial harvests. Nearly 90 % of the erosion from timber harvesting can be traced to the logging road system (USEPA 1993; MDNR March 2000). Of primary concern is how roads accelerate the delivery of sediment to steams and rivers. Harvest areas are scattered throughout the analysis area and harvest activities with accompanying haul roads would occur over a four-year to five-year period. This would reduce the amount of the road system open in any given year, thus restricting runoff to just the roads being used at that time. Use of "Best Management Practices" (BMP) in constructing and maintaining skid trails and temporary roads would help reduce erosion from timber harvesting. Non-Point source contaminants of forestry activities as proposed in this alternative are not significant enough to have an adverse effect on water quality, so long as "Best Management Practices" (Missouri Watershed Protection Practices, 1990) (Waters, 1995) (MDNR, March 2000), Forest Plan Standards and Guidelines and mitigation measures as listed in this document are implemented.

The proposed prescribed burns, viewed at the right scale of time and space, would not have a negative impact on water quality. A low intensity, landscape prescribed burn is by nature extremely patchy. The local effect of a given prescribed burn on streams varies depending on the intensity of the fire, which is directly related to the time of the year the burn takes place. The primary concern is how the fire accelerates the delivery of sediment to the surface water system. The intensity of a wildland fire could have negative effects on streams by exposing mineral soil to sheet erosion; whereas, a low intensity prescribed fire which did not burn down to mineral soil, would not contribute a significant sediment load into the Meramec watershed. There would be approximately 25 miles of plowed fire line which will expose mineral soil. Plowed and/or bladed fire lines could cause soil erosion and allow sediment to enter stream courses. It is critical to intercept and retain sediment between the fire line and a receiving stream. Plowed fire lines will not have an adverse effect on water quality; so long as Forest Plan Standards and Guidelines and mitigation measures as listed in this document are implemented. Prescribed burning of the woods would not release mercury into the atmosphere unless items containing mercury were to be burned (John Ford, personal communication).

There are three grazing allotments in the analysis area: Barney, Casey, and Fortune Hollow. Allotment management plans will comply with Forest Plan Standard and Guides. In Fortune Hollow, the allotment management plan will involve fencing cattle out riparian areas. This action will help maintain MDNR designated beneficial water uses.

There are approximately 16 acres of Lake and pond Rehabilitation. Rehabilitation activities include: draining, deepening, and stocking to restore or increase the fisheries carrying capacity; installing fish shelters to provide nursery habitat for sunfish; lake drawdown to control the amount of vegetation; nuisance animal control; fishing piers; and new access trails and launch sites.

Nonpoint source contaminants of non-system roads in riparian areas are most likely to contribute to the amount of sediment entering the Meramec watershed. In this alternative, these non-system roads would be decommissioned and water bars would be installed and vegetated. This action would reduce the amount of sediment moving off site on approximately 55 miles of non-system roads in the Analysis Area and help maintain MDNR designated beneficial water uses for Huzzah Creek watershed and Upper Meramec (also called Crooked Creek) watershed.

Table 3 - 3: Alternative 2 - Potential Effects Upon Water Quality

Activity	Units of Measure	Potential Effects upon Water Quality
Silvicultural treatments, and associated temporary roads, reconstructed roads, and newly constructed roads.	Approx. 931 acres Complete salvage; Approx. 26 acres Seed Tree; Approx. 1275 acres Shelterwood; Approx. 1746 acres Uneven Aged; Approx 122 acres Over-Story Removal; Approx. 562 acres Sanitation; Approx. 1197 acres Thinnings. Approx. 25 miles of temp. roads. Approx. 8.4 miles of reconstruction. Aprrox. 0 miles new construction.	Sediment generated by silvicultural treatments and associated roads could enter streams and alter natural relationships between the biota and the stream substrate by changing the condition of the substrate. With implementation of BMP and mitigation measures, there would be no effect on MDNR designated beneficial water uses.
Prescribed burn and fire line construction.	Approx. 8401 acres to be burned and approx 25 miles of dozer line to be constructed.	Prescribe burning reduce forest floor vegetation cover. Plowed fire lines expose mineral soil. Sediment generated by these activities could enter streams and alter natural relationships between the biota and the stream substrate by changing the condition of the substrate. With implementation of BMP and mitigation measures, there would be no effect on MDNR designated beneficial water uses.
Graze cattle	3 allotments	Allotment management plans will comply with Forest Plan Standard and Guides and will involve fencing out riparian area. This action will help maintain MDNR designated beneficial water uses.
Pond and Lake Rehabilitation	Approx. 16 acres	Rehabilitation includes draining, deepening, and stocking. With implementation of BMP and mitigation measures, there would be no effect on MDNR designated beneficial water uses.
Miles of non-system roads (abandoned roads to be decommissioned.)	Approx. 55 miles	Abandoned roads contribute sediment to streams which could lower water quality. Non-system roads would be decommissioned; water bars installed, and vegetated. This action will help maintain MDNR designated beneficial water uses.
Illegal dump sites to be removed	5 sites	Existing dump sites invite oil, chemical and dead animal disposal which may pollute streams. Removal of refuse would eliminate the dump site which should help maintain MDNR designated beneficial water uses.

Alternative 3 (Reduced Complete Salvage with Natural Regeneration Only)

This alternative would be the same as Alternative 2 except there would be 294 acres less of complete salvage, resulting in approximately two less miles of temporary roads.

Table 3 - 4: Alternative 3 - Potential Effects Upon Water Quality

Activity	Units of Measure	Potential Effects upon Water Quality
Silvicultural treatments, and associated temporary roads, reconstructed roads, and newly constructed roads.	Approx. 637 acres Complete salvage; Approx. 26 acres Seed Tree; Approx. 1275 acres Shelterwood; Approx. 1746 acres Uneven Aged; Approx 122 acres Over-Story Removal; Approx. 562 acres Sanitation; Approx. 1197 acres Thinnings. Approx. 23 miles of temp. roads. Approx. 8.4 miles of reconstruction. Aprrox. 0 miles new construction.	Sediment generated by silvicultural treatments and associated roads could enter streams and alter natural relationships between the biota and the stream substrate by changing the condition of the substrate. With implementation of BMP and mitigation measures, there would be no effect on MDNR designated beneficial water uses.
Prescribed burn and fire line construction.	Approx. 8401 acres to be burned and approx 35 miles of dozer line to be constructed.	Prescribe burning reduce forest floor vegetation cover. Plowed fire lines expose mineral soil. Sediment generated by these activities could enter streams and alter natural relationships between the biota and the stream substrate by changing the condition of the substrate. With implementation of BMP and mitigation measures, there would be no effect on MDNR designated beneficial water uses.
Graze cattle	3 allotments	Allotment management plans will comply with Forest Plan Standard and Guides and will involve fencing out riparian area. This action will help maintain MDNR designated beneficial water uses.
Pond and Lake Rehabilitation	Approx. 16 acres	Rehabilitation includes draining, deepening, and stocking. With implementation of BMP and mitigation measures, there would be no effect on MDNR designated beneficial water uses.
Miles of non-system roads (abandoned roads to be decommissioned.)	Approx. 55 miles	Abandoned roads contribute sediment to streams which could lower water quality. Non-system roads would be decommissioned, water bars installed, and vegetated. This action will help maintain MDNR designated beneficial water uses.
Illegal dump sites to be cleaned-up.	5 sites	Existing dumpsites invite oil, chemical and dead animal disposal which may pollute streams. Removal of refuse would eliminate the dumpsite which should help maintain DNR designated beneficial water uses.

Cumulative Effects on Water Quality:

The area considered for cumulative effects is Meramec River Watershed. The time period considered for cumulative effects is the next 10 years.

Public lands total 17,178 acres (17 %) of the watershed area. Therefore, during the next decade, non-

federal landowners will determine land uses on approximately 84,309 acres (83 %) within the watershed area. Conversion from timber to other land uses would involve persistent increases of water yield, storm flow, and sediment yield, and usually include increased inputs of nutrients and bacteria. Non-federal lands are a mixture of small homes and farms with open pastures and forest. Water quality will depend in large part on how non-federal lands are managed, especially non-federal riparian areas. Potential Point Source Pollution types include rural septic tanks and illegal dumpsites. An example of Potential Nonpoint Source Pollution would be grazing practices along perennial streams that contribute to stream bank instability, nutrient loading, and poor riparian corridor conditions. Increased land clearing and higher runoff associated with urbanization and county roads in riparian areas also impact stream habitat quality. It will take the cooperation of all landowners within the watersheds of the analysis area to minimize Point and Nonpoint pollution and its impacts.

In terms of potential pollutants, Mercury emissions are of particular concern. Examples of man-caused sources of mercury are: coal and oil burning, lead smelting, building demolition (thermostats and switches), and waste water treatment plants. Once mercury is released to the atmosphere, it can travel great distances. Mercury falls from the atmosphere as part of the rain cycle where it is converted in the environment by microorganisms into highly toxic methylmercury. This methylmercury accumulates in the bodies of aquatic animals and becomes concentrated in the largest predator fish. In Missouri, largemouth bass are the largest of the predator fish. Thus, humans are at some risk to methylmercury poisoning by eating contaminated fish.

The FY 2002 Mark Twain National Forest Monitoring and Evaluation Report indicate the Forest Plan's Standards and Guidelines for maintenance of water quality on timber management projects are effective. The guidelines provide for buffer zones around riparian areas, and prevent excessive soil disturbing activities in areas that could be prone to excessive erosion.

Alternative 1: No Action - In this alternative, current and on-going activities would continue, but no new management activities would be initiated on National Forest land under this analysis. Siltation tops the list of the ten foremost pollutants in rivers, half-again higher than the second most important pollutant, nutrients (United States Environmental Protection Agency (USEPA), 1993; Waters, 1995). Over a 10-year period, nonpoint source contaminants of non-system roads (approximately 55 miles) could contribute to the amount of sediment entering the Meramec watershed. These non-system roads within the analysis area would remain open under this alternative. Over this 10-year period, the amount of sediment entering stream water courses would most likely increase or remain the same; however, it is doubtful this action by itself would cause changes to water quality associated with the Meramec River which would impair MDNR designated uses.

Alternative 2 and 3: Watershed are classified and have designated beneficial uses as presented in Tables G and H of the Rules of the Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality (MDNR, August 2000). These waters must meet or exceed established criteria as defined in Table A of the Rules of the Department of Natural Resources Division 20-Clean Water Commission Chapter 7-Water Quality for those beneficial uses (MDNR, August 2000).

Forest Service actions as described in Alternative 2 and 3 would cause no changes to the water quality of the Meramec Watershed which would impair its MDNR designated uses. This is under the provision that Forest Plan standards and guides and mitigation measures for either action alternative are implemented. In fact, in alternatives 2 and 3, the amount of sediment entering water courses may be reduced by decommissioning non-system roads.

Air Quality

Existing Conditions of Air Quality

The major physiographic features influencing the climate, movement and dispersion of smoke in this area are the Upper Meramec River, Huzzah Creek, Crooked Creek, and other small-entrenched valley areas. The valleys can act as cold sinks and trap smoke. The river valleys can act as drainages for the smoke causing it to flow downstream.

The climate in the area is defined by hot, humid summers with temperatures ranging from 63 to 88 degrees Fahrenheit (17 to 31 degrees Celsius). The autumns are warm and moist with average temperatures ranging from 35 to 79 degrees Fahrenheit (2 to 26 degrees Celsius). The winters can be cold and snowy, withn temperatures ranging from 18 to 43 degrees Fahrenheit (-8 to 6 degrees Celsius). The springtime is cool and moist with temperatures ranging from 33 to 75 degrees Fahrenheit (1 to 24 degrees Celsius). The annual monthly precipitation ranges from a low in the winter of 1.70 inches to a high of 4.8 inches in the spring (Midwest Regional Climate Center). Winds in this region will blow predominately from the southwest to the northeast.

In general, air quality in the analysis area is good (Ozark-Ouachita Highlands Assessment 1999). All six criteria pollutants (Carbon Monoxide (CO), Particulate Matter (PM-2.5), Ozone (O_3), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), and Lead (Pb) are within the National Ambient Air Quality Standards (NAAQS). See Table 3-5 for the NAAQS standards for the six criteria pollutants. Episodes of regional haze occur mainly in spring and summer.

Table 3 - 5: National Ambient Air Quality Standards for the Six Criteria Pollutants

Pollutant	Averaging Period	National Ambient Air Quality Standards (NAAQS) Primary	Secondary
Carbon Monoxide (CO)	8 hour average	9 ppm (10 mg/m^3)	N/A
	1 hour average	35 ppm (40 mg/ m^3)	N/A
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm(100 ug/ m^3)	Same as Primary
Ozone (O_3)	8 hour average	0.08 ppm (157 ug/ m^3)	Same as Primary
	1 hour average	0.12 ppm (235ug/ m^3)	Same as Primary
Particulate Matter with diameters Of 10 micrometers or less (PM-10)	Annual Arithmetic Mean	50 ug/ m^3	Same as Primary
	24 hour average	150 ug/ m^3	Same as Primary
Particulate Matter with diameters Of 2.5 micrometers or less (PM-2.5)	Annual Arithmetic Mean	15 ug/ m^3	Same as Primary
	24 hour average	65 ug/ m^3	Same as Primary
Sulfur Dioxide (SO_2)	Annual Arithmetic Mean	0.03 ppm (80 ug/ m^3)	N/A
	24 hour average	0.14 ppm (365 ug/ m^3)	N/A
	3 hour average	N/A	0.50 ppm (1300 ug/ m^3)
Lead (Pb)	Quarterly average	1.5 ug/ m^3	Same as Primary

Units of measure: ug/mg^3 – Micrograms per cubic meter of air.
- ppm – Parts per million by volume.
- mg/m^3 – Milligrams per cubic meter of air.

Primary Standard – This is a standard set by the Environmental Protection Agency (EPA) to protect public helath including the health of "sensitive" populations such as asthmatics, children, and the elderly.

Secondary Standard – This is a standard set by EPA to protect public welfare. This includes, but is not limited to decreased visibility, damage to animals, crops, vegetation, and buildings.

National Ambient Air Quality Standards (NAAQS) – These are standards set by the EPA Office of Air Quality Planning and Standards (OAQPS), for six principle pollutants called criteria pollutants. All the above information was obtained from the EPA website dated April 20, 2004.

The proposed project lies within lands designated as Class II with respect to the air resource. The Clean Air Act (CAA) defines a Class II as, "A geographic area designated for a moderate degree of protection from future degradation of the air quality (Clean Air Act, 1990). The closest Class I area is the USDI, Fish and Wildlife Services's Mingo Wilderness at the Mingo National Wildlife Refuge (Puxico, Missouri) located about 135 miles to the southeast (USDI NP, 2001). The CAA defines Class I areas as "A geographic area desginated for the most stringent degree of protection from future degradation of air quality". The only other Class I area in the state is the Hercules Glades Wilderness on the Mark Twain National Forest (USDI NP, 2001). It is approximately 153 miles southwest of the Analsyis Area.

Proposed activities for the Crooked Creek Analysis Area are primarily within Crawford and Dent Counties. The city of St. Louis and the five counties in and around the city are the closest non-attainment areas. This determination is based on the Environmental Protection Agency's (EPA) Aerometric Information Retrieval System (AIRS) and data maps (US EPA, 2000). EPA defines non-attainment areas, as "A geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards"(US EPA, 2001). St. Louis and the surrounding counties are approximately 58 miles north of the proposed analysis area. All these areas are non-attainment for ozone. The analysis area is designated as attainment for all six NAAQS criteria pollutants. The EPA defines attainment areas as "A geographic area in which levels of a criteria air pollutant meets the health-based primary standard (NAAQS) for the pollutant" (US EPA, 2001).

Of the six criteria pollutants identified by the EPA, the main pollutants of concern for this proposed project are: 1) carbon monoxide (CO), 2) particulate matter (PM-2.5 and PM 10), and 3) ozone (O_3). Although the other three pollutants (nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb)) are important, levels associated with this type of project are typically well below NAAQS (Sandberg, and Dost, 1990).

The main sources of carbon monoxide are from combustion engines associated with vehicles and outdoor burning. Major sources of PM-2.5 and PM-10 are wood burning home units, burning on private and federal lands, wildland fire, fugitive dust from unsurfaced roads, and mineral development. Wildland and prescribed fires can also be sources of fugitive particulate matter less than10 microns in size. There are no main sources of ozone in the proposed area. There are a few activities such as wildland burning, which can produce some of the precursors to ozone, such as oxides of nitrogen and organic carbon.

Based on Forest Plan direction (Mark Twain LRMP, 1986, IV-22), the Forest Service will not engage in, support, license, or approve any activity that does not conform to the State Air Quality Implementation Plan and associated regulations. The desired condition for air resources in the proposed analysis area is to maintain NAAQS, comply with state and local regulations and to protect Class I area Air Quality Related Values (AQRV's) from anthropogenic-caused degradation. The AQRV(s) used for the Mingo Wilderness area is visibility. The applicable state and local regulation is 10 CSR 10-3.030,4 (c.7), which deals with open burning in Missouri and general conformity as outlined byt the CAA 176(c) and adminsterd by the state.

Direct and Indirect Effects on Air Quality

All analysis for the proposed project would be based on potential impacts to the identified smoke sensitive receptors with respect to the NAAQS levels for Carbon Monoxide, PM-10, PM-2.5, Ozone, and Visibility. See Table 3 – 6 for the smoke sensitive receptors and Table 3 – 5 for the six criteria pollutants. The State of Missouri uses the same standards for the criteria pollutant as the EPA.

Table 3 - 6: Smoke Sensitive Receptors within the Analysis Area.

Smoke Sensitive Receptor	Distance from Receptor to Fire In km/mi	Direction from Project To Receptor
Davisville	7.6/4.7	Northeast
Dillard	1.3/0.8	East
Viburnum	7.2/4.5	East
Boss	6.0/3.7	Southeast
Howes Mill	1.4/0.9	South
Missouri State Highway 32	Immediately adjacent	South
Missouri State Highway 49	0.8/0.5	East

Smoke sensitive receptors were used in the analysis to estimate the impacts of the various alternatives at these locations. They were chosen, in part, based on proximity to the proposed project, known smoke concerns, safety concerns, and ability to represent similar locations in the area.

Carbon monoxide as a product of combustion is rapidly diluted at short distances from a fire and therefore poses little or no health risk to the general public. Firefighters are at the greatest health risk because they have longer exposures at higher concentrations. It is recommended that fire-line crew bosses rotate personnel away from the fire-line to decrease their exposure. By doing this, they will be able to mitigate the health impacts to firefighters. This would be implemented under all alternatives, thus allowing the proposed activity to comply with NAAQS for carbon monoxide. Because the No Action alternative allows for only wildland fire situations, there are no specific recommended mitigation measures identified for this alternative. Each wildland fire is unique, and thus, mitigations would have to be determined after reconnaissance.

All alternatives have some potential to impact visibility. The smoke sensitive receptors with the greatest potential for impact are the primary state highways in the analysis area. Based on the designated speed for primary state highways in the Analysis Area, and using the Forest Service Handbook 7709.56, a safe stopping distance will require a minimum sight distance of 300 to 500 feet. If the mitigations for air quality identified in the previous chapter are implemented, the proposed project will meet visibility concerns for all action alternatives.

As previously stated, there are a few activities, such as prescribed fires, that can produce some of the precursors to ozone such as oxides of nitrogen and organic carbon. Levels for the proposed project are estimated to be low enough that they would not contribute to the development of ozone levels above the NAAQS (Sandberg and Dost, 1990).

Based on the distance and direction from the proposed project, visibility will not be impacted at Mingo National Wildlife Refuge and Wilderness Area. Based on analysis, literature review, and implementation of the identified mitigation measures, all NAAQS will be met for the proposed project.

Under state rule 10 CSR 10-3.030,4 (c.7), which addresses open burning in Missouri, the USDA Forest Service is exempt. Because the proposed activities are in an attainment area, the conformity requirement will be met. No further conformity analysis is needed at this time. Thus, the project would be in compliance with all federal, state, and local regulations relating to air quality as well as the Forest Plan.

Alternative 1-No Action: This alternative may result in large wildland fires since there will be no management treatment to reduce natural fuel accumulations. Many years of suppression actions have reduced the amount of acres burned, thus increasing the amount of available fuels for wildland fire. In the action alternatives, fuels will be treated by removal (harvest) and fuels reduction (prescribed burning). Direct effects may be similar to those for action alternatives described below, but at higher concentrations and uncontrollable levels.

Smoke from uncontrolled fires has the potential to cause impacts for several days. This situation may possibly occur during multiple events (more than one uncontrolled wildland fire). An uncontrolled wildland fire also has the potential to spread from or into areas outside the Analysis Area, which may cause increased smoke impacts to several smoke sensitive receptors. These impacts can be mitigated for the other alternatives. Under this alternative, only after a wildland fire is reported and it is determined that smoke is or may cause safety concerns, can mitigation measures be implemented.

Alternatives 2 – 3: The direct effects on air quality will be similar for all action alternatives. The following effects may occur during prescribed burns:

- Increases in particulate matter and carbon monoxide concentrations.
- Eye, nose, and throat irritations.
- Decreased visibility along travel ways.
- Odor/nuisance of smoke

In general the public, with the exception of the very ill, very young, and the elderly, have a low risk of long-term chronic health impacts, such as asthma, pulmonary disease, or other respiratory diseases from prescribed burns (Sandburg and Dost, 1990). This is due in part to the short duration times, typically 15 hours or less, at concentrations that are below the NAAQS.

Based on the purpose burning times, the nuisance of smoke should be short-term, less than ten hours.

Firefighters are at the greatest health risk because they have longer exposures at higher concentrations. It is recommended that the fire-line crew bosses rotate personnel away from the fire-line to decrease their exposure. For all action alternatives there will be a decrease in potential smoke exposure to firefighters, due to preplanned mitigation measures to rotate firefighters out of high concentrations of smoke during prescribed burns.

Indirect effects for this and all alternatives will be similar; the amount will vary based upon acres burned and whether or not fires are prescribed burns or wildland fires.

- Development of ozone precursor from the combustion process.
- Decrease in potential of exceeding NAAQS due to a decrease in fuels available to burn during a wildland fire.

The amount of ozone precursors produced is small enough that they will not produce ozone levels that will exceed NAAQS (Sandburg and Dost, 1990). The decrease in NAAQS will be applicable to all alternatives except the No Action. Here there would be an increase in the potential of exceeding NAAQS, specifically PM-10 and PM 2.5. Decreasing the amount of fuel available to burn is one way to decrease the potential for NAAQS being exceeded by an uncontrolled wildland fire.

Cumulative Effects on Air Quality

Cumulative effects include reasonable and foreseeable activities that produce pollutants. This includes, but is not limited to, activities such as operation of combustion engines (i. e. vehicles, lawn mowers, turbines, etc.), use of fireplaces, wood stoves, and dust from unsurfaced roads, wildland fires, industrial emissions, etc. These emissions, coupled with prescribed burning, may have the potential to exceed the NAAQS for ozone and PM2.5. Based on the growth of these other activities that produce pollutants, the project would be implemented before they reach a level that would cause NAAQS to be exceeded.

Transportation System

Existing Condition of the Transportation System

The Crooked Creek Analysis Area is within the 3.41, 3.42, and 3.43 management areas. Missouri State highways 32, 49, and 72, along with secondary state highways AC and MM in Dent County provide primary access to the Crooked Creek Analysis Area. Within the analysis area are county, Forest Service, and private roads. There are 40 National Forest System roads within the management areas, with a combined length of 52.5 miles. National Forest System roads within the analysis area vary from 0.1 mile to over 6 miles in length. The analysis area contains 23,217 acres or 36.3 square miles of National Forest System land. This equates to 1.4 miles of system road per square mile of Forest Service managed land. The Forest Plan, page IV-123, provides direction on the maximum density of system roads allowed within a 3.4 management area, which is 2-mile/square mile of Forest Service land. The road density for the analysis area is below the Forest Plan's maximum density limit.

The Crooked Creek Analysis Area has 8.4 miles of National Forest System roads that need reconstruction before they can be used to access project activities. The other system roads within the analysis area would be maintained as necessary to provide access, while reducing damage to the road and surrounding resources. Some of system roads have gates in order to limit motorized vehicle access on them.

System roads within the analysis area provide access for both commercial and non-commercial resource

activities. They generally have an aggregate surface, are located on ridge tops, are maintained and signed in accordance with their maintenance and traffic service levels, and are considered adequate for use under normal operating conditions. Any management activity, which substantially increases use or considerably alters normal traffic patterns, may be mitigated with appropriate warning and precautionary signing. Additional road maintenance may be required to safely accommodate heavier volumes of traffic.

In addition to system roads, there are non-system roads on National Forest System land in the analysis area. Some have been in place since the early 1900's, when the entire area was first logged. Many of these roads have been used repeatedly since this early logging period for timber harvesting and recreational pursuits. Some were inherited through land purchase or acquisition. The condition of these roads is usually fair to poor because no road improvement or maintenance work has ever been done. Those located on ridge tops are relatively stable, except for areas that become soft when wet. Those located on side slopes or in riparian areas are less stable and may become entrenched, rutted, or washed out. Regardless of their origin, the Forest Plan on page IV-85 gives direction that all roads under Forest Service jurisdiction "not shown on the Transportation Plan, or its subsequent revisions, shall be decommissioned unless under special use permit". Some of the non-system roads have been decommissioned by the District or have become inaccessible due to natural vegetation growing up, but many have remained open because of continued unauthorized recreational vehicle use. Other non-system roads are under special use permit to allow access to private property. There are several non-system roads in the analysis area under special use permit.

All roads that are open, including both system and non-system, receive some degree of vehicular traffic. Use occurs primarily on weekends for recreational driving, hunting, firewood gathering and other recreational pursuits. A majority of non-system roads within the analysis area are used frequently by ATVs. Horseback riders and mountain bikers also use the non-system roads for recreational pursuits.

Direct and Indirect Effects of the Transportation System on Access and Forest Use

The Forest Plan, pages IV 81-85, identifies the general forest-wide management direction for roads; including construction, reconstruction, maintenance, improvement, and decommissioning. The need for these road activities is based on proposed management activities, management area objectives, and the need for resource protection.

The intent of road construction or reconstruction is to provide long-term access into an area with the least amount of disturbance possible. Part of the "least disturbance" objective is to ensure resource damage does not occur in the future after a road has been constructed or reconstructed. Seasonal restrictions, access closures and proper construction will minimize disturbance to the area. Road construction or reconstruction increases the degree of soil and vegetative disturbance in the short term while providing long term load bearing strength and stabilization of the surrounding soil and vegetation. Roads are constructed or reconstructed to provide the minimum standard of road necessary for management area objectives. Road reconstruction will reduce seasonal access restrictions due to wet weather.

Road maintenance and improvement are preventive measures and are used to stabilize an existing road, protect road investments, and minimize disturbance to surrounding resources. Activities associated with road maintenance and improvement may include surface blading, replacement of surface material, mowing and limbing of roadside vegetation, cleaning and restoring drainage features, and replacing signs. Only commercial sources of aggregate material are used to provide a stable road surface.

Road decommissioning eliminates motorized vehicular travel and returns the road back to a natural state. The result of road decommissioning is restored hydrology, a reduction in soil erosion and sedimentation, and the growth of new vegetation where the road once existed. Road decommissioning may involve one or more of the following treatments: blocking access with earthen berms, rock berms, boulders, or slash piles; restoration of natural drainage features by removing culverts and recontouring the area; scarification to remove the road bed; revegetation by seeding, planting, or fertilizing; and signing to discourage motorized use of the road.

Alternative 1 -No Action: No changes would be made to the existing 52.5 miles of system roads within the analysis area. Current road conditions would be maintained. No roads would be reconstructed. Non-system roads within the analysis area would remain open. No temporary roads would be created. The management area's road density would remain at 1.4-miles/square mile. Public access to the area would remain unchanged. There would be no evident change in environmental effects, except that system roads, which need to be reconstructed, would continue to deteriorate if not eventually reconstructed.

Alternative 2 -Proposed Action: Current road conditions for 44.1 miles of system road would be maintained. Reconstruction of 8.4 miles of system road would be required to access project activities. Forest Roads 1634 (0.4 mile), 2353A (0.4 mile), 2361 (0.6 mile), 2366 (1.0 miles), 2383A (1.0 mile), 2384A (0.4 mile), 2743 (0.9 mile), 2748A (1.0 mile), 2748AA (0.7 mile), 2749 (0.6 mile), 2754 (0.9 mile) and 2838 (0.5 mile) will need to be reconstructed to remove infringing brush, correct drainage problems, **and** provide a stabile road surface by applying crushed aggregate base.

There are approximately 60 miles of non-system roads within the analysis area, of which 5 miles are under special use permit. Additional non-system roads have been identified as possible candidates for special use permits. Non-system roads, except for those converted to National Forest system roads, designated as trails, or those under special use permit, would be decommissioned. Approximately 55 miles of non-system road would be decommissioned. Decommissioning these roads will result in less unauthorized motorized vehicle use in the area. In addition, the amount of soil erosion and sedimentation into nearby streams and drainages will decrease. The regrowth of vegetation will also occur.

Alternative 3: Same as alternative 2.

Table 3 - 7: Summary of Transportation System by Alternative

	Alt. 1	Alt. 2	Alt. 3
Total miles of system roads	52.5	52.5	52.5
Road density (Miles/Square Mile)	1.4	1.4	1.4
Miles of system road to construct	0	0	0
Miles of system road to reconstruct	0	8.4	8.4
Miles of system road to decommission	0	0	0
Miles of non-system road converted to system road	0	0	0
Miles of non-system road converted to trail	0	0	0
Miles of non-system road to decommission	0	55	55

Cumulative Effects on the Transportation System

The road density for each of the alternatives would be 1.4-miles/square mile, which is less than the 2-mile/square mile allowed in the Forest Plan for MA 3.4. Past transportation system activities, the proposed action, and the potential activities in the reasonably foreseeable future do not pose any appreciable cumulative effects on access to or use of the analysis area or its vicinity for each of the alternatives.

BIOLOGICAL ENVIRONMENT

Vegetation – Timber Management

Historical Perspective

The types of plant communities and associations found in the Crooked Creek Analysis Area have resulted from a combination of ecological processes and human activities. The effects of some of these processes and activities are for a short period, and others have created long-term changes in the vegetative cover.

Early records of Henry Schoolcraft who traveled through the Analysis Area in 1818-19 (Rafferty, 1996) show the vegetation was much different than the current condition:

> "Our path this day has lain across an elevated ridge of land, covered with yellow pine, and strewed with fragments of sandstone, quartz, and a species of coarse flinty jasper, the soil being sterile, and the vegetation scanty…."
>
> "Our path, for the first four miles, lay across a succession of sterile ridges, thinly covered with oaks,…."
>
> "On leaving the valley of Osage Fork (Huzzah Creek), we immediately entered on a hilly barren tract, covered with high grass, and here and there clumps of oak trees. Soil poor, and covered with fragments of jaspery flint, horn-stone, quartz, and detached masses of carbonate of lime."

The most influential disturbance which created the landscape that Schoolcraft saw was probably the Native Americans use of fire. Opening the understories to create hunting areas with grassy ground cover was one of their primary reasons for burning the landscape. The fire would kill the stem of the oak sprouts but wouldn't affect the root system. After the fire, the oaks would once again resprout to try and produce a stem large enough that the next fire wouldn't kill it and thus establish itself as a tree.

Non-human disturbances were, of course, also present. Historically wind, including tornados, was one of the primary natural disturbances, along with drought and ice. Significant damage from ice storms occurred more recently on the Forest in 1997. Naturally occurring lightning-caused fires are reported as happening in the Ozarks with a frequency of every 2 to 40 years (Ozark-Ouachita Highland Assessment #5, Terrestrial Vegetation and Wildlife, p. 14). Defoliation from insects and forest diseases is also undoubtedly part of the natural disturbance regime of the forest. While many forest stands were mature or over mature, the forest was composed of stands of different age and size classes due to these natural and human-caused disturbances. The variability in stand structure and composition represents the various stages of recovery from past disturbances.

