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Environmental Assessment

The Crooked Creek Analysis Area

Salem Ranger District
Mark Twain National Forest
Dent and Crawford Counties, Missouri

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CHAPTER 1 – PURPOSE AND NEED FOR ACTION

Document Structure

The Forest Service has prepared this Environmental Assessment (EA) in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. The purpose of this proposed action is to improve forest health and vigor, enhance terrestrial and aquatic wildlife habitat, and to reduce hazardous fuel loads in the Crooked Creek Analysis Area. This is needed in order to meet Forest Plan goals and objectives and to limit the adverse effects of oak decline and mortality in the analysis area.

Under NEPA, federal agencies must consider and analyze the environmental effects of agency actions and to disclose these effects to the public. This EA discloses the direct, indirect, and cumulative environmental effects that would result from the proposed action and alternatives. The document is organized into five chapters:

Chapter 1 – Purpose and Need for Action: The chapter includes information on the history of the project proposal, the purpose and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.

Chapter 2 – Alternatives Considered: This chapter provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on issues raised by the interdisciplinary team, public, and other agencies. This discussion also includes mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.

Chapter 3 – Environmental Effects: This chapter describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by Physical, Biological, and Social Environments; individual resource topics are addressed under each of these headings. Each resource discussion will include short-term uses and long-term productivity and cumulative effects of each alternative proposed for implementation.

Chapter 4 – Consultation and Coordination: This chapter provides a list of preparers and consulting agencies consulted during the development of the environmental assessment.

Chapter 5 – Appendices: The appendices provide more detailed information to support the analysis presented in the environmental assessment.

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

Additional information may be obtained from James L. Turner, Integrated Resource Analyst at (573) 729-6656 or (573) 729-2867 (FAX), or in person at Salem Ranger District, 1301 S. Main, Salem, MO 65560. The Environmental Assessment is also available on the Mark Twain National Forest website at *http://www.fs.fed.us/r9/marktwain/projects/crooked_creek/crooked_creek.htm*.

Project Location and Background

The Crooked Creek Analysis Area is located on public lands administered by the Salem Ranger District of the Mark Twain National Forest (MTNF). The analysis area is east of Salem, Missouri, in Dent and Crawford Counties. The legal description is Township 35 North, Range 3 West, Sections 7, 9-11, 14-23, 26-29, and 31-34; Township 34 North, Range 3 West, Sections 1-6, 8-10, 16-23, 25-27, and 34-36; and Township 34 North Range 4 West, Sections 8, 9, 13-17, and 22-24. Please refer to the maps in Appendix H. The analysis area is approximately 23,217 acres.

The analysis area is characterized by a topography of gently rolling hills and bedrock outcropping that is typical of the Ozark Highlands. The forest found in the analysis area today is the culmination of years of natural development and active forest management. Like most areas on the Mark Twain National Forest, these hills have had a history of timber harvest and various attempts at cultivation and livestock grazing prior to being abandoned in the early 1900s.

In addition, the Crooked Creek Analysis Area was severely impacted by timber harvest for charcoal production from 1888 to 1923. This charcoal was used to fuel the iron works smelters at the community of Sligo, just west of the analysis area. Aerial photographs of the analysis area, taken in 1939, show a landscape dominated by sparse vegetation on ridges and cleared pastures along major drainages. After the iron works closed, the sparsely forested lands were organized into what is now part of the MTNF. The Civilian Conservation Corps (CCC), local citizens, and United States Department of Agriculture (USDA) Forest Service personnel worked together to re-establish and sustain the developing forest. The analysis area is located within the native area for shortleaf pine (See Figure 1 - 1). While the forest was historically a mixed oak and short-leaf pine composition, the resulting re-growth was primarily black oak, post oak, hickory, and white oak. Later short-leaf pine plantations were established in localized areas.

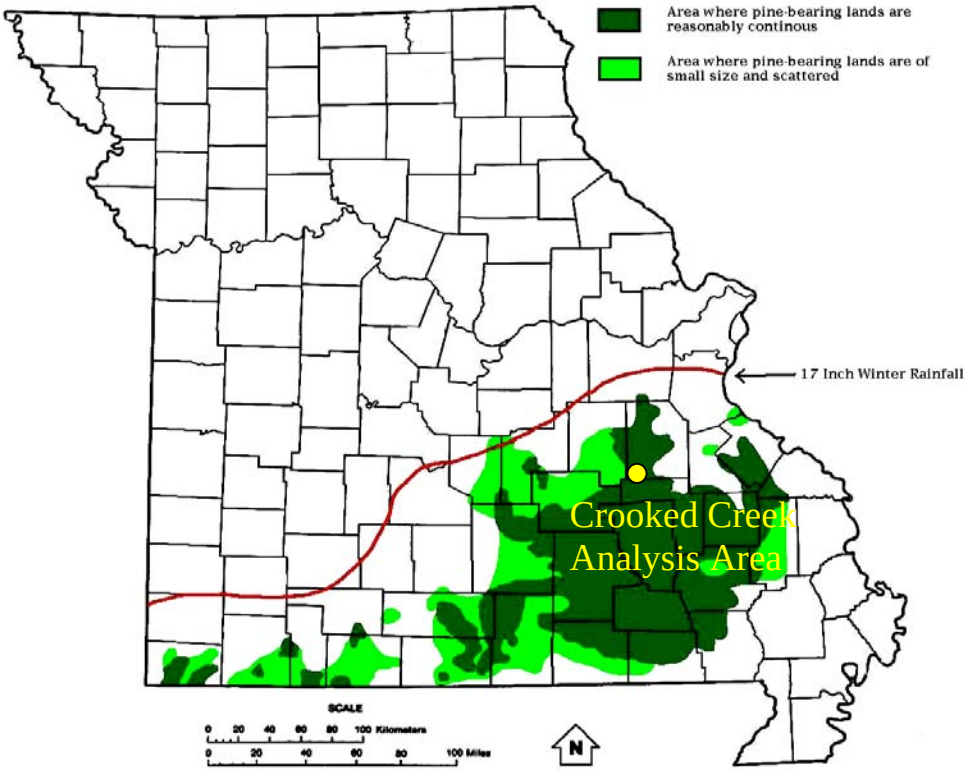


Figure 1 - 1: Native range for shortleaf pine.

The soils in the analysis area are typically cherty, droughty soils derived from sedimentary rocks, mostly limestone and dolomite. Due to the shallow nature of these soils, and the relative age and composition of the vegetation that now occupies the Ozark Highlands, an increasing amount of oak decline is evident throughout the Crooked Creek Analysis Area. Under these conditions, oaks are susceptible to insects and disease (See Figure 1 – 2).

Figure 1 - 2: Dead and dying black and scarlet oak specimens are a common sight in the Crooked Creek Analysis Area. This photo was taken in Compartment 39, Stand 10. (See also Figure 3-4, pg. 3-41).

At this time, approximately 17 % of the Crooked Creek Analysis Area is considered to be at high risk with significant numbers of dead and dying trees. This decline is particularly prevalent where black oak and scarlet oak occur in more or less homogenous stands. Other stands are overcrowded and losing vigor from increased competition for nutrients and growing space.

Purpose and Need for Action

The Salem Ranger District is proposing to improve forest health, enhance wildlife habitats, and provide additional recreational opportunities in the Crooked Creek Analysis Area. The purpose of this proposed action is to improve forest health and vigor, enhance terrestrial and aquatic wildlife habitat, and to reduce hazardous fuel loads in the Crooked Creek Analysis Area. This is needed in order to meet Forest Plan goals and objectives and to limit the adverse effects of oak decline and mortality in the analysis area.

Preliminary analysis of the analysis area indicates that there are certain conditions that warrant action in order to:

1. Manage and mitigate severe oak decline and associated mortality within the analysis area to maintain viable, healthy, and sustainable timber stands through species composition management.

2. Accomplish the direction and desired conditions identified in the Mark Twain National Forest Land and Resource Management Plan (LRMP).

Broad management guidelines for areas of oak decline are discussed in the *Ozark—Ouachita Highlands Assessment (OOHA)* (USDA 1999). More specific management guidelines may be found within federal, state, and private forestry reports; North Central Experimental Station reports and assessments; and Missouri Department of Conservation (MDC) publications (Moser and Melick 2003; Lawrence et al. 2002, USDA 2002a).

The Crooked Creek Analysis Area Project objectives are to:

- Improve forest health and resiliency to improve wildlife habitat.
- Improve wildlife habitat diversity by moving towards the Desired Future Conditions (DFC) for wildlife habitat components identified in the Forest Plan.
- Reduce hazardous fuel loads in analysis area.
- Protect Threatened, Endangered, and Sensitive Species.
- Protect and enhance cultural resources, special areas and specialized habitats.

The Role of the Forest Plan

The LRMP (also known as the Forest Plan), approved in 1986, provides a programmatic framework regarding allocation of land and the measures necessary to protect National Forest resources. It describes how different areas of the MTNF should be managed and what resources should be provided by these lands now and in the future. The Forest Plan Final Environmental Impact Statement (FEIS) displays the forest-wide effects of activities such as timber harvest, wildlife habitat management, recreation management and visual resource management. The site-specific effects of those practices to this project are not part of the Forest Plan FEIS. An environmental assessment will be prepared to analyze site-specified management activities to the Crooked Creek Analysis Area.