After European exploration and inhabitation, the forest and landscape began to experience new manipulations which would once again shape the forest and vegetation in new ways. This is particularly evident in the Crooked Creek Analysis Area starting around the 1880's. Iron deposits were discovered and intensive exploitation brought about the building of an iron furnace. The Sligo Iron Furnace was built just west of the Analysis Area and began gathering resources from the surrounding land. Iron was mined and charcoal was needed to fire the furnace. The wood for the production of charcoal was timbered from the surrounding hills. Sligo operated for close to 40 years, so it is logical to assume that the hillsides around the furnace for a great distance were denuded of timber once, if not twice, during the time of operation. When the furnace closed in the early 1920's, the hills once again began to sprout back,

and in the 1930's, much of the land began to be purchased by the Forest Service for a new National Forest. Fire was reduced or eliminated from the landscape by intensive control efforts and the timber grew into what we see at the present time. Different tree species began to be more prevalent, i.e., black and scarlet oak, which grow very fast and thus create a landscape dominated by the red oak family. The original solid and scattered shortleaf pine which once was in the area gave way to an almost solid oak/hickory forest. The history of this area places most of the stands at about the same age. Due to a reduction in recent harvesting, a drought from 1998-2001, well-drained and mostly infertile soils, and the mature and over-mature conditions of the stands, the Analysis Area is now experiencing oak decline. The decline is most readily visible in the black oaks and scarlet oaks which make up the majority of the stands. Salvage operations in areas adjacent to the Crooked Creek Analysis Area have been able to utilize a lot of the dead and dying trees.

Recent Past Management Activities

More recent vegetative management activity projects have taken place within the Crooked Creek Analysis Area: Timber Stand Improvement (1989 Decision Memo); Fortune Hollow Project Set (1990 Decision Notice); Pine Post Thinning (1990 Decision Memo); Barney Fork Project, Opportunity Area 3.4-3 (1991 Decision Notice); Wildlife Habitat Improvement (1991 Decision Memo); James Branch and Beefsteak Project Sets, Opportunity Area 3.4-1 and 3.4-2 (1991 Decision Notice); Crooked Tower Project Set, Opportunity Area 3.4-1 (1992 Decision Date) Bates Hollow, Fiebelmann Cemetery, Waterfork, Crooked Creek Projects, Opportunity Areas 3.4-1 and 3.4-2 (1993 Decision Notice); Viburnum, Guy Brooks Ridge, Ballfield, Huzzah Hatchery, and Casey Projects, Opportunity Areas 3.4-1 and 3.4-2 (1994 Decision Notice); and Barney Fork, Management Area 3.4-3 (1998 Decision Notice). These projects included a wide range of silvicultural treatments including Complete Salvage. The current temporary openings are results of these past project implementations. Additionally, intermediate treatments (uneven-age management, thinning) resulted in healthier stands as noted by field reviews post treatment. The current oak decline problem now faced is mainly evident in stands not previously treated.

Vegetation – Existing Conditions

Primary tree species commonly found in the Analysis Area include black, scarlet, white and post oak, shortleaf pine, and various hickories. Primary forest types include shortleaf pine (mostly plantations), black oak, post oak, mixed oak and a mix of oak and pine. Because of the extensive logging that occurred in the early 1900's, most trees in the stands are the same age (even-aged), mature, or over-mature. Stand structure is typically a combination of dominant over-story trees with suppressed or shade tolerant trees in the under-story. This is best explained by the suppression of fire for many decades.

Besides forested land, permanent openings, including rights-of-way, make up less than 5 % of the national forest ownership and generally consist of lowland or upland shrubs and grasses. Permanent openings needed by wildlife for a variety of reasons and are a key component of a diverse landscape in a healthy forest ecosystem are lacking. Forested stands that have been recently regeneration harvested (complete salvage/seedtree) are classified as temporary openings until they reach a height of 20 feet (LRMP, p. IV-38) Additionally, these stands are counted as early successional areas under wildlife habitats (0-9) as defined until the age of 10 years.

Under these definitions, once a stand is older than 10 years, it is still considered an opening under LRMP guidelines for timber management opening limitations but is not contributing to the early successional habitat DFC. Currently, 589 acres (2.5 %) of NFS land in the analysis area meet the 0-9 criteria.

The dynamics of oak decline and mortality over the last 20 years has created some openings in the over-story that have allowed an under-story of advanced oak and hickory regeneration to become established in many stands, but without more disturbance, these will not likely have room to fully develop into a healthy future stand.

Previously untreated timber stands that are predominantly black oak and scarlet oak in excess of 70 years of age account for 27 % (approximately 6,354 acres) of the National Forest land in the Analysis Area. Field surveys conducted during the planning stage of this project verified many of these stands are

suffering from moderate to severe oak decline as a result of relatively old age (70+ years), well drained rocky soils, and successive severe droughts. This is mainly evident on south and west slopes over the Analysis Area. These slopes typically are warmer due to their aspect, and the well-drained soils which cover the area hold little water during most of the year. Aerial reconnaissance has shown the mortality can be spotty or widely broadcast based on the black/scarlet oak component within the affected stands. Secondary factors causing further stress and damage to these trees are red oak borers, chestnut borers, Armillaria root rot, and Hypoxylon canker. An additional 20 % (approximately 4,542 acres) of the Analysis Area is in white/post oak or mixed oak/hickory over 70 years of age. The black and scarlet oak component in these stands range from 20 % to 40 %. Many of these individual trees are also experiencing moderate to severe oak decline. Total acres being affected or with the immediate potential to be affected by oak decline is 47 % (10,896 acres) of the analysis area and displayed as bold numbers in the shaded area on Table 3-8.

Table 3 - 8: Summary of Transportation System by Alternative

FOREST TYPE	ACRES (AGE)					
	NON-STOCKED	SEEDLING (0-9)	SAPLING/ POLE (10-49)	SMALL SAW-TIMBER (50-69)	MATURE (70-99)	OVER MATURE (100+)
Shortleaf pine		0	1722	1275	352	0
Black/ Scarlet oak		449	1082	**3011**	**5963**	**391**
Mixed Oak/Oak-Pine		123	875	**949**	**1819**	**27**
White/Post Oak		17	347	**1049**	**1912**	**784**
Misc. Hardwood		0	26	49	73	0
Open/semi-Open	922					
TOTALS	922	589	4052	6333	10119	1202

Laws and Regulations Pertaining to Even-Aged Management

The Code of Federal Regulations (CFR) guiding direction for maximum size limitations of openings can be found in 36 CFR 219.27 (d) (2) (iii). This states:

> The established limit (opening size 36 CFR 219.27 (d) (2)) shall not apply to the size of areas harvested as a result of natural catastrophic condition such as fire, insect and disease attack, or windstorm.

Direct and Indirect Effects on Vegetation by Alternative

Temporary Openings

Temporary openings are defined as regeneration areas that are currently less than 20 feet in height. Presently, the analysis area contains 589 acres of temporary openings less than 10 years of age and 1,333 acres of temporary openings less than 20 years of age created by past management activities. As field reviews were completed, these openings were noted and stand data were analyzed; it is a fair assumption to correlate age to height in this area based on noted heights and Site Index (SI) data. SI in these stands averages 50 over the analysis area. The height (and predicted height), therefore, can be roughly based on age. On average, most stands show a one-to-one ratio between age and height, i.e., a 15 year old stand is 15 feet tall. Some of these openings are adjacent to proposed complete salvage areas. Those existing openings that would contribute to a temporary opening greater than 40 acres, under Alternative 2, can therefore be predicted to have grown out of the "temporary opening" classification (will be expected to reach a height of 20 feet) by the year 2012 (8 years from the present). The affected proposed complete salvage stands include 295 acres.

Alternative 1 – No Action: Under Alternative 1, no vegetative management would take place, no system roads would be reconstructed, and no prescribed burning would occur. Any existing open-lands would continue to be encroached by woody vegetation and the limited open understory conditions would dwindle.

Currently, 47 % of the analysis area stands are over 70 years old and an additional 22 % is over 50 years old. These stands will continue to mature, decline, and experience mortality depending on stocking levels and amount of black and/or scarlet oak composition. Trees currently in decline will never recover, and some may persist, though significantly lower growth rates will be realized (Dwyer and Kurtz, 1994).

Over time, additional mortality will continue to contribute to fuel loading both on the ground and in the form of standing snags. This will result in more intense fires, should they occur. Additionally, safety hazards to forest visitors will not be addressed.

The stands that are currently overstocked, mainly those proposed for thinning or UAM, would continue to stagnate until some natural occurrence either thins or regenerates the area. In the short term (within the next 10 years), selection of Alternative 1 would maintain the current species composition in stands less than 70 years old or that are mostly shortleaf pine or white oak species. Over the long-term, species composition would depend on available seed trees and the amount of natural disturbance (mortality, wind, ice storms, or wildland fire). Age-class distribution would tend to become further skewed towards the older-age classes since no new age-classes are being created except in stands suffering from extreme oak decline.

In the remaining stands proposed for treatment, over-story and mid-story oaks will continue to die out, and the existing shade tolerant under-story would then be allowed to dominate, for a time, keeping desirable intolerant species from regenerating to a fully stocked condition. This would result in a lower percentage of black and scarlet oak than currently exists. This change will be more pronounced on north and east facing slopes and in the limited stands currently dominated by white or post oak.

***All* existing early successional stands (0-9 age class) currently present will move into the sapling class by 2006.**

Alternative 2 – Proposed Action

Silvicultural Treatments for Timber Management

Common silvicultural terms are used here in an effort to describe what the end result of stand treatment will look like after the treatment is complete. The term applied to each individual stand

to be treated was based on the current composition, as the primary trees to be removed in all treatments will be declining black and scarlet oak. For example, if the existing stand has greater than 60-70 % of trees in the red oak group, that stand would have seed tree or shelterwood prescription. If the existing stand has less than 50 % of its trees in the red oak group, that stand would likely have a sanitation or uneven-aged prescription. Some white oak and post oak may also be harvested as needed to reduce canopy cover as required for the regeneration of desired species to create a mix more resistant to oak decline. Some low quality white and post oak (forked/crooked trees) may also be removed to allow the resulting growing space to be utilized by other trees. In any event, it is estimated that most of the trees harvested will be black and scarlet oak.

What follows are descriptions of the various harvest methods involved in conducting even-aged management (EAM) and uneven-age management (UAM). With implementation of activities identified in the Forest Plan, one would encounter a mosaic of seedling, sapling, pole size timber, sawtimber, and old growth stands across the landscape (Forest Plan, Appendix D). This vegetative mix also contributes to a sustainable forest ecosystem.

Complete Salvage

Complete Salvage with reserves is proposed on 931 acres. This treatment is used on sites where other harvest alternatives have been reviewed and found to be inappropriate to treat the decline and mortality condition while establishing a fully stocked new stand of shade intolerant trees and achieve wildlife/age class diversity objectives. Additionally, this treatment is primarily used where stands have limited species composition diversity that would allow another prescription to be used. These stands are in the late stages of decline, have inadequate stocking on the site, and/or have significant amounts of mortality within the red oak group (black oak and scarlet oak). Due to the location of these stands in relation to existing regeneration areas, some **temporary openings** greater than 40 acres would be created. Figures 3 - 1 and 3 - 2 show the locations of ten temporary opening that would exceed 40 acres in size under Alternative 2. Figures 3 - 3 through 3 - 9 show how stands proposed for complete salvage and existing openings would combine to make these larger temporary openings.

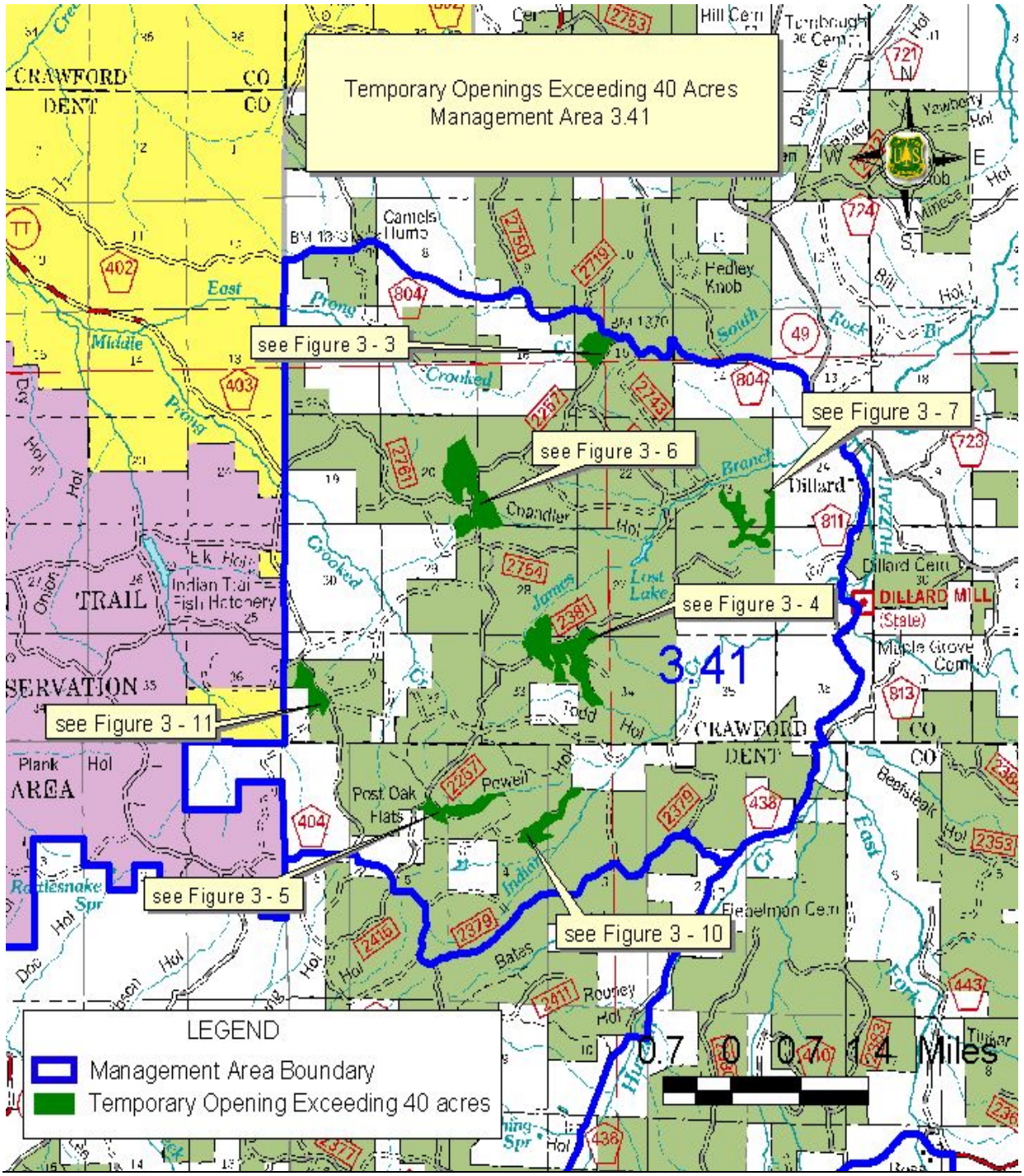


Figure 3 - 1: Temporary Openings Exceeding 40 Acres in Management Area 3.41 Under Alternative 2

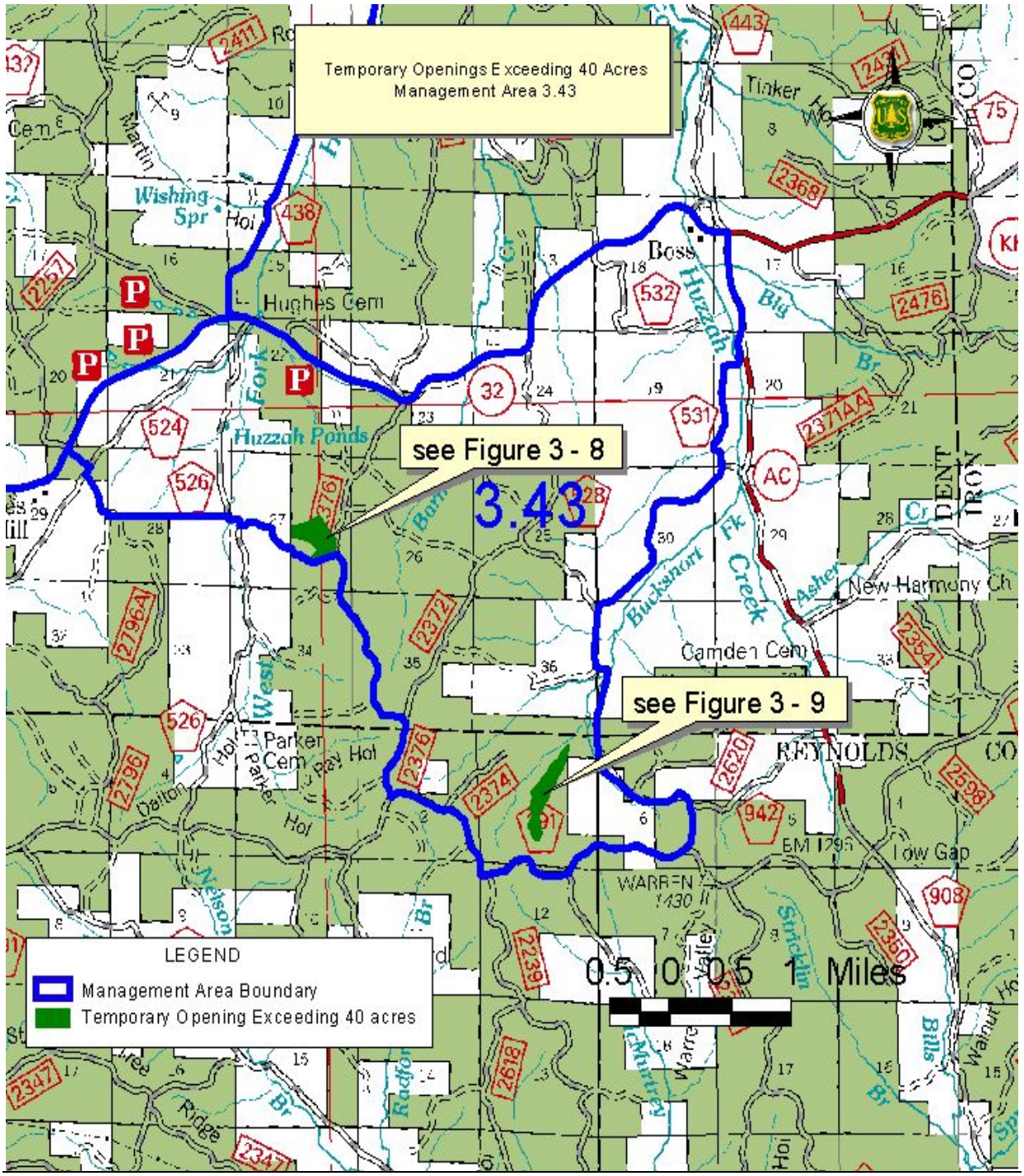


Figure 3 - 2: Temporary Openings Exceeding 40 Acres in Management Area 3.43 Under Alternative 2

Ten existing openings that would contribute to a temporary opening greater than 40 acres are specifically identified under Alternative 2. Three proposed harvest scenarios are planned for areas adjacent to existing openings in the 0 to 10 year age class. The greater than 40-acre issue will no longer be a consideration by the year 2011 because the stands will no longer be considered openings.

In compartment 22, stand 24, a harvest of 24 acres is proposed adjacent to a 22-acre temporary opening (see Figure 3 – 3). This existing opening is in compartment 22, stand 22 and was cut in 1991. The temporary opening created by the planned salvage activity and the existing opening would be 46 acres. Given the one-to-one ration between age and height, this stand should average approximately 13 feet in height at this time. In seven years (2011), stand 22 will average 20 feet in height and the temporary opening will be only 24 acres (the area of stand 24).

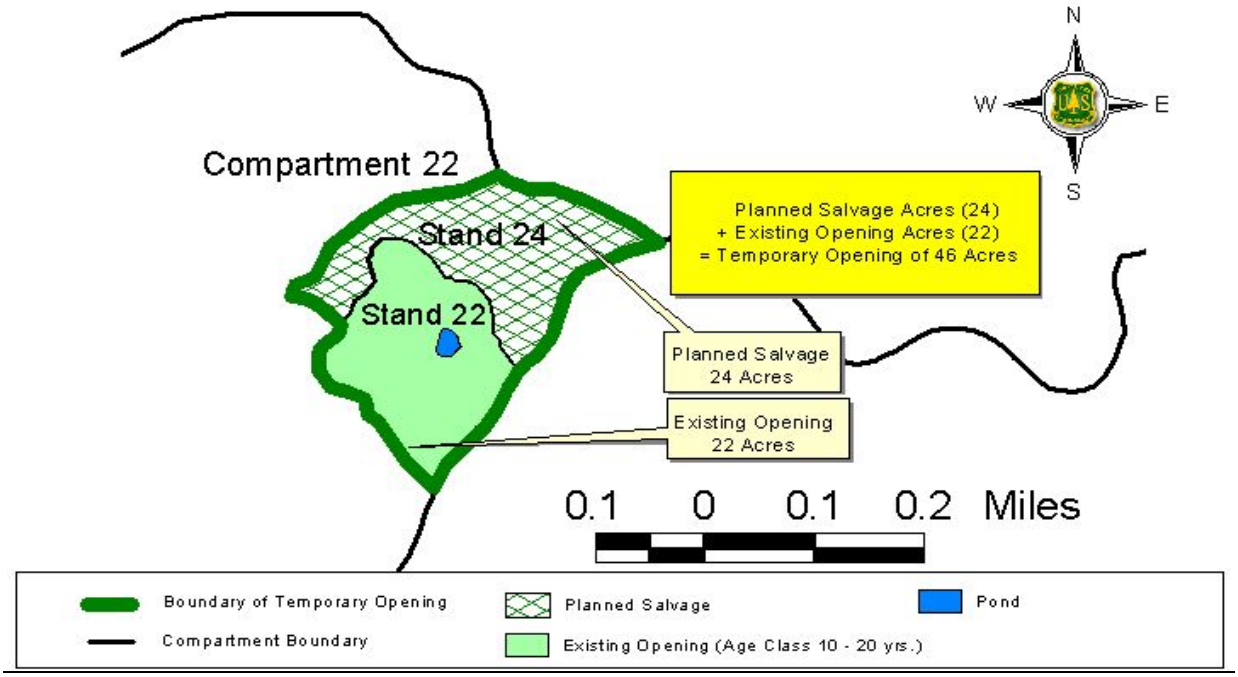


Figure 3 - 3: Temporary Opening, Compartment 22, Stands 22 and 24

In compartment 39, adjacent harvests of 21 acres (compartment 39, stand 10) and 38 acres (compartment 39, stand 14) are proposed next to 42-acre (compartment 38, stand 31), 25-acre (compartment 39, stand 13), and 20-acre (compartment 40, stand 1) existing openings (see Figure 3 - 4). The planned salvage would create a temporary opening of 146 acres. The three existing openings were cut in 1992 and would average approximately 12 feet height at this time. In eight years (2012), the existing openings will reach an average height of 20 feet (i.e. they will no longer be classified as openings). At that time, the opening would be reduced to 59 acres (the combined acreage of the planned salvage areas).

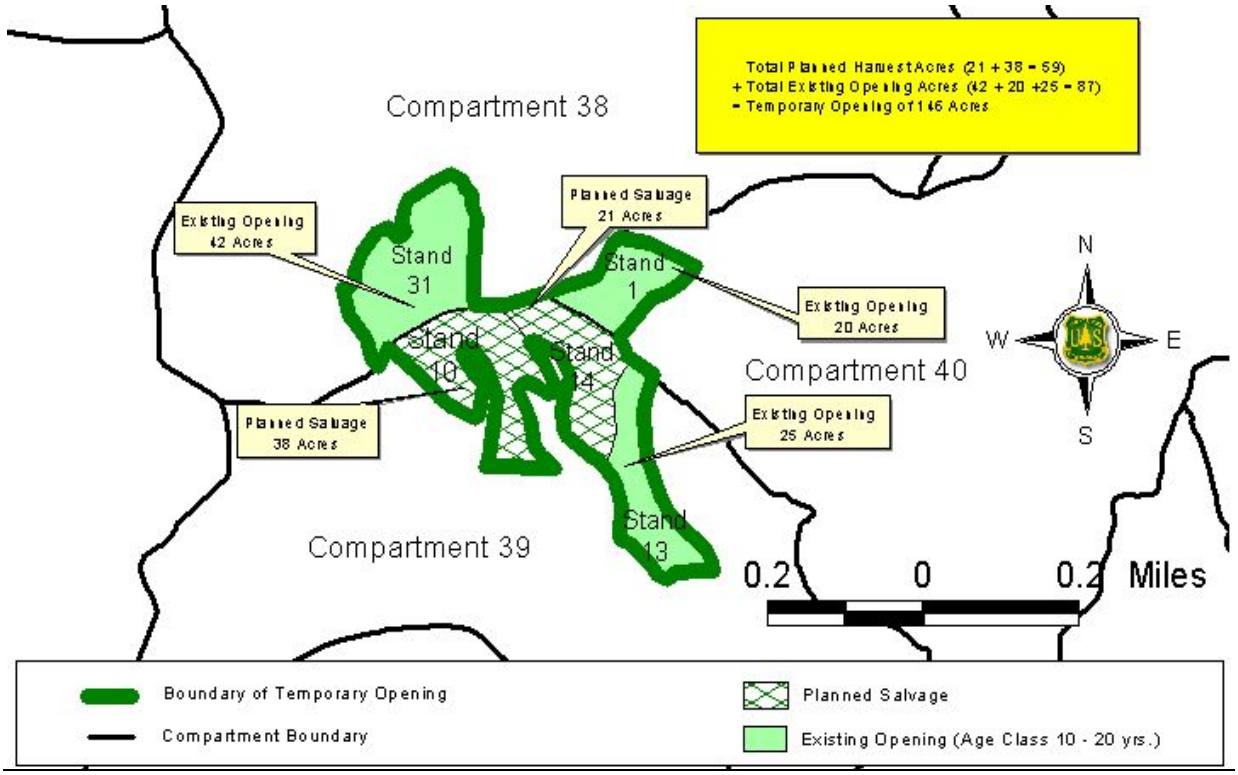


Figure 3 - 4: Temporary Opening, Compartment 38, Stand 31; Compartment 39, Stands 10, 13, and 14; Compartment 40, Stand 1

In compartment 50 stand 15, a harvest of 18 acres is proposed adjacent to a 33-acre existing opening (compartment 50, stand 19), creating a temporary opening of 51 acres. Stand 19 was cut in 1992 and would average approximately 12 feet in height at this time. In eight years (2012), the existing opening (stand 19) will reach an average height of 20 feet. At this time, the opening would be reduced to 18 acres (the area of stand 15).

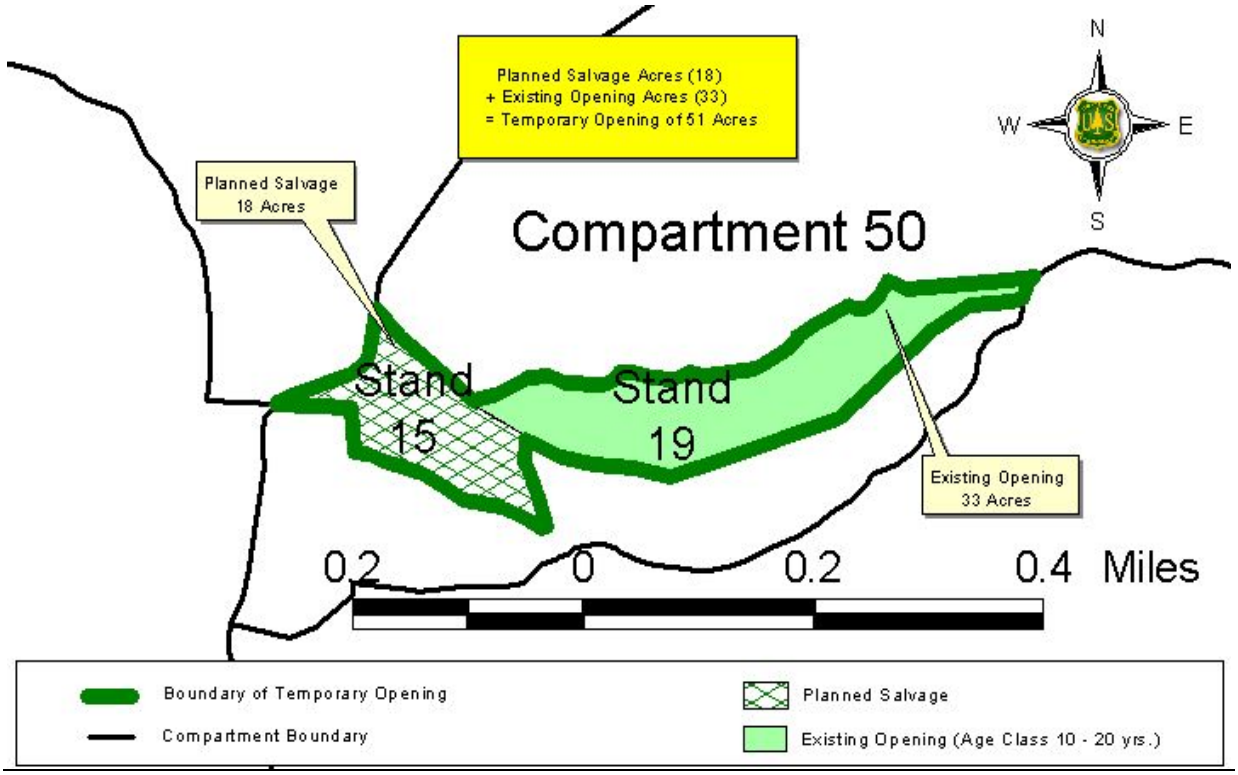


Figure 3 - 5: Temporary Opening, Compartment 50, Stands 15 and 19

Four of these proposed harvest scenarios are planned for areas adjacent to stands in the 10 to 20 year age class. The greater than 40-acre issue will no longer be a consideration by the year 2017. In compartments 21, 35, and 38, adjacent harvests of 13 acres (compartment 21, stand 3), 21 acres (compartment 21, stand 4), 35 acres (compartment 21, stand 5), 30 acres (compartment 38, stand 2), 14 acres (compartment 38, stand 3), and 12 acres (compartment 35, stand 12) are proposed (see Figure 3 – 6). These harvests are also adjacent to 16-acre (compartment 21, stand 26) and 7-acre (compartment 35, stand 26) existing openings which were both cut in 1996. The combined acreage of the planned salvage and the existing openings would be 148 acres. Since the two existing openings were cut in 1996, they would average approximately 8 feet in height at this time. The will reach an average height of 20 feet in 12 years (2016). At that time, the opening would be reduced to 125 acres (the combined acreage of the planned salvage areas).

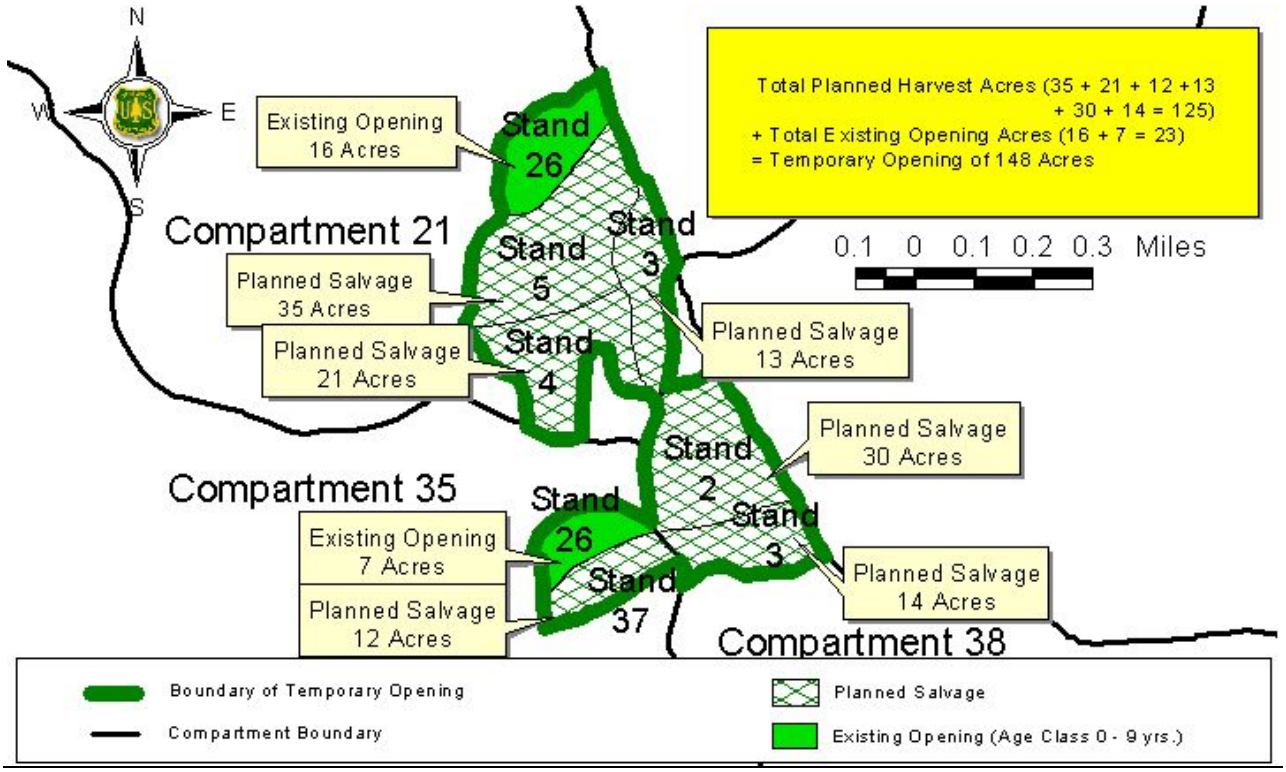


Figure 3 - 6: Temporary Opening, Compartment 21, Stands 3, 4, 5, and 26; Compartment 35, Stands 26 and 37; Compartment 38, Stands 2 and 3

In compartment 33 stand 23, a harvest of 31 acres is proposed adjacent to a 33-acre existing opening (compartment 33, stand 15), which would create a temporary opening of 64 acres (see Figure 3 - 7). Stand 15 was cut in 1996 and would average approximately 8 feet in height at this time. In twelve years (2016), the existing openings will reach an average height of 20 feet. At that time, the opening would be reduced to 31 acres (the acreage of the planned salvage area).

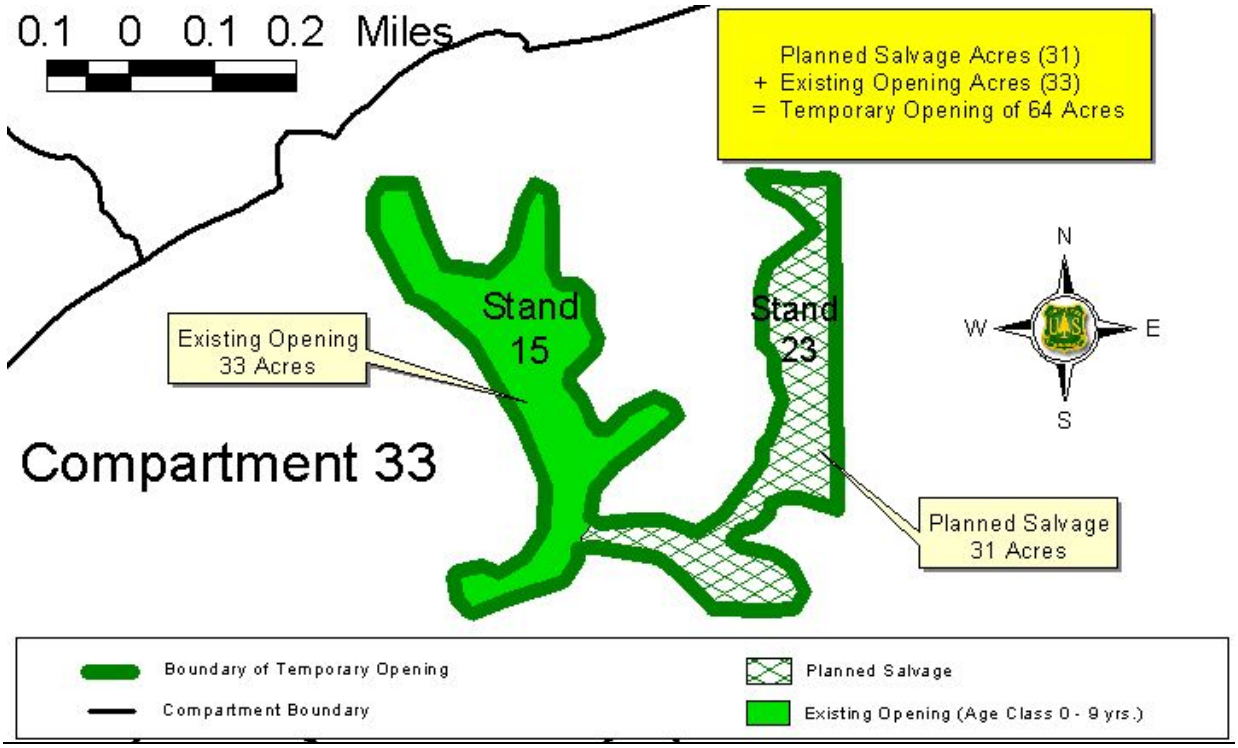


Figure 3 - 7: Temporary Opening, Compartment 33, Stands 15 and 23

In compartment 90 stand 35, a harvest of 35 acres is proposed adjacent to a 10-acre existing opening (compartment 90, stand 38), which would create a temporary opening of 64 acres (see Figure 3 - 8). Stand 38 was cut in 1996 and would average approximately 8 feet in height at this time. In twelve years (2016), the existing openings will reach an average height of 20 feet. At that time, the opening would be reduced to 35 acres (the acreage of the planned salvage area).

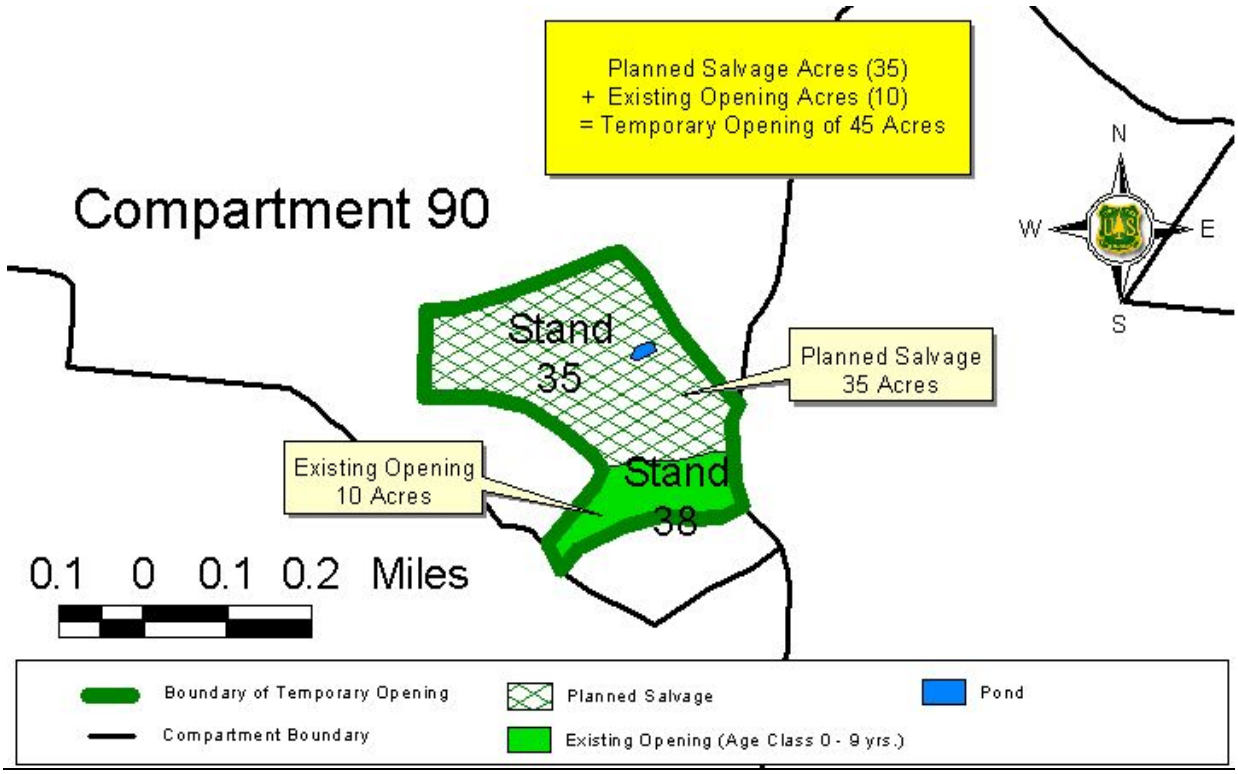


Figure 3 - 8: Temporary Opening, Compartment 90, Stands 35 and 38

In compartment 118, 17-acre (stand 19) and 18-acre (stand 22) harvests are planned, respectively, to the north and south of a 10-acre opening (stand 46). This would create a temporary opening of 45 acres (see Figure 3 - 9). Stand 46 was cut in 1997 and would average approximately 7 feet in height at this time. In thirteen years (2017), the existing openings will reach an average height of 20 feet. At that time, there would be two smaller openings of 17 acres and 18 acres (the two planned salvage areas).

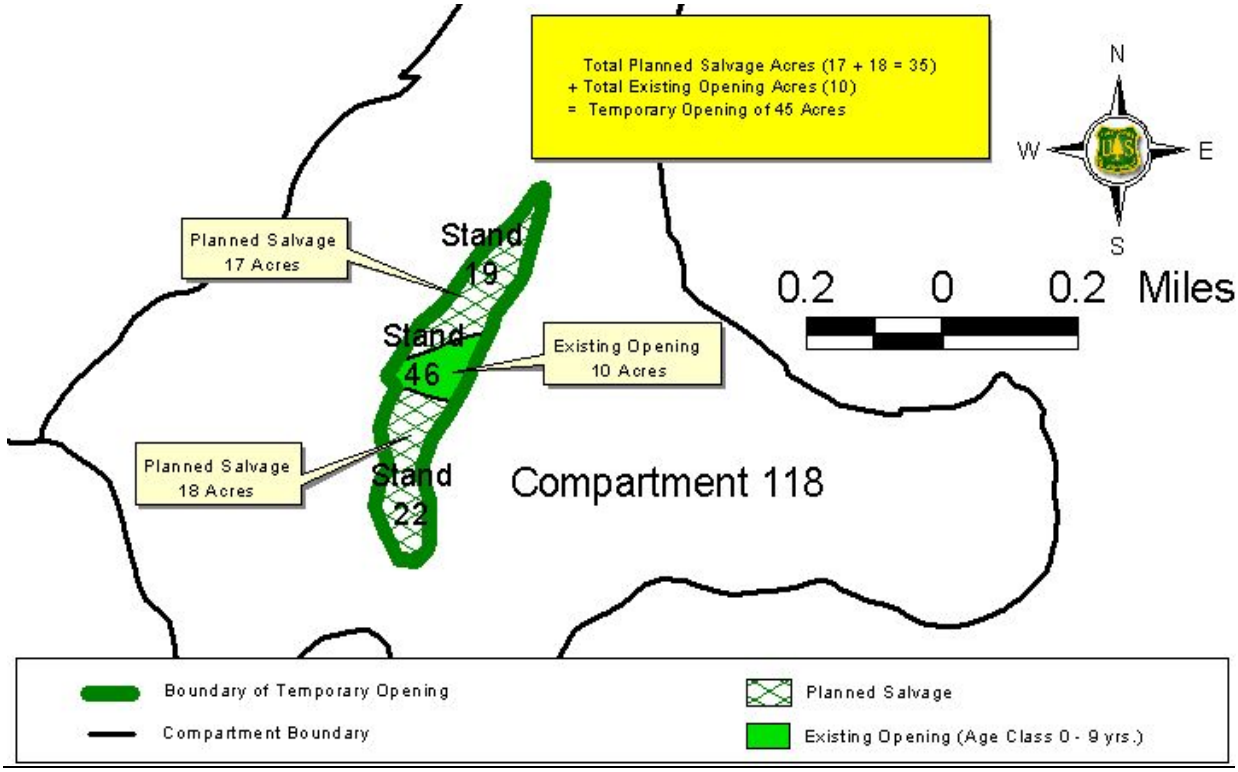


Figure 3 - 9: Temporary Opening, Compartment 118, Stands 19, 22, and 46

Alternative 2 also includes creating temporary openings initiated by complete salvage in two specific areas where the cumulative salvage area is greater than 40 acres without incorporating any existing openings. In compartment 51 stands 34 and 40, a salvage harvest of 53 acres is proposed (see Figure 3 – 10). In compartment 52 stands 16, 17, and 18, a salvage harvest of 46 acres is proposed (see Figure 3 -11). These are necessary due to the extreme extent of the late decline and mortality within these specific areas in need of silvicultural treatment.

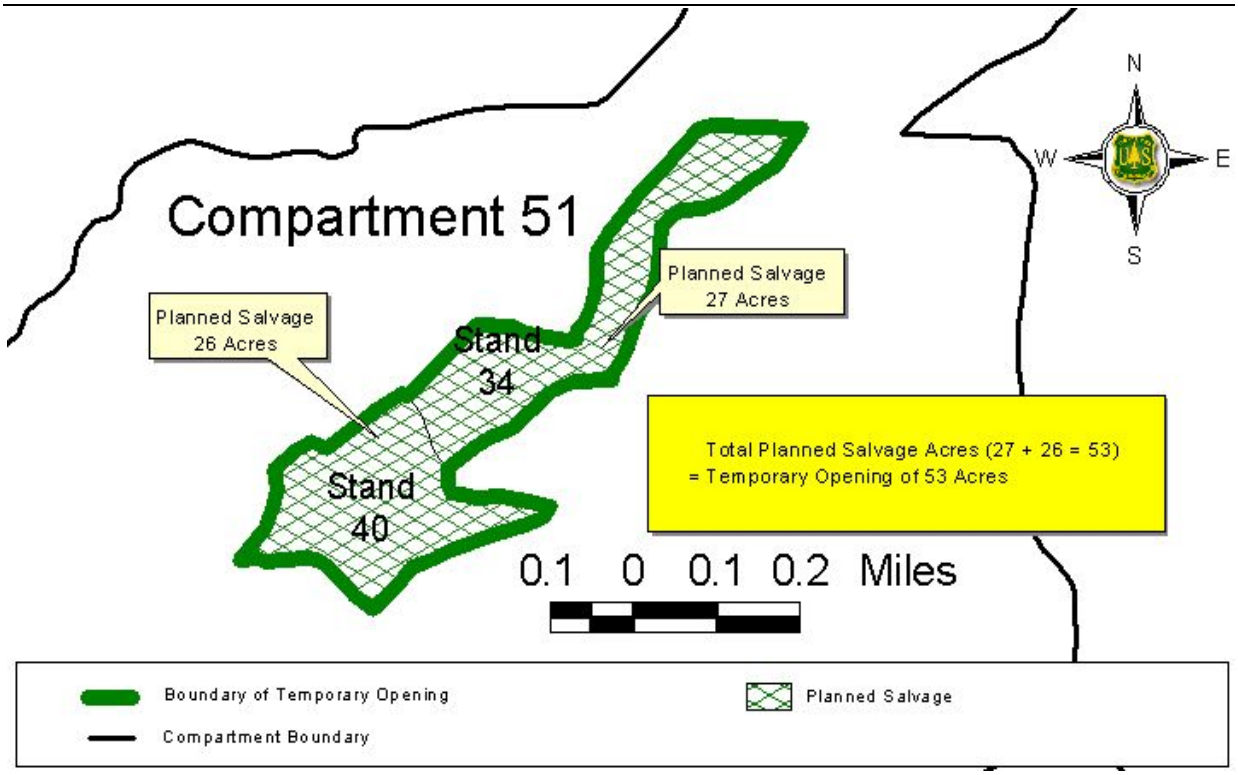


Figure 3 - 10: Temporary Opening, Compartment 51, Stands 34 and 40

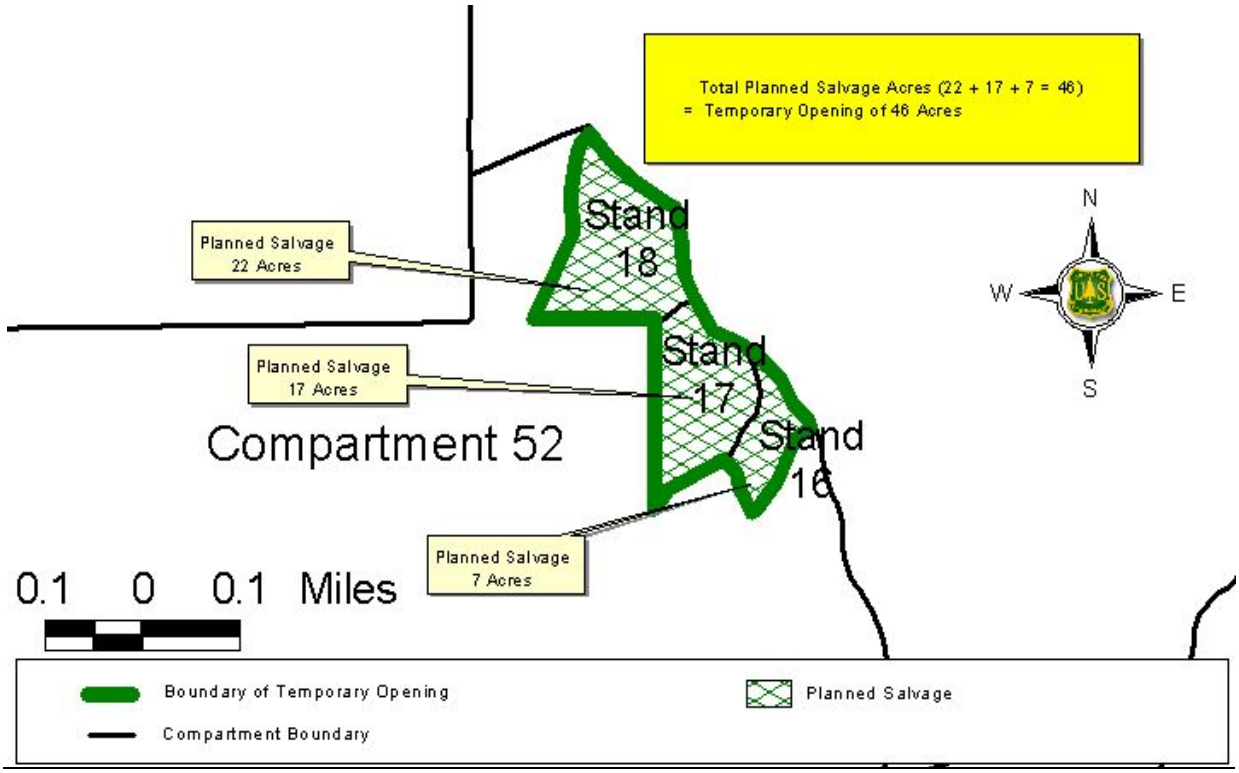


Figure 3 - 11: Temporary Opening, Compartment 52, Stands 16, 17, and 18

Management options in these areas are limited because of the lack of species diversity, potential loss of coppice sprouting, and poor stocking in trees of acceptable condition, i.e., trees resistant to decline. Due to natural catastrophic conditions from oak decline and associated tree mortality, the size of these temporary openings is allowed under guidelines discussed on page IV-39 of the LRMP. This is based on guidance provided under 36 CFR 219.27 as discussed above. The stands under this prescription are normally greater than 60 % black and/or scarlet oak, are greater than 70 years of age, and either lack the potential to regenerate naturally to a fully stocked condition of desirable species, or have predisposed conditions that will only result in regeneration to the same composition and condition of susceptibility to the influences that have caused the decline and mortality currently being expressed. This method removes most of the existing stand of trees, with residual individuals and clumps of trees being left as reserves throughout the area. Full sunlight exposure with minimum competition creates the conditions necessary for any existing oak and hardwood reproduction to develop. This would also precipitate the establishment of shortleaf pine if planted in regard to specific needs and/or concerns with regeneration species composition (Moser and Melick, Management Recommendations for Oak Decline, 2001).

Any residual reserve trees and/or areas will consist mostly of trees with a life expectancy of 20 years or greater. The first priority for reserves is white oak, due to white oak's drought tolerance and wind-firmness. The next order of reserve species includes any cavity tree, post oak, hickory, or pine. If pine, the trees will be of good to superior quality, suitable for a seed source, and capable of adding growth. This treatment also encourages a great variety of early successional plants to meet wildlife habitat needs in the form of temporary forage which is a primary need in this area (Forest Plan, Appendix D). Regeneration treatment specifics are discussed below.

Seed Tree Salvage

Seed tree cuts in Alternative 2 are proposed on 26 acres. A seed tree cut treatment is used on sites where mature pine is present, but only as individuals, rather than as a stand. The remaining species are predominantly black and/or scarlet oak in decline, and treating the area for regeneration is

needed to develop a more resilient stand featuring more of a pine component. Purposefully creating these open conditions will also help regeneration by allowing full light to reach the forest floor, necessary for any existing oak and pine reproduction to develop. It is these large pine trees scattered throughout the stand that serve as seed trees to help facilitate the establishment of a new fully stocked stand of oaks and pines. White oaks, when present, are normally left as reserves also to provide mast and other wildlife benefits. Additionally, the lightly stocked over-story of superior trees will maintain above average growth rates due to low competition and have the potential to develop into trees of larger size than normally found on these sites under fully forested conditions. This treatment also encourages a great variety of early successional plants to meet wildlife habitat needs in the form of temporary forage which is a primary need in this area (Forest Plan, Appendix D). It also promotes large tree crowns on healthy, fast growing trees with the potential to produce more acorns and pinecones. Regeneration treatment specifics are discussed below.

Shelterwood Salvage

Shelterwood cuts in Alternative 2 are proposed on 1,275 acres. A shelterwood cut is used on sites where species composition allows treatment of the red oak group to address decline issues while maintaining a broken canopy of large trees. This allows the establishment of a fully stocked new stand of shade intolerant trees. Crown gaps will be the rule rather than the exception. Purposefully creating these openings will help establish oak and hardwood regeneration which is currently lacking. These stands have an adequate representation of hearty white and post oak, as well as some hickory, which will serve as the “shelter” to developing reproduction for the future stand. The development of a moderately stocked over-story of healthy trees that will maintain above average growth rates due to low competition have the potential to develop into trees of larger size than normally found on these sites under fully forested conditions. White oak will likely become more abundant as they are more shade tolerant than red oaks and thus are expected to become established and incorporated into the new stand at a higher stocking level. The harvesting of only high risk and low quality trees retains the shelterwood trees needed to meet the objectives of this prescription. Residual stocking will average below 50 % for the site, thus the residual sawtimber will not fully utilize the available growing space. Follow-up natural regeneration will include cutting of most non-commercial stems as discussed below.

Uneven-aged Management for Salvage

Uneven aged management methods in Alternative 2 are proposed on 1,746 acres. Uneven-aged treatments are designed to encourage the development of three or more age classes within the stand. With an uneven-aged system, a systematic entry cycle of 15 to 20 years is assumed to maintain this condition over time. The stands will eventually consist mostly of trees with a life expectancy of another 20 years or more and will promote recruitment of a variety of species to provide a more diverse stand composition. White oak will become more prevalent over time because of its longer life expectancy, its tolerance of semi-shade conditions, and its accumulation in relatively greater numbers in the younger age classes. In this first entry, we propose to remove most of the red oak group because of its high-risk condition, while keeping residual stocking above 50 % of maximum stocking for the site. This will create conditions in favor of developing a new age class of shade intolerant tree species including oaks, hickories, and shortleaf pine. This prescription is normally applied using a combination of individual tree selection and group selection as red oak decline conditions necessitate (see Stambaugh, 2001; Larson, et al., 1999; Larson, et al., 1997).

This treatment will also maintain and encourage a forage component in the stand by increasing light to the ground, increasing the potential for mast production by promoting larger tree crowns on younger trees with more fruiting potential, and maintaining or developing fast growth on best trees to avoid stagnation. Additionally, these conditions will allow these stands to remain resistant to insect and disease problems, as well as promote larger diameter trees in a shorter time frame.

The use of UAM, as well as the other silvicultural treatments, is based on the vegetative composition and biological capability of the sites. Cutting methods that develop and maintain uneven-aged stands are single tree selection and group selection. Both methods would usually be applied concurrently in the prescription area. This combination of the two distinct UAM methods has been termed "Selection with Groups" on MTNF.

Overstory Removal for Salvage

Overstory removal cuts are proposed on 122 acres under Alternatives 2. An over-story removal treatment is used on sites where there has been acceptable regeneration resulting from preceding oak decline, wildland fire, or shelterwood cuts. The removal of most of the remaining over-story trees that will inhibit the new stand's proper growth and development will be carried out. Reserve trees will be longer-lived shortleaf pine or white oak, as available, to meet wildlife needs for mast and cover. Additional regeneration work will be completed post-harvest to continue development of the new age class of shade intolerant species.

Sanitation Cuts for Salvage

Sanitation cuts in Alternative 2 are proposed on 562 acres. Sanitation cuts are designed to harvest trees of poor quality and at risk of dying during the next 5 to 10 years and to reduce stocking in overly-dense stands to enhance residual tree survival, health, and growth. This will also maintain fast growth on the best trees to avoid stagnation and insect and disease problems, in addition to promoting larger diameter trees in a shorter time frame. Opening up the stands will maintain or encourage a forage component in the stand by allowing light to reach the ground. This will also stimulate under-story development. The visual characteristics will be enhanced in the stand by promoting larger trees. Developing larger tree crowns will increase seed and mast production on residual trees.

Leaving the best-formed, healthiest and youngest trees in the dominant size class in the stand for future growth will be the practice in these stands. Removing the high risk and poor quality trees will be the objective (red oak group). The trees that remain following harvest would consist primarily of large diameter trees with healthy crowns and adequate growing space.

Commercial Thinning

Thinning cuts in Alternative 2 are proposed on 1,197 acres. These treatments are predominantly planned within existing pine plantations within the analysis area.

The objective of this treatment is to maintain a stocking level of dominant trees that fully utilizes the growing space while allowing for optimum growth on the remaining trees in order to avoid stagnation and insect and disease problems, in addition to promoting larger diameter trees in a shorter time frame. This is accomplished by thinning pine and younger hardwood in the main size class from below, leaving the best-formed dominant trees in the stand for future growth. Additional benefits include encouragement of a forage component in the stand by allowing more light to the ground. This will also begin to develop a native hardwood/pine understory if an existing undesirable understory is not already present.

Natural Regeneration

Natural regeneration site preparation would be completed on many sites proposed for either even-aged or uneven-aged regeneration (see Table 3 - 9 below). Conducted following seed tree, shelterwood and some uneven-age harvests, this treatment would encourage sprouting of desired

species and involves chainsaw cutting poorly formed, suppressed, or severely damaged trees that may interfere with development and growth of the desired species. Trees specially designated for retention on the site would not be cut. Cutting undesirable species, such as red maple, and sassafras will not eliminate them from treated stands since most stumps will produce sprouts. Cutting these trees will primarily reduce their stature, shading, and competitive advantage over commercially desired oak, hickory, and shortleaf pine reproduction.

Pine Planting

Pine planting would be completed on selected sites following a complete salvage (see Table 3 - 9). These selected areas are predominantly black oak stands in late stages of decline. These areas are either lacking advance reproduction needed to replace the dying black oak or have black oak reproduction that will merely create the same problem of monoculture stands currently being experienced. This treatment would only diversify the future stand and is not intended nor designed to be a pine plantation. Mixed species stands are considerably more resilient to natural events such as drought, fire, or insect and disease infestation, and the pine planting prescription will help ensure long term sustainability for these areas.

Table 3 - 9: Proposed Reforestation Activities by Action Alternative (acres)

Activity	Alternative 2	Alternative 3
Pine Planting	667	0
Site Preparation for Planting *	667	0
Natural Regeneration Site Preparation	2,512	2,167
Total Acres	3,179	2,167

* Included in Natural Regeneration total in Activity Listing.

Prescribed Fire

Prescribed fire effects, as described above, are proposed in specific areas to reduce hazardous fuels and to enhance wildlife habitat. Where these areas contain proposed harvest units, a companion benefit would be the establishment of new tree seedlings to perpetuate well-stocked forest cover and to increase the forb and grass component in the stands that are burned.

Roads

Road reconstruction proposed under this alternative includes 8.4 miles of system road and 25 miles of non-system roads. Tree removal within the right-of-way is minimal on these existing roads. The disturbance to vegetation is very limited, and road stability is restored to minimize erosion potential. For temporary access, these existing non-system roads would be reopened and graveled as needed. Upon completion of all management activities, these roads are then decommissioned.

Alternative 3 – Reduced Complete Salvage with Natural Regeneration Only

Complete Salvage

Complete Salvage with reserves is proposed on 637 acres. The differences in effects under this action alternative include a reduced harvest acreage (294 acres) and resulting early successional habitat. Under this alternative, any proposed complete salvage in Alternative 2 that would exceed

40 acres or was adjacent to an existing regeneration opening, which when combined would create a temporary opening greater than 40 acres, is eliminated. The excluded acreage under this alternative represents a significant amount of mortality and decline which would not be treated. The resulting stands would be allowed to degrade further and lose the regeneration potential as other effects described in Alternative 1 for high risk black and scarlet oak stands.

Additionally, no pine planting would be planned under this alternative. Natural regeneration would be the featured reforestation method as described above. This would result in a lack of needed species diversity in the stands identified to be regenerated to address oak decline issues.

In this alternative, all other harvest treatment levels and effects described in Alternative 2 remain the same.

Natural Regeneration

Natural regeneration site preparation treatments proposed under this alternative will have the same effects as described above, only they will be reduced at the same level of the complete salvage.

Road Reconstruction

Road reconstruction needs and effects remain the same under this alternative. A reduced need for temporary access under this alternative will eliminate 2 miles of non-system road use.

Cumulative Effects on Vegetation

Within the Crooked Creek Analysis Area, approximately 50 % of the land base is within federal ownership. The remaining private land is owned primarily by local landowners, mainly in small farms or woodlots. Approximately 12 % of these private holdings are in open condition either for pasture or agricultural use. The remaining private land is generally in timber consisting of a wide variety of management conditions. Past activities on private land include timber harvest, grazing, and land clearing for conversion to pasture. Some tracts are “unmanaged” areas reserved for aesthetic values by the landowner. Timber harvest within this area is both traditional and generally accepted as legitimate use of land. Public land management as proposed will blend with surrounding private property management history and may well add to overall vegetative diversity and resiliency.

Under **Alternative 1**, no vegetative management would take place. Forty-eight percent (48 %) of the stands within the Analysis Area are over 70 years old and an additional 27 % are over 50 years old. In the short term, these stands would continue to mature and remain high risk or low quality (see Table 3 - 10) The species composition of stands that are heavy to red oak species would change as the over-story and mid-story oaks continue to die out and are replaced by shade tolerant under-story and/or the existing advance reproduction primarily of the red oak group. As the mature trees continue to die, they then lose the ability of coppice sprouting, resulting in a lower percentage of intolerant oaks than currently exists. This change will be less pronounced on north and east facing slopes and in the few stands currently dominated by white or post oak. Over the long term, species composition would depend on available seed source and the amount of natural disturbance (mortality, drought, wind, ice storms, or wildland fire). Age-class distribution would tend to become further skewed towards the older age-classes since no new age-classes are being created except in stands suffering from extreme oak decline. In which case, the lack of advance reproduction is expected to be inadequate to fully utilize the site, allowing non-mast producing species to become more prevalent. The effects of this alternative would not necessarily be significant, but they would be obvious from the amount of dead and dying trees.