The Forest Plan gives management prescriptions designed to accomplish a DFC. The Forest Plan identifies the area in which this project is to occur as Management Area (MA) 3.4-1, 3.4-2 and 3.4-3. The general direction for the management of these areas is:

> … to provide a managed forest setting which emphasizes wildlife habitat diversity to maintain and enhance populations of native and naturalized vertebrates…to emphasize recreational opportunities based on consumptive and non-consumptive

> use of wildlife and fish…to provide dispersed recreation opportunities featuring a roaded natural recreation environment…to provide for moderate to high production of other resources such as timber products, forage, and minerals.
> (Mark Twain National Forest LRMP, page IV-115).

The prescription for MA 3.4 also states that any temporary openings created by even-aged silviculture management should not exceed a maximum limit of 40 acres (Mark Twain National Forest LRMP, page IV-118). The definition of an "opening" is an area where the trees are less than 20 feet in height (Mark Twain National Forest LRMP, page IV-38). Some of the treatments described in the proposed actions below will result in temporary openings in excess of 40 acres. The reason for this, in most cases, is that some proposed complete salvage treatments are adjacent to previously created openings where trees have yet to reach a height of 20 feet. The condition of these combined "opening" acreages exceeding 40 acres would exist for a very limited duration, as trees in the existing openings would reach a height of 20 feet in approximately 4 to 7 years. In three particular cases, the mortality is so widespread that complete salvage is proposed in multiple stands that, when combined, will exceed 40 acres. In accordance with the Forest Plan, temporary openings may exceed the 40-acre limit when natural catastrophic conditions occur (Mark Twain National Forest LRMP, page IV-39).

The Forest Plan also provides guidelines for maintaining forest health and conserving biological diversity on National Forest lands. Vertical diversity of plant and animal communities are maintained by managing for natural communities in varying stages of development. These stages, or habitat conditions, help provide diverse habitats and ecosystems necessary to sustain healthy populations of plants and animals for the Crooked Creek Analysis Area. The following proposed actions are designed to enhance these habitats and move the existing condition toward the DFC (please refer to the maps in Appendix H).

Desired Future Conditions and Proposed Action

1. **Provide for Healthy, Resilient Forests:**

   Existing Conditions: We can improve the health, vigor, and resistance to insects and disease of forested stands by improving growing conditions. We have previously discussed the decline of oak stands in the analysis area. Stand conditions in the area indicate a need for modification in management and age class distribution. The planted pine stands have become overcrowded, thus slowing growth of trees in these areas.

   Approximately 3948 acres in the analysis area are located within stands designated as having a high risk condition. High risk stands are those which will not survive 10 years or in which, due to decay, insect or disease infestations, mortality, or other factors there will be a net volume loss within 10 years. High risk stands compose approximately 17 % of the total acreage in the analysis area. Some high risk stands in the analysis area exhibit over 25 % mortality in larger trees and/or have greater than 30 % crown dieback resulting from terminal decline symptoms. In addition, approximately 396 acres (2 %) of the analysis area are in stands designated as sparse and 4203 acres (18 %) are in stands designated as low quality.

   By modifying the management approach for these stands, their condition may be improved to meet the DFCs prescribed by the Forest Plan. The Salem Ranger District proposes the following actions to meet the need for healthy, resilient forests. The total area for these treatments is approximately 14,305 acres.

The following proposed actions are stated in silvicultural terms that describe the post-treatment condition and composition of project stands. All of these actions, with the exception of pine thinning, are specifically intended to ***salvage dead and dying trees*** *posing a* ***catastrophic*** *health problem for forest stands in the analysis area.*

Proposed Thinning, Sanitation Thinning for Salvage, and Overstory Removal for Salvage: We propose to thin stands in the analysis area. This treatment would provide more growing space for the remaining trees and promote health and vigor within the stands. Thinning removes only some of the trees in the stand, leaving the healthiest and most vigorous trees to grow. This treatment will be used primarily for pine stands in this project. Sanitation thinning for salvage will be used in mature oak stands to remove high risk overstory trees (primarily black and scarlet oaks) while leaving an acceptable growing stock of healthy trees. Overstory removal for salvage is primarily used in stands where a healthy young understory has developed. This method involves removing most of the remaining mature overstory trees, thus allowing full sunlight and more growing space for the understory. The overstory trees are mainly mature trees showing signs of decline. Approximately 1197 acres of thinning, 562 acres of sanitation thinning for salvage, and 122 acres of overstory removal for salvage are proposed for this project.

Proposed Uneven-aged Management for Salvage: Uneven-aged management with group selection will be used for salvage in mixed oak and oak/pine stands where the black and scarlet oak are declining. Salvaging the declining trees will result in small openings in the canopy from ½ to 2 acres. These openings will help provide more sunlight on the forest floor to promote the regeneration where present. After the completion of salvage activities, small, suppressed, damaged, and undesirable trees would be cut to encourage regeneration establishment. Group selection harvests for salvage are planned on approximately 1746 acres of the analysis area.

Proposed Even-aged Managemen for Salvage: In some stands, black and scarlet oak are dominant with very few other species present. In these stands, the proposal is to use even-aged salvaging (complete salvage, seed tree salvage, or shelterwood salvage). The type of salvage depends on the distribution and amount of other species in each stand. Complete salvage with reserves is proposed for approximately 931 acres of the analysis area. Approximately 26 acres of seed tree salvage and approximately 1275 acres of shelterwood salvage are also proposed for the analysis area.

Followup Treatments for Even-aged Management stands above: Treatments following salvage harvests are necessary to achieve the desired results.

Natural Regeneration: After the completion of salvage activities, suppressed, damaged, and undesirable trees would be cut to provide and encourage regeneration. Natural regeneration is proposed for 2462 acres.

Pine planting is proposed as the regeneration method for 667 acres. Initiating pine growth in stands containing high percentages of black oak and scarlet oak increases species richness on the site and will improve tree species composition and stand vigor in the long term (FEIS, Oak Decline and Forest Health, USDA Mark Twain National Forest, 2002a, page 3-49). MA 3.4 calls for reforestation by natural reforestation methods (Mark Twain National Forest LRMP, page IV-118). A non-significant Forest Plan amendment allowing pine planting as a reforestation method would be required in conjunction with the Crooked Creek Analysis Area Project. **Planting pine in the analysis area will not alter the current management focus. The emphasis will**

continue to be on maintaining a mix of oak and other hardwoods, shortleaf pine, and grassland.

2. **Improve and Maintain Wildlife Habitat:**

Provide 0-9 Age Class Habitat:

Existing Conditions: This habitat type is important to 5 of the 9 Management Indicator Species (MIS): White-tailed deer, Eastern wild turkey, Ruffed grouse, Bobcat, and Indigo bunting. Approximately 3.4 % of MAs 3.4-1 and 3.4-2 is woodland habitat in the 0-9 age class and approximately 2.3 % of MA 3.4-3 is composed of this habitat. This is below the DFC of 8-15 % prescribed by the Forest Plan (Mark Twain National Forest LRMP, page IV-103).

Acorn production is important to many forest animals. In the Crooked Creek Analysis Area, black and scarlet oaks are the more abundant oak species, but a high percentage of these oaks exhibiting symptoms of decline are past their life expectancy. As a result, many trees are dying and acorn production has been reduced. Timber harvesting will diversify age classes of these oaks and allow the acorn production to become more consistent over time.

Proposed Actions: The even-aged management activities proposed above would create 0-9 age class habitat.

Provide Open Woodland Habitat:

Existing Conditions: Woodland habitats in oak, oak-pine, and pine forest types with 20 % to 30 % forbs, grass, and shrub ground cover are important habitat types for wildlife. Some of the Threatened and Endangered (T&E), MIS, Neotropical Migratory Birds (NMB), and Regional Forester's Sensitive Species (RFSS) that use this habitat type include: Eastern wild turkey, Bobcat, White-tailed deer, Ovenbird, Royal catchfly, and Indiana bat. Approximately 7.8 % of MAs 3.4-1 and 3.4-2 is the woodland habitat in oak, oak-pine, and pine forest types with 20 % to 30 % forbs, grass, and shrub component. Approximately 4.4 % of MA 3.43 is composed of this habitat. This is below the DFC of 40-50 % prescribed by the Forest Plan (Mark Twain National Forest LRMP, page IV-103).

Proposed Actions: The thinning treatments described above will contribute to the production of grass, forbs, and shrub ground covers. Where appropriate, prescribed burns for open woodland development are proposed for approximately 2445 acres. In addition, the prescribed burns planned for hazardous fuels (see below) will also move the analysis area towards the DFC. These actions would help these stands to move toward the 20 % to 30 % ground cover by forbs, grasses, and shrubs.

Maintain Open and Semi-Open Lands:

Existing Conditions: The Forest Service maintains numerous open areas, semi-open areas, and grazing allotments in order to provide habitat for wildlife. These are scattered throughout the analysis area and occur in a variety of sizes. Over time, brush and other competing vegetation has encroached on these openings. About 7.5 % of MAs 3.4-1 and 3.4-2 is composed of open or semi-open habitat. This is lower than the DFC of 10-20 % prescribed by the Forest Plan (Mark Twain National Forest LRMP, page IV-103). Approximately 6.5 % of MA 3.4-3 is open or semi-open habitat. This falls below the DFC for this MA which is 7-12 %. Objectives of these actions are to improve the distribution of these openings to maximize their benefit to wildlife, maintain a highly nutritional food source for wildlife, and maintain areas with native grasses and provide forage in grazing allotments.