Table 3 - 10: Stand Condition Classes

Stand Condition	Acres (%)
1 – High Risk	3,948 (17)
2 – Sparse	396 (02)
3 – Low Quality	4,203 (18)

Alternatives 2 and 3 propose various combinations of vegetative treatments which include complete salvage, seed tree cuts, shelterwood cuts, UAM cuts, and over-story removal cuts, as well as intermediate harvests, such as sanitation and thinning. Table 3 -10 illustrates the treatment of these high risk and low quality stands by alternative. A look at just two age classes serves to explain most of what will happen in the Analysis Area over time. By examining the age-class 0-9, we can evaluate how alternatives effect regeneration.

The effects of treatments specified in **Alternatives 2 and 3** would be to increase the 0-9 year age class for the next decade (2004-2013) to 4.1 % and 2.8 % respectively. In 2004, the 0-9-age class on federal land within the analysis area is currently 3.4 %. By 2005, 372 acres will have grown into the next age class (10-19). The remaining 217 acres of existing 0-9 age class will grow into the next age class by 2006 (see Table 3 - 11).

Table 3 - 11: Potential 0 – 9 Age Class by Alternative (Complete Salvage and Seed Tree)

% 0 – 9 *			
Year	2004	2005	2006
Alt 1	2.5	1.0	0.0
Alt 2	2.5	5.1	4.1
Alt 3	2.5	3.8	2.8

* This does not include shelterwood harvest areas as 0-9.

In 2004, the high risk, sparse, and low quality stand condition classes made up 8,547 acres of the analysis area (Table 3 - 10). Many of these are the featured areas for the treatment alternatives due to the advanced decline and mortality. The remaining stands in these classifications are not currently prescribed for treatment and are to be retained as old growth, riparian areas, or for other resource values.

Alternatives 2 and 3 would address issues of public safety, oak decline, forest health, and wildlife habitat enhancement toward the DFC within the LRMP. Additionally, forest products would be produced as well as the jobs associated with timber harvesting and the wood products industry. The cumulative effects of these action alternatives would not be significant in relation to negative impacts; however, they would have lasting positive impacts over time.

Vegetation – Fire Management

The Federal Wildland Fire Management Policy and the MTNF Land and Resource Management Plan (Forest Plan) are the guiding policy documents for fire management on the MTNF.

The Federal Wildland Fire Management Policy directs Federal agencies to achieve a balance between suppression to protect life, property, and resources, and fire use to regulate fuels and maintain healthy ecosystems. The Forest Plan further identifies the fire management policy on National Forest System lands is to provide fire protection and fire use programs that are cost effective and responsive to management area objectives. The policy also allows for the use of prescribed fire to meet management

direction as appropriate for ecosystems involved and to meet project objectives (Mark Twain LRMP, page IV 74-76).

The amount of fuel loading occurring in natural communities affects how a fire burns and its effects on the landscape. The fire's intensity, and how it burns in the environment either enhances or impacts natural resources, and either reduces or threatens harm to human life, property, and the environment. Reducing the fuel can reduce the likelihood and intensity of wildland fires while simultaneously enhancing wildlife habitat and enriching native oak-pine woodland vegetation.

The attempt to eliminate fire from natural landscapes has been demonstrated to be futile. When fire threatens societal values, hazard fuel reduction treatments can aid suppression by providing safe access for firefighters and has shown that fire intensities are reduced when wildland fire burns into an area that has had fuels treatment. A fuels treatment program has the potential to increase fire behavior due to an increase in the production of fuels with high surface-area-to–volume ratios through a lowering in moisture content from solar radiation and growth stimulation of fine herbaceous fuels. Research and anecdotal information shows fuels treatments do moderate--extreme fire behavior within treated areas and provides for landscape management that balances the preference to avoid the recurrence of damaging wildfire (Omi and Martinson 2002).

The fire regime of the oak-hickory forest varied because of changing cultural influences. Dendro-chronological studies conservatively suggest fire return intervals of 7 to 14 years in the Ozarks. Cutter and Guyette (1994) reported a fire-return interval of 2.8 years on a ridge top in the Mark Twain National Forest during 1740 – 1850.

Generally during prescribed fire with flame lengths of less than four feet, damage to dominant oaks is not a problem in uncut stands due to the fuel loadings, while in a shelterwood cut, care must be taken so that slash has not accumulated at the base of the trees. Prescribed fire has considerable value as a silivcultural method, a wildlife management tool and a means for restoring habitats such as oak savannas and open woodlands. (Wade, et al 2000)

The effects of fires on trees are variable and dependant on tree species, site conditions, intensity of the fire and time of year (i.e. whether it is growing season or dormant). Tree bark thickness directly relates to the trees survivability. The thicker the bark the more likely it is unaffected by fire. Smaller saplings (less than 4 inch dbh) can be top killed by fire, but readily re-sprout from dormant buds at or above the root crown (Carey 1992).

Perhaps the single greatest fire management problem in the Mark Twain centers on the continuously evolving Wildland/Urban Interface issue (WUI). The intermingled land ownership pattern in the Mark Twain oak-pine and oak-hickory ecosystem creates an ever-increasing challenge for the Forest and its fire management partners. We are now facing an increased fire threat due to oak mortality and oak decline in the Crooked Creek Analysis Area. This declining forest condition is contributing to the increasing fuel load.

Proposed prescribed burning in the Crooked Creek Analysis Area follows direction within the Federal wildland Fire Management Policy with each prescribed burn authorized by the Line Officer in a written burn plan that is prepared by a qualified individual. The written plan lists all prescriptive criteria under which the specific burn shall be conducted, and includes a risk analysis and contingency planning in the event the burn project goes out of prescription. Each prescribed burn plan complies with planning and execution elements specified the forest service Manual 5140.

Fire season for the Salem Ranger District has been established as a fall season, October 10 through December 10, and spring season February 1 to May 24. During the other time periods, fire occurrence is normally low due to weather and fuel conditions. During the fire season, historically 63 days with high to extreme fire behavior conditions occur.

Our knowledge of fuels is sufficient enough that fuel models have been developed to model expected fire behavior to describe a fire situation based on site-specific data of fuels conditions and weather information. The Fire Intensity Level (FIL), which corresponds to flame height is a predictor to a fire's effect on the environment. Wildland fires that occur during high to extreme burning conditions are expected to burn at a FIL 3 or FIL 4, which would produce a flame height in excess of four feet. Proposed prescribe burns would be conducted under low to moderated fire behavior conditions and produce flame heights of less than three feet.

Direct and Indirect Effects on Fuels

Alternative 1 – No Action

Under Alternative 1, No fuels treatment, through prescribe burning would occur. The USFS would continue the wildland fire suppression program for the analysis area, however the potentially hazardous fuel situations that now exist within the analysis area would be left untreated and continue to pose risk to firefighter and public safety, property, and resource values. Fuel loads would continue to accumulate until there was a natural disturbance that mitigated the fuels situation.

The no action alternative would perpetuate fuel accumulations that could result in more extreme wildland fires that tend to increase the risk of stand-replacement fires in the analysis area. High-intensity fires (FIL 3 or 4) often result in direct, widespread mortality of overstory tree layers in forest (Brown 2000) due to the severity of the burn. They also tend to consume a larger percentage of both forest floor and below ground plant biomass relative to cooler fires and prescribed burns (Whelan 1995; Pyne 1991). Under this alternative, healthy timber and regenerating stands would be at the greatest level of risk to high-intensity fire and would, therefore, be more likely to sustain damage. In these circumstances, the overall mortality of trees, shrubs, and herbaceous flora would be expected to be higher than under the other project alternatives.

Items Common to All Action Alternatives

Firing methods would be to use spot fire ignition on the interior of the burn working the regenerating stands first by firing the up hill side of each stand and allowing fire to back through each stand. This would be done in the early morning while still in the high end of the prescription (high relative humidities and lower temperatures). Next, ignitions (including aerial) would continue in the afternoon during the low end of the prescription (lower relative humidities and higher temperatures) on the major ridges so that fire can back down the ridges in a mosaic pattern with a low to moderate fire intensity. By keeping the fire at this lower intensity, any potential for damage to healthy timber will be minimal. Strip ignition patterns ignited by hand will be used on the perimeters in such a fashion that will reduce the chance of head fire starting from the control lines.

Alternative 2 - Proposed Action

Under Alternative 2, 8401 acres broken into burn units are identified for fuels reduction treatment and open woodland development through the use of prescribe fire. The prescribed burn units utilize natural and existing man-made features, supplemented with some newly constructed fire line to create project areas that from technical and safety considerations are logical and implementible with little additional ground disturbance. These burn units have been selected for fuels reduction in that they represent a fire regime and condition class two or three or are in the wildland urban interface where fuels reduction would be beneficial. Fire regime refers to the long-term nature of fire in an ecosystem including both frequency and severity of effects. Fire severity describes the condition of the ground surface after burning, and fire

intensity is the rate at which an ongoing fire produces thermal energy. Oak leaf litter affects the likelihood of a fire sustaining ignition and increases fire intensity. It is widely believed that the oak-hickory forest evolved with frequent fire occurrence, which kept the forest open and that the now closed canopy dominate in the Missouri Ozarks is a result of fire suppression.

The prescribed fires would be conducted under fire behavior environmental conditions to produce a burn that is expected to stay under control and achieve the desired results. Fine fuels are the primary fuel that sustains fire in oak/pine forest, with the larger dead limb wood and logs contribute to severity and resistance to control. Objectives of the prescribe fire would be to consume 80 to 100 % of the leaf litter, removing about 50 % of the over abundant dead and downed limb wood on the forest floor and less than 50 % of the duff layer. A combination of ignition patterns and firing techniques to result in a fire with an intensity level and severity that is manageable, yet providing ability to manage smoke dispersal, and meet the burns objectives will be utilized.

Fire effects are related to intensity and duration of exposure. Any fire that consumes the entire organic layer and alters mineral soil structure would be classified as a severe burn.

Wildland fires that burn into areas previously burned cause less damage and are controlled more easily. The appropriate interval between prescribed burns for fuel reduction varies with several factors, including the rate of fuel accumulation, past fire occurrences, and values at risk. Prescribed fires on a three to five year cycle after an initial fuel reduction burn is usually adequate to maintain the desired conditions.

Alternative 3 – Reduced Complete salvage with Natural Regeneration Only

Under Alterative 3, the proposed fuels reduction treatments are the same as under Alternative 2, and would have the same effects.

Cumulative Effects on Fuels

The 8401 acres proposed for treatment with prescribed fire represents roughly thirty-three percent of the analysis area, with approximately one third of the proposed acres being treated in any one year. Prescribed fire has been shown useful for maintaining the diversity of oak-hickory forest, and has been used to modify understory composition and/or size class structure. Most oaks are resistant to fire, to some extent, with resistance increasing generally with increases in stem diameter. In the prescribed burn units, it is expected that the forest would be more open. In previous prescribed burns in grasslands and adjoining woods, an increase in flowering of forbs and reduction of woody species were recorded. Fires that occur in areas previously burned were patchy and of low severity due to lack of surface fuels.

Wildlife

Existing Condition

Wildlife in the Missouri Ozarks is diverse and abundant. This diversity and abundance is as a result of the following factors: southern Missouri is at the crossroads of the eastern hardwood forest, southern pine forest, and western tallgrass prairie and some species are at the edge of their range here; southern Missouri was not glaciated so there are some species that are relicts of when the ice sheets receded; the Missouri Ozarks are also one of the most extensive karst areas of the country, with the resulting diversity of cave-adapted species. These factors make the Ozarks by far the most biologically diverse region of the state, and one of the most significant centers of biodiversity in the country (The Biodiversity of Missouri, MDC 1992).

The Missouri Fish and Wildlife Information System (MOFWIS) lists 548 vertebrate species that may

occur in Crawford and Dent Counties in the Meramec watershed (1/30/04). While each of these species is important, it would be impossible to evaluate potential effects of this project on every one. Therefore, this analysis will focus on those species of special significance to this analysis area and include Management Indicator Species, neotropical migratory birds, and species with viability concerns (federally listed, Eastern Region sensitive species, state endangered species). By analyzing potential effects on these species, as well as special habitats and habitat conditions described in the Forest Plan, all habitats present in the analysis area will be covered.

Management Indicator Species

Also identified in the Forest Plan are several species considered to be indicators of the general forest condition and its ability to provide for overall wildlife species' viability. These species are considered Management Indicator Species (MIS) and have been identified for each LTA. For the Oak Hickory Hills and Oak-Pine Hills LTAs, thirteen MIS species have been identified (refer to Table 3 - 12).

Table 3 - 12: Management Indicator Species for the Crooked Creek Analysis Area

Pileated woodpecker	White-tailed deer	Ruffed grouse
Ovenbird	Raccoon	Bobcat
Wild turkey	Wood thrush	Indigo bunting
Bobwhite quail	Orchard oriole	Eastern bluebird
Cottontail rabbit		

These MIS are connected to many of the habitat objectives that have been identified in the Forest Plan. Refer to Table 3 - 13 for a crosswalk of the MIS and their associated habitat objectives.

Table 3 - 13: Forest Plan Wildlife Habitat Objectives that Have Been Established for the Oak-Hickory Hills and Oak-Pine Hills LTAs and the MIS that are Associated with Each of these Objectives.

Habitat Objective	MIS that Would be Expected to Utilize this Habitat Condition
1. Woodland habitat in the 0-9 year age class	Wild turkey, White-tailed deer, Ruffed grouse, Indigo bunting, Eastern bluebird, Bobwhite quail, Cottontail rabbit
2. Woodland habitat in the old growth condition	Pileated woodpecker, Wild turkey, White-tailed deer, Raccoon, Wood thrush, Bobcat
3. Woodland habitat in the oak and oak-pine types over 50 years of age	Pileated woodpecker, Ovenbird, Wild turkey, White-tailed deer, Raccoon, Wood thrush, Bobcat
4. Woodland habitats in pole and sawtimbe size classes with crown closure over 80 %	Pileated woodpecker, Wild turkey, White-tailed deer, Raccoon, Wood thrush, Bobcat
5. Woodland sawtimber habitat in the oak, oak-pine, and pine type that has a condition of 20-30% forbs, grass, and shrub ground cover	Pileated woodpecker, Ovenbird, Wild turkey, White-tailed deer, Raccoon, Wood thrush, Ruffed grouse, Bobcat, Indigo bunting
6. Woodland habitat in the oak type over 50 years of age with dense understory	Pileated woodpecker, Ovenbird, Wild turkey, White-tailed deer, Raccoon, Wood thrush, Ruffed

Habitat Objective	MIS that Would be Expected to Utilize this Habitat Condition
	grouse, Bobcat, Indigo bunting
7. Open and semi-open habitat	Wild turkey, White-tailed deer, Raccoon, Ruffed grouse, Bobcat, Indigo bunting, Eastern bluebird, Bobwhite quail, Cottontail rabbit, Orchard oriole
8. Permanent water sources	Wild turkey, White-tailed deer, Raccoon, Bobcat

It is important that the Mark Twain National Forest monitor the populations trends of these MIS in order to evaluate the effectiveness of planned activities and how these activities may influence MIS populations. Table 3 – 14 shows the most recent information regarding MIS population trends for the period of 1980 to 2000.

Table 3 - 14: Population Trends of MIS from 1980-2000 (% change)

MIS	Trend Statewide	Trend on the Ozark-Ouachita Plateau (contains most of the MTNF)
Wild turkey	-2.6 %	-2.6 %
Ruffed grouse	Slight decline	Slight decline
Northern bobwhite	-3.3 %	-4.9 %
Pileated woodpecker	-0.3 %	+0.5 %
Eastern bluebird	+1.6 %	+1.3 %
Wood thrush	+3.7 %	+2.7 %
Ovenbird	+2.2 %	+0.6 %
Indigo bunting	-0.1 %	+0.5 %
Orchard oriole	-0.9 %	-2.1 %
Raccoon	Stable	Stable
Bobcat	Stable in Ozarks	Stable in Ozarks
White-tailed deer	Stable	Stable
Cottontail rabbit	Stable	Stable

Source: FY 2002 MTNF Monitoring and Evaluation Report

Based upon the information in Table 3 - 14, MIS that may be declining on the Mark Twain National Forest are wild turkey, ruffed grouse, northern bobwhite, and orchard oriole. Reasons for these declines are not fully known. Although wild turkey populations may be declining, they are still considered a relatively common species on the National Forest and are frequently hunted. Ruffed grouse are uncommon on the National Forest, despite several reintroduction attempts, and it has been suggested that there is more habitat for ruffed grouse today than there are grouse available to occupy it (Jacobs and Wilson 1997). Declines in northern bobwhite quail and orchard oriole could be as a result of decreases in suitable habitat.

For this analysis, it is assumed that the population levels of MIS within the Crooked Creek analysis area are the same as the population levels identified in Table 3 - 14 for the Ozark-Ouachita Plateau. Field surveys conducted in preparation of this analysis indicated that all of these MIS have habitat within the analysis area. Eleven of these MIS (pileated woodpecker, ovenbird, wild turkey, wood thrush, indigo bunting, white-tailed deer, cottontail rabbit, northern bobwhite quail, eastern bluebird, bobcat, and raccoon) were documented within the analysis area during field surveys for this project and many, such as the pileated woodpecker, white-tailed deer, wild turkey, ovenbird, and indigo bunting, seemed to be relatively common (S. Bradley, pers. observation).

Birds (emphasizing Neotropical Migrants)

The Crooked Creek analysis area offers a wide variety of habitats, nearly all of which are occupied by various neotropical migratory birds during the spring through fall months. Many of these neotropical migrants breed within the analysis area. Approximately 294 species of birds are likely to be found within the analysis area (MoFWIS). Of these 294 species, approximately 148 species would be considered likely to use the analysis area regularly as breeding habitat and approximately one-third of these species that may breed in the analysis area are considered neotropical migrants (Jacobs and Wilson 1997). Many other neotropical migrants may not breed in the analysis area, but do use the area as "stopover" habitat during their migration to summer and wintering grounds.

Neotropical migrant birds, as well as many other bird species, are susceptible to a wide variety of factors that may influence their populations. Two of the most recognized management issues that have been determined to be important to maintaining populations of breeding birds, especially neotropical migrants, are:

- Avoiding fragmentation and loss of suitable breeding habitat, particularly forest habitat
- Monitoring and limiting opportunities for nest predation and parasitism by brown-headed cowbirds and other wildlife.

Regarding fragmentation of forest habitat, the analysis area is represented predominantly by mature oak-hickory forest and a variety of other habitats. Approximately 84 % of the analysis area (including private lands) is forested, with the remaining 16 % containing mostly agricultural and pasture on private lands with some scattered openings and grazing allotments on FS lands. Habitat availability within the analysis area for most birds species is shown in Table 3 - 15.

Table 3 - 15: Habitat Availability for Birds within the Crooked Creek Analysis Area

Birds associated with the following habitats	% of Birds in Ozark/ Ouachita physiographic area that are likely to occupy this habitat	Abundance of habitat within the analysis area
Wetland or riparian areas	13 %	Limited. Habitat is present along many miles of stream within the analysis area, however most is private pastures
Grassland or glades	17 %	Limited. Habitat present is represented by private pastures and some openings and glades on FS
Forests of various age classes	43 %	Abundant. 84 % of analysis area is forested (private and FS). Early successional forest and scrub-shrub habitat is limited.
No specific habitat	27 %	N/A

Source: Fitzgerald and Pashley 2000

As indicated in Table 3 - 15, the majority of birds within the analysis area would be species associated with forests. Habitat for closed-canopy forest-dwelling birds is not limited within the analysis area and is contiguous with both forested private lands and National Forest. Habitat for open-canopy, forest-dwelling birds, and birds that occupy scrub-shrub and early successional forests is limited, especially on private lands. Habitat for these species is most likely provided on National Forest in the analysis area, and based upon the existing percentage of habitat in the 0 to 9 year age class (2.5 %) and in open or semi-open conditions (4.0 %), habitat for these species on National Forest is also somewhat limited. Species

that occupy these scrub-shrub habitats are mostly relegated to roadsides, old fields, and powerline corridors within the analysis area. Many bird species prefer riparian habitat in the form of forested stream and river corridors. This habitat is limited and provided for within the analysis area mainly on private pastures that are adjacent to small streams within the analysis area, and along the West Fork of Huzzah Creek. Bird species that prefer grasslands are not well provided for within the analysis area and would be most likely restricted to fields/pasture on private and some open areas on FS within the analysis area.

The level of nest parasitism and cowbird parasitism that is occurring within the analysis area is unknown. Within the Ozark/Ouachita Physiographic area (which includes the Crooked Creek analysis area), reproductive success of forest-breeding birds appears to be above that needed to sustain local populations, and offspring from birds breeding in the physiographic area may be the sources of individuals that colonize other geographic areas where reproductive rates of forest birds are extremely low. Research in the Midwest has shown that such "source-sink" dynamics result primarily from the effects of high levels of cowbird parasitism and nest predation in areas where forest fragments fall below a size of 10,000 acres or where forest coverage across broad landscapes falls below 70 % (Fitzgerald and Pashley 2000). Therefore, since the Crooked Creek analysis area (including FS and private) is 84 % forested and contains well over 10,000 acre blocks of forested land, it is assumed that high levels of cowbird parasitism and nest predation are not occurring across the analysis area. However, some cowbird parasitism and nest predation may be occurring in some locally fragmented areas where forest land is interspersed with agricultural lands, wide road corridors, or other non-forested areas.

Currently, 33 species of birds have been identified as Partners in Flight priority species for the Ozark/Ouachita physiographic area (Fitzgerald and Pashley 2000). These priority species represent birds that deserve special conservation efforts that will ensure their viability. Of these 33 species, 28 are likely to occur and breed within the Crooked Creek analysis area (refer to Table 3 - 16).

Table 3 - 16: Partners in Flight Priority Species for the Ozark/Ouachita Physiographic are that are Likely or Known to Occur within the Crooked Creek Analysis Area (species in bold were documented in the analysis are during recent field surveys).

Swainson's warbler	Prothonotary warbler	**Ovenbird**	**Summer tanager**
Cerulean warbler	**Louisiana waterthrush**	**Pileated woodpecker**	**Wood thrush**
Kentucky warbler	Field sparrow	**Carolina chickadee**	Red-headed woodpecker
Worm-eating warbler	Orchard oriole	Chuck-will's widow	Loggerhead shrike
Prairie warbler	**Northern bobwhite**	**Blue-winged warbler**	**Purple finch**
Whip-poor-will	Brown thrasher	Yellow-billed cuckoo	Rusty blackbird
Acadian flycatcher	**Great-crested flycatcher**	**Yellow-throated warbler**	Bewick's wren

Field surveys also revealed the presence of many more bird species in the analysis area, several of which are neotropical migrants.

Specialized Habitats

The Forest Plan identifies many species that are associated with specialized habitats across the National Forest. Ongoing protection and maintenance of these specialized habitats is essential in maintaining the viability of these species and, thus, ensuring overall forest biodiversity. Species requiring these specialized habitats will receive priority when encountered (LRMP IV-51). Table 3 - 17 shows specialized habitats that are recognized in the Forest Plan and are known to occur within the Crooked Creek Analysis Area.

Table 3 - 17: Specialized Habitats in the Crooked Creek Analysis Area and their Associated High Priority

Specialized Habitat	Associated Priority Species (Species in bold were documented from the analysis area during recent field surveys)
Springs, seeps and fen	Oklahoma salamander, four-toed salamander, longtailed salamander, dark-sided salamander, cave salamander, graybelly salamander, Ozark zig-zag salamander, **southern red-backed salamander**, slimy salamander, grotto salamander
Riparian areas	No species identified.
Bottomland hardwood forests	Swamp rabbit, Swainson's warbler, Kentucky warbler, great blue heron, great egret, black-crowned night heron, yellow-crowned night heron, **Acadian flycatcher**, **hooded warbler**
Glades	Grasshopper sparrow, Bachman's sparrow, Texas mouse, greater roadrunner, common nighthawk, eastern collard lizard, eastern narrowmouth toad, six-lined racerunner, northern lined snake, eastern coachwhip snake, great plains rat snake, red milk snake, northern scarlet snake, ground snake, flathead snake, western worm snake, western pygmy rattlesnake, Texas horned lizard, southern coal snake, ornate box turtle
Shortleaf pine forest	Cooper's hawk, red-cockaded woodpecker, **sharp-shinned hawk**, long-eared owl, **pine warbler**, brown-headed nuthatch
Fishless ponds and temporary pools	Ringed salamander, **spotted salamander**, marbled salamander, central newt, **American toad**, Blanchard's cricket frog, **northern spring peeper**, **Cope's gray treefrog**, eastern narrowmouth toad, **southern leopard frog**, wood frog

Roads and Wildlife

Currently, the analysis area contains several hundred miles of maintained and unmaintained roads. The majority of these roads are state or county roads (refer to Table 3-18). The presence of roads can directly affect habitat for many species. Direct effects can include habitat loss and fragmentation, edge effects, and increased mortality and disturbance of wildlife.

Table 3 - 18: Approximate Miles of Roads within the Analysis Area on FS Managed Lands

Type of Road	Approximate Miles
State Highways	35
County Roads	83
Forest Service System Roads	52.5
Non-system roads on National Forest	55
Total Miles	225.5

Source: Roads analysis, A. Sullivan

Different wildlife species are affected by road systems in different ways, depending upon their habitat requirements and general life histories and behaviors. Various studies have indicated that, depending upon the species involved, some wildlife species are more tolerant of roads than others. Roads tend to create a distinct habitat, generally favorable to species that prefer edge habitats. For forest interior species, this could be detrimental; whereas, for other species, this may increase the amount of suitable habitat available to them.

"Road density" is often a useful index to determine the effect of roads on wildlife populations. High road densities in an area are often associated with a variety of negative human effects on several wildlife species (US Forest Service 2000). Even in a landscape of high average road density, a few large areas of low road density may be the best indicator of suitable habitat for large vertebrates (US Forest Service 2000). In the Adirondacks, for instance, the population of black bears was inversely related to road

density (US Forest Service 2000). Mountain lions have been found to establish home ranges in areas with lower road densities than the average in an area (Ercelawn 1999).

Another index associated with road density that may be used to determine the effects of roads on wildlife is the "road effect zone". The "road effect zone" is the zone or distance from a road in which wildlife species are directly or indirectly affected by activities occurring on or along the road. The effects of roads can extend some distance from their centers, so that their "effective widths" can be many times their actual widths. Research has determined that this "road effect zone" varies depending upon the type of wildlife species being considered. For example, in a Tennessee study, researchers found a 60 % decrease in arthropods within 50 ft (15 m) of roads (King and DeGraaf 2002). Other research indicates that large mammals tend to avoid roads and areas within 328 to 656 ft (100 to 200 m) of roads (Ercelawn 1999). Depending upon the edge habitat created by a road, some birds have been found to avoid habitat within 328 ft (100 m) of a forest edge and have lower nesting success within 164 ft (50 m) of forest edges (Ercelawn 1999). Other studies, however, have indicated that nest survival for some forest interior birds does not differ within 492 ft (150 m) and beyond 492 ft (150 m) from maintained forest roads (King and DeGraaf 2002), so further research in this area is warranted.

The type of road design and use also plays a key role in the effects of roads upon wildlife. Roads that are paved and have high traffic volumes, in which traffic is traveling at a high rate of speed, would be expected to have a greater "road effect zone" than unpaved roads with low traffic volumes. Black bears, for example, have been found to almost never cross heavily used roads, but cross roads with little traffic more frequently (Ercelawn 1999). Bobcats have also been found to cross paved roads less than expected (US Forest Service 2000). Small mammals, amphibians, and reptiles also are influenced by road conditions and traffic use. Some roads have been determined to be barriers to movement of eastern chipmunks and white-footed mice, and frog and toad density near paved roads has been found to decrease with increasing traffic density (Ercelawn 1999).

Road width also has an influence on its effect upon wildlife and their habitat. Generally speaking, the wider the road, the greater the edge effect it may have upon wildlife species. This may also be influenced by the surrounding landscape adjacent to the road. Roads that are wide enough to create a large gap in the forest canopy, for instance, could potentially fragment habitat for canopy-dependent birds and wildlife species and create corridors by which predators can enter the forest and affect wildlife populations (US Forest Service 2000). In general, biological invasion of predators and undesirable edge species, whether they be plant or animal, is another negative effect of extending roads into forest interiors (US Forest Service 2000).

With regards to forest fragmentation, one group of species that tends to be of great concern is the forest-interior birds. This group represents birds that tend to prefer large tracts of contiguous, mature forest, located away from edge habitats and openings. Where this habitat does become fragmented by edge and openings, these species may be especially vulnerable to cowbird nest parasitism and general nest predation. In a study conducted by King and DeGraaf (2002), the effect of forest roads on the reproductive success of forest-dwelling passerine birds was studied. The results of this research indicated that small (< 26 ft; 8 m wide) forest roads had no negative effects upon the reproductive success of forest passerine birds nearby, and that there was no evidence that ovenbirds, a species known to be sensitive to fragmentation, actively avoided nesting near roads within this width range. While there may be some consensus that the effects of forest roads varies with road width and density, this study by King and DeGraaf indicated that roads < 26 ft (8 m) wide, and areas with a road density < 2.7 mi/sq.mi (1.7 km/km2), are below the threshold at which significant negative effects on forest birds appear.

In this analysis, the road width and type of road design were taken into account when determining a "road effect zone" for each alternative. Using applicable research as a guide, it has been assumed in this analysis that the State and County roads have an effective width of 656ft (200m), Forest System roads have an effective width of 328 ft (100m) and non-system roads have an effective width of 164 ft (50m)

extending from either side of the road. Temporary roads were not included in calculating "road effect zones" because they are generally < 26 ft (8 m) wide and are temporary in nature.

Forest Plan Habitat Objectives for Wildlife

The Forest Plan identifies eight habitat objectives that are to be used to indicate viable populations of terrestrial wildlife on the Mark Twain National Forest. Each habitat objective represents a particular forest condition that projects should strive to achieve in order to ensure ongoing viability of wildlife species on the Forest. This does not necessarily mean that projects must achieve these habitat conditions within the 10-year planning period, but rather, that each project planned on the Forest should either move the area toward these conditions or, at least, not preclude moving the area toward them in the future.

There are two levels of habitat objectives established in the Forest Plan for achieving and maintaining terrestrial wildlife species' viability. One level represents the Minimum Viable Population (MVP) level. The MVP level represents the minimum percentage of a habitat condition that should be provided within a particular Landtype Association (LTA) in order for species' viability to be maintained. The MVP habitat objectives for each LTA are identified on pages IV-59 through IV-65 in the Forest Plan. Projects that cause a particular habitat condition to fall below the MVP may jeopardize the viability of some species on National Forest within that particular LTA.

The second level represents the Desired Future Condition (DFC) level. A DFC level has been established for most of the Management Prescriptions (MP) on the Forest and their respective LTAs. The DFC level represents the percentage of a habitat condition that is desired within a particular LTA in order for that LTA to provide the optimum amount of habitat necessary to ensure all species' viability. Projects should be planned with an objective of moving the analysis area toward the DFC for each LTA. The Crooked Creek analysis area falls within the 3.4 Management Prescription (MP) and the Oak-Hickory Hills (OHH) and Oak-Pine Hills (OPH) Land Type Associations (LTA). The 3.4 MP general objective for wildlife is to provide habitats for native and naturalized fish and wildlife common to the area while emphasizing habitat for management indicator species groups and for those species most sought by the public (FP IV-118). Table 3 - 19 and 3 - 20 identify the eight wildlife habitat objectives (with one row added to display designated old growth) for the OHH and OPH LTAs and the existing condition within the analysis area.

Table 3 - 19: Forest Plan Wildlife Habitat Objectives that have been Established for the Oak-Hickory Hills when they Occur within the 3.4 Management Prescription

Habitat Objective	MVP	DFC	Existing Forest-wide Levels within the Oak-Hickory Hills LTA*	Existing Analysis Area Levels within the Oak-Hickory Hills LTA**	Need for change
1. Woodland habitat in the 0-9 year age class	4 %	8-15 %	2 %	3.4 %	Increase
2. Woodland habitat in the old growth condition	5 %	10-15 %	4.5 %	1.8 %	Increase
2a. Designated old growth				10 %	Maintain
3. Woodland habitat in the oak and oak-pine types over 50 years of age	35 %	45-55 %	44 %	44 %	Decrease (due to oak decline)
4. Woodland habitats in pole and sawtimber size classes with crown closure over 80 %	20 %	25-35 %	43 %	87 %	Decrease
5. Woodland sawtimber habitat in the oak, oak-pine, and pine type that has a condition of 20-30 % forbs, grass, and shrub ground cover	20-30 %	40-50 %	Below required for MVP	7.8 %	Increase
6. Woodland habitat in the oak type over 50 years of age with dense understory	5 %	10-15 %	13 %	7.3 %	Increase
7. Open and semi-open habitat	1 %	10-20 %	15 %	7.5 %	Maintain/Increase
8. Permanent water sources per square mile	1 per sq. mile	1-4 per sq. mile	1.5	1.5 per sq. mile	Maintain/Increase

*source: FY2002 MTNF Monitoring and Evaluation Report
**source: cds_hap reports 02/10/04
#source: cds data

Table 3 - 20: Forest Plan Wildlife Habitat Objectives that have been Established for the Oak-Pine Hills when they Occur within the 3.4 Management Prescription

Habitat Objective	MVP	DFC	Existing Forest-wide Levels within the Oak-Pine Hills LTA*	Existing Analysis Area Levels within the Oak-Pine Hills LTA**	Need for change
1. Woodland habitat in the 0-9 year age class	4 %	8-15 %	4 %	2.3 %	Increase
2. Woodland habitat in the old growth condition	5 %	10-15 %	3 %	2.2 %	Increase
2a. Designated old growth				10 %	Maintain
3. Woodland habitat in the oak and oak-pine types over 50 years of age	25 %	35-45 %	50 %	63.6 %	Decrease (due to oak decline)
4. Woodland habitats in pole and sawtimber size classes with crown closure over 80 %	20 %	35-45 %	54 %	89 %	Decrease
5. Woodland sawtimber habitat in the oak, oak-pine, and pine type that has a condition of 20-30 % forbs, grass, and shrub ground cover	20-30 %	40-50 %	Below required for MVP	21.2 %	Increase
6. Woodland habitat in the oak type over 50 years of age with dense understory	10 %	10-15 %	9 %	20.4 %	Maintain/Decrease
7. Open and semi-open habitat	1 %	7-12 %	7 %	6.5 %	Maintain/Increase
8. Permanent water sources per square mile	1 per sq. mile	1-4 per sq. mile	1.5	2.5 per sq. mile	Maintain/Increase

*source: FY2002 MTNF Monitoring and Evaluation Report
**source: cds_hap reports 02/10/04
#source: cds data

The existing levels within the 3.4 MP of the analysis area indicate that the current condition within the analysis area reflect the current conditions across the Oak-Pine Hills and Oak-Hickory Hills LTAs forest-wide. The levels show a heavily forested, aging forest condition in which a majority of the forest is greater than 50 years of age and has > 80 % canopy cover. As would be expected given these dense forest conditions, the levels of more open forest habitat are considered low and should be increased in order to provide for species that require open areas with a dense grass or shrub understory. The levels of 0 to 9 year old forest, of forest in an old growth condition, and sawtimber forest with 20-30 % forb and shrub ground cover are particularly low and need to be increased forest-wide. Currently, these habitat

conditions are below the minimum identified as necessary in the Forest Plan for ensuring some species' viability.

Federally Threatened and Endangered Species

The Forest Service is legally required to provide protection to insure survival of federally listed species. In Missouri, twelve federally listed species are considered to have habitat or known populations on the Mark Twain National Forest. These species and their most current population trends in Missouri are identified in Table 3 - 21.

Table 3 - 21: Federally Listed Species Considered and their Population Trends in Missouri

Species	Trend	Species	Trend
Gray bat	Stable	Scaleshell mussel	Decreasing
Indiana bat	Decreasing	Tumbling Creek cavesnail	Decreasing
Bald eagle	Increasing	Ozark hellbender	Decreasing
Topeka shiner (fish)	Decreasing	Hine's emerald dragonfly	Unknown
Curtis' pearlymussel	Decreasing, possibly extirpated	Running buffalo clover	Stable
Pink mucket pearlymussel	Stable	Mead's milkweed	Decreasing

Source: FY 2002 MTNF Monitoring and Evaluation Report

The US Fish and Wildlife Service identified these twelve species in a letter to the Forest Supervisor, dated 12/29/03. Of these twelve species, six are considered likely to occur in the Crooked Creek analysis area (Table 3 - 22).

Table 3 - 22: Federally Listed Species Considered Likely to Occur or to have Habitat within the Crooked Creek Analysis Area.

Status	Common Name	Associated Habitat within the Analysis Area
Threatened	Bald eagle	Forest along large streams
Endangered	Gray bat	Caves and riparian areas
Endangered	Indiana bat	Caves and forests
Endangered	Hine's emerald dragonfly	Groundwater fed, limestone or dolomite grassy wetlands or fens
Endangered	Running buffalo clover	Open, well-lit stream sites
Threatened	Pink mucket pearlymussel	Meramec river

Federally listed species described in the Missouri Fish and Wildlife Information System (MOFWIS) as known or likely to occur in Crawford and Dent Counties within the Meramec watershed are **bald eagle, gray bat, Indiana bat, Hine's emerald dragonfly, pink mucket, and scaleshell.** The MTNF BE Program documented the presence of habitat for **running buffalo clover, Indiana bat,** and **gray bat** within the LTAs for this project. A review of the Missouri Heritage database (10/28/03, ver.1.3) documented occurrences of only **Hine's emerald dragonfly** within the analysis area. Three Indiana bats and two Gray bats were captured in July 2004 near the analysis area.

Additional information regarding these species can be found in the federally listed species BAE prepared for the Crooked Creek analysis area, April 13, 2004, and Supplement dated August 20, 2004 (see Appendix E).

Regional Forester's Sensitive Species and other Species of Concern

Regional Forester's Sensitive Species (RFSS) considered in this analysis are those included in the list dated 2/29/2000 with maintenance on 10/20/03.

A review of field surveys, the Missouri Fish and Wildlife Information System (MoFWIS) for Crawford and Dent Counties (Meramec River drainage), Missouri, plus a review of the Missouri Heritage 2003 (10/28/03, ver. 1.3) database, and the MTNF BE Program for the two LTAs in the analysis area indicated that the following RFSS are known or likely to occur in the Crooked Creek analysis area:

Table 3 - 23: Regional Forester's Sensitive Species Likely or Known to Occur within the Analysis Area or that May be Affected by Project Activities (Species' scientific names in bold have been documented in the analysis area; species' scientific names not in bold are considered known or likely, according to BE Program and MOFWIS, but have not been documented within the analysis area)

Scientific Name	Common Name	Species Group	Suitable Habitat in Analysis Area
Agalinis skinneriana	Purple false-foxglove	Plant	Glades
Aimophila aestivalis	Bachman's sparrow	Bird	Glades, old fields, clearcuts
Anemone quinquefolia	Wood anemone	Plant	Fens
Aster dumosus var. strictior	Tradescant aster	Plant	Fens
Aster furcatus	Forked aster	Plant	Moist rocky ledges
Aster macrophyllus	Big-leaved Aster	Plant	Cliff face/bare rock
Calamagrostis porteri var. insperata	Oferhollow reed grass	Plant	Cliff face/bare rock
Campanula aprinoides	Marsh bellflower	Plant	Fens
Campylium stellatum	Yellow starry fen moss	Moss	Fens
Carex buxbaumii	Buxbaum's sedge	Plant	Fens
Carex cherokeensis	Cherokee sedge	Plant	Miscellaneous wetlands
Carex decomposita	Epiphytic sedge	Plant	Miscellaneous wetlands
Carex fissa var. fissa	Hammock sedge	Plant	Miscellaneous wetlands
Carex sterilis	Dioecious sedge	Plant	Fens
Carex straminea	Straw sedge	Plant	Miscellaneous wetlands
Carex stricta	Tussock sedge	Plant	Fens
Carex tenanica	Rigid sedge	Plant	Fens

Scientific Name	Common Name	Species Group	Suitable Habitat in Analysis Area
Carex triangularis	Eastern fox sedge	Plant	Miscellaneous wetlands
Cryptobranchus alleganiensis	Eastern hellbender	Amphibian	Meramec drainage
Crystallaria asprella	Crystal darter	Fish	Meramec drainage
Cumberlandia monodonta	Spectacle case	Mollusk	Meramec drainage
Cycleptus elongatus	Blue sucker	Fish	Meramec drainage
Dendroica cerulea	Cerulean warbler	Bird	Bottomland hardwoods, riparian
Echinacea simulata	Wavy-leaf purple coneflower	Plant	Glades
Juglans cinerea	Butternut	Plant	Riparian, rich woods, base of slopes
Juncus debilis	Weak rush	Plant	Miscellaneous wetlands
Lanius ludovicianus migrans	Migrant loggerhead shrike	Bird	Old fields with scattered shrubs and trees
Menyanthes trifoliata	Bog buckbean	Plant	Fens
Metzgeria furcata	a liverwort	Plant	Cliff face/bare rock
Ophiogomphis westfalli	Westfall's snaketail	Insect	Fens
Parnassia grandifolia	Large-leaved grass of Parnassuss	Plant	Fens, seeps, springs
Phlox maculata ssp. pyramidalis	Spotted phlox	Plant	Fens
Potamogeton pulcher	Spotted pondweed	Plant	Miscellaneous wetlands
Schoenoplectus purshianus	Weak-stalk bulrush	Plant	Miscellaneous wetlands
Scutellaria bushii	Bush's skullcap	Plant	Glades
Silene regia	Royal catchfly	Plant	Glades
Solidago gattingerii	Gattinger's goldenrod	Plant	Glades
Spiranthes ovalis var. erostellata	Ladies' tresses	Plant	ens
Stenonema bednariki	A heptageniid mayfly	Insect	Meramec drainage
Sullivantia sullivantii	Sullivantia	Plant	Cliff face/bare rock
Torreychloa pallida	Pale manna grass	Plant	Miscellaneous wetlands

(MoFWIS report 12/3/03; BE Program reports run 11/19/03)

In addition to these RFSS species, there are other Species of Concern that have no Regional Forester or federal status, yet, are considered in this evaluation because they have some type of state designation that determines they are at risk in Missouri or throughout their range. These species were identified for the Mark Twain National Forest using the Missouri Fish and Wildlife Information System (MoFWIS) 7/13/00 and Wildlife Code of Missouri (3/1/03).

A review of this list using MoFWIS, the BE Program and the MTNF Heritage CD (10/28/03 ver. 1.3) indicated that, of all these Species of Concern, only the following would be expected to occur within the analysis area or be affected by project activities because there is habitat available within the analysis area or downstream from the analysis area.

Table 3 - 24: Additional Species of Concern Known of Likely to Occur in the Analysis Area or that May be Affected by Project Activities (Species' scientific names in bold have been documented in the analysis area; species' scientific names not in bold are considered known or likely, according to BE Program and MOFWIS, but have not been documented within the analysis area)

Scientific Name	Common Name	Species Group	Suitable Habitat in Analysis Area
Circus cyaneus	Northern harrier	Bird	Winter transient-pasture, large openings
Platygobio gracilis	Flathead chub	Fish	Meramec drainage
Elliptio crassidens	Elephantear	Mollusk	Meramec drainage
Epioblasma triquetra	Snuffbox	Mollusk	Meramec drainage
Fusconaia ebena	Ebonyshell	Mollusk	Meramec drainage
Plethobasus cyphyus	Sheepnose	Mollusk	Meramec drainage

Additional information regarding these species can be found in the RFSS and Species of Concern BAE prepared for the Crooked Creek analysis area, dated March 24, 2004 (see Appendix E).

Direct and Indirect Effects on Wildlife by Alternative (see Table 2 – 1: Activity Comparison Table)

Management Indicator Species (MIS)

Alternative 1: In general, old growth and mature forest would increase and early successional forest would decline. Existing openings would not be maintained and would decrease in size and quality of habitat. In addition, the variation within old growth habitats would be expected to decline with closed canopy forest becoming more dominant in the analysis area and open canopy forested habitats are declining. These changes would benefit MIS including the wood thrush, pileated woodpecker, and ovenbird. Other MIS would be expected to eventually decrease in the analysis area, especially species using openings. This includes indigo bunting, ruffed grouse, rabbit, bluebird, and quail.

Alternatives 2 and 3: Timber harvest activities, prescribed fire, maintenance of wildlife openings and water sources (and planting of short-leaf pine in Alternative 2) would help diversify habitats in the Crooked Creek analysis area. Timber harvest activities, such as complete salvage and seed-tree, would increase the early successional habitats that would benefit MIS including indigo bunting, ruffed grouse,

bobcat and forest edge MIS including orchard oriole and rabbits. There would be slightly more complete salvage activity in Alternative 2 than in Alternative 3 so there would be slightly more benefit to MIS using regeneration habitats. These activities would decrease mature and old growth forest, but the project would retain at least 75 % of the forest that is 50 years of age and older. Proposed timber harvest activities would also make an effort to retain all large diameter (>26" dbh) trees and trees that are hollow, which would benefit pileated woodpeckers and raccoons. Also, old growth has been designated along drainages to help provide continuous patches of this habitat type that are relatively unfragmented. These patches are large enough to help maintain pileated woodpecker, ovenbird, and wood thrush populations in the analysis area.

Other timber harvest activities such as shelterwood, thinnings, unevenaged harvest, sanitation cuts, and overstory removal would help diversify the mature and old growth forest. These activities would open the canopy and increase soft mast plant species, grasses, forbs and shrubs in the under-story. This increase in soft mast would help to offset the decrease in hard mast (acorns) due to the harvest of mature oaks. Increases in these plant species would also directly or indirectly increase forage and/or cover for MIS like eastern wild turkey, white-tailed deer, indigo bunting, raccoon, and bobcat. Indigo bunting does not require large patches of early successional habitats; as a result, group selections would make these mature and old growth forests more suitable for the bunting. These activities would not significantly affect the pileated woodpecker as long as some den trees and snags were reserved. All Forest Plan standards and guidelines would be followed for protection of den trees and snags. Wood thrush and ovenbird may decrease initially but would increase as shrubs become more dominant in the under-story.

Prescribed burning for open woodland development, hazardous fuels reduction, and maintenance of existing openings through burning, mowing, grazing, and handcutting would benefit MIS including quail, cottontail rabbit, and orchard oriole that use openlands and open woods. Prescribed fire would decrease the shrub component of the under-story, especially if the area is repetitively burned. In those areas that would be repetitively burned, shrubby under-story would only become dominant or a significant component in riparian habitats on north to east facing slopes. As a result, ovenbirds and wood thrush may be restricted to these areas.

Birds (Emphasizing Neo-tropical Migrants)

Alternative 1 would have no direct effects upon birds. Indirectly, this alternative would benefit species that prefer mature forest stands because it would not implement any activities that would result in younger forest stands or scrub-shrub habitat within the analysis area. Under Alternative 1, fragmentation of mature forest habitat would not be increased by any proposed actions on National Forest and increases in cowbird parasitism as a result of increased edge within the National Forest would not be expected. Species that occupy closed-canopy forests would be expected to remain at the current levels or increase slightly within the analysis area. Habitat for birds that occupy early successional forest and openings within the forest would continue to be limited within the analysis area and not increased under this alternative.

Table 3 - 25: Anticipated Effects of Alternative 1 upon Partners in Flight Priority Species for the Ozark/Ouachita Physiographic Area that are Likely to Occur within the Analysis Area

Species	Preferred Habitat	Effect of Alternative 1
Kentucky warbler, Prairie warbler, Whip-poor-will, Field sparrow, Orchard oriole, Northern bobwhite, Brown thrasher, Chuck-will's widow, Blue-winged warbler, Loggerhead shrike, Bewick's wren	Forest edge, young sapling/poletimber forest, scrub-shrub, fields, or openlands, often intermixed with mature forest.	Would not improve habitat conditions for these species. Habitat for these species expected to be reduced over the long term.

Species	Preferred Habitat	Effect of Alternative 1
Swainson' warbler, Cerulean warbler, Acadian flycatcher, Prothonotary warbler, Louisiana waterthrush, Yellow-throated warbler, Rusty blackbird	Mature riparian forests, often with some midstory and shrub development	Would maintain existing mature riparian forest. Would not encourage shrub development in the midstory and understory.
Worm-eating warbler, Great-crested flycatcher, Ovenbird, Pileated woodpecker, Carolina chickadee, Yellow-billed cuckoo, Yellow-throated warbler, Summer tanager, Wood thrush, Red-headed woodpecker, Purple finch	Mature forest with semi-open canopies and relatively open midstory and some shrub development	Would maintain and increase availability of mature forest in the analysis area. Would not improve conditions for species that prefer semi-open canopies or shrub development in the midstory and understory.

Alternatives 2 and 3 would implement several activities that may have a direct effect upon individual birds. Many stand treatments proposed involve tree felling, and this could destroy active bird nests and disrupt nesting or breeding behavior. Prescribed burning during the nesting season may also have a similar effect. However, this would be a short term effect and only involve some individual birds. Populations of these birds within the analysis area would not be expected to change as a result of these disruptions. Many birds would successfully renest following loss of a nest, depending upon various conditions.

Indirectly, this alternative would benefit birds that prefer early successional forest stands because it increases the availability of young forest and scrub-shrub habitat within the analysis area. These early successional forest stands would be surrounded by interconnected mature forest and not result in complete isolation of any mature forest stand from other mature forest stands. None of the activities proposed would result in conversion of any forested lands to non-forested lands. Where edge habitat is created by activities proposed in the alternative, the potential for increased cowbird parasitism and nest predation does increase. Given that most of the analysis area is forested, cowbird parasitism levels are not expected to be high within the analysis area. Some individual birds that occupy closed-canopy forests may be temporarily displaced by some activities proposed in Alternatives 2 and 3. However, even with implementation of these alternatives, population levels of these species would be expected to remain near the current levels within the analysis area since most of the analysis area would continue to offer mature closed-canopy forest. Habitat for birds that occupy early successional forest and openings within the forest would increase under this alternative but continue to be somewhat limited within the analysis area.

Table 3 - 26: Anticipated Effects of Alternative 2 and 3 upon Partners in Flight Priority Species for the Ozark/Ouachita Physiographic Area that are Likely to Occur within the Analysis Area

Species	Preferred Habitat	Effect of Alternatives 2 and 3
Kentucky warbler, Prairie warbler, Whip-poor-will, Field sparrow, Orchard oriole, Northern bobwhite, Brown thrasher, Chuck-will's widow, Blue-winged warbler, Loggerhead shrike, Bewick's wren	Forest edge, young sapling/poletimber forest, scrub-shrub, fields, or openlands, often intermixed with mature forest.	Would improve conditions for these species by increasing availability of forest edge, young forest and scrub-shrub habitat within the analysis area.

Species	Preferred Habitat	Effect of Alternatives 2 and 3
Swainson' warbler, Cerulean warbler, Acadian flycatcher, Prothonotary warbler, Louisiana waterthrush, Yellow-throated warbler, Rusty blackbird	Mature riparian forests, often with some midstory and shrub development	Would maintain existing mature riparian forest habitat and may increase shrub component within some riparian areas.
Worm-eating warbler, Great-crested flycatcher, Ovenbird, Pileated woodpecker, Carolina chickadee, Yellow-billed cuckoo, Yellow-throated warbler, Summer tanager, Wood thrush, Red-headed woodpecker, Purple finch	Mature forest with semi-open canopies and relatively open midstory and some shrub development	Would reduce some existing mature forest habitat but overall, habitat for these species would be maintained within the analysis areas in stands not proposed for treatments. Some stand treatments would improve conditions for species that prefer semi-open canopies and some shrub understory.

Specialized habitats

The effects of Alternatives 1-3 upon spring, seeps, fens, riparian areas, bottomland hardwoods, and glades and their associated species are described in the BAE prepared for RFSS and other Species of Concern (Appendix E).

Shortleaf Pine Forest

There are no naturally occurring shortleaf pine stands within the analysis area. There are some mixed oak/pine stands. **Alternative 1** would have no direct impact upon the oak pine forest because no activities would occur under this alternative that would directly disturb this habitat. Alternative 1 may have an indirect effect upon the occurrence of shortleaf pine within stands, however, because no disturbance would occur to forest stands under this alternative. Shortleaf pine is considered a "disturbance species," and generally responds favorably to activities such as burning, timber treatments, and other activities that open the forest canopy. Under Alternative 1, none of these types of activities would occur. As a result, existing mixed pine stands would gradually succumb to more shade tolerant species. Over many decades, this lack of disturbance would likely result in more hardwood stands and fewer mixed oak/pine stands within the analysis area.

Alternatives 2 and 3 would implement several stand treatments that are intended to regenerate and encourage shortleaf pine within the analysis area. Alternative 2 also proposes pine planting in some regeneration areas to help develop mixed oak/pine stands. Without these stand regenerating activities, many existing oak/pine stands would likely become more hardwood dominated. Prescribed burning proposed under Alternatives 2 and 3 would also improve conditions for shortleaf pine by creating more open stand conditions and reducing leaf litter, which would encourage natural pine regeneration.

Fishless Ponds and Temporary Pools

Alternative 1 would not have a direct effect upon any fishless ponds or pools because it does not propose any activities that would impact these habitats. Over time, this alternative may lead to a loss of ponds and pools within the analysis area because there would be no maintenance of existing ponds. Existing road ruts and mud holes in the analysis area could provide some of this habitat; however, these ruts and mud holes are heavily disturbed by traffic and offer only marginal habitat for species dependent upon this specialized habitat.

Alternatives 2 and 3 would maintain fishless ponds within the analysis area. This would improve habitat conditions for species that require this specialized habitat.

Roads and Wildlife

Alternative 1: There would be no change in the existing road density on National Forest within the analysis area because no new roads would be constructed as part of this alternative and no existing non-system roads would be decommissioned. Currently, the road density within the analysis area is approximately 6.2 mi. /sq. mi. This road density estimate includes all State, County, Private, and USFS System and Non-System roads that have been identified within the analysis area on FS lands.

Based upon research by King and DeGraaf (2002), a road density of 2.4 miles/sq. mile is at or below the threshold at which significant negative effects on forest birds generally appear. With a road density of 1.4 miles of system road/sq. mile of National Forest, the road density of FS system roads for the National Forest in the analysis area is below the Forest Plan's maximum density limit (LRMP IV-123). This indicates that the road density of FS roads is not at a level that would jeopardize any wildlife species' continued viability within the analysis area.

In Alternative 1, approximately 12,542 acres would be considered within the "road effect zone." Some wildlife species would be expected to avoid this "road effect zone" due to the likelihood that road noise, human activities, and edge effects would be greater with this zone than outside it. In particular, activities that may impact game species, such as hunting, trapping, and poaching, would be expected to be higher within this zone than outside it because these areas are more accessible. Other activities, such as gathering plant materials for medicinal or commercial uses and general wildlife observation, would also be expected to be higher within these zones. These zones would also be most likely to harbor or introduce non-native plant species, many of which are considered noxious weeds. The contribution that roads may be making within the analysis area to overall fragmentation of interior forest habitat would not change from the existing situation under Alternative 1. Because no existing non-system roads would be decommissioned under this alternative, there would be no reduction in edge effect that may be occurring as a result of existing roads in the analysis area. Conversely, no new roads would be constructed under this alternative; therefore, there would be no increase in fragmentation or edge effect as a result of new roads on National Forest System lands.

No unique communities or rare or listed-species would be expected to be further impacted directly by roads under Alternative 1. Although some unique plant communities, especially glades and seeps, occur close to some of the roads within the analysis area, effects to these unique communities as a result of roads would not be expected to change from the existing situation because this alternative does not propose any changes to the existing road conditions, locations, or maintenance. There are no federally threatened, endangered, or candidate species known to occur within any of the "road effect zones" or within the influence of any roads in the analysis area.

Table 3 - 27: Summary of Road Effects Indices for Alternative 1

Units of Measure		Potential Effects upon Wildlife
Road Density (includes state, county, FS system and FS non-system roads)	6.2 mi./sq. mi.	As road density increases, negative impacts upon wildlife such as habitat disturbance, road kill, and changes in their population distributions would likely also increase.
Acres within "Road Effect Zones"	12,542	These zones represent areas in which wildlife species would be most vulnerable to human activities and habitat conditions created by the roads.

Alternatives 2 and 3 propose the decommissioning of approximately 55 miles of existing, non-system roads within the analysis area. This would reduce the existing road density within the analysis area from 6.2 mi. /sq. mi to 4.7 mi/sq. mi. This road density estimate includes all State, County, Private, and USFS

System roads that would likely be maintained within the analysis area if these alternatives are implemented.

Based upon research by King and DeGraaf (2002), a road density of 2.4 mi. /sq. mile is below the threshold at which significant negative effects on forest birds generally appear. With a road density of 1.4 miles of system road/sq. mile of National Forest, the road density of FS system roads for the National Forest in the analysis area is below the Forest Plan's maximum density limit (LRMP IV-123). This indicates that the road density of FS roads is not at a level that would jeopardize any wildlife species' continued viability within the analysis area.

In Alternatives 2 and 3, approximately 11,449 acres would be considered within the "road effect zone". Some wildlife species would be expected to avoid this "road effect zone" due to the likelihood that road noise, human activities, and edge effects would be greater within this zone than outside it. In particular, activities that may impact game species, such as hunting, trapping, and poaching, would be expected to be higher within this zone than outside it because these areas are more accessible. Other activities, such as gathering plant materials for medicinal or commercial uses and general wildlife observation, would also be expected to be higher within these zones. These zones would also be most likely to harbor or introduce non-native plant species, many of which are considered noxious weeds.

In these alternatives, the contribution that roads may be making within the analysis area to overall fragmentation of interior forest habitat would be improved when compared to the existing situation. Because 55 miles of non-system roads would be decommissioned under this alternative, there would be an expected reduction in edge effect that may be occurring as a result of existing roads in the analysis area. Temporary roads would not be considered likely to increase the edge effect or fragmentation of habitat within the analysis area because of their temporary nature and narrow widths (26 ft; < 8 m). No new, permanent roads would be constructed under these alternatives; therefore, there would be no increase in fragmentation or edge effect as a result of new permanent roads on National Forest.

No unique communities or rare or listed-species would be expected to be further impacted directly by roads under Alternatives 2 and 3. Although some unique plant communities, especially glades and seeps, occur close to some of the roads within the analysis area and within areas where temporary roads would be constructed, adverse effects to these unique communities as a result of roads would not be expected to occur under Alternatives 2 and 3 because protective measures have been incorporated within these alternatives to protect these unique communities and species sites from potentially disturbing activities associated with road decommissioning and temporary road construction. There are no federally threatened, endangered, or candidate species known to occur within any of the "road effect zones" or within the influence of any roads in the analysis area.

Table 3 - 28: Summary of Road Effects Indices for Alternatives 2 and 3

Units of Measure		Potential Effects upon Wildlife
Road Density (includes state, county, FS system and assumes that FS non-system roads would be decommissioned under these alternatives)	4.7 mi./sq. mi.	As road density increases, negative impacts upon wildlife such as habitat disturbance, road kill, and changes in their population distributions would likely also increase.
Acres within "Road Effect Zones"	11,449	These zones represent areas in which wildlife species would be most vulnerable to human activities and habitat conditions created by the roads.

Forest Plan Habitat Objectives for Wildlife

Alternative 1 does not propose any activities that would have a direct effect upon the eight wildlife habitat objectives that have been identified in the Forest Plan because this alternative would initiate no new active management within the analysis area.

By not implementing any habitat management activities within the analysis area, however, there are likely to be some indirect effects upon some of the wildlife habitat objectives.

Failure to implement any timber treatments that regenerate mature forest would result in a continuing decline in the 0-9 year age class. Over time, the percentage of National Forest within the analysis area that is 0- 9 years old would decline from its current 2.5 % to 0.9 % by 2006. By 2007, none of this habitat would be available on National Forest in the analysis area, barring some unforeseen event such as a windstorm, tornado, or severe wildland fire.

Correspondingly, the implementation of Alternative 1 would result in an increase in more mature forest stands within the analysis area, particularly those stands that would meet old growth criteria. Over time, the percentage of National Forest in the analysis area that meets old growth criteria would continue to increase from the existing condition, barring some unforeseen event that prevents these stands from reaching full maturity, such as an insect infestation, wildland fire, or weather event. However, the analysis area is suffering from oak decline and insect infestations, so it is possible that these stands would not reach full maturity.

Along with an increase in old growth within the analysis area, there would also be an expected increase in the oak and oak-pine forest types that are greater than 50 years of age. The current 47 % of the analysis area that meets this objective is likely to increase since no management would occur in theses stands. Also, as these and other mature forest stands age, they would be expected to increase in canopy closure, since no stand-disturbing activities would occur within this alternative that may reduce or maintain existing canopy closures. As these stands mature, and canopies grow larger, the percentage of the analysis area that has canopy closure greater than 80 % would also be expected to increase from its existing 87 %.

Conversely, as stands would continue to mature in this alternative without any stand disturbing activities, the amount of more open forest with less dense canopy cover would be expected to decrease. As canopy cover within these stands increases, the percentage of sawtimber habitat that has a condition of 20-30 % forb, grass, or shrub ground cover would decrease. This decrease would be due to the gradual lack of sunlight that reaches the forest floor as stand canopies continue to become more dense and closed. Because most grasses, forbs and many shrubs are shade-intolerant, the lack of sunlight upon the forest floor would reduce the existing shrub, grass, and forb layer and preclude the growth of new understory. For the same reasons, the percentage of woodland habitat in the oak type over 50 years of age with a dense understory would also be expected to decrease over time.

Alternative 1 would not involve the maintenance of water sources or open/semi-open habitats for wildlife. Over time, without maintenance of these habitats, the availability of water for wildlife within the analysis area would be expected to decrease, as these existing waterholes begin to fill in with sediments and vegetation and the availability of open/semi-open habitats would decrease as these areas grow up with wood species.

Alternatives 2 and 3 propose several activities within the 3.4 MP of the analysis area that would have both direct and indirect effects upon the eight wildlife habitat objectives that have been identified in the Forest Plan.

Under Alternative 2, seed tree and complete salvage methods would be used to treat 957 acres. Alternative 3 would have 294 less acres of complete salvage. Because these harvest methods would reduce the canopy cover to less than 30 % within the treated stands, these acres would be considered within the 0 to 9 age class. Therefore, the amount of woodland habitat in the 0 to 9 age class in within the analysis area would increase

by 957 acres, or 4.1 %, in alternative 2 and 663 acres, or 2.8 %, in alternative 3. Immediately following implementation of Alternatives 2 and 3, the percentage of habitat that meets this objective in the analysis area would be 6.6 % and 5.3 % respectively. Since the existing levels of habitat that meet this objective within the Oak-Hickory Hills and Oak-Pine Hills LTAs are below the desired DFC, an increase in this habitat component is desired to provide habitat for wildlife species that prefer young forest conditions and scrub-shrub habitat.

Woodland habitat in the old growth condition would decrease in the short term under this alternative, but increase over the long term. Currently, approximately 1.9% of the analysis area meets old growth criteria. Ten percent of the analysis area has been designated as old growth. Designated old growth will help to increase the percentage of woodland habitat in the old growth condition with in the analysis area. Since the existing levels of habitat that meet this objective within the Oak-Hickory Hills and Oak-Pine Hills LTAs are below the DFC, an increase in this habitat component is desired to provide habitat for wildlife species that prefer old growth conditions. Most of the designated old growth has been located in riparian areas and is interconnected. In the future, this would provide more contiguous and larger blocks of old growth habitat within the analysis area than currently exists. This would improve habitat conditions for species that require unfragmented tracts of mature and old growth forest.

The amount of woodland habitat in the oak and oak-pine types over 50 years of age would decrease slightly under Alternatives 2 and 3. This habitat objective was established as a measure of hard mast availability for wildlife and assumes that 77 pounds per acre of mast is produced in stands have an average diameter at breast height DBH greater than 8 inches and a canopy cover greater than 44 %. To measure the changes in this habitat objective under Alternatives 2 and 3, it has been assumed that only seed tree and complete salvage treatments proposed would result in a canopy cover less than 44 %. Therefore, current levels of this habitat objective would be reduced under Alternative 2 by 958 acres, or 4.1 % and in Alternative 3 by 638 acres or 2.7 %. Since the existing levels of habitat that meet this objective within the Oak-Hickory Hills and Oak-Pine Hills LTAs are above the desired future conditions DFC, a decrease in this habitat component is desired. The levels of this habitat would still be well above the MVP of 25 % for species that require this habitat condition, and wildlife species dependent upon hard mast would still be well provided for under Alternatives 2 and 3.