Proposed Actions: We propose hand cutting or mowing approximately 1375 acres and prescribed burns on 2445 acres (includes some of the acres that will be mown or cut) of existing open and semi-open habitat in order to remove competing vegetation. Some of the open and semi-open habitat areas will be burned on a 3 to 4 year rotation to encourage the proliferation of native grasses. In addition, term grazing permits will be issued with allotment management plans (AMP) for three existing grazing allotments.

Improve and maintain aquatic habitat:

Existing Conditions- lakes and ponds: The Forest Service, in partnership with Missouri Department of Conservation, maintains five lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah cutoff pond number 3, and Gnuse pond. These lakes and ponds are stocked with channel catfish, bluegill, and largemouth bass. There is a lack of hiding cover for fish at these lakes (see maps in Appendix H). The lack of hiding cover, such as woody debris, increases the risk of predation, while reducing opportunities for shade and nesting sites. The Forest Plan gives direction to provide for fisheries management on waters capable of supporting viable fish populations by maintaining and improving cover and spawning structures (Mark Twain National Forest LRMP, page IV-118). Additionally, siltation in Howes Mill Lake has decreased the water depth on the upper end to a point where the lake needs to be drained, deepened, and stocked. A few other problem areas have also been identified: the spillway at Howes Mill South is eroding on the back side; and the rock gabions are being undercut on the spillway at Howes Mill Lake. Thus, there is a need for major lake and pond rehabilitation to maintain and improve fish habitat that is favorable to the growth and development of fish populations.

Proposed Actions: The Forest Service proposes fish stocking, fish habitat improvements (including fish structures, fertilization, liming), and dam maintenance and reconstruction (including draining and deepening Howe's Mill Lake), for the five lakes and ponds managed for flat water fishing opportunities. This action will enhance and maintain existing flat water fishing opportunities for public fishing.

3. Hazardous Fuel Reduction

Existing Condition: Due to the level of tree mortality, wind and ice damage, understory growth, and past fire exclusion, some portions of the analysis area are proposed for fuels treatments. The purpose of these burns is to reduce the potential for stand replacing intensity fires should they occur at a period when burning conditions are more extreme. 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 behaves in the environment, either enhances or impacts natural resources, and either reduces or threatens harm to property, human life, and the environment. Reducing the fuel loading can reduce the likelihood and intensity of wildland fires while simultaneously enhancing wildlife habitat and enriching native oak-pine woodland vegetation. The Federal Wildland Fire Management Policy and the 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 directs that the fire management policy on National Forest System (NFS) 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 fires to meet management direction as appropriate for ecosystems involved and to meet project objectives (Mark Twain National Forest LRMP, page IV 74-76).

Proposed Action: Prescribe burn 5956 acres. Proposed prescribed burning in the Crooked Creek Analysis Area follows direction within the Federal Wildland Fire Management Policy. Each prescribed fire will follow specific prescriptions contained in approved operational plans in compliance with planning and execution elements specified in Forest Service Manual 5140.

4. Connected Actions:

Some actions require other actions in order to be accomplished. These actions will be considered in the environmental analysis of this project.

Fire Lines: Existing roads and natural fire breaks are used whenever possible. New fire line construction is necessary in some areas.

Proposed Road Work: There are 40 Forest Service system roads within the management areas, with a combined length of 52.5 miles. The analysis area contains 36.3 square miles of NFS land, which equates to 1.4 miles of system road per square mile of Forest Service land. The Forest Plan, page IV-123, provides direction on the maximum density of system roads allowed within a 3.4 MA, 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.

National Forest system roads within the analysis area vary from 0.1 miles to over 6 miles in length. The Crooked Creek Analysis Area has 8.4 miles of system roads that need reconstruction before they can be used to access project activities. The other 44.1 miles of system road need routine maintenance, such as replacing surface material, surface blading, improving drainage features, removing brush from right-of-ways, and cleaning culverts.

In addition to system roads, there are non-system roads on NFS land in the analysis area. The condition of these roads is usually fair to poor because no road improvement or maintenance work has ever been done. Approximately 55 miles of non-system roads in the analysis area will be decommissioned and rehabilitated with natural vegetation. These roads will be blocked using earthen berms, rocks, and/or gates. In addition, five illegal trash dumps located along these non-system roads would be cleaned-up.

Decision Framework

Given the purpose and need, the Forest Supervisor of the Mark Twain National Forest will review the proposed action and the other alternatives in order to make the following decisions:

- Whether the proposed action would result in significant environmental effects that would require the preparation of an Environmental Impact Statement, or results in a finding of no significant impact.

- If significant impacts are not anticipated, the Forest Supervisor will determine whether the proposed action will proceed as described above and in the **"Alternatives"** section, as modified by an alternative, or not at all.

- If it proceeds, the Forest Supervisor will determine the mitigation measures and monitoring requirements to be implemented by the Forest Service.

The scope of the decision to be made is confined to a reasonable range of alternatives aimed at implementing the Forest Plan on the area of NFS land described as the Crooked Creek Analysis Area within the 3.4-1, 3.4-2, and 3.4-3 MAs of the Salem Ranger District, Mark Twain National Forest,

Missouri. The decision is not one of land allocation, nor is the analysis intended to look at every possible combination of activities.

Public Involvement

The proposal was first provided to the public and other agencies for comment in a Scoping Report on November 26, 2003. Comments from this scoping are being retained and included in the current analysis. A public scoping report was sent to 294 individuals and organizations at that time. The proposal was also posted at the MTNF website and on the on the forest-wide Schedule of Proposed Actions (SOPA). Approximately 34 responses to this scoping report were received by mail, e-mail, or in-person. All comments received were summarized and evaluated by the project interdisciplinary team and used in the development of issues and alternatives to the proposed action. On April 8, 2004, a letter with a proposal for the Crooked Creek Project was mailed to everyone on the district mailing list and adjacent neighbors to invite timely, substantive comments on the proposed projects as permitted by our revised regulations for notice, comment, and appeal (36 CFR 215). Legal Notice of this 30-day comment period was published April 11, 2004 in the *Rolla Daily News*, Rolla, Missouri. Twelve comments were received, with nine of them timely. These comments were incorporated into this document in the Issues Section below. A listing of the comments can be found in the project file.

Issues

Using the comments received from the public, organizations, and other agencies, the interdisciplinary team developed a list of issues to address. Issues are statements of discussion, dispute or debate that represent points of unresolved conflict regarding specific environmental effects of the proposed action. Issues were identified as those concerns not resolved by one of the following conditions: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level of decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. The Council for Environmental Quality (CEQ) NEPA regulations require this delineation in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…" A summary of the scoping process and the disposition of comments received during the scoping period are in the project file.

The Forest Service identified the following significant issues based on comments received during scoping:

Issue 1: Effects of grazing on Fortune Hollow fen area. As per the Forest Plan, a buffer zone of at least 100 feet in radius will be established around the fen area that which be restricted from any grazing activities (Mark Twain National Forest LRMP IV-52). Allotment Management Plans must comply with the Forest Plan and are designed to use cattle grazing to help meet wildlife habitat objectives and to minimize impacts to other resources such as soil, water, and aquatics.

Issue 2: Effects of prescribed burns for hazard fuel reduction on healthy timber and regenerating stands. Exposure risks from prescribed fire to healthy timber and regenerating stands in the 0 - 9 and 10 - 20 yr. age-classes have been examined in previous environmental analyses (see EA, Kaintuck Fuel Reduction Project, 2001a; FEIS, Oak Decline and Forest Health, 2002a). Effects will be described in narrative form in the "Vegetation – Fuels" section of Chapter 3 of this Environmental Assessment.

Prescribed burn mitigation measures to reduce the potential for fire damage to healthy timber and regenerating stands will be implemented under 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.

Issue 3: Maximum size limit on temporary openings. While the Forest Plan establishes a maximum size limit on temporary openings, it also provides for conditions where it is necessary to exceed that limit. According to the Forest Plan:

> Temporary opening size in excess of the maximum by management prescription standards and guidelines may occur:...Due to natural catastrophic conditions caused by fire, insect and disease, or windstorm when based on an environmental analysis approved by the Forest Supervisor (Mark Twain National Forest LRMP IV-39).

The severe oak decline in the Crooked Creek Analysis Area is indicative of these catastrophic conditions. For this reason, salvage treatments are recommended in the proposed action (Alternative 2) which would result in ten temporary openings that would each exceed 40 acres in size. Alternative 3 is responsive to this issue and does not include complete salvage areas that would create temporary openings in excess of 40 acres. Any complete salvage areas that would produce temporary openings in excess of 40 acres have not been included in Alternative 3.