Woodland habitat in pole and sawtimber size classes with crown closure over 80 % would be decreased from the existing 87 % to approximately 66 % in Alternatives 2 and 3 within the analysis area. This is a reflection of the loss of 80 % canopy cover as a result of even and uneven-aged management treatments, as well as overstory removal, sanitation, shelterwood, and thinning. Since the existing levels of habitat that meet this objective within the Oak-Hickory Hills and Oak-Pine Hills LTAs are above the desired future conditions (DFC), a decrease in this habitat component is desired. The levels of this habitat would still be well above the minimum viable levels (MVP) of 20 % for species that require this habitat condition and wildlife species dependent upon closed canopy forest would still be well provided for under these alternatives.

The amount of woodland habitat that has at least a 20 to 30 % forb, grass, or shrub ground cover would increase dramatically under Alternatives 2 and 3, from the current level of 9.9 % to approximately 43 % within the analysis area. This dramatic increase is directly attributed to activities that would occur that would create more open forest stands and result in more sunlight reaching the forest floor, which generally creates a heavier grass, forb, and shrub component. Activities proposed under this alternative that are likely to achieve this condition include seed tree, shelterwood, thinning, sanitation, and uneven-aged management treatments, prescribed burning, and open woodland restoration/development.

Similarly, the amount of woodland habitat over 50 years of age with a dense understory would also increase due to activities that would create more open forest stands. The seed tree, shelterwood, thinning, sanitation, and uneven-aged management treatments proposed in Alternatives 2 and 3 would be expected to contribute to a dense understory by opening the forest canopy. Currently, 9.3 % of the analysis area meets this habitat objective. Under Alternatives 2 and 3, this would be expected to increase to approximately 20 %. This increase is desirable, given that the existing levels for this habitat objective within the Oak-Hickory Hills and

Oak-Pine Hills LTAs are below the minimum required Forest-wide. This increase within the analysis area would benefit many species that prefer a dense shrub understory but still utilize a mature forest overstory.

For this analysis, the habitat objective for open and semi-open lands is considered represented by forest stands that are classified as being in a permanently non-forested (brush or grassland) or savannah condition (open woods). Currently, 7.3 % of the analysis area meets this objective. Alternatives 2 and 3 propose activities (prescribed burning, mowing, hand-cutting, and grazing) that would maintain the open characteristics on the majority of this. With implementation of Alternatives 2 and 3, the levels for this habitat objective would be maintained. Many of the wildlife species that require these open and semi-open habitats would also utilize forest stands in the 0 to 9 year age class, as well as forest stands with a low canopy cover and grassy or shrubby understory, and levels of those types of habitats are expected to increase under these alternatives.

The availability of upland water sources within the 3.4 MP of the analysis area would be maintained under Alternatives 2 and 3. These alternatives would allow for maintenance of existing water sources. This would be within the Forest Plan's DFC levels of 1 to 2 water sources per square mile for the 3.4 MP, and would provide habitat for many wildlife species that are dependent upon readily available water sources during part or all of their life cycle.

Federally Threatened and Endangered Species

The effects of Alternatives 1-3 upon federally threatened, endangered, and proposed species of the Mark Twain National Forest have been disclosed in a Biological Evaluation/Assessment (BAE) that was prepared specifically for this analysis. The BAE can be found in Appendix E. Consultation with the US Fish and Wildlife Service was initiated in February and was completed in July 2004 with the issuance of a concurrence letter. Tables 3 – 29 and 3 – 30 detail the Determination of Effects for Federally Threatened and Endangered Species for all alternatives.

Table 3 - 29: Determination of Effects for Federally Threatened and Endangered Species: Alternative 1

Species	Species present in analysis area?	Habitat present in analysis area?	Habitat affected by project?	Determination
Indiana bat	**Yes;** roosting in suitable trees in the analysis area; foraging in the analysis area	**Yes**; suitable roost trees present in analysis area; suitable foraging habitat present	**Not likely;** potential effects from wildland fire and other forces unpredictable and immeasurable	**May affect-Is not likely to adversely affect**.
Gray bat	**Yes;** may forage over streams in analysis area, foraging over small ponds in the analysis area	**Yes;** suitable foraging habitat available along perennial streams and ponds in the analysis area	**Not likely;** potential effects from wildland fire and other forces unpredictable and immeasurable	**May affect-Is not likely to adversely affect**
Bald eagle	**Possible**; may forage in analysis area in the winter	**Yes;** suitable habitat along larger perennial streams and waterbodies in analysis area	**Not likely;** potential effects from wildland fire and other forces unpredictable and immeasurable	**May affect-Is not likely to adversely affect**
Topeka shiner	**No;** not known south of Missouri River	**No**; no streams which feed prairie regions	**No**	**No effect**
Hine's emerald	**Possible**; documented	**Yes**; fens known to occur throughout	**Not likely;** potential effects	**May affect-Is not likely to**

Species	Species present in analysis area?	Habitat present in analysis area?	Habitat affected by project?	Determination
dragonfly	nearby	analysis area	from wildland fire and other forces unpredictable and immeasurable	**adversely affect**
Curtis' pearlymussel	**No**; known range not within analysis area	**No**	**No**	**No effect**
Pink mucket pearlymussel	**Not likely**; known range (Meramec watershed) is within analysis area, but known locations 100 miles downstream	**Yes**; watershed of Meramec River	**Not likely;** potential effects from wildland fire and other forces unpredictable and immeasurable	**May affect-Is not likely to adversely affect**
Scaleshell mussel	**No**; known range not within analysis area	**No**	**No**	**No effect**
Tumbling creek cavesnail	**No**; known range not within analysis area	**No**; no caves known within analysis area	**No**	**No effect**
Ozark hellbender	**No;** known range not within analysis area	**No**	**No**	**No effect**
Running buffalo clover	**Possible**; however species not documented from within analysis area	**Yes**; riparian habitat known to occur throughout analysis area	**Not likely;** potential effects from wildland fire and other forces unpredictable and immeasurable	**May affect-Is not likely to adversely affect**
Mead's milkweed	**No**; known range not within analysis area	**No**	**No**	**No effect**

Table 3 - 30: Determination of Effects for Federally Threatened and Endangered Species: Alternatives 2 and 3

Species	Species present in analysis area?	Habitat present in analysis area?	Habitat affected by project?	Determination
Indiana bat	**Yes**; roosting in suitable trees in the analysis area; foraging in the analysis area	**Yes**; suitable roost trees present in the analysis area; suitable foraging habitat present	**Yes;** will involve burning and felling of some suitable roost trees during time they may be occupied, activities could change potential foraging habitat	**May adversely affect but no effects** beyond those evaluated in the programmatic BA/BO.

Species	Species present in analysis area?	Habitat present in analysis area?	Habitat affected by project?	Determination
Gray bat	**Yes**; may forage over streams in analysis area, foraging over small ponds in the analysis area	**Yes**; suitable foraging habitat available along perennial streams and ponds in the analysis area	**Not likely;** protective measures incorporated to protect riparian habitat; wildlife ponds, perennial streams, and uplands would continue to be available for foraging after proposed management activities are implemented	**May affect-Is not likely to adversely affect**
Bald eagle	**Possible**; may forage in the analysis area in the winter	**Yes;** suitable habitat along larger perennial streams and waterbodies in analysis area	**Not likely;** protective measures incorporated to protect riparian habitat	**May affect-Is not likely to adversely affect**
Topeka shiner	**No;** not known south of Missouri River	**No**; no streams which feed prairie regions	**No**	**No effect**
Hine's emerald dragonfly	**Possible**; documented nearby	**Yes**; fens known to occur throughout the analysis area	**Yes;** burning could enhance fen habitat; protective measures incorporated to protect fen habitat from negative water quality changes	**May affect-Is not likely to adversely affect**
Curtis' pearlymussel	**No**; known range not within analysis area	**No**	**No**	**No effect**
Pink mucket pearlymussel	**Not likely**; known range (Meramec watershed) is within analysis area, but know locations are 100 miles downstream	**Yes**; watershed of Meramec River	**Not likely;** protective measures incorporated to protect water quality	**May affect-Is not likely to adversely affect**
Scaleshell mussel	**No**; known range not within analysis area	**No**	**No**	**No effect**
Tumbling creek cavesnail	**No**; range not within analysis area	**No**; no caves known in analysis area	**No**	**No effect**
Ozark hellbender	**No;** known range not within analysis area	**No**	**No**	**No effect**

Species	Species present in analysis area?	Habitat present in analysis area?	Habitat affected by project?	Determination
Running buffalo clover	**Possible**; however species not documented from within analysis area	**Yes**; riparian habitat known to occur throughout analysis area	**Not likely;** protective measures incorporated to protect riparian habitat, prescribed burning could improve habitat	**May affect-Is not likely to adversely affect**
Mead's milkweed	**No**; known range not within analysis area	**No**	**No**	**No effect**

Regional Forester's Sensitive Species and other Species of Concern

The effects of Alternatives 1-3 upon Regional Forester's Sensitive Species and other Species of Concern of the Mark Twain National Forest have been disclosed in a Biological Evaluation/Assessment (BAE) that was prepared specifically for this analysis. The BAE can be found in Appendix E. Table 3 – 31 detail the Determination of Effects for Regional Forester's Sensitive Species and other Species of Concern for all alternatives.

Table 3 - 31: Determination of Effects for Regional Forester's Sensitive Species and other Species of Concern: All Alternatives

Species Habitat Group	Species documented from analysis area ?	Habitat present in analysis area ?	Habitat affected by proposed action ?	Determination		
				Alt. 1	Alt. 2	Alt. 3
Riparian, bottomland hardwood-associated Species	Yes	Yes	Alternative 1 - No Alternatives 2 and 3- Not likely	No impact	May impact individuals or habitat but will not likely contribute to a trend towards federal listing or loss of population viability	May impact individuals or habitat but will not likely contribute to a trend towards federal listing or loss of population viability
Stream/River-associated Species	No	Yes	Alternative 1 - No Alternatives 2 and 3- Not likely	No impact	No impact	No impact
Glade-associated Species	No	Yes	Alternative 1 – No Alternatives 2 and 3 – Yes;	No impact	Beneficial impact	Beneficial impact
Grassland-associated Species	Yes	Yes	Alternative 1 - No Alternatives 2 and 3 – yes	No impact	Beneficial impact	Beneficial impact

Species Habitat Group	Species documented from analysis area ?	Habitat present in analysis area ?	Habitat affected by proposed action ?	Determination		
				Alt. 1	Alt. 2	Alt. 3
Seep/Fen-associated Species	Yes	Yes	Alternative 1 – No Alternatives 2 and 3 – Yes;	No impact	May impact individuals or habitat but will not likely contribute to a trend towards federal listing or loss of population viability, beneficial impact through habitat enhancement	May impact individuals or habitat but will not likely contribute to a trend towards federal listing or loss of population viability, beneficial impact through habitat enhancement
Miscellaneous Wetland Species	No	Yes	Alternative 1 – No Alternatives 2 and 3 – Yes;	No impact	Beneficial impact	Beneficial impact
Cliff face/bare rock	No	Yes	Alternative 1 - No Alternatives 2 and 3- Not likely	No impact	No impact	No impact

Cumulative Effects on Wildlife by Alternative

Management Indicator Species (MIS)

Alternative 1: Pileated woodpecker, ruffed grouse, indigo bunting, northern bobwhite, orchard oriole, and wild turkey are MIS species are showing population declines either state-wide or within the Ozark-Ouachita Plateau. The contribution of Alternative 1 to these declines would be considered negligible, given the size of the analysis area to the overall trends area. For ruffed grouse, indigo bunting, northern bobwhite, orchard oriole, and wild turkey, Alternative 1 does not propose any activities that would directly or indirectly improve habitat conditions for these species; therefore, this alternative would also not create any cumulative beneficial effects that could increase or stabilize these populations over the long-term.

Alternative 1 is expected to improve habitat conditions for the pileated woodpecker within the analysis area. Although the pileated woodpecker is showing declines state-wide, within the Ozark-Ouachita Plateau, populations seem to be increasing, and Alternative 1 is expected to contribute to this increase.

Ovenbird, wood thrush, white-tailed deer, raccoon, eastern bluebird, cottontail rabbit, and bobcat are MIS considered to be either increasing or stable both state-wide and within the Ozark/Ouachita Plateau. The implementation of Alternative 1, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, is expected to maintain habitat conditions for these MIS similar to the current conditions. Although there may be some decrease in the shrub component of forest stands within the analysis area under this alternative, this loss is not expected to be great enough to have a cumulative negative effect upon the populations of these species in the analysis area or elsewhere.

Alternatives 2 and 3: The cumulative effects of these alternatives upon MIS and their habitats are expected to be similar to those described for Alternative 1. Alternatives 2 and 3 would create slightly higher levels of early successional habitat and forest stands with a shrub/forb component and would maintain more open/semi-open habitat than Alternative 1. Therefore, potential for beneficial cumulative effects upon MIS that prefer these habitat conditions would likely be somewhat higher under Alternatives 2 and 3 than Alternative 1.

Alternatives 2 and 3 is expected to temporarily reduce some habitat for the pileated woodpecker, ovenbird, and wood thrush within the analysis area, however, not to the extent that population levels of these species would be expected to decline significantly within the analysis area or throughout their ranges. Although the pileated woodpecker is showing declines state-wide, within the Ozark-Ouachita Plateau, populations seem to be increasing, and although Alternatives 2 and 3 may not contribute to this increase, activities proposed would not jeopardize the continued viability or abundance of this species. Ovenbird and wood thrush are showing population increases throughout the state and on the Ozark-Ouachita plateau. The implementation of Alternatives 2 and 3, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would continue to offer suitable habitat for MIS, and no adverse cumulative effects upon these species' population levels are anticipated.

Birds (Emphasizing Neo-tropical Migrants)

Alternatives 1-3: Across the Ozark/Ouachita physiographic area, many species of birds that are considered priority species for conservation (identified in Table 3 - 16) are considered species that prefer or are favored by open woods or scrub-shrub or grassland habitat. Declines in several of these species are being observed across the physiographic area. The implementation of Alternative 1, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the

analysis area, is expected to maintain habitat conditions similar to the current conditions. Alternative 1 would not implement any activities that would benefit these species by providing their desired habitat. Therefore, while this alternative would not have a direct negative effect upon these species, it may have a cumulative negative effect upon species that are in decline across the physiographic area and prefer more open environments or dense shrub understories. The implementation of Alternatives 2 and 3, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area would be to the benefit of many species, especially from the prescribed burning and other activities proposed in Alternatives 2 and 3 that would maintain a semi-open canopy of mature trees, with an understory of shrubs and grasses. Therefore, these alternatives would contribute to a positive cumulative effect upon these species. For species that prefer open, mature forest conditions, Alternatives 2 and 3 would not necessarily improve habitat availability for these birds, but also would not likely contribute to a negative cumulative negative effect upon these species, since all of the activities proposed would maintain a forested condition over the long term.

Specialized habitats

Alternative 1 does not propose any activities that would directly or indirectly improve the short leaf pine component within oak stand or fishless pond habitats; therefore, this alternative would not create any cumulative beneficial effects that could increase or stabilize these habitats over the long-term.

The implementation of Alternative 1, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, is expected to maintain habitat conditions similar to the current conditions. Although there may be some decrease in the quality of these habitats within the analysis area under this alternative, this loss is not expected to be great enough to have a cumulative negative effect upon theses habitats in the analysis area or elsewhere.

Alternatives 2 and 3 propose activities that would directly or indirectly improve short leaf pine component within oak stands and fishless pond habitats; therefore, these alternatives could create cumulative beneficial effects that could increase or stabilize these habitats over the long-term.

The implementation of Alternatives 2 and 3, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would help to improve these special habitats, and no adverse cumulative effects upon these habitats are anticipated in the analysis area or elsewhere.

Roads and Wildlife

Alternative 1-The cumulative effects of implementing Alternative 1 are based upon knowledge of the current conditions, past activities, other present activities being considered, and reasonable foreseeable activities in the analysis area. Also considered are the current and foreseeable conditions of the National Forest at a landscape scale, as well as adjacent private lands.

The foreseeable cumulative effect that implementation of Alternative 1 would have upon the road density for the 3.4 MP would be that there would be no new roads added, but no non-system FS roads would be decommissioned.

When combined with past, present and foreseeable activities on both National Forest and private lands, these cumulative effects would be most pronounced in the “road effect zones” were roads will most likely have the most effect on wildlife. Effects would remain similar to what they are currently.

Alternatives 2 and 3: The cumulative effects of implementing Alternatives 2 and 3 are based upon knowledge of the current conditions, past activities, other present activities being considered, and

reasonably foreseeable activities in the analysis area. Also considered are the current and foreseeable conditions of the National Forest at a landscape scale, as well as adjacent private lands.

The foreseeable cumulative effect that implementation of these Alternatives would have upon the road density for the 3.4 MP would be that there would be no new roads added and several miles of non-system FS roads would be decommissioned, reducing the acres in the "road effect zones" and subsequent affects to wildlife.

When combined with past, present and foreseeable activities on both National Forest and private lands, these cumulative effects would be most pronounced in the "road effect zones" were roads will likely have the most effect on wildlife.

Forest Plan Habitat Objectives for Wildlife

Alternative 1: The cumulative effects of implementing Alternative 1 are based upon knowledge of the current conditions, past activities, other present activities being considered, and reasonable foreseeable activities in the analysis area. Also considered are the current and foreseeable conditions of the National Forest at a landscape scale, as well as adjacent private lands.

The foreseeable cumulative effect that implementation of Alternative 1 would have upon the eight wildlife habitat objectives identified for the 3.4 MP would be an overall decrease in early successional forest and open or semi-open habitat, and a lack of diverse forest understory represented by grasses, forbs and shrubs. Habitat objectives that focus on mature forest stands with a dense forest canopy would be expected to increase throughout the analysis area and within the 3.4 MP. This may lead to a cumulative increase in forest conditions that benefit species preferring old growth conditions and deeply shaded forests.

When combined with past, present and foreseeable activities on both National Forest and private lands, these cumulative effects would be most pronounced on the National Forest. Given that 88 % of the private land within the analysis area is currently forested and some of this appears to have been recently harvested, it is assumed that early successional forest habitat within the analysis area would continue to be provided on private lands even if Alternative 1 is implemented. This assumes that stand disturbing activities such as timber harvesting would be ongoing at its current levels on private lands.

Alternatives 2 and 3: The cumulative effects of implementing Alternatives 2 and 3 are based upon knowledge of the current conditions, past activities, other present activities being considered, and reasonably foreseeable activities in the analysis area. Also considered are the current and foreseeable conditions of the National Forest at a landscape scale, as well as adjacent private lands.

The foreseeable cumulative effect that implementation of Alternatives 2 and 3 would have upon the eight wildlife habitat objectives identified for the 3.4 MP would be an overall increase in early successional forest and diverse forest understory represented by grasses, forbs and shrubs. Habitat objectives that focus on mature forest stands with a dense forest canopy would be expected to slightly decrease throughout the analysis area and within the 3.4 MP with implementation of Alternatives 2 and 3. However, this is not expected to have a negative cumulative effect upon wildlife species that require dense forest canopy, since the majority of forested private lands within the analysis area and across the Ozarks are mature forests that meet this habitat condition, as well as most of the National Forest both within and outside the analysis area.

Aquatic Communities and Recreational Fisheries

Existing Conditions

General

In the revised edition of "The Fishes of Missouri" dated 1997, William L. Pflieger described four aquatic faunal regions: the Prairie, Ozark, Lowland, and Big River. The geographic location of the analysis area places it in the central part of the “Ozark Aquatic Faunal Region”.

Lakes and Ponds

The following lakes and ponds are managed for fisheries:

Howes Mill Lake – This is a 6 acre impoundment located sixteen miles east of Salem on north side of State Highway 32. The Forest Service acquired Howes Mill Lake, Howes Mill Pond, Howes Mill South and Huzzah Cutoff ponds in 1972 as part of what was called the Huzzah Fisheries, Inc. acquisition. Howes Mill Lake has a watershed ratio of approximately 38:1. The lake is fairly shallow on the upper end. There is low organic productivity in its watershed. The lake is managed for bluegill, largemouth bass, and channel catfish. This lake receives a high amount of fishing pressure because the lake can be viewed from State Highway 32 and because there are few flat water fishing opportunities in this area. The 6 acre Howes Mill Lake was electroshocked April 28, 1999. The catch rate for bass > 8 inches was 26/hour, which is low. The catch rate for bluegill > three inches was 280/hour, which is high. There is poor recruitment to 12-inch size bass which is probably due to heavy fishing pressure. Fishing regulations and creel limits are set by the MDC. The Forest Service stocks approximately 180 channel catfish in Howes Mill Lake each year.

In August 1993, heavy rainfall (> 3 inches in less than 24 hour period) deposited a mound of earthen material at the inlet of the box culvert on State Highway 32, which caused the water to cross over Highway 32. The spillway was relocated and gabions placed between the spillway and Highway 32 culvert. Over time, water flow has forced the gabions out of position and bare soil and rock is exposed.

Howes Mill Pond – This is a 4 acre pond that lies north and connects to Howes Mill Lake and it too receives considerable fishing pressure. Howes Mill Pond has a watershed ratio of approximately 24:1. This pond is managed for bluegill, largemouth bass, and channel catfish. The Forest Service stocks approximately 120 channel catfish in Howes Mill Pond once every two years.

Howes Mill South – This is a 2 acre pond, located seventeen miles east of Salem on the south side of State Highway 32. This pond can be viewed from State highway 32; however, it receives less fishing pressure because fishing access is limited, as there is no boat launch or fishing trail around the lake. This pond is managed for bluegill, largemouth bass, and channel catfish. The Forest Service stocks approximately 60 channel catfish in Howes Mill South once every two years. Most of the spillway has eroded on the back side, which has created a downward raceway for water flowing over the spillway.

Huzzah cutoff pond 3 – The pond is approximately 1 acre in size and is managed as a put-grow-take channel catfish fisheries. The district **stocks** approximately 20 channel catfish every other year.

Gnuse pond – this is a small fishing pond about ½ acre in size located next to Dent County Road 438 in Section 1, T34N, R3W. On May 21, 2002, the Forest Service Fisheries Biologist and the MDC Fisheries Biologist conducted a pole and line sample. This pond has a balanced population

of bluegill and largemouth bass. The district stocks approximately 20 channel catfish every other year.

The following lakes and ponds are **not** managed for fisheries:

Huzzah cutoff ponds 1 and 2 are not managed for fisheries because the ponds leak water. These ponds offer excellent habitat for amphibians.

Lost Lake – this 4-acre lake is not managed for fisheries because the existing dam is not structurally sound. The Forest Fisheries Biologist conducted a "pond fisheries evaluation" in July1995. The water was stained but clears enough to observe a largemouth bass approximately 12 inches in length and eight bluegill approximately 8 inches in length. The adult bluegills appeared thin across the back indicating lack of forage and/or overcrowding. Seining was attempted but unsuccessful because sticks on the lake bottom became entangled in the net. There was not an excessive amount of vegetation in 1995; however, an MDC biologist noticed filamentous algae had almost covered the entire lake in 1988. On May 21, 2002, the Forest Service Fisheries Biologist and the MDC Fisheries Biologist conducted a pole and line sample. No fish were collected; however, the lake was muddy and twice its normal size. The 30-40 foot dam is an abandon railroad grade. During a flood event, the lake will triple in size to approximately 12 acres. Water will then gush out the base of the dam in four or more spots. Also, there is a small pipe near the base of the dam which slowly releases water.

Streams and Rivers

This project lies within the Meramec River Watershed. The Meramec River is unique because it is the second longest free-flowing river in the state of Missouri (228 miles total length and 100 % non channelized or submerged by large impoundment). The Meramec River basin drains a total of approximately 2,149 square miles or 1,375,360 acres of land. Approximately 29.6 % of the Meramec watershed is in public ownership (Forest Service, Missouri Department of Conservation, Missouri Department of Natural Resources). The Meramec River is a cool water fishery, with management emphasis on smallmouth bass and goggle eye (also called shadow bass). MDC ranked the Meramec watershed first out of thirty-six watersheds surveyed in a statewide fishing pressure survey. The Forest Service has 0 miles of river frontage on the Meramec River; however the 8-digit Meramec watershed is divided into seven 11-digit subbasin watersheds. The analysis area is located in parts of two of these: the 11-digit Huzzah Creek (07140102030) subbasin watershed and the11-digit Upper Meramec (also called Crooked Creek) (07140102020) subbasin watershed. Wade fishing for smallmouth bass is known to occur on Huzzah Creek around MDNR's Dillard Mill state historic site. About 2 miles downstream of Dillard Mill at State Highway 49, the Huzzah becomes marginal for canoeing. There exists a concrete dam on Huzzah Creek at Dillard Mill, which creates an eight foot waterfall. This waterfall prevents fish migration upstream into the East and West Fork of Huzzah Creek. MDC's Indian Trail Conservation Area is located on the west side of the analysis area, north of Watery Fork and south of Middle Prong of Crooked Creek. Indian Trail Hatchery primarily rears channel catfish, bluegill, and largemouth bass but no trout (James Swindell, per. Com.).

Inventory of Fish and Fish Habitat

The Missouri Department of Conservation, Research Division, Columbia, MO maintains a current and comprehensive fish inventory in a GIS formatted data base. There are four fish sampling sites within or adjacent to the analysis area, all within the Huzzah Creek (07140102030) watershed. The fish sample site numbers are 0365, 0369, 0461, and 2088. Huzzah Creek is a cool water fishery, with management emphasis on smallmouth bass and goggle eye. A list of species for each fish sampling site can be found in the Project file. There are 24 fish species represented in the four sample sites listed above. There were no Federal, RFSS, or Forest Species of Concern fish species

identified at any of the four sample sites. There are no fish sample sites on the Middle Prong Crooked Creek, East Prong of Crooked Creek or Watery Forks Creek within or near the Analysis Area on the Upper Meramec watershed (also called Crooked Creek watershed).

The MDC fisheries division, conducted a watershed inventory and assessment of the Meramec River Watershed in November 1998. The results of this survey may be found at http://www.conservation.state.mo.us/fish/watershed/usgs8.htm.

MDC concluded Stream habitat quality to be fair to good throughout most of the basin but some areas like Huzzah Creek was poorly forested and suffer from a lack of riparian vegetation. Riparian vegetation helps protect streams against erosion. Stream reaches with no vegetation have accelerated runoff and increased stream energy. Climax vegetation comprised 43 % of corridors in the Huzzah as compared to 67 % in the Courtois. MDC assessment pointed out Courtois Creek as a good example of a stream system with a healthy corridor that slows a stream's natural sinuosity. Pool depth was measured to determine the available habitat for smallmouth bass. Sixty percent of fourth-order sites in the Huzzah Creek watershed were less than adequate for adult smallmouth bass and 66 % of fourth-order sites in the Courtois were less than adequate for adult smallmouth bass. Pool depth in both the Huzzah and Courtois is a limiting factor for adult smallmouth bass habitat. MDC assessment identified cattle were free to use streams for watering throughout the Meramec River basin. Their activities can alter the riparian area enough to cause changes in channel morphology and water quality.

Huzzah Creek is one of four reference streams for the Ecological Drainage Units (EDU) established by Missouri Department of Natural Resources (MDNR). An EDU is a region in which similar biological communities are expected to be found. The MDNR maintains a sampling site (01-37069) on West Fork of the Huzzah Creek located in the SW1/4, Section 2, T34N, R3W, Dent County. Results of the biological assessment are summarized by the Macroinvertebrate Stream Condition Index (MSCI), which ranges from 4 (very poor) to 20 (very good). On 9/20/2001, the MSCI scored 20 (very good) and on 4/2/2002, the MSCI scored 14 (fair to good). The West Fork of the Huzzah Creek is considered to be a fully biologically supporting stream segments within the Meremec watershed. The lower score of 14 (fair to good) is most likely related to the small size of the West Fork Huzzah Creek as compared to the other Biocriteria Reference Streams. Stream waters of good quality are identified by the greater abundance of pollution-intolerant macroinvertebrate taxa, such as those in EPT (Ephemeroptera or mayflies, Plecoptera or stoneflies, Trichoptera or caddisflies). EPT are those kinds of invertebrates that serve as fish food. Degraded streams contained pollution-tolerant Oligochaeta or worms and burrowing Chironomids or midges which are not good fish foods. A summary of the MDNR biological and chemical samples taken at each site can be found in the project file.

The Missouri Department of Conservation, Natural Heritage Division, Jefferson City, Missouri, maintains a current and comprehensive TES inventory in a GIS formatted data base. There are a number of sensitive aquatic species found in the Meramec watershed; all outside the analysis area including Regional Forester Sensitive Species (RFSS) and/or Forest Species of Concern: Eastern hellbender, Crystal darter, Blue sucker, Flathead chub, Sheepnose, Snuffbox, and Spectacle case. A complete listing of sensitive species, including aquatic species, can be found in the Biological Evaluation for Regional Forester Sensitive Species and Species of Forest Concern which can be found in the project file.

Fish Consumption Advisory

The Meramec River is listed for the pollutant Mercury from atmospheric deposition for 75 river miles from Meramec State Park to T38N, R5W, Section 22. The last MDC contaminant samples from the Meramec River were taken in CY 2001. Mercury exceeded the action level of 300 ppb in the sample collected from the Meramec River in St. Louis County. Samples taken from the

Bourbeuse River, a Meramec River tributary, near I-44 exceeded the action level. Samples taken from the Meramec River at Meramec State Park had mercury but the concentration was below 300 ppb. (Andy Austin, per.Com.). In July 2001, the Missouri Department of Health (DOH) issued a fish consumption advisory for all largemouth bass in the State of Missouri because of methylmercury contamination. Sampling and analysis of Largemouth Bass by MDC indicate that Mercury is widespread, and present in fish in streams, rivers, ponds and lakes throughout Missouri. The DOH advisory recommends women who are pregnant and children twelve years of age and younger not eat any largemouth bass over twelve inches in length from anywhere in Missouri (Missouri Department of Health and Senior Services, 2003). The MDNR, Water Pollution Control Program, has not completed a TMDL for the Meramec River (see http://www.dnr.mo.gov/wpscd/wpcp/wpcp-about.htm)

Direct and Indirect Effects on Fisheries and Aquatics

Goals for the MTNF Fisheries Program can be found IV – 2 and 3 of the LRMP. The primary fisheries goals for the MTNF are to Protect Aquatic Ecosystems, Restore degraded Aquatic Ecosystems and Enhance Aquatic Resources User Opportunities. Forest-Wide Standards and Guidelines for the MTNF Fisheries Program can be found on Pages IV – 49 and 49 of the LRMP. These are specific Forest-Wide Standards and Guidelines which apply to streams, lakes, and ponds.

Those fish species collected at MDC Fish Sampling Sites 0365, 0369, 0461, and 2088. are listed in the project file. There were no Federal, RFSS, or Forest Species of Concern fish species collected at any sampling site. A Biological Evaluation (BE) for Federal listed species was completed and is located in project file. Site-specific effects determinations for each species are summarized in this document. The BE discusses direct and indirect effects to Federal listed aquatic species and concludes that there will be no effects outside those evaluated in the programmatic Biological Assessment and Biological Opinion. The USDA Forest Service Eastern Region Sensitive Species (RFSS) BE is also located in the project file. The RFSS BE concluded there would be no direct or indirect effects to R-9 listed aquatic species.

The existing and proposed road system does not restrict the migration and movement of aquatic organisms. There exist one crossing on FR 2741 and two crossing on FR 2741A which are ford crossings where the streambed serves as the road. Ford crossings provide a natural passageway for the migration and movement of aquatic organisms where the streambed has a firm rock or gravel bottom and road traffic is light. There is one crossing on National Forest on County Road 438 which is a culvert. This culvert provides drainage for an unnamed tributary, which is intermittent and seasonally dry. This culvert would have no effect on the migration and movement of fish**. No new roads with stream crossings which would restrict migration of aquatic organisms are planned in any of the alternatives.**

Lost Lake is not managed for fisheries because the existing dam is not structurally sound. The 30-40 foot dam is an abandon railroad grade. During a flood event, the lake will triple in size to approximately 12 acres. Water will then gush out the base of the dam in four or more spots. Also, there is a small pipe near the base of the dam which slowly releases water. This dam will remain in place for this 10 year planning period; during which time the Forest dam inspector will determine if the dam should be removed.

The Forest Service in partnership with MDC will maintain and the following lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah cutoff pond #3, and Gnuse pond (total 14 acres). Animals, including fish, on National Forest belong to the people of the State and therefore are property of the State. The State Legislature passed laws which empowered MDC to manage wildlife and fish population within the State for the people of the State. MDC's fisheries management includes sampling, fertilization, setting harvest season and regulations, etc. The Forest Service's Memorandum of Understanding with MDC dated March 26, 1997, pledges close cooperation

and coordination between the two agencies. On-going cooperative maintenance include: (a) fish stocking – bluebgill, largemouth bass, channel catfish, fat head minnows,; (b) dam maintenance – Maintenance is necessary to keep a pond/lake in good working condition. The dam (front and back) should be kept free of trees and large shrubs, because decaying root systems can cause leaks. (c) The spillway, outlet pipes should be kept free of obstructions to prevent erosion damage. (d) placement of soil and rock along dam and spillway where damage has occurred. These actions will help reduce erosion and sedimentation being carried downstream; thereby, maintaining MDNR designated beneficial water uses. (e) Passive capture gears involve the entanglement or entrapment in hoop nets, gill nets and other nets. Other capture gear involves electrofishing, which is the use of electricity to capture fish for analysis.

Alternative 1

Lake/Ponds

The Forest Service is obligated to inspect and maintain dams which hold back water. Failure to maintain ponds and lakes could result in breach of dam, which could erode Hwy 32 culvert and bank downstream of Hwy 32. The Forest Service in partnership with MDC will maintain the following lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah cutoff pond #3, and Gnuse pond (total 16 acres). This alternative would not permit rehabilitation such as: (1) draining, deepening, and stocking to restore and/or increase the fisheries carrying capacity; (2) use of lime and fertilizer to increase fisheries carry capacity; (3) installing fish shelters and planting aquatic vegetation to provide nursery habitat for sunfish; (4) lake drawdown to control the amount of vegetation; (5) new fishing piers, access trails, and launch sites to improve anglers access.

Creeks/Streams/River

There would be no direct impacts to creeks/streams/river fisheries under the no action alternative. There may be indirect impacts to creeks/streams/river fisheries in Upper Meramec and Huzzah Creek watersheds due to increased sediment and pollution loads from existing dumps and soil erosion from unregulated roads.

Alternatives 2 and 3

Lake/Ponds

This alternative would permit Lake/Ponds rehabilitation such as: (1) draining, deepening, and stocking to restore and/or increase the fisheries carrying capacity; (2) use of lime and fertilizer to increase fisheries carry capacity; (3) installing fish shelters and planting aquatic vegetation to provide nursery habitat for sunfish; (4) lake drawdown to control the amount and kind of aquatic vegetation; (5) new fishing piers, access trails, and launch sites to improve anglers access. Howes Mill Lake, Howes Mill Pond, and Howes Mill South would be drain, deepened and stocked. The dam must be breached to drain water out of the lake or pond. After the ground has dried, the lake can be deepened by removal of soil from the lake bed and/or edge of the shoreline. Liming the lake bottom would buffer the bottom muds and allow phosphorus in fertilizer to be available to be utilized by the plankton instead of being tied up and bound to the aluminum ions in the bottom muds. Soil removed from lake and ponds can be placed in the Huzzah ponds, which do not hold water. This soil could help these amphibians ponds hold water for longer periods of time.

The most common cause of dam failure is poorly designed spillways. Frequently, they are built too narrow and with not enough freeboard. The spillway should be located on solid soil next to the dam and should be wide and level enough to carry the overflow in a slow, shallow stream not more than 3-6 inches deep. To prevent erosion by flowing water, the slope of the spillway should be as gentle as the

topography allows. A pipe can be added approximately one foot below the elevation of the vegetative spillway to handle the burden of all but the very heavy rains which would limit the amount of erosion on the vegetative spillway.

Lake and ponds can be stocked with fathead minnows to provide a food source. The lake and ponds can then be stocked with channel catfish, bluegill, largemouth bass, and redear sunfish. Fish structures are elements in or near the water that provide valuable fish habitat. These elements attract fish by providing them with shade, spawning areas or places to rest or escape from predators. Elements include Brush/Trees, stakes, logs, concrete blocks, rocks, drain tile, wooden pallets, pipe and prefabricated plastics, such as PVC, and planting desirable aquatic plants. Fish structures are to be added to lake and ponds within the analysis area. The trail surface should be hardened with crush limestone to prevent erosion.

Creeks/Streams/River

Nearly 90 % of the erosion from timber harvesting can be traced to the logging road system (USEPA, 1993; MDNR, 2000). Soil erosion can results in sedimentation to streams. Sedimentation alters the natural relationship between the 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 (Water 1995). The Best Management Practices (BMP) as described in Thomas F. Waters' Monograph 7 "Sediment in Streams", page127, "Methods for the reduction of erosion from logging roads" will be utilized in designing the logging road system (a description of the various methods Waters described can be found in the project file). In addition, careful planning of road and skid trail system locations will reduce the amount of land disturbance by minimizing the area in roads and trails, thereby reducing erosion and sedimentation. Intercepting and retaining sediment between the site of its origin and a receiving stream is 2nd best to preventing erosion; therefore, the skid trails and haul roads will be monitored to identify where maintenance is needed to prevent soil movement into stream courses. Use of BMP's will reduce the amount of sediment entering stream courses; therefore, commercial harvest activities will not adversely affect beneficial water uses, including "cool water fisheries" of the Meramec River.

The proposed prescribed burns, viewed at the right scale of time and space, would not have a negative impact on aquatic biota. The primary concern is how the fire accelerates the delivery of sediment to the surface water system. The intensity of a wildland fire could have negative effects on streams by exposing mineral soil to sheet erosion; whereas, a low intensity prescribed fire which did not burn down to mineral soil, would not contribute a significant sediment load into the 11-digit Huzzah Creek (07140102030) subbasin watershed and the11-digit Upper Meramec (also called Crooked Creek) (07140102020) subbasin watershed. Prescribe burns will not include trash dumps that may contain common house hold items such as thermometers, button batteries, thermostats, fluorescent light bulbs; items known to contain mercury.

The grazing management strategy is to restore the integrity of riparian communities by fencing cattle out of riparian sites. Hardwood riparian species, such as sycamore, silver maple, black walnut, green ash, hackberry, northern red oak, hazelnut will be planted in open areas adjacent creek and streams to help establish a healthy riparian corridor. A healthy riparian corridor will help reduce the amount sediment entering streams.

Siltation tops the list of the foremost 10 pollutants in rivers, half-again higher than the 2nd most important pollutant, nutrients (Waters, 1995; USEPA, 1993). Approximately 55 miles of non-system roads within the analysis area would be decommissioned. This action would reduce the sediment load into the 11-digit Huzzah Creek (07140102030) subbasin watershed and the11-digit Upper Meramec (also called Crooked Creek) (07140102020) subbasin watershed.

These alternatives will not affect the short or long-term viability of the existing fisheries or aquatic life. Habitat for aquatic species on the MTNF lands will be available in approximately the same amount and distribution as currently exists.

Cumulative Effect on Fisheries and Aquatics

The area considered for cumulative effects is Meramec Watershed. The Meramec River basin drains a total of approximately 2,149 square miles or 1,375,360 acres of land. Approximately 29.6 % of the Meramec watershed is in public ownership (Forest Service, Missouri Department of Conservation, Missouri Department of Natural Resources). The time period considered for cumulative effects is the next 10 years.

Cumulative Effects Common to all Alternatives

Lake/Ponds

There are no anticipated cumulative adverse effects resulting from maintenance and rehabilitation of existing Lake/Ponds. The existing 14 acres of flat water would not increase nor decrease in size.

Creeks/Streams/River

Long term population and even species trends may changed as during the next decade, non-federal landowners will determine land uses on approximately 70.4 % of the Meramec watershed (MDC, 1998, Meramec River Watershed Inventory and Assessment. http://www.conservation.state.mo.us/fish/watershed/usgs8.htm).

Stream channels morphology changes could occur without the protection of a riparian corridor and this could affect the numbers and types of aquatic species present. Jacobson and Primm identify destruction of riparian vegetation from livestock grazing on bottom lands as the most disrupting force on Ozarks stream channels. Livestock grazing in the riparian zone will not be permitted on National Forest lands.

Alternative 1

Over a 10-year period, Non-Point source contaminants of approximately 55 miles of non-system roads and further deterioration of 8.4 miles of system road needing reconstruction could contribute to the amount of sediment entering the Meramec River. Over this 10-year period, the amount of sediment entering stream water courses within the 11-digit Huzzah Creek (07140102030) subbasin watershed and the11-digit Upper Meramec (also called Crooked Creek) (07140102020) subbasin watershed would most likely increase; however, it is doubtful this action by itself would cause changes to water quality associated with the Meramec River watershed which would impair MDNR designated uses.

Alternatives 2 and 3

In these alternatives there would be 8.4 miles of system road reconstructed and approximately 55 miles of non-system roads within the analysis area would be decommissioned. Over this 10-year period, the amount of sediment entering stream water courses within the 11-digit Huzzah Creek (07140102030) subbasin watershed and the11-digit Upper Meramec (also called Crooked Creek) (07140102020) subbasin watershed would most likely decrease. This action will help maintain MDNR designated uses.

Range

Existing Condition

Most livestock grazing on National Forest System lands has occurred in the areas presently grazed, in a variety of forms, for over a hundred years. Grazing is another tool, along with mowing, hand-cutting and prescribed burning, to maintain and manage some open and semi-open habitats and is allowed under the Mark Twain National Forest LRMP. Currently there are three grazing allotments within the Crooked Creek analysis area. All are managed under a deferred rotation system. Barney Fork and Casey are currently under term grazing permits. Fortune Hollow is inactive at this time, but has been under a term grazing permit in the past.

Barney is comprised of 52 grazed acres and is managed as a three-pasture rotation grazing system. One pasture is managed to enhance native warm season grasses and forbs and two pastures are managed for a diverse mix of cool season grasses and forbs. Carrying capacity for this allotment is estimated at 82 Animal Unit Month's (AUMs). Currently this allotment is grazed for three months from April 16 to July 15 with 21 cow/calf units.

Casey is comprised of 85 grazed acres and is managed as a three-pasture rotation grazing system. All pastures are managed to enhance native warm season grasses and forbs. The term permit is for 35 cow/calf units from May 5 to August 14. Monitoring of this allotment has shown the need to graze cattle later in the season for less time. This allotment is currently grazed for two months from July 5 to August 30 with 35 cow/calf units for a total of 86 AUMs.

Fortune is comprised of 208 grazed acres and is managed as a three-pasture rotation grazing system. One pasture is managed to enhance native warm season grasses and forbs and two pastures are managed for a diverse mix of cool season grasses and forbs, with a component of native warm season grass. Carrying capacity for this allotment is estimated at 117 Animal Unit Month's (AUMs). The last term permit was for 30 cow/calf units from April 15 to July 14. This allotment was last grazed in 1996 for four months from May 1 to August 31 with 9 cow/calf units.

Table 3 - 32: Current/Past Range Management in Analysis Area

Allotment	Acres grazed	No. of pastures	AUMs grazed	AUMs avail.	Grazing period on term permit
Barney	52	3	82	82	04/16- 07/15
Casey	85	3	86	86	05/15- 08/14
Fortune	208	3	47	117	04/15- 07/14

Grazing at less than full capacity or at different times with different numbers of cattle is designed to mitigate for seasonable climatic variations such as temperature, amount and timing of precipitation, and drought regimes. This allows flexibility in management by minimizing the need to reduce livestock numbers based on seasonal forage availability (such as reduced production of cool season grasses through hot summer months). It allows for long-term sustainability of the livestock operation, forage resource, the warm season grass emphasis pastures, as well as invasive plant management. It also has the important benefit of allowing production of high quality open land habitat for wildlife.

Cool season grass species such as tall fescue, orchardgrass, redtop, and Kentucky bluegrass occur throughout the analysis area. Legumes such as red clover, white clover, Korean lespedeza, western ragweed, golden rod, and Sericia lespedeza are the dominant forbs in pastures managed for cool season grasses.

Warm season and other native grasses and forbs are found primarily within warm season emphasis pastures although scattered remnants of prairie grasses and forbs may be found throughout grazed as well as un-grazed portions of the Crooked Creek analysis area. Native grass species within the analysis area include: (warm season) big bluestem, Indiangrass, little bluestem, sideoats gramma, broomsedge bluestem, switchgrass, Eastern gammagrass , and (cool season) Canada wildrye. Native forbs that are present within the open and semi-open portions of the analysis area include: Illinois bundleflower, compassplant, butterfly weed, blazing star, and partridge pea.

Maintaining a diverse openland habitat structure benefits a variety of grassland birds including Partners in Flight priority species for the Ozark/Ouchita physiographic area such as field sparrow, blue-winged warbler, loggerhead shrike, prairie warbler, and northern bobwhite. Warm season and cool season pastures are currently managed to maximize plant species diversity as well as openland structural diversity (cover). Special emphasis is also given to maintaining interstitial spaces between grasses in warm season (bunch grass) pastures and cool season grass pastures (typically sod forming grasses) and providing for covey headquarters for bobwhite quail. Interstitial spaces between grasses allow ground-nesting birds to travel freely while foraging as well as providing for a diverse forb population.

Management for diverse herbaceous plant composition within grazed areas also is beneficial to livestock performance and production. Inter-seeding legumes within cool season pastures and managed deferred rotational grazing of warm season pastures aids in the dilution of the amount of tall fescue consumed which reduces the effects of fescue toxicity (summer slump). Fescue toxicity is caused by a fungal endophyte found within tissues of the fescue plant. Symptoms include poor weight gains, reduced conception rates, intolerance to heat, elevated body temperature and nervousness.

Direct and Indirect Effects on Range by Alternative

Alternative 1

Existing term grazing permits would be allowed to expire and would not be renewed. After the permits expire, existing open land management would no longer benefit from the use of livestock grazing as a tool to maintain and enhance open/semi-open habitats. Permittees would have to find other areas to graze their cattle for part of the year. There would be no fee credits available from grazing to be used to pay for management activities such as seeding, liming and fertilizing to enhance these open/semi-open areas. Existing range improvements (fences, stock tanks) would not be utilized and would be removed or allowed to deteriorate.

Items common to all action alternatives:

The following watershed, open-land, and range improvements would occur: Pond and stock tank maintenance, maintenance of existing range structural improvements, exclusion of livestock from riparian areas and other sensitive areas by fencing, mechanical treatment of non-native invasive plant species, mowing of woody species, prescribed burning, seeding, liming, and fertilizing. These projects would reduce sedimentation in the long term, improve open-land plant structure and species diversity and provide for a sustainable forage resource.

Alternative 2

This alternative proposes an adaptive management approach on the allotments to better utilize forage and enhance open/semi-open habitats within the allotments. The proposed adaptive management will specify the maximum limits or parameters for the appropriate timing, intensity, frequency, and duration variables instead of specifying a fixed number of livestock and on and off dates. Monitoring of the effects of grazing will be used to determine specific numbers and periods of use. Monitoring will also be used to

determine the need for additional structures (fencing), hardening of crossing, changes in water systems, and other management practices to accomplish objectives in the Allotment Management Plan. This alternative would also remove several acres of pasture on the Fortune Hollow Allotment from grazing use through the construction of new fences. This addresses the issue of reducing impacts to newly discovered fens within this allotment. This reduction in grazed acres on the Fortune Hollow Allotment would result in the reduction of Animal Unit Months available for grazing and reduce the authorized animal units. The area with fens would be managed to maintain and enhance this specialized habitat.

Adaptive management approach-

The LRMP stipulates that only cattle and horses will be permitted to graze on allotments, permits will be based on a cow/calf operation, and the upper limit for term permits is 150 head of cows. Forage will be utilized under split or less than year long grazing seasons.

Timing- grazing will generally occur between April 1st and September 31st. When cattle can be turned onto the allotment will often depend upon the severity of the winter and drought conditions. The timing will also depend upon whether the allotment is mainly cool season or warm season grasses with the warm season grasses grazed later in the season. The timing will compliment other management practices such as prescribed burning, mowing, and hand-cutting.

Intensity- grazing generally will not exceed 1.5 AUMs per acre for cool season grass pastures and 1.2 AUM's per acre for warm season grass pastures.

Frequency- the deferred rotation grazing system will be used on all allotments.

Duration- will depend on the amount of forage available. This is often weather dependent. Grazing will be used to help move the areas toward desired plant communities and maintain open/semi-open conditions. Stubble heights in the FP will be adhered to. Grazing will not result in unacceptable increases in non-native invasive plant species. Grazing will not result in unacceptable impacts to water quality or sensitive habitats. The convenience of the permittee will be considered when determining on and off dates.

Alternative 3

Existing livestock management, animal units, season of use, number of pastures, animal unit months, and acres grazed would not change. Numbers would be the same as in Table 3 - 32 above. Allotment management plans would be similar to current/past plans with some minor changes to comply with Forest Plan direction. Numbers and season of use would not change and there would be no adjustments to better utilize forage and provide for habitat diversity.

Cumulative Effects on Range

Past actions that have affected the openland vegetation in this area include: logging prior to Forest Service ownership to clear land for openlands, farming, haying and grazing. Through conversion of some of the primarily cool season grass (fescue fields) to native warm season grasses, diversity of habitats have been improved over the last 60 years. These native grass fields and the other cool season fields will continue in all alternatives.

Alternative 1 does not propose any activities (including grazing) that would directly or indirectly improve the open/semi-open habitats and would not create any cumulative beneficial effects that could increase or stabilize these habitats over the long-term.

The implementation of Alternative 1, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, is expected to maintain habitat conditions similar to the current conditions. Although there may be some decrease in the quality of these habitats within the analysis area under this alternative, this loss is not expected to be great enough to have a cumulative negative effect upon theses habitats in the analysis area or elsewhere.

Alternatives 2 and 3 propose range activities that would directly or indirectly improve open/semi-open habitats; therefore, these alternatives could create cumulative beneficial effects that could increase or stabilize these habitats over the long-term.

The implementation of Alternatives 2 and 3, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would help to improve these habitats, and no adverse cumulative effects upon these habitats are anticipated in the analysis area or elsewhere.

SOCIAL AND ECONOMIC ENVIRONMENTS

Recreation

Existing Conditions

This area of the Missouri Ozarks has long been known for dispersed recreation opportunities. These include hunting, berry picking, auto touring, camping, fishing, hiking, gathering forest products, wildlife viewing, and horseback riding.

The most prevalent dispersed recreation activity in the analysis area is hunting. There are numerous hunter camps (sites where hunters traditionally camp along Forest roads) located throughout the Crooked Creek area. These camps are repeatedly used primarily in the fall during deer hunting season and again in the spring during turkey hunting season. The amount of hunters in the area varies from moderate to heavy, depending primarily upon weather conditions and the amount of non-local (both state residents and non-residents) hunters in the area. The Crooked Creek area has been managed for a variety of habitats (early successional to mature forest) since the 1930's. There are 1,172 acres of wildlife openings, including small ponds, ranging in size from 1 to 61 acres. These areas provide an important food source during the fall and winter and help sustain a healthy population of deer and turkey during the winter. The wildlife openings also provide areas in which people like to hunt. A good population of game species contributes to high hunter satisfaction. The analysis area is well known for providing successful hunts to local, non-local Missourians and out of state residents.

The only developed recreation facility in the area is Howe's Mill Lake. Picnic sites, a boat launch, and a hiking trail are associated with this site. Proposed activities included in this project relating to Howe's Mill Lake are discussed in the fisheries section of this document. This area provides Forest users the opportunity to fish, picnic, and hike.

The analysis area has been classified as Roaded Natural in the Recreation Opportunity Spectrum (ROS). (Reference MTNF LRMP, Chapter IV pp.27-30, p. 115, MA 3.4; Opportunity Area Analysis, p. 7; USDA Forest Service. This is tiered to MTNF Final EIS, Appendix B, p. 61.)

Direct and Indirect Effects on Recreation by Alternative

Alternative 1 - No Action

The no action alternative would have increasing short and long term effects on dispersed recreation for quite some time since the character of the area would change as the affected trees die and, over time, fall. Additionally, the natural regeneration of tree species would take longer than if management activities were to take place.

The short term effects include continued tree mortality, mainly within the red oak family. Safety issues from falling limbs, fire hazard potential, and visual impacts of dead and dying trees would continue until natural tree senescence and/or natural catastrophic events allow for and encourage regeneration. As more trees are affected, potential safety hazards would increase in all areas of the forest including developed and dispersed recreation sites. Though few accidents have been reported in the last 3 years, there have been instances of trees falling in campgrounds, blocking trails, trees falling across roads and limbs falling near people recreating in the forest.

Long term effects include regeneration of the same tree species compositions currently occupying this area. This will merely only perpetuate the problems of tree mortality, insect and disease susceptibility, and inadequate tree species diversity necessary to maintain a resilient condition over time.

In the absence of vegetation management, the quality of deer and turkey hunting (and consequently the amount of hunting-season camping) and berry picking opportunities may be somewhat reduced after a period of time. Firewood gathering opportunities would increase as declining black oak die and fall to the ground.

Finally, wildlife species diversity would decline as habitat diversity is lost over time. An examples includes the loss of open-woodland and early successional habitats, barring natural events that tend to be more destructive and less beneficial (wildland fires, drought, or tornadoes). Habitat diversity resulting from harvesting or prescribed burning would not occur under this alternative, and consequently, opportunities to observe species associated with these habitats would likely not be as great. For these reasons, recreational opportunities such as hunting, and wildlife viewing would likely decline.

The Ozark-Ouachita Highland Assessment (OOHA) discusses the “scenic character” as an esthetic value description of a landscape (OOHA Report #4, Social and Economic Conditions, p. 139). With the expected continued decline and mortality within the landscape, weighed against the anticipated improved scenic value with management, one could conclude that lack of management would diminish this “scenic character.” Overall, this alternative would not preclude recreation opportunities; but it could possibly diminish them.

Alternative 2 – Proposed Action

Impacts from Noise - In any of the action Alternatives, logging activities and skidding operations would create intermittent noise that could reduce the enjoyment recreationists get from experiencing the natural outdoor environment. The actual impact of the noise depends on the time of day, time of year, and proximity of the recreation user to the harvest operation. Since most recreation activity occurs on weekends, and most timber harvest occurs on weekdays, user conflicts from noise are minimal. No harvest operations are scheduled within developed recreation areas, though hazard tree removal activities may take place outside of the recreation season.

During spring and fall turkey seasons and during deer hunting seasons (firearm and archery), hunters are camping, hiking and hunting throughout the parts of the proposed harvest areas. Hunters in the analysis area would be most affected if harvesting were active at that time. Hunting season has long been a traditional time for the harvest crews to be among the hunting enthusiast groups; thus, they are rarely working during times of hunting seasons, mainly turkey and deer firearms. This is also a tradition of courtesy. It is likely, however, that fuelwood cutting activities, a form of recreation in and of itself for some, would be encountered during these times, thus some user conflicts may result. This may be more

apt to happen as previously harvested areas under this action alternative are made available for firewood gathering following the commercial timber sales.

Impacts from Traffic -During harvest and/or burning operations, forest visitors could also encounter truck traffic and adverse road conditions that may detract from enjoyment of relative solitude, as well as increase the risk of accidents. The use of warning signs and temporary public access closures are methods normally used to warn recreationists of logging traffic or burning activities and restrict exposure to traffic conflicts on one lane Forest Service roads in the area.

Specific to harvest, any effected road surfaces will be repaired using money (road maintenance deposits) collected from the timber purchaser or be repaired by the purchaser at his expense as a term of the harvest contract.

This alternative will continue to provide roaded natural motorized recreation opportunities as featured in MTNF LMP Management Areas 3.4 prescription designation. Currently, most through system roads accommodate passenger car traffic. Dead-end “access” roads normally require higher clearance vehicles (such as a pick-up truck) as these roads are constructed and maintained at a lower standard than higher traffic through roads.

Impacts on Scenery - In the short term, management activities would cause the visitor to encounter specific areas of disturbance of the vegetation, either from timber harvest, regeneration activities, or prescribed fire. This disturbance will be more dramatic in the regeneration harvests (Complete salvage and Seedtree) and less obvious in the Removal, Shelterwood, UAM, or thinning areas, as well as prescribed burned areas.

The harvested areas will have slash and logging debris present for several years until site preparation is complete, and time and decay have had a chance to “melt” down this debris.

Prescribed burned areas will appear "blackened" for several months until understory vegetation resprouts and/or reseeds to create a greener lush appearance. Vegetation management would be expected to have some short-term negative effect on sightseeing due to the appearance of disturbed vegetation; however, some benefits of improved sight distance will also be occurring. Implementation strategies that would help mitigate most negative effects (see Mitigation Measures at the end of Chapter 2) include leaf-off logging in specific areas, log-landing location planning, slash treatment requirements along area roads, and prescribed burning timing requirements.

As described in the Vegetation Effects section, the pine planting proposed in this Alternative is for future stand diversification and is not meant to be a “plantation” of pine per se. A mixed oak-pine condition is more of the conceived result that will not likely be susceptible to the problems now afflicting the black oak dominant stands currently in decline.

Over the long term, improved stand vigor, stand composition (from pine planting), wildlife habitat, and road conditions would result in improved “scenic character” as defined in Alternative 1. Healthy, resilient stands of trees and areas of recruitment and regeneration will help to retain overall diversity and sustainability over time. Additionally, as the more lasting effects of prescribed burning begin to show (more grass growth and wildflowers), these areas should become more attractive for viewing as fire dependant vegetation becomes established and sight distance through the trees improves.

Impacts on Opportunities - Under this alternative, hunting experience may be less enjoyable or productive for some hunters in the short term due to reasons discussed under Noise Impacts, as well as the resulting slash from timber harvest making foot travel more difficult within treated stands.

Additional long term impacts from the creation of early successional (0-9 age class) and open-woodland habitat, along with the improvement of existing wildlife openings and open woodland habitat from

prescribed fire, would be beneficial for many game and non-game wildlife species. Therefore, hunting activities would more likely be successful.

This alternative would also enhance wildlife viewing opportunities for the same reasons listed above, as well as improve berry-picking opportunities from the increase in temporary openings.

Other dispersed recreation opportunities would be expected to remain relatively unchanged.

Under this Alternative, the greatest recreation benefit would be the increased fishing opportunities from the deepening of Howe's Mill Lake and the spillway repair of Howe's Mill South. These treatments should provide specific habitat conditions currently lacking within the lakes that are necessary to manage and maintain healthy fish populations. Specific treatments and effects are discussed in the Fisheries Management section of this document.

Alternative 3 – Reduced Complete Salvage with Natural Regeneration Only

This Alternative contains less early successional habitat creation, thus there would be diminished benefits of this condition as discussed under Alternative 2. Conversely, less regeneration would not have the short term disturbance and impacts that accompany management activities also described above.

One main additional characteristic of this alternative would be the lack of pine planting within specific complete salvage stands. The existing isolated pine and mixed oak-pine stands in the analysis area are currently the most resilient and thrifty stands, a tribute to past management activities. These stands contribute greatly to scenery, habitat, and productivity of the area. The lack of perpetuating a pine component within remaining declining stands that can and have supported pine will only allow history to repeat itself, which currently is a testament to a previous era of exploitation, rather than management and conservation.

Future scenic, diverse, healthy, productive, and beneficial (for all values and resources) timber stands and ecosystems alike depend upon a mixed condition and composition to withstand natural occurrences over time.

Cumulative Effects on Recreation

The crossroads of effects between conservation, stewardship, and preservation are very subtle as they are encountered, but longer lasting and divergent the farther each is traveled. Although each does not preclude the other in a national sense, the values of natural resources and natural areas have come to mean many things to many people in specific areas and specific settings.

The action alternatives of this analysis each have benefits better related to long term conditions that are more involved with health and restoration of the area rather than creating any additional recreational opportunities that do not currently exist. The Management Prescription emphasis as defined in the LRMP would be best served by maintaining roads and trails, promoting health and vigor of wildlife and vegetation, and providing dispersed recreation opportunities in the action alternatives. In that light, and under the direction and spirit of multiple use goals and objectives, no one alternative will exclude or deny current recreation trends within the surrounding area of the proposed project. Abandoning "restoration" and management efforts begun in previous decades may only delay the benefits of these investments, and perpetuate the consequences of natural as well as man-influenced responses of the environment to past management or the lack thereof.

Visual Resources

The Mark Twain Land and Resource Management Plan establishes Visual Quality Objectives (VQO) for each management prescription. The VQO for a specific area is determined by relating the variety class

and distance zone/sensitivity level mapped for each district to the visual quality matrix found in the standards and guidelines (2300) for each management prescription.

The Crooked Creek Analysis Area is in the Variety Class B- Common and a small amount in Variety Class C, within the 3.4 management area, LRMP pg. IV-115. Highway 32, Highway 49 and County Road 811 are Sensitivity Level One travelways with a VQO of Partial Retention (PR) to Modification (M). All the other roads in the analysis area are Sensitivity Level Three travelways with a VQO of Modification. (Reference Visual Management System Map for the area). A table using travel speed, VQO, and Sensitivity Level determines the slash disposal height (see table, LRMP IV-34). The slash disposal height requirements mitigate the negative visual impact of an activity and shorten the length of time the slash would be visible.

Existing Condition of Visual Resources

The Crooked Creek Analysis Area is in the 3.4 management area with a VQO of Partial Retention to Maximum Modification. It is characterized by moderately rolling, rocky topography with broad ridges, valleys, springs, and creeks. It contains Variety Class B-Common and a small area of Variety Class C-Minimal. The adjacent private land is both forested and in open land. There has been management activity, both thinning and regeneration, in the area over the past 20-30 years. Evidence of these past activities can be seen in the varying size of the trees in different stands. The vegetation and wildlife diversity is typical for this area. Large overstory deciduous trees, cedar, and pines, as well as young trees and openings, are interspersed throughout the analysis area. The road surfaces within the analysis area are blacktop and gravel with slow to medium speeds. Bordering the analysis area are Highway 32, Highway 49 and County Road 811 and they are Sensitivity Level One travelways with a VQO of Partial Retention to Modification in the near foreground seen area. The illegal use of ATV’s causing multiple trails and erosion is very visible. The red oak borer infestation has caused oak decline/mortality to many of the large trees showing dead and dying areas. Illegal dumping has created many places along travelways that are visually unacceptable.

Direct and Indirect Effects on Visual Resources

The broad/generalized effects on the visual resource associated with the management activities proposed in this project set are contained in the Final Environmental Impact Statement (FEIS) portion of the LRMP. Reference the following headings: Management Problem 4 - Wildlife IV-22; Management Problem 6 - Road Network IV-30; and Management Problem 7 - Timber Resource Management IV-35 and 36. More detailed site-specific effects are contained in the following alternative discussions.

Application of the Mark Twain's LRMP Forest-Wide S&G's Chapter IV-31-36, relative to the visual resource, would help mitigate adverse impacts and achieve visual resource objectives. Standard mitigation measures are described in Appendix F of the LRMP. More detailed site-specific mitigation measures are contained in the following alternative discussions.

All proposed actions have been reviewed by the forest landscape architect through field visits and/or map review and would meet the established VQO unless specifically noted otherwise in the following discussion. The LRMP standards and guides (S&G’s) would mitigate the temporary visual effects of the slash by requiring a disposal height of 36” or below along sections of Highway 32, Highway 49 and County Road 811- Sensitivity Level One travelways, in the near foreground seen area where activity is occurring.

The general effects of the proposed actions on the visual quality of the analysis area are addressed in the following discussion.