Issue 4: Reforestation through pine planting. Planting pine, where appropriate, in scarlet oak/black oak stands after timber harvest will improve stand health and vigor by creating a diverse composition of species. This diversity would serve as a deterrent to the type of widespread, catastrophic problems that presently exist as a result of oak decline. However, the prescription for Management Area 3.4 currently restricts reforestation to only natural regeneration treatments (Mark Twain National Forest LRMP, page IV-118). A non-significant forest plan amendment would be required in order to plant pine in harvested stands. Alternative 3 is responsive to this issue and would use only natural regeneration treatments in accordance with the current Forest Plan (i.e. no pine would be planted). As previously stated, **planting pine in the analysis area will not alter the current management focus. The emphasis will continue to be on maintaining a mix of oak and other hardwoods, shortleaf pine, and grassland.**

Relationship to Other Documents

A number of National Environmental Policy Act (NEPA) decisions have been made since June, 1986 (the date in which the LRMP went into effect), which affected all or part of the Analysis Area. Some documents provided for site-specific implementation of the forest plan and some of the documents provided broader programmatic direction.

Site-Specific Projects

Management Area analysis was the first step in the Forest Plan implementation process. These analyses identified needs and opportunities by management areas and were known as Step 2 Analysis. Previous NEPA documents were written for the same kinds of activities (timber harvesting, wildlife habitat restoration or maintenance, prescribed burning, and allotment management) in the same geographical area as this project. The analyses done in these documents did not reveal any significant effects from the proposed activities. Post activity monitoring has verified that the analyses were compliant with the NEPA document and the effects were displayed.

Site-Specific Environmental Analyses

These studies were completed on portions of the Crooked Creek Analysis Area:

- Timber Stand Improvement (Decision Memo (DM), Decision Date: 8/19/89)
- Fortune Hollow Project Set, Opportunity Area 3.4-2 (EA, Decision Date: 4/10/90)
- Pine Post Thinning (DM, Decision Date: 5/21/90)
- Barney Fork Project, Opportunity Area 3.4-3 (EA, Decision Date: 4/26/91)
- Wildlife Habitat Improvement (DM, Decision Date 3/12/91)
- James Branch and Beefsteak Project Sets, Opportunity Area 3.4-1 and 3.4-2 (EA, Decision Date 6/6/91)
- Crooked Tower Project Set, Opportunity Area 3.4-1 (EA, Decision Date: 3/17/92)
- Bates Hollow, Fiebelman Cemetery, Water Fork, and Crooked Creek Projects, Opportunity Areas 3.4-1 and 3.4-2 (EA, Decision Date: 4/20/93)
- Viburnum, Guy Brooks Ridge, Ballfield, Huzzah Hatchery, and Casey Projects, Opportunity Areas 3.4-1 and 3.42 (EA, Decision Date 9/22/94)
- Barney Fork, Management Area 3.4-3 (EA, (5/7/98))
- Barney Fork and Marcoot South Prescribed Burns (Decision Memo (DM), Decision Date: 11/19/03)

Programmatic Documents

Mark Twain National Forest – Land and Resource Management Plan (LRMP) Final Environmental Impact Statement and Record of Decision (Mark Twain National Forest 6/86, as amended).

The Forest Plan is a programmatic document, which is required by the rules implementing the Forest and Rangeland Renewable Resource Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1976 (NFMA). The purpose of the Forest Plan is to provide direction for the multiple uses and the sustained yield of goods and services from NFS lands in an environmentally sound manner.

The Forest Plan sets management direction for the Mark Twain National Forest through the establishment of short-term (10-15 years) and long-range goals and objectives through the year 2035. It prescribes the standards, practices, approximate timing and locations needed to achieve goals and objectives. The Plan prescribes the monitoring and evaluation needs necessary to ensure that direction is carried out, measures quality and quantity of actual operations against predicted outputs and effects, and forms the basis for implementing revisions.

The Secretary of Agriculture shall not be considered to be in violation of subparagraph 6(f)(5)(A) of the Forest and Rangeland Renewable Resource Planning Act (RPA) of 1974 (16 USC 1604(f)(5)(A)) solely because more than 15 years have passed without revision of the plan for a unit of the NFS (FY2002 Interior Appropriations Bill, Section 327).

Following the signing of these earlier documents, the Forest Plan has been amended to reflect new information concerning threatened, endangered, and sensitive species. This project analysis reflects those amendments and supplemental information reports to the Forest Plan.

The Mark Twain National Forest Programmatic Biological Assessment (Mark Twain National Forest, September 1998) and Biological Opinion on the Impacts of Forest Management and Other Activities to the Gray bat, Bald Eagle, Indiana bat, and Mead's milkweed on the Mark Twain National Forest, Missouri (USDI, Fish and Wildlife Service, 1999)

Federal agencies are required to comply with provision of the Endangered Species Act (ESA) of 1973, as amended. This includes a requirement to consult with the U.S. Fish and Wildlife Service on

projects, which may affect species federally listed as threatened or endangered (TE). These documents update the original consultation completed for the Forest Plan in 1985. They include species not originally consulted on and describe potential effects to federally listed species of activities that implement the Forest Plan. The Biological Opinion 1) determined that implementation of the Forest Plan would not jeopardize the existence of any of the species considered, 2) exempted the Forest Service from a specified amount of incidental take on three species, and 3) to minimize the impacts of incidental take on the MTNF. The Forest Plan was subsequently amended March 2000 to include the RPM/TC as standards and guidelines. A decision on the proposed amendment for management of Areas of Influence was signed on November 16, 2001.

This analysis is tiered to the following documents:

- The Mark Twain National Forest Land and Resource Management Plan Final Environmental Impact Statement and Record of Decision (6/86), as Amended, including all supplemental information reports.
- Mark Twain National Forest Programmatic Biological Assessment (Mark Twain National Forest, September 1998).
- Biological Opinion on the Impacts of Forest Management and Other Activities to the Gray bat, Bald eagle, Indiana bat, and Mead's milkweed on the Mark Twain National Forest, Missouri (U.S. Fish and Wildlife Service, June 1999).
- Forest Plan Supplemental Information Report dated December 6, 2000 and April 5, 2001 (Update concerning Chip Mills).
- Supplemental Information Report dated June 27, 2001 concerning 2000 Regional Forester's Sensitive Species (RFSS) List.
- Revised Forest Plan Supplemental Information Report on Salamanders, May 21, 2001.
- Oak Decline and Forest Health Final Environmental Impact Statement and Record of Decision (4/02).

The following documents are incorporated by reference:

- Ozark—Ouachita Highlands Assessment (December 1999)
- National Fire Management Plan (January 2001)

CHAPTER 2 – ALTERNATIVES CONSIDERED

ALTERNATIVE DEVELOPMENT

This section describes alternatives to the proposed action and summarizes the environmental consequences of each alternative in relation to the issues. Information in this chapter will provide the decision maker with a range of alternatives to consider for the Crooked Creek Project. It will include the analysis of the proposed activities and their anticipated effects. The process used to develop alternatives, the description of alternatives analyzed in further detail, a comparison of those alternatives and the reasoning for eliminating other alternatives that were considered from further analysis will be explored in this section of the EA.

Formulation of Alternatives

The Interdisciplinary Team analyzed both internal and external comments received during the scoping period. Alternatives were developed to respond to unresolved issues as they related to the purpose and need for this project, laws, regulations, and policies that govern land use on the NFS lands. These alternatives represent different levels and types of management activities. The alternatives, both those considered in detail and those eliminated from further study, display a range of options which could be used to implement the Crooked Creek Analysis Area Project. Management needs and opportunities as determined by on-the-ground investigations were also considered in this process.

Alternatives to the proposed action (Alternative 2) must meet the purpose and need as stated in Chapter 1 and address the key issues described above. A “No Action” (Alternative 1) alternative must be included as one of the alternatives. The IDT recommended that one other alternative be analyzed: this alternative is a modification of the proposed action to meet the desired current Forest Plan direction for restricting openings to 40 acres and using only natural regeneration methods for reforestation. The District Ranger agreed that this alternative, along with the No Action alternative, represent the range of concerns of the Forest Service, local residents, other agencies, and most members of the public that responded to the Forest Service during the public involvement phase.

Descriptions of Alternatives Considered in Detail

The following is a description of alternatives analyzed in detail by the Interdisciplinary Team. After an alternative has been selected and as the project is implemented, actual amounts of activities on the ground (measured in acres or miles) may vary. All changes would be evaluated to ensure that any effects are within the parameters of the effects analyzed in this document and would be documented in the Crooked Creek Analysis Area project record. Pertinent Forest Plan standards and guidelines designed to mitigate the affects of alternative treatments are also listed. All acres listed are approximate. At the end of Chapter 2 is a listing of all activities by stand and maps for each alternative.

Alternative 1 (No Action)

Under this alternative, current management would continue to guide management of the analysis area. The No Action Alternative provides the baseline for comparison against all other alternatives. This is a viable alternative and responds to the concerns of those who want no vegetation management activities to take place. The option for future additional management activities in this area would not be foreclosed.

If this alternative is selected, there will be no attempt to minimize adverse impacts of insects and disease

infestation. The active grazing allotment permits for Casey and Barney Fork would be maintained, but not renewed at the end of their terms. Changes, such as road maintenance, might occur through permanent management direction, natural processes, or other management decisions in the future.

Alternative 2 (The Proposed Action)

This alternative includes those activities proposed in the scoping report that was distributed to the public on November 26, 2003. This alternative responds to the following identified needs: provision for healthy, resilient forests; improvement and maintenance of wildlife habitat; and the reduction of hazardous fuels. The alternative would implement a combination of commercial harvest, non-commercial thinning, reforestation, and prescribed burn treatments to meet these needs.

Commercial harvests are designed to salvage merchantable wood fiber, while moving conditions for the residual stand towards sustaining healthy forest communities. Some trees experiencing the effects of oak decline may not be of a merchantable quality, therefore, some timber would not be removed through commercial harvest. Portions of the analysis area may be open to firewood collection under permit once salvage activities are completed. Reforestation activities are proposed to allow suitable light conditions to promote the development of desired tree seedlings, herbaceous vegetation, and shrubs. The amounts of treatment depend on the amount of even-aged and uneven-aged regeneration proposed. This alternative uses prescribed burning for various primary objectives, including site preparation for seedling development, restoration of open woodlands with native groundcovers such as sedges and forbs, and for reduction of hazardous fuels. These prescribed burning treatments would also improve wildlife habitat, for the short term, and in some cases, i.e. open woodlands, for the long term.

This alternative would move the existing condition of the Forest towards the DFC for wildlife habitat as outlined in the Forest Plan. Specific actions that are proposed can be found in the attached activity listing and maps. Some minor changes in acreages and treatments are different from the original action proposed in the scoping report distributed on November 26, 2003. Below is a summary of actions that would occur in Alternative 2:

Provision for Healthy, Resilient Forests

- Complete salvage on approximately 931 acres.
- Seed Tree salvage on approximately 26 acres.
- Shelterwood salvage on approximately 1275 acres.
- Uneven-aged management for salvage on approximately 1746 acres.
- Overstory removal for salvage on approximately 122 acres.
- Sanitation cuts for salvage on approximately 562 acres.
- Thinning on approximately 1197 acres.
- Reforestation by natural regeneration on approximately 2512 acres.
- Reforestation by pine planting on approximately 667 acres.

Improvement and Maintenance of Wildlife Habitat

- Prescribed burning for open woodland development on approximately 2445 acres.
- Grazing and fertilizer/lime application in 3 allotments on approximately 345 acres.
- Issue term grazing permit on Fortune Hollow allotment and renew term permits on Casey and Barney allotments with management plans that incorporate protection measures that are indicated in the EA.
- Mechanical/hand-cutting, mowing, and waterhole maintenance on approximately 1375 acres.
- Pond maintenance and rehabilitation on five fishing ponds (16 acres): Howe's Mill Lake, Howe's Mill Pond, Howe's Mill South, Huzzah Cutoff Pond # 3, and Gnuse Pond. This

includes draining and deepening Howe's Mill Lake and maintenance work on the Howe's Mill South spillway.
- Improving aquatic habitat and fish stocking on the ponds listed above (16 acres).

Reduction of hazardous fuels
- Prescribed burning on approximately 5956 acres.

Associated or connected actions
- Constructing fire lines for prescribed burns.
- Reopening approximately 25 miles of non-system roads for use as temporary roads.
- Reconstructing approximately 8.4 miles of Forest system roads.
- Decommissioning approximately 55 miles of non-system roads.
- Cleaning up five illegal dump areas.

Alternative 3 (Reduced Complete Salvage with Natural Regeneration Only)

This alternative was developed in response to issues concerning the Forest Plan's maximum size limits on temporary openings and restrictions on regeneration through pine planting. Complete salvage areas that would be adjacent to existing openings, and that would create cumulative, temporary openings in excess of forty acres, are not included in this alternative. Therefore, the area proposed for complete salvage treatments has been reduced to 637 acres from the 931 acres proposed in Alternative 2.

This alternative includes no provision for pine planting as a reforestation approach. All reforestation treatments would be through natural regeneration. The acreage of reforestation activities has been reduced as a result of the reduction in complete salvage acres for this alternative.

The reduction in complete salvage acres would also reduce the need for temporary access. This means approximately two fewer miles of non-system roads would be needed for access than under Alternative 2.

Grazing activities under this alternative would be in accordance with the current AMP. The Barney and Casey allotment term permits would be renewed with existing AMPs. The Fortune Hollow permit would be issued with the last AMP.

Prescribed fire treatments and wildlife habitat improvement activities would be the same as in Alternative 2.

This alternative would move the existing condition of some portions of the analysis area towards the DFC of habitats as outlined in the Forest Plan. Specific actions that are proposed are listed in Table 1, which is attached to this document along with maps of the alternatives.

Alternatives Considered but Eliminated from Further Analysis

Federal agencies are required by NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the Proposed Action provided suggestions for alternatives that may have been outside the scope of this discussion, are duplicative of the alternatives considered in detail, need to be addressed at a higher level within the organization, are beyond the authority of the Forest Service, or are determined to be components

that would cause unnecessary environmental harm. Therefore, a number of alternatives were considered, but dismissed from detailed consideration for reasons summarized below.

Reduced prescribed burn acreage – Several comments from the public focused on potential adverse effects from prescribed burns on healthy timber (Issue 2) and private property. The team discussed the possibility of developing an alternative with a reduction in prescribed burn acreage and determined that such a reduction would not meet project goals and objectives for the improving forest health, wildlife habitat, and hazard fuel conditions. In addition, it was decided that potential adverse effects to healthy timber and private property could be effectively mitigated.

Manage areas by prescribing uneven age methods only – There is a mix of salvage methods prescribed for the Crooked Creek Analysis Area to remove trees that show signs of decline or are infected with oak borers and disease. In some cases, the amount of oak decline is severe and only an even-aged method would respond to the need to remove the infested trees. Using an uneven-aged method would leave insects to populate other trees in the area. For this reason, this alternative was not carried further into analysis.

Vegetation management without commercial harvests – An alternative utilizing this approach was analyzed in the Final Environmental Impact Statement for Oak Decline and Forest Health (USDA Mark Twain National Forest, 2002a). The results of this analysis showed that this approach would be less effective for improving forest stand health and would move the existing condition of the Forest towards the Desired Future Conditions outlined in the Forest Plan at a much slower rate than if commercial harvest treatments were applied. Under such an alternative, only high risk stands would be treated. Valuable timber products would not be recovered and active management for a diversity of tree species would be addressed to a lesser degree or not at all. Forest visitor safety and hazardous fuel build-ups would be addressed to a more limited extent. There could also be adverse effects to vegetation and wildlife by not removing more of the declining trees. Reforestation would occur at a slower rate as a result of trees not being removed. For all of these reasons, this alternative was not carried into further analysis.

Mitigation Common to Action Alternatives

The following are mitigation measures in addition to the Forest Plan standards and guidelines. Mitigation measures identified with a “T” pertain to timber salvaging, an “M” refers to mechanical treatments, an “F” pertains to fire, and a “G” refers to grazing.

Mitigation Measures - Heritage Resources (CR):

CR1 (T & M):

Site avoidance is the preferred mitigation action pursuant to the Forest Plan, Section IV-30, 31 [also FSM 2361.21(2)]. Avoidance of cultural resources would be understood to require the retention of such properties in place and their protection from effects resulting from the undertaking [MOU, 2002, Section II, H (2a, 2b)]. Effects would be avoided by implementing the following specific actions where feasible (where not feasible, see Mitigation Measure CR5):

(1) Establishing buffer zones around those sites in areas where timber salvage activities would take place; buffer zones would be of sufficient size to ensure that the integrity of the characteristics and values which contribute to,

(2) Routing the non-motorized trail to avoid any archaeological sites or sensitive cultural features that might be in the trail area.

(3) Locating parking pull-offs and gates to avoid archaeological sites.

(4) Locating landings, skid trails, and temporary roads away from archaeological sites.

(5) Locating road re-alignments and sections of roads that would be reconstructed to avoid archaeological sites.

(6) Locating new wildlife openings and ponds away from archaeological sites.

It should be noted here, that in the case of the large farmstead sites with surrounding field areas and historic field sites, the intent is not necessarily to exclude all activities from the entire enclosed areas within the defined site boundaries. In the case of these sites, "Avoidance" would be taken to mean avoidance of all historic cultural features. Principally, the core areas and stone features (rock piles, stone walls, checkdams, for example) associated with farmsteads would be avoided. Project activities may be carried out in the field interiors so long as cultural features are avoided.

CR2 (F)

1. Firelines

(a) Those archaeological sites located along existing non-system roads to be used as fire lines would be protected by hand-clearing those sections of the road/fireline that cross sites. Although these roads are generally cleared of combustible debris using a small dozer, those sections of roads crossing archaeological sites would be cleared using leaf blowers and leaf rakes. There would be no removal of soil or disturbance below the ground surface during fireline preparation.

(b) Archaeological sites and features that may be located along proposed routes of dozer-constructed fire lines, where firelines do not now exist, would be avoided by fireline construction – by routing firelines around archaeological sites. Sites that lie along previously constructed dozer lines from past burns would be protected during future burns by hand clearing those sections of line that cross the sites, rather than re-clearing the lines using heavy equipment.