Alternative 1: No Action

No immediate changes from the existing visual condition would be expected to occur. Barring natural disturbance, continued illegal ATV use, or continued illegal dumping, it is anticipated that the existing visual condition of the analysis area would be relatively maintained at its current state. The analysis area as a whole would appear as a natural mature or old growth forest in the future with additional mortality due to the red oak borer infestation causing additional oak decline/mortality. The illegal ATV use would continue to be very visible with multiple trails and erosion continuing and growing. There would be less visual variety over time and continued deterioration. When illegal dumps are not removed, they continue to grow and attract additional dumping, worsening the visual quality of the area with the unsightly refuse.

Under all the alternatives, there would continue to be open woods and fields due to natural low soil fertility, natural disturbance (windstorm, insect and disease, etc.), or wildland fire.

Alternative 2: Proposed Action

Harvests would cause an overall reduction in the number of trees per acre, create additional temporary slash on the ground, and require temporary roads or landings that would be visible from Forest Service roads. The temporary effects of harvest on visual values adjacent to these roads would be minor and stay within the VQO for that area. Thinning and removing the overstory would allow the remaining trees to grow larger and improve areas with heavy oak decline/mortality. Opening up the understory would give the forest user an opportunity to see into the woods from the roadway at a greater distance and provide an opportunity to view wildlife and varying plant material. Restoring and rehabilitating areas impacted by illegal ATV use would visually improve the area over the existing conditions. The prescribed burning would improve the grasses, forbs and shrubs in selected areas providing seasonal blooms and color. The visual effects of the burned areas would only be temporary until the green up in the spring. Cleaning and removing all illegal dumps would greatly improve the visual quality of the area and discourage further dumping.

This alternative would have the most activity visible from the travelways and existing non-system roads. The long term effects of this alternative would improve the visual quality of the area overall.

Alternative 3:

The visual effects of this alternative would be similar to Alternative 2 with less harvest activity and regeneration visible. The prescribed burning would remain the same and the visible effects would be visible only for a short time until green up in the spring. The restoration and rehabilitation of the areas impacted by the illegal ATV use would improve the visual quality of the area as well as the cleanup of illegal dumps.

Cumulative Effects on Visual Resources

The scope of cumulative effects on visual resources is limited to the area from which the proposed and past treatment areas can be seen. Evidence of previous management practices is visible from some of the roads. Private land management, including cattle grazing, timber cutting, and conversion of woods to pasture can also be seen near the analysis area. Because these past activities are visually evident, the proposed actions would not change the overall character of the landscape.

Alternative 1 after time would not meet the assigned visual quality of Partial Retention to Maximum Modification for some of the area due to illegal ATV use and dumping. Alternatives 2 and 3 would meet the assigned visual quality objectives of Partial Retention to Maximum Modification for the analysis area

due to seen area and protective measures. The use of site-specific protective measures that follow Forest Plan standard and guidelines as described for Alternatives 2 and 3 would aid in meeting those objectives. The cumulative effects of past cutting, the proposed treatments, and activities in the reasonably foreseeable future would result in a forest area that is natural appearing and meets the VQO desired future condition for the analysis area as identified in the Forest Plan.

Private land uses are likely to remain much the same as in the past 10 years. Much of the private land is farmland and is interspersed throughout the analysis area. There are dwellings and outbuildings on the private land and varying farm and timber practices.

In all of the alternatives, several things would remain the same. The highways and roads would continue to exist, but may be altered, improved or relocated. Natural disturbances, such as windstorm, ice storms, frosts, insects/disease would continue to affect the analysis area. Fire protection would continue because it is the policy of the Forest Service to protect resources from wildland fire, and because the proximity of private lands and dwellings makes it imperative. The local economy would continue to rely on wood products, which would be removed from private lands as well as other public lands. Hiking, trail riding, hunting, fishing, trapping and other recreational pursuits would continue.

Alternative 1:

Under this alternative, natural disturbances would occur and illegal ATV use and dumping would continue. All communities present would continue to exist, although the amount of each community type might fluctuate over time, particularly with the red oak borer effect. Fire protection would keep wildland fires to a minimum, except in the areas of the oak decline/mortality where areas of woody material increase fuel build up. The oak-pine communities would continue to mature and decline, with many small openings created by natural mortality of individual trees and some larger openings created by windstorm, ice damage, insect, disease, or other disturbance. A large percentage of the area would soon be in mature and old growth successional stages with only a small amount of early to mid successional stages. Roads would still exist and be used. Illegal dumping would continue and grow and be encouraged by not removing previous dumpsites and be more unsightly. Illegal ATV use would be very visible with multiple trails and erosion would continue, thus reducing visual quality. There would be less visual variety over time and continued deterioration of visual rsources.

Alternatives 2 and 3:

These alternatives would allow for regeneration of the maturing and declining stands and identify the areas of old growth to maintain. Open woods (an overstory of medium to large size trees with few midstory trees and abundant ground cover of grasses and forbs) would be recreated and maintained through a combination of activities. The areas along travelways and private land would contain open and forested sections on both sides of the roads, providing for visual variety. Restoring and rehabilitating areas impacted by illegal ATV use would visually improve over the existing conditions. Cleanup and removal of illegal dumpsites would improve the visual quality and discourage the use of these existing dumpsites.

Heritage Resources

Existing Conditions

Cultural Resource Surveys

Cultural resource inventory surveys in the Crooked Creek Analysis Area have focused on those stands and areas in which activities are proposed that have the potential to affect archaeological sites, as outlined below (Definition of Effects and the Areas of Potential Effects). The entire 23,217 acres in the Crooked Creek Areas of Potential Effects (APEs) have been either previously or recently surveyed for cultural resources. A listing of the reports documenting the various surveys in the Crooked Creek area can be found in Appendix A.

Pursuant to 36 CFR 800.4 and 5, consultation with the Missouri State Historic Preservation Officer (SHPO) has been completed with respect to the expected effects on the cultural resources of the various actions proposed in the alternatives for the Crooked Creek Analysis Area. The Missouri SHPO concurs that cultural resource surveys for the analysis area meet current standards and also concurs with the Forest's determination both of National Register significance and eligibility for the various archaeological sites and of the expected project effects on significant sites (copies of correspondence relating to this consultation are on file with the Mark Twain National Forest).

Cultural Resources

Forty (40) archaeological sites have been identified to date in, or adjacent to, the Crooked Creek Analysis Area. Of these sites, four (4) contain evidence for prehistoric occupation, thirty-two (32) contain evidence for historic period occupation, and four (4) archaeological sites that contain both temporal components. In addition to the archaeological sites, seventeen (17) isolated finds (consisting of a single artifact not associated with any cultural features) and eighteen (18) historic features (isolated historic features such as rock piles from field clearing activities that are not associated with a larger archaeological site or artifacts) were also recorded in the analysis area.

Most of the prehistoric sites in the analysis area appear to be small, essentially surface, or very shallow, scatters of lithic artifacts. This type of site represents an ephemeral, short-term camp or work site. The shelter site and other, larger habitation site, in contrast, are likely to contain material spanning a large time period, and were likely repeatedly used throughout prehistory. It is likely that the prehistoric sites date from the very early prehistoric Early Archaic stages to the much later Woodland stage. With the information at hand, however, the cultural/temporal affiliation of most of the prehistoric sites in the Crooked Creek Analysis Area cannot be determined.

The historic archaeological sites found within the analysis area to date include farmsteads and rural residences that date to the late 19th and early 20th centuries, as well as sawmills and railroad trams associated with the logging industry that dominated the region at the turn of the last century. The former site type varies widely in appearance, and usually contains the foundation for one or more structures. These sites can also contain other features, such as a cistern, well, privy, or domestic plants. The latter site type consists of the remnants of industrial complexes, as well as narrow-gauge railroads and their associated tram beds. Although company affiliation of the single tram site containing archaeological remains in the analysis area has not been determined with certainty, it would appear to be associated with the Dillard spur of the Sligo and Eastern Railroad that remained operational from 1880 to 1921 (Dent County Historical Society 1978:662).

The isolated finds include such things as stove parts, cans, tile, wire, automobile parts, and ceramic sherds. The historic features include depressions, rock circles, mining pits, rock piles and charcoal pits.

The features and artifacts primarily date to the early to mid-twentieth century and are associated both with general habitation patterns, as well as use of National Forest lands following federal acquisition.

Information on the cultural sequence and on both the historic and prehistoric backgrounds for the Crooked Creek Analysis Area can be found in the following reports, *Determinations of Effects for the Barney Fork and Marcoot South Pine Hazard Fuel Reduction Project, Dent County Missouri* (Turner 2003) and *Phase I Survey for the Casey Road Project and Phase II Evaluation of the Casey Houseplace Site, 23CR491, Crawford County, Missouri* (Wettstaed 1994). Summary information on the archaeological sites, isolated finds, and historic features, as well as maps showing the locations of the cultural resources, can be found in Hill (2004: 7-14 and Attachments A and C). The Site Inventory Forms (on file with the Mark Twain National Forest) provide more detailed descriptions of each of the archaeological sites.

National Register of Historic Places Significance

With a few exceptions, investigation at the archaeological sites to date is presently insufficient to fully evaluate them again the National Register of Historic Places (NRHP) significance criteria as found in 36 CFR 60. These archaeological sites, therefore, are being managed as unevaluated properties that appear to meet one or both of principally two NRHP significance criteria as found in 36 CFR 60.6:

1. Criterion A: That are associated with events that have made a significant contribution to the broad pattern of our history;

2. Criterion D: That have yielded, or the potential to yield, information that is important to prehistory or history.

These sites are afforded protection from project activities that may harm the sites in the same manner that eligible sites are protected. The exceptions to this rule include two very small prehistoric activity loci and three previously damaged historic sites, all of which do not appear to meet National Register significance criteria. All of the isolated finds and historic features are considered to be non-contributing properties in that their data producing potential has been exhausted by the simple act of recordation (see Hill 2004:7-8).

Definition of Effects and Area of Potential Effect (APE)

An Effect to a cultural resource is defined as "…alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the National Register" [36 CFR 800.16(i)]. An Adverse Effect is found "when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association" [36 CFR 800.5(a)(1); see also subsection (a)(2)].

The Area of Potential Effect is defined as "…the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties…. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking" [36 CFR 800.16(d)].

Direct Effects on Heritage Resources

With respect to the Crooked Creek project, direct effects are those that will occur during project implementation. These effects can occur during implementation of forest management activities. In essence, any activity that has the potential to disturb the ground has the potential to directly affect archaeological sites. Prescribed burning may also directly affect archaeological and architectural sites not only by construction of firelines with heavy equipment, but also by damage and/or destruction of cultural features and artifacts by the fire itself.

Specific activities outlined in the Crooked Creek project alternatives **that have the potential to directly affect cultural resources, and therefore, are considered to be undertakings for the purpose of this project** include the following:

Forest Management
- Commercial timber harvest including thinning and understory removal
- Construction of landings, temporary roads, skid trails
- Issuance of personal firewood permits after harvesting

Wildlife Habitat Management
- Prescribed burning
- Mechanical treatment that involves ground disturbing activities

Watershed Health and Recreation Management
- Pond or dam reconstruction that involves ground disturbing activities
- Maintenance of Forest Service Roads that are currently maintained and where ground disturbance takes place outside existing road prisms and ditches
- Road reconstruction where the ground is disturbed outside the existing road prism

The Area of Potential Effects (APE) for the above-listed Crooked Creek project activities are those geographic areas in which the ground disturbing activities will take place.

Activities proposed that **do not have the potential to affect cultural resources, and therefore, are not considered to be undertakings for the purpose of this project** in the following:

Forest Management and Wildlife Habitat Management
- Pre-commercial and non-commercial thinning and understory removal
- Hardwood planting/Native vegetation seeding
- Designation of Old Growth

Watershed Health and Recreation Management
- Pond maintenance
- Fish stocking and habitat improvements
- Continued maintenance of Forest Service roads along currently maintained roads where ground disturbance does not take place outside existing road prisms and ditches

Indirect Effects on Heritage Resources

In general, project activities of the kind proposed for this project have the potential to indirectly affect cultural resources by opening up areas of the forest in which cultural resources are located to increased visitor use. Increased visitor use of an area in which cultural resources are located can render the sites vulnerable to both intentional, as well as unintentional, damage. Intentional damage can occur through

the unauthorized digging in archaeological sites and unauthorized collecting of artifacts from sites. Unintentional damage can result from such activities as driving motorized vehicles across archaeological sites, as well as from other activities that disturb the ground during dispersed recreational use.

Analysis of Effects on Cultural Resources by Alternative

Summary statements of expected effects for the proposed activities within the various alternatives are presented in this section. Table 1 in Attachment C in Hill (2004) provide additional information on expected effects on individual sites.

Direct Effects

Alternative 1: With selection of Alternative 1, there will be no change in the condition of the archaeological resources over the present condition. Significant archaeological sites will continue to be afforded protection during management activities that have the potential to harm the sites.

Alternatives 2 and 3: The effects on the cultural resources are expected to be similar with selection of either of the two action alternatives. Differences between the two alternatives exist in how the project will be implemented, rather than on the number of sites subject to effect and requiring mitigation. With respect to both alternatives, all of the archaeological sites that appear to meet National Register significance criteria, as well as all unevaluated sites, will be afforded protection during implementation of project activities that have the potential to harm the sites (see Mitigation Measures, Cultural Resources at the end of Chapter 2). The following discussion of effects presumes application of the appropriate mitigation measures to the significant resources.

In general, the effects on the cultural resources of the various activities that are proposed for this project are expected to be as follows:

(1) In those stands and project areas where no historic properties (archaeological sites meeting National Register criteria) are present, proposed project activities have **No Potential to Affect** cultural resources.

(2) In those stands and other project areas in which ground disturbing activities would be carried out as listed above, (see Definition of Effects and Areas of Potential Effect), where historic and/or unevaluated properties are present, and where Site Avoidance (Mitigation Measure CR1) is feasible and is implemented, the proposed project activities are expected to have **No Effect** on cultural resources.

(3) In those stands in which prescribed burning would be carried out, where historic and/or unevaluated properties are present, and where the mitigation measures described in Mitigation Measure CR2 are applied, the proposed project activities are expected to have **No Adverse Effect** on cultural resources.

(4) Where archaeological sites occur along routes of access (such as non-system roads that have not been maintained) and where site avoidance (CR1) is not feasible, the Mitigation Measure CR5 will be applied with the expectation that a mitigation plan can be developed to result in a finding of **No Adverse Effect** on cultural resources.

Table 1 of Attachment C in Hill (2004) provides information on the mitigation measures that are applicable to the individual archaeological sites.

Indirect Effects

With respect to implementation of any of the three alternatives proposed for the Crooked Creek project, increased site vulnerability to both intentional, and unintentional damage is expected to be the principal indirect effect to cultural resources resulting from proposed activities (see above, Definitions of Effects and Area of Potential Effects). Such increased vulnerability is generally directly related to increased visitor use of the area.

Alternative 1: It is expected that some intentional, as well as unintentional, site damage will continue to occur in the foreseeable future as a result of visitor activities in the Crooked Creek area. There will, however, be no change in the expected frequency of such incidents as a result of selection of this alternative, since there will be direct change in the frequency of visitor use under this alternative.

Alternative 2 and 3: As is the case with Alternative 1, both intentional and unintentional site damage is expected to continue to occur with selection of either of these alternatives. The activities proposed in the action alternatives that may enhance recreational opportunities in the Crooked Creek area, however, may increase the frequency in indirect effects on cultural resources. Mitigation addressing these effects will be critical to limiting adverse indirect effects on sensitive resources. With application of appropriate mitigation measures (principally with Mitigation Measure CR1, Site Avoidance), it is not expected that the proposed project activities will increase visitor use in those areas in which archaeological sites are located.

Cumulative Effects

Because it is not expected that any of the proposed project activities, with implementation of appropriate mitigation measures, will adversely any of the eligible and unevaluated archaeological sites, it is not expected that there will be any cumulative adverse effects to the cultural resources. It is expected that there will be no change in the condition of the cultural resources over the existing condition.

Social Economics

Environmental Justice

This analysis is intended to evaluate some selected quantitative demographic indicators of minority populations and low-income populations of communities for purposes of assessing environmental justice. This quantitative 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 addresses indicators to determine the presence or absence of minority and/or low-income communities in a study area. This analysis summarizes one

key demographic indicator of minority populations and three 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 3 - 33 highlights the key indicators of minority and low-income for Crawford and Dent Counties. There is no indication that these counties, a community with a population of 37,731 residents in 2000, have a significant *minority* population. There is no indication that these counties have a significant *low-income* population.

Table 3 - 33: Summary of Key Indicators of Minority and Low-Income Populations; Crawford and Dent Counties, Missouri, 2000.

County Demographic Characteristic	County	Threshold	Potential EJ Concern?
Minority Population			
Race/Ethnicity: Pct minority residents			
Crawford County	1.7 %	>25 %	No
Dent County	2.9 %	>25 %	No
Low-Income Population			
Income (annual): Median household less than $25,000			
Crawford County	$30,860	>$25,000	No
Dent County	$27,193	>$25,000	No
Poverty: Pct individuals below Federal poverty level			
Crawford County	16.3 %	>25 %	No
Dent County	17.2 %	>25 %	No
Household Income: Pct with public assistance			
Crawford County	3.9 %	>25 %	No
Dent County	4.7 %	>25 %	No

Source: 2000 Census

Project county indicators are compared to the State of Missouri in Table 3 - 34. The minority and low-income population indicators for the project counties do not exceed threshold percentages, and the low-income characteristics for these counties do not differ by more than 10 % from any indicators of Missouri.

Table 3 - 34: Summary Comparison of Crawford and Dent Counties, and Missouri Indicators of Minority and Low-Income Populations, 2000.

Community Demographic Characteristic	County	State	More than 10 % Difference
Minority Population			
Race/Ethnicity: Pct non-white residents		15.1 %	
Crawford County	1.7 %		Yes
Dent County	2.9 %		Yes
Low-Income Population			
Income (annual): Median household less than $25,000		$37,934	
Crawford County	$30,860		No
Dent County	$27,193		No
Poverty: Pct families below Federal poverty level		11.7 %	
Crawford County	16.3 %		No
Dent County	17.2 %		No
Household Income: Pct with public assistance		3.4 %	
Crawford County	3.9 %		No
Dent County	4.7 %		No

Source: 2000 Census.

Minority Population

Some 4.6 % of the population of the Crooked Creek Analysis Area is *non-white minority* (e.g. Black, Hispanic, Asian, Alaska Native or other Native American, Hispanic, or Latino). This is less than the EPA threshold value of 25 %, but more than 10 % different from the state average of 15.1 %. However, it is unlikely that a project completed in the counties surrounding the Crooked Creek project would have disproportionate negative impacts on any minority population.

Low-Income Population

Households in both counties of the analysis area have an annual median income of *more than $25,000 a year*. This is more than the EPA threshold value of less than $25,000, and within 5 % of state averages. Additional indicators of low-income status include percentages of families receiving some form of public assistance. In the analysis area counties and Missouri, an average of about 3.5 % of families receive some form of assistance, significantly less than the threshold value of 25 %. It is unlikely that a project completed in the area surrounding the Crooked Creek Analysis Area would likely have disproportionate negative impacts on any low-income populations.

Based upon the review of demographic characteristics of the populations of Crawford and Dent counties and how they compare with suggested threshold levels for concern, there is little reason to immediately suspect that this community might fall under the provisions of Executive Order 12898.

Economics

Existing Condition of Economics

The Ozarks-Ouachita Highland Assessment (OOHA) area (which includes the Mark Twain National Forest) containes 4.4 million acres of national forest land, which produces approximately 2.4 % of the total United States output of forest products. The associated forest products industry contributes 5 % of the industrial output, 3 % of the employment, and 3 % of the employee compensation directly attributive in the OOHA area. Thirty-five of the one hundred and seven OOHA counties had at least double the national average percentage output, employment, and/or employment compensation from the forest products industry. These counties derived an average 16 % of their output, 8 % of their employment, and 11 % of their employment compensation from the forest products industry. National Forests influence about 1 % of the Highlands overall employment (1.9 million jobs). Of the three principal national forest programs affecting the Highlands' economy (timber, mineral and recreation), timber has the greatest influence on employment, employee compensation, and total income when all three forests are considered together (OOHA, 1999).

Jobs and income in Crawford, Dent, and surrounding counties are affected by management activities on the Mark Twain National Forest through direct employment in mining, guiding services, timber harvest, campground concession, forest regeneration and timber stand improvement contracts, as well as needed products and services that are generated from these activities and recreation activities on National Forest system lands. Priced commodities (revenues) from the Crooked Creek project would be timber sale receipts. The main non-priced benefits include dispersed recreation opportunities such as hunting, fishing, hiking, horseback riding, wildlife viewing, berry picking and so on.

Recreation activities on the Salem district include a wide range of settings. Opportunities available for recreation range from semi-primitive dispersed opportunities, motorized trail use, or specific developed recreation areas. Most recreation use occurs at the developed recreation sites such campgrounds, trails, or fishing areas. The nature of dispersed recreation is that it is flexible, based on the needs of the user and the characteristics of the local surroundings at a given time. Local and non-local recreation users of the Analysis Area contribute to the local economy as they pass through or stay overnight in the area. According to a National Hunting, Fishing and Wildlife Survey conducted by the US Fish and Wildlife Service, forest related recreation activities in Missouri has contributed approximately *1.6 billion* in sales and 3.5 billion in business activity (jobs) annually in the state.

The following analysis focuses on incremental economic differences between the alternatives. The analysis includes only variable costs associated with the alternatives. Since fixed costs, such as general administration and program management, do not change among alternatives, these costs are not included. Furthermore, the costs included in the economic analysis are only those to be incurred by the Forest Service. Costs incurred by timber purchasers or other parties are not included. The estimates are based on historical costs for similar projects on the MTNF.

Economics - Direct and Indirect Effects

This project identified the need to perpetuate and maintain the health and vigor of the oak-hickory and oak-pine forest types and salvage dead, dying and high-risk hardwood tree species. With implementation of **Alternative 1,** no vegetative treatments would be carried out. Any future increase in the economic value of the timber resource would more likely be lost due to the mortality and accelerated decline currently prevalent throughout the Analysis Area within the specific stands proposed for treatment. The decline and resulting mortality only predisposes most stands to further attack by insect and disease agents,

which results in further degradation of the valuable wood in the trees. For the black and scarlet oak species, oak decline and mortality would be expected continue to occur due to several years of drought, low Site Index (SI), and the mature and over-mature condition of the stands.

The economic benefits of delaying a harvest are marginalized at the point the live crown ratio falls below 70 %. This is due to the limited or even nonexistent growth rate of trees suffering the effects of decline (Kurtz and Dwyer 1994). All regeneration (Complete Salvage, Seed Tree, Shelterwood) and/or Sanitation harvests proposed include stands that have less than 70 % live crown ratio on black oak or scarlet oak species on average. Additionally, within the proposed Thinning stands, overcrowding will continue to the point that more dominant individuals (of trees) eventually crowd out less hardy stems, which soon die as a process of natural selection. This is the primary component of the stand that would be thinned and captured as a commodity and economic benefit under the action alternatives.

Normally there would be no monetary cost for the government with implementation of Alternative 1 other than the standard custodial or stewardship costs associated with managing a National Forest. In this instance, a completely new set of circumstances will have to be dealt with, including increased fire intensity potential and associated suppression costs due to heavier fuel loading in the area; potential accidents and resulting claims (both bodily and property); increased road maintenance and hazard tree removal costs; and increased wildlife habitat degradation. In the short term, no change in local jobs or income would result from the implementation of Alternative 1, but there would be no monetary benefit from timber harvesting either in supplying jobs directly, indirectly, or generating revenues to the federal treasury. In the long term, forested stands in the anlaysis area would produce lower value timber, any future harvest revenues would be reduced accordingly, and future local employment opportunities could be reduced. The Forest Plan goal for a sustained yield would not be met and any associated future economic benefit would be lost.

Employment

In **Alternative 2,** timber harvested as a result of vegetative treatments would provide economic benefits beyond revenues generated by the timber sales. These benefits include local employment of harvest crews, wood products industries, and the local and surrounding businesses associated with goods and services support. In the short term, income and jobs would be produced through timber harvesting, subsequent reforestation work, prescribed burning support, and wildlife activities. As the indirect employment is variable, the direct employment from this project can be analyzed and expressed as crew weeks. A crew week is equivalent to three individuals producing 50 thousand board feet (MBF) of timber harvesting in a five day week. Table 3 - 35 below shows the expected amount of crew weeks of employment needed to complete the proposed harvests.

Table 3 - 35: Crew Weeks Employment by Alternative

	Alt 1	Alt 2	Alt 3
Crew Weeks	0	291	270

Future Economic Values

In **Alternatives 2 and 3,** the value of remaining residual trees in stands treated by intermediate harvest (UAM, Sanitation, and Thinning) will increase over time as these stands grow to maturity. Regenerated stands (Complete Salvage, Seed Tree, and Shelterwood) would provide sustained yields of timber for the future, thus providing future economic benefits. Timber management activities would improve the quality and size of preferred timber species, foster the establishment of higher value, shade-intolerant tree species, and provide for a sustained yield of high quality hardwoods and softwoods. Increased long range benefits for other resources include: habitat for wildlife species requiring early successional and semi-open areas, variety in canopy closure in mature stands, healthy mast producing stands, reduced potential

fire severity, decreased fire suppression costs, and a less hazardous outdoor experience due to treatment of areas with heavy decline and mortality. While there would be costs to the government associated with the implementation of these alternatives, the costs would be offset by the revenues returned to the national treasury (under the action alternatives). Job production will result in maintaining a tax base for federal, state, and local infrastructure. Finally, a healthy, productive forest land will require less investment over time to remain available for multiple use by all forest visitors.

Cash Flow Analysis

Table 3 - 36 below shows a net cash flow comparison of priced activities proposed in each alternative for a relative comparison. Appendix D includes the Quick-Silver Economic Analysis of the project economic factors. For simplicity, this analysis was calculated with a timeframe that only includes one year for all costs and benefits realization. In actual implementation of any action alternative, costs and revenues will be spread out over multiple years. Actual yields, values, and costs are estimates based on previous projects, and actual realized costs and values may vary. **It is recognized that many of the values generated by the various alternatives (both positive as well as negative) involve goods and services that are not priced in the market place and are thus not represented in this comparison.** These goods and services involve such things as the value of a hunting experience, a hike in the woods, watching wildlife, or the quality of water. The cost of producing some of these non-priced goods, i.e. creating new wildlife habitat, is included in the total cost figures. Total Cost was computed by summing costs of all the timber harvest, reforestation, prescribed burning, wildlife activities, and roadwork needed to implement each alternative. Total Revenue was derived from multiplying the expected volume in each alternative with the estimated stumpage value by species. Present Net Value (PNV) is the value left after subtracting Total Cost from Total Revenue.

Table 3 - 36: Cash Flow Comparisons of Alternatives *

	Alternative 1	Alternative 2	Alternative 3
Total Volume (MBF equivalent)	$0	14,537	13,505
Total Cost**	$0	$1,266,245	$1,001,374
Total Revenue	$0	$1,791,713	$1,647,886
Benefit/Cost Ratio	NA	1.41	1.65
Present Net Value	$-525,468***	$525,468	$646,512

*** From Quick-Silver economic analysis (results in project file).**

** **All timber, wildlife, and burning activities**

***** Value as an opportunity cost**

The PNV, which is considered to be the most reliable of all the investment performance criteria (Vasievich et.al. 2002), shows that implementation of either Alternative 2 or Alternative 3 would have a positive net return. The PNV from the Quick-Silver analysis shows that Alternative 3 has the higher PNV

of $646,512. Alternative 2 has a lower PNV of the two at $525,468. The negative PNV of Alternative 1 is expressed as an opportunity cost, or a foregone opportunity value, from doing nothing.

Under Alternative 2, more total volume is produced, as is the anticipated associated employment (Crew Weeks). Additionally, the pine planting proposed in this alternative will enhance and diversify the treated areas to mitigate the likely future effects of oak decline that may be perpetuated if the black and scarlet oak were to remain the dominant component of the stands on the existing low SI sites.

Alternative 3 has a higher return on investment (PNV), however, this is mainly due to excluding the cost of pine planting, and the subsequent pine release treatment needed to ensure success of their establishment (see Appendix D).

The Benefit/Cost (BC) Ratio defines the amount costs may rise and still make the project economically feasible. The project can be accepted as economically feasible as long as the ratio is equal to 1 or greater. In this example, the BC ratio of 1.41 in Alternative 2 would allow costs to rise 41 % before the ratio would be driven down to 1. For Alternative 3, this ratio is 1.65, which has a margin of 65 %. Ratios this high in both alternatives allow a relative "safety margin", as costs have historically risen (inflation) at a rate of less than 5 % (US Bureau of Labor Statistics, 2004).

Economics - Cumulative Effects

The cumulative effects on economics from past activities, the proposed action and future foreseeable actions are at best difficult to measure but should be similar to the past ten years. One factor that has remained constant is that the local economy relies heavily on timber production, mining activities and recreation opportunities provided by the Mark Twain National Forest, as well as the associated indirect monetary benefits supporting these activities (food, fuel, equipment sales and other services).

The counties included in this analysis area (Crawford and Dent) and surrounding counties have contributed to the state's timber production for many decades. Recently, due to falling federal timber outputs, increasing harvest pressure has been placed on private lands. Stumpage rates have been stable but may see slight increases due to an improving economy (Missouri Timber Price Trends Quarterly Market Report, Vol. 13 No.2). On some private lands within the analysis area, it is evident that the timber was liquidated, removing these lands from production for many decades. Additionally, red oak borer damage has drastically reduced the value of logs where infestations are high, and reduced the chances for sustainability over the short term until these lands can be regenerated to a more sustainable mix.

Under the no action alternative, this trend will continue. In the short term, disturbance may displace some recreation opportunities, resulting in lower generated income locally from these visitors. Conversely, the work to control spread of oak decline and degradation from the red oak borer will eventually bring more recreation opportunities to the area as safety issues are alleviated, forest health is moved toward restoration, and wildlife habitat is maintained. Over the long term, any of the action alternatives will help to provide market sustainability and increase value of all timberlands in the future by reducing high-risk, declining, low quality and borer damaged areas with healthy, vigorous timber stands.

Monitoring

Project level monitoring is designed to determine whether or not the resource management objectives of the EA have been implemented as specified and whether or not the mitigating measures were effective. These help determine if management activities are meeting the direction of the Forest Plan. Monitoring and evaluation help improve management and planning decisions.

Forest-wide project monitoring would be conducted by MTNF Resource Staff on a sample of randomly selected project areas on an annual basis. The Crooked Creek Analysis Area could be included in this sample at any time and stage of the project planning and implementation process.

Air Quality Monitoring:
Monitor that prescribed burning would occur according to the mitigation measures.

Timber and Soil/Water Monitoring: Implementation monitoring of project mitigation measures and other project actions would be conducted by the timber sale administrator.

The West Fork Huzzah Creek is considered a reference streams for the Ecological Drainage Units (EDU) established by MDNR. It is expected MDNR will take additional biological and chemical samples during and after project implementation. These samples will be compared to existing conditions to determine what biologically and water quality values may have change and if project implementation may have been the cause for any change.

Forest-wide project implementation audits would be conducted by Forest resource staff on a sample of randomly selected project areas on an annual basis. The Crooked Creek Analysis Area could be included in this sample at any time and at any stage of the project planning and implementation process.

Wildlife Monitoring:
Ensure that mitigations are followed regarding tree retention.

Monitor population levels in cooperation with other agencies.

Ensure that prescribed burning follow mitigation measures regarding wildlife nesting.

Visuals Resources Monitoring:
Ensure that visual mitigations are being implemented.

Heritage Resources Monitoring
Ensure that mitigation measures are implemented on heritage sites.

Monitor disturbance level of sites during and after project implementation.

CHAPTER 4 – CONSULTATION AND COORDINATION

Preparers and Contributors

The Forest Service consulted the following individuals, Federal, state, and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

List of Preparers and Contributors

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Appendices:

Appendix A – References Cited

Appendix B – Glossary of Terms

Appendix C – Soil Characteristics Tables

Appendix D – Economic Analysis Tables

Appendix E – Biological Evaluation and Assessment

Appendix F – Biological Diversity

Appendix G – Detailed Forest Stand Activity Listing by Alternative

Appendix H: Crooked Creek Project Maps