2. Burn Unit Interior

(a) Combustible elements at eligible and unevaluated sites in the burn unit interiors would be protected from damage during the burns by removing fuels from the feature vicinity, and, where necessary, by burning out an area around the feature prior to igniting the main burns. Burning out is accomplished by constructing a set of two hand lines, approximately 30 to 50 ft. apart, around the feature and by then burning the area between the two lines while the burn is carefully monitored. A fuel-free zone is thereby created around the combustible elements. Any combustible features that might be located in a burn unit would also be fully documented with photographs and field drawings prior to the burn. A Heritage Specialist would attend the pre-burn briefing and Forest Service personnel would be on each burn squad during the burn.

(b) Those sites containing above ground features, removing, by hand, any concentrations of fuels that might have built up on the sites and features, would protect non-combustible, cultural features and exposed artifacts. Where such fuel concentrations are not present, no mitigation is required.

(c) No mitigation measures are proposed for any of the other sites in the burn interior, because it is not expected that the burns proposed for the Crooked Creek Analysis Area would harm these sites.

3. Post-Burn Monitoring

(a) Post-burn monitoring would be conducted at selected sites to assess the actual effects of the burns on the sites against the expected effects and to check for indirect effects at the sites following the burn. SHPO consultation would be carried out with respect to mitigation for any sites that suffer unexpected damage during the burn, or that suffer damage from indirect effects following the burn.

CR3 (T & M)

Although it is believed at this time that all temporary road and landing locations have been surveyed, additional roads may be necessary when various commercial timber sale units are laid out. In cases in which these activities would take place outside stands not already included in cultural resource surveys, cultural resource surveys would be completed prior to project implementation. Appropriate mitigation measures as noted in CR1, CR2, and CR5 would be applied prior to project implementation to protect any archaeological sites that may be located in these areas. Consultation with the Missouri SHPO would be completed prior to project implementation.

CR4 (T, M & F)

Although the cultural resources surveys completed for this project are designed to locate all archaeological sites that might be eligible for the National Register, such sites may go undetected for a variety of reasons. Pursuant to the provisions found in 36 CFR 800.13, should any previously unrecorded cultural resources be discovered during project implementation, activities that may be affecting that resource would be immediately halted and the resource would be evaluated by a professional archaeologist. Consultation would be initiated with the Missouri State Historic Preservation Officer (SHPO), as well as with the Advisory Council on Historic Preservation, if required, to determine appropriate actions for protecting the resource and for mitigating any adverse effects on the resource. Project activities would not be resumed until the resource is adequately protected and agreed-upon mitigation measures are implemented with SHPO approval.

CR5 (T, M & F)

If it is not feasible to completely avoid an archaeological site (CR1), the following steps would be taken: (1) In consultation with the Missouri State Historic Preservation Officer (SHPO), the site(s) would be evaluated against National Register of Historic Places significance criteria (36 CFR 60.6) to determine if the site is eligible for, or appears to be eligible for, inclusion in the National Register of Historic Places. (2) In consultation with the Missouri SHPO, mitigation measures would be developed which would lessen, or minimize, adverse effects on the site, so that a finding of No Adverse Effect results. (3) The agreed-upon mitigation measures would be implemented prior to initiation of project activities that have the potential to affect the site.

Mitigation Measures - Air Quality (A):

A1 (F)

Prescribed burning would be completed during weather conditions that facilitate smoke dispersal. The public would be informed of the planned burning days and Forest Service employees would monitor for public safety hazards, if needed, along public travel ways.

Mitigation Measures – Soil and Water (SW):

SW1 (T & M)

Temporary road and main skid trails would be located on the ground by Forest Service personnel prior to salvage operations, avoiding layouts that concentrate runoff into draws, ephemeral drainages, sinkholes or watercourses.

SW2 (T & M)

Proper grade and water control structures would be constructed and maintained on skid trails. Roads would not drain directly onto skid trails or into stream channels. Specifications that are indicated in the Missouri Department of Conservation's "Missouri Watershed Protection Practice" would be followed.

SW3 (T)

When logging is complete, additional slash would be pulled onto skid trails.

SW4 (T)

Temporary road construction, road maintenance, skidding, and hauling activities will be suspended during wet periods, when excessive rutting and churning of the soil begins, or when runoff from skid trails is turbid and no longer infiltrates within a short distance from the skid trail.

SW5 (T & M)

Reconstructed system roads and temporary road constructions, which have potential to cause severe erosion, would have additional water protection mitigations as follows: Temporary roads that cross drainages would be closed as soon after the harvest or treatment as possible. All crossings would be constructed at right angles to the channel at locations chosen to have the least impact as possible on the stream channel and banks. A slash filter would be placed uphill from any drainage and used as filter at the outside of the water-bar nearest the drainage. If the crossing location is soft, it would be reinforced with aggregate.

SW6 (F)

Prescribed burn units should have as little mechanical disturbance to the soil before and just after burning as possible. Equipment would not use stream channels as "roads." Where stream crossing is unavoidable it would be done in locations that would create the least impact on stream banks and beds.

SW7 (T, F & M)

Stands with soils that have perched water tables would have little to no mechanical disturbance to wet soil.

SW8 (F & T)

All fire lines would be seeded with a cover crop suited to area objectives and would be fertilized, if necessary, with standard fertilizer immediately after construction or as soon afterwards as to allow the best chance of germination. Water bars would be constructed in accordance with the Missouri Department of Conservation's "Missouri Watershed Protection Practice" to minimize water movement along fire lines.

SW9 (T & M)

Trees anchoring stream banks of any distinct channel would not be cut unless they are species that is known to "sprout" from a cut tree's roots, even if the stream does not require a buffer zone. This includes channels that are the result of road drainage ditches. Road drainage ditches may be cleared, but outflow channels will be cleared only when vegetation impedes water flow.

SW10 (F)

Fire lines created with dozers would not be placed in riparian areas, fens, wetlands, or other sensitive habitats.

SW11 (T & M)

No mechanical disturbance of the soil would occur on slopes greater than 35 %.

SW12 (T & M)

A 50-foot no-cut zone will be place around all fens, seeps and springs. A buffer zone of at least 100 feet in radius would be retained in association with seeps, fens, springs, and any other special features or habitats. Skidding and decking would be prohibited within these buffer zones.

SW13 (T, F & M)

There will be a no cut zone of at least 50 feet from the edge of any sinkhole that currently exists within the activity area, or if one develops before the action is initiated. A buffer of 100 feet will be provided around natural sinkhole ponds. Within this buffer, there will be no commercial harvest of trees, no firewood permits, and no ground-disturbing activity. Prescribed fire would be allowed within the buffer zone.

Mitigation Measures - Vegetation (V):

V1 (F)

Prescribed burn plans would incorporate burning conditions that best meet specific management area objectives to reduce fuel loads, stimulate forest regeneration, have minimal impact on future timber resources, meet visual standards, and protect sensitive species. Prescribed burns may be conducted according to standards and guidelines under 5100 Fire Management, and as frequently as necessary to meet management objectives as determined through annual evaluations of initial and subsequent burn treatments.

V2 (T & M)

For perennial and intermittent streams, the no cut zone will include the riparian zone as defined by the forest plan, or 50 feet, whichever is greater. Riparian zone includes frequently and occasionally flooded areas.

V3 (T & M)

A 50-foot no-cut zone will be place around all fens, seeps and springs.

V4 (T, M, & F)

A protection zone will be designated around glades. This zone will surround the glade itself, as well as any adjacent grassy areas, rock ledges, exposed bedrock, and/or rock outcrops. Trees, other than post oak and chinquapin oak, may be removed from within this zone, but may only be removed by winching or dragging. No heavy equipment may be used within this zone unless pre-approved by a

biologist/ecologist. Removal of small diameter trees, especially red cedar, is encouraged within this zone.

Mitigation Measures - Wildlife (WL):

WL1 (T & M)

Retain a minimum of 15 sq. ft. of basal area in complete and seed tree salvage areas, and a minimum of 25 sq. ft. of basal area in shelterwood salvage units, of reserve trees grouped or retained around large snags, large live trees, den trees, and within intermittent drainages to minimize potential for wind throw and provide thermal protection of suitable Indiana bat roost trees. Leave larger, long-lived trees (white oak, post oak, pine or hickory) where opportunities exist. For both cavity trees and snags, retain at least 0.5/ac nineteen inches (19") dbh or greater in size, if available. Retain at least 4.0/ac 11-18" dbh cavity trees and snags, if available. Retain at least 2.0/ac 10 inches (10") dbh or less in size cavity trees and snags, if available.

WL2 (T&M)

In all even-aged salvage (seed tree, and shelterwood seed cut), reserve trees should be left in groups of at least 5 or more trees wherever possible. No snags should be left standing alone within the cut area, but rather, should be surrounded by several live trees. In uneven-age salvages (group selection with improvement cutting), the longer-lived trees (white oak, post oak, hickory, and pine) will be featured leave trees with a range in the diameter distribution. Snags and dens from the red oaks will be left, if available, to meet standards and guidelines.

WL3 (T& M)

In all salvage areas retain all shagbark hickory, shellbark hickory, sycamore, and lightning struck trees (MTNF Biol. Assess. p. 32). Retain, as available and to the maximum extent possible and tree >= 26" dbh unless a human safety hazard. Also, retain some (not all) dead or dying trees >= 9" with at least 10 % exfoliating/defoliating bark, and most den/cull trees.

WL4 (T)

There would be no harvest within 50 feet of a sinkhole or pond.

WL5 (T, M, F, & G)

The discovery of a new site occupied by federally listed species within the analysis area (such as eagle communal night roosts, or Indiana bat maternity sites) at any time during the course of activities described in this EA, will lead to further consultation with the US Fish and Wildlife Service and development of protective measures as determined necessary for protection of the species and its habitat.

WL6 (T, M, & F)

A buffer zone of at least 100 feet in radius will be retained in association with seeps, fens, springs, and any other special features or habitats (other special features to be determined by a biologist). Temporary road construction, skidding and decking and new dozer line construction will be prohibited within these buffer zones.

WL7 (T)

Any active sharp-shinned and Cooper's hawk nests discovered shall be protected when encountered. Within mature pine stands retain 2 mature pine trees per 5 acres to provide potential nest trees.

WL8 (T&M)

During salvage and reforestation treatments, retain butternut dogwood, serviceberry, walnut and other minor components of the stand, particularly soft and hard mast producers.

WL 9 (T&M)
Retain water-holding ruts and puddles where they do not conflict with road maintenance and use activities or create an increased potential for erosion and runoff (MTNF Biological Assessessment, USDA Forest Service 1998, p. 34)

WL10 (F)

Prescribed burning activities will be conducted in a manner to ensure that smoke does not accumulate heavily in areas likely to be occupied by Indiana or gray bats. These areas include caves known to support gray or Indiana bats.

WL11 (F)

Hand lighting with drip torches will not occur within 100 feet of a seep or fen. Aerial ignition will not occur within 100 yards of a seep or fen.

WL12 (G)

There will be no grazing within 100 feet of Thorny Hollow fen and Fortune Hollow fen within the Fortune Hollow Allotment.

WL13 (T, M, & F)

Known Indiana bat roost trees that occur within harvest units will be marked as leave trees. Known roost trees that occur within prescribed burn units will be protected by raking the fuel way from the base of the tree before ignition of the burn unit.

Mitigation Measures - Visuals (VS):

VS1 (T & M)

"Not more than 10 chains (660') of temporary opening may occur along any 40 chains (0.5 mile) of hiker or horse trail during this plan period. Log landings are prohibited within 100' of a recreation trail. Where skidding across a recreation trail is unavoidable it will be done at a right angle and at designated locations."

VS2 (T & M)

Slash adjacent to travel ways within a Sensitivity Level (SL) 1 or 2 will be lopped and scattered to lie within 30" of the ground. Slash adjacent to travel ways within SL 3 with a Variety Class of A or B will be lopped and scattered to lie within 48" of the ground.

VS3 (T& M)

Slash disposal protective measures are specified by stand within contract specifications by Forest Plan regulation. The negative visual impacts will be mitigated concurrently with or immediately after each phase of activity. Protective measures will be completed for each cutting unit before beginning activities in the next sequential block in the same corridor or view shed. The total lapsed time from initiation of activities to completion of obligations specified by a contract or a project prescription shall not exceed one year for any single cutting unit. Emphasis will be placed on completing all work within these areas in a systematic manner within the shortest practical time." (Page IV-31 Forest Plan)

VS4 (T & M)

Harvest edges will be feathered away from the property line where the private land is open.

VS5 (T & M)

All harvest areas will be laid out on the ground in a manner that will reflect natural lines and be visually subordinate to the characteristic landscape

Comparison of Alternatives

The Following table is an overview of proposed actions by activities for each alternative.

Table 2 - 1: Activity Comparison Table

	Alt.1	Alt.2	Alt. 3
Silvicultural Methods	**Acres**	**Acres**	**Acres**
Complete Salvage	0	931	637
Seed Tree Salvage	0	26	26
Shelterwood Salvage	0	1275	1275
Uneven Aged Salvage	0	1746	1746
Overstory Removal for Salvage	0	122	122
Sanitation for Salvage	0	562	562
Thin	0	1197	1197
Reforestation	**Acres**	**Acres**	**Acres**
Natural Regeneration	0	2512	2167
Pine Planting	0	667	0
Prescribed Fire	**Acres**	**Acres**	**Acres**
Open woodland development	0	2445	2445
Hazardous fuel reduction	0	5956	5956
Transportation	**Miles**	**Miles**	**Miles**
Temporary	0	25	23
Reconstruction	0	8.4	8.4
Soil and Water	**Each**	**Each**	**Each**
Dump Clean-up	0	5	5
Non-system Road Decommissions	0	55	55
Range/Wildlife	**Acres**	**Acres**	**Acres**
Grazing	0	345	345
Fertilize	0	345	345
Mechanical-Hand Cut, Mow, and Waterhole Maintenance	0	1375	1375
Fisheries *	**Acres**	**Acres**	**Acres**
Pond Rehab	0	16	16
Stock Fish	0	16	16

*** Includes Howe's Mill Lake Deepening, Fish Structures, and Howe's Mill South Spillway Work.**

Table 2 - 2: Comparison of the Alternatives in Terms of the Issues

Issue	Measure	Alternative 1	Alternative 2	Alternative 3
Issue 1: Effects of Grazing on Fortune Hollow Fen Area	Acres of fen planned for grazing activities	N/A	0	0
Issue 2: Effects of Prescribed Burns for Hazard Fuel Reduction	N/A	This issue is resolved through mitigation measure **V1**	This issue is resolved through mitigation measure **V1**	This issue is resolved through mitigation measure **V1**
Issue 3: Maximum Size Limit on Temporary Openings	Acres of planned Complete Salvage activities	0	931	637
Issue 4: Reforestation Through Pine Planting	Acres planted with pine	0	667	0

Table 2 - 3: Areas Affected by Alternatives

Acres and Percentage of Area Affected Directly by Timber Related Activities	**Alt.1**	**Alt. 2**	**Alt.3**
Total Analysis Area (23,217 ac)	0	4,486 (52 %)	4,101 (48 %)
MA 3.4-1 (4,117 ac)	0	2,064 (50 %)	1,427 (35 %)
MA 3.4-2 (5,926 ac)	0	4,203 (71 %)	4,010 (68 %)
MA 3.4-3 (2,625 ac)	0	283 (11 %)	91 (3 %)
Acres and Percentage of Area Affected by Prescribed Fire Activities	**Alt. 1**	**Alt. 2**	**Alt. 3**
Total Analysis Area (23,217 ac)	0	1,518 (18 %)	4,582 (54 %)
MA 3.4-1 (4,117 ac)	0	358 (9 %)	2,042 (50 %)
MA 3.4-2 (5,926 ac)	0	1,518 (26 %)	3,487 (59 %)
MA 3.4-3 (2,625 ac)	0	0	1,098 (42 %)

Table 2 - 4: Summary of Effects by Alternative

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Soils	Possible negative effects from wildland fires. Increases in accumulations of light and heavy fuels would cause fires to burn with more intensity.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes to inherent long-term productivity of the land.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes to inherent long-term productivity of the land.
Water	Possible negative effects from wildland fires and no road reconstruction.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes to inherent long-term quality of the water.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes to inherent long-term quality of the water.
Air	Possible negative effects from wildland fires.	Adherence to FP S&Gs, Burn plan and site-specific mitigation measure would result in no appreciable changes to inherent long-term or short-term air quality.	Adherence to FP S&Gs, Burn plan and site-specific mitigation measure would result in no appreciable changes to inherent long-term or short-term air quality.
Fuel Loading	Increased fuel loading, potential for larger wildland fires.	Reduction of fuel loading would decrease potential for large wildland fire within stands treated.	Reduction of fuel loading would decrease potential for large wildland fire within stands treated.
Ecosystem Health and Vigor	Stands continue to be attacked by insects and disease, possibly spreading to other oak and tree species. Increase of shade intolerant species in the under-story would inhibit growth of desirable seedlings.	Infestation by insect and disease would be reduced as infected trees are removed. Provides for the increase diversity of species, which would result in a healthier more productive forest. Provides diverse under-story and vertical structure. Early successional habitat would be created created.	Infestation by insect and disease would be reduced as infected trees are removed, although to a lesser extent than Alt. 2. Less species diversity under this alternative without pine planting.
Est. Timber Sale Receipts	0	$1,791,713	$1,647,866
Est. Timber Costs	0	$1,266,245	$1,001,374

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Est. Volume (Mbf)		14,537	13,505
Wildlife	Habitats would be impacted by changes due to insects and disease. (Stands would move towards old growth condition. At this point, most trees would die and the stand would move towards early succession.) Less species diversity. Improvements in forest health may take longer since stands will not be treated.	Habitats would be managed to reduce the impacts from insect and disease infestation. Stands would move toward the desired future conditions for habitats listed in the FP. No appreciable change to wildlife populations for the long-term.	Habitats would be managed to reduce the impacts from insect and disease infestation. Stands would move toward the desired future conditions for habitats listed in the FP. No appreciable change to wildlife populations for the long-term.
T&E Species	May affect Indiana bat. No opportunity to increase foraging habitat for Indiana bats. Not likely to adversely affect the bald eagle, gray bat, and Hine's emerald dragonfly. No effect to Mead's milkweed.	May affect Indiana bat. No likely to adversely affect the bald eagle, gray bat, and Hine's emerald dragonfly. No effect to Mead's milkweed.	May affect Indiana bat. No likely to adversely affect the bald eagle, gray bat, and Hine's emerald dragonfly. No effect to Mead's milkweed.
RFSS Species	No impacts to Regional Foresters Sensitive Species	No impacts to Regional Foresters Sensitive Species	No impacts to Regional Foresters Sensitive Species
Heritage	No potential to affect heritage resources from management activities. Could be negative impacts due to wildland fire suppression activities on individual heritage resource sites.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes heritage resource sites.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes heritage resource sites.
Visuals	Less visually pleasing views due to large amounts of dead, dying and fallen trees in forested stands.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes to visuals.	Adherence to FP S&Gs and site-specific mitigation measure would result in no appreciable changes to visuals.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Recreation	Increasing negative effects on dispersed recreation with deadfall and hazard trees. Safety concerns increase for forest users from more hazardous wildland fires.	Safety concerns would be reduced as stands are harvested. In the short-term some areas may not be available for dispersed recreation due to logging operations or prescribed fires. Long-term, many recreation opportunities could be improved as forest diversity increases.	Safety concerns would be reduced as stands are harvested. In the short-term some areas may not be available for dispersed recreation due to logging operations or prescribed fires. Long-term, many recreation opportunities could be improved as forest diversity increases.

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

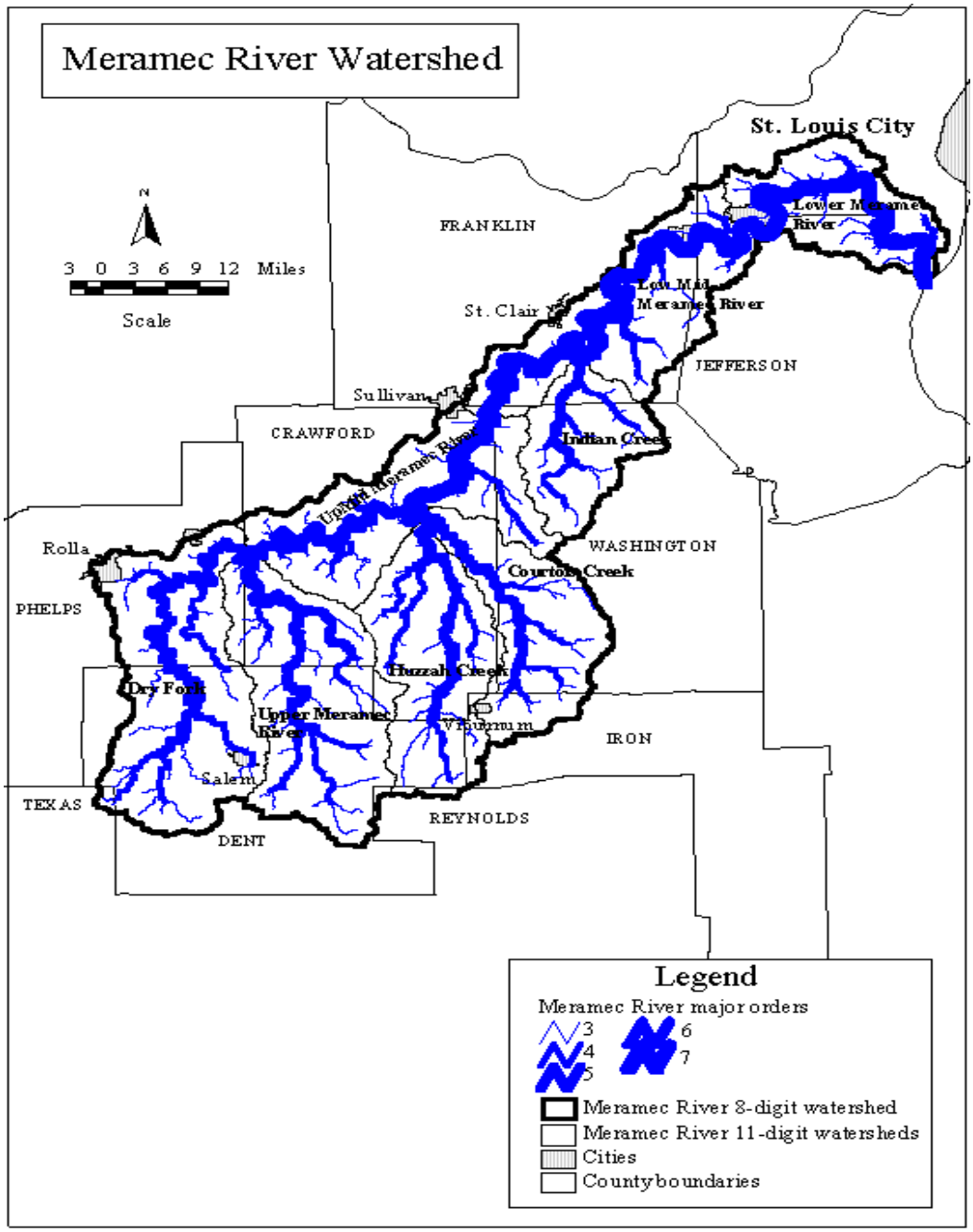
Lakes and Ponds: The Forest Service in partnership with Missouri Department of Conservation maintains the following lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah Cutoff Pond #3, and Gnuse Pond (total 16 acres). The water chemistry in the lake and ponds is not 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.

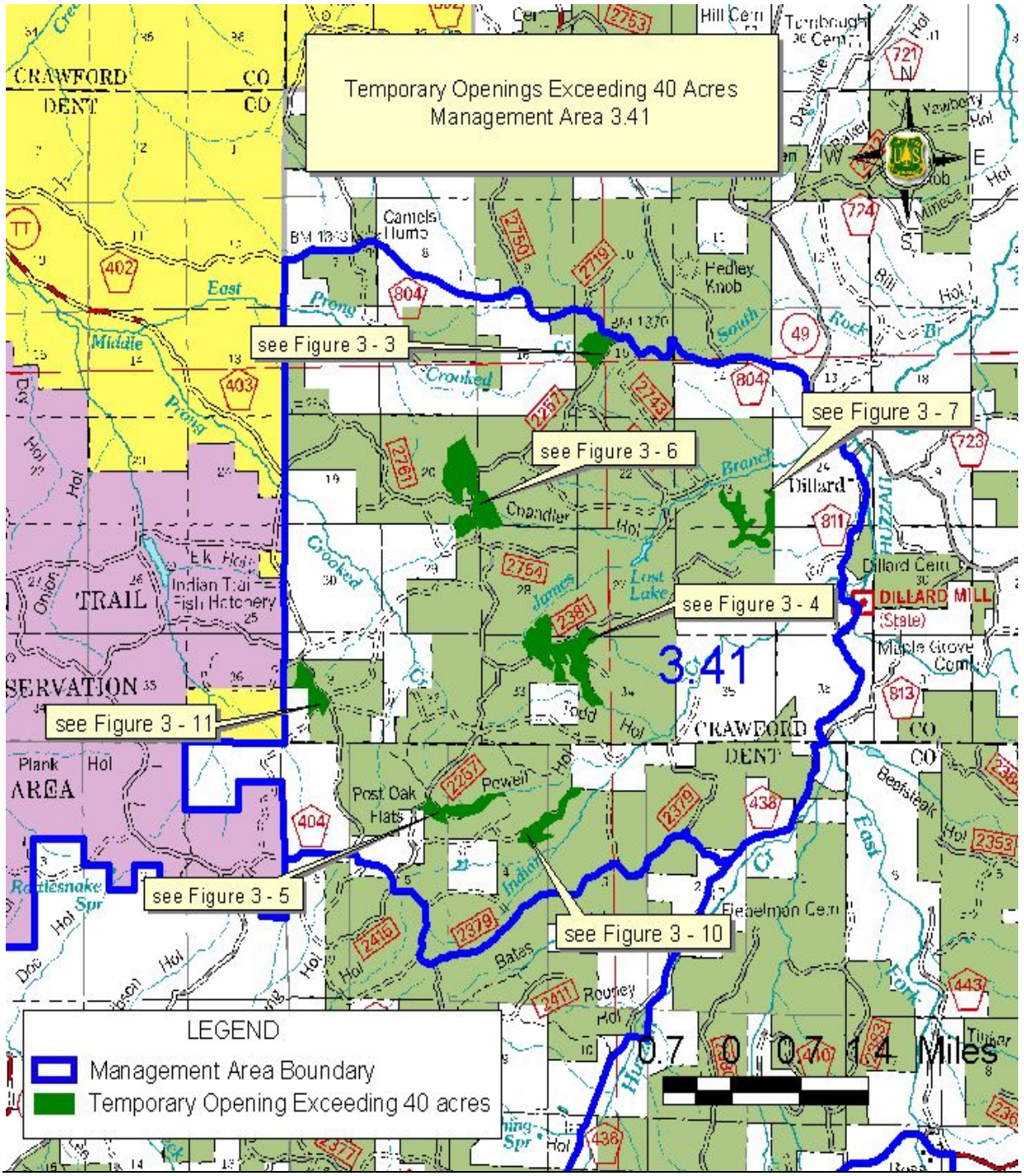


Figure 3 - 1: Temporary Openings Exceeding 40 Acres in Management Area 3.41 Under Alternative 2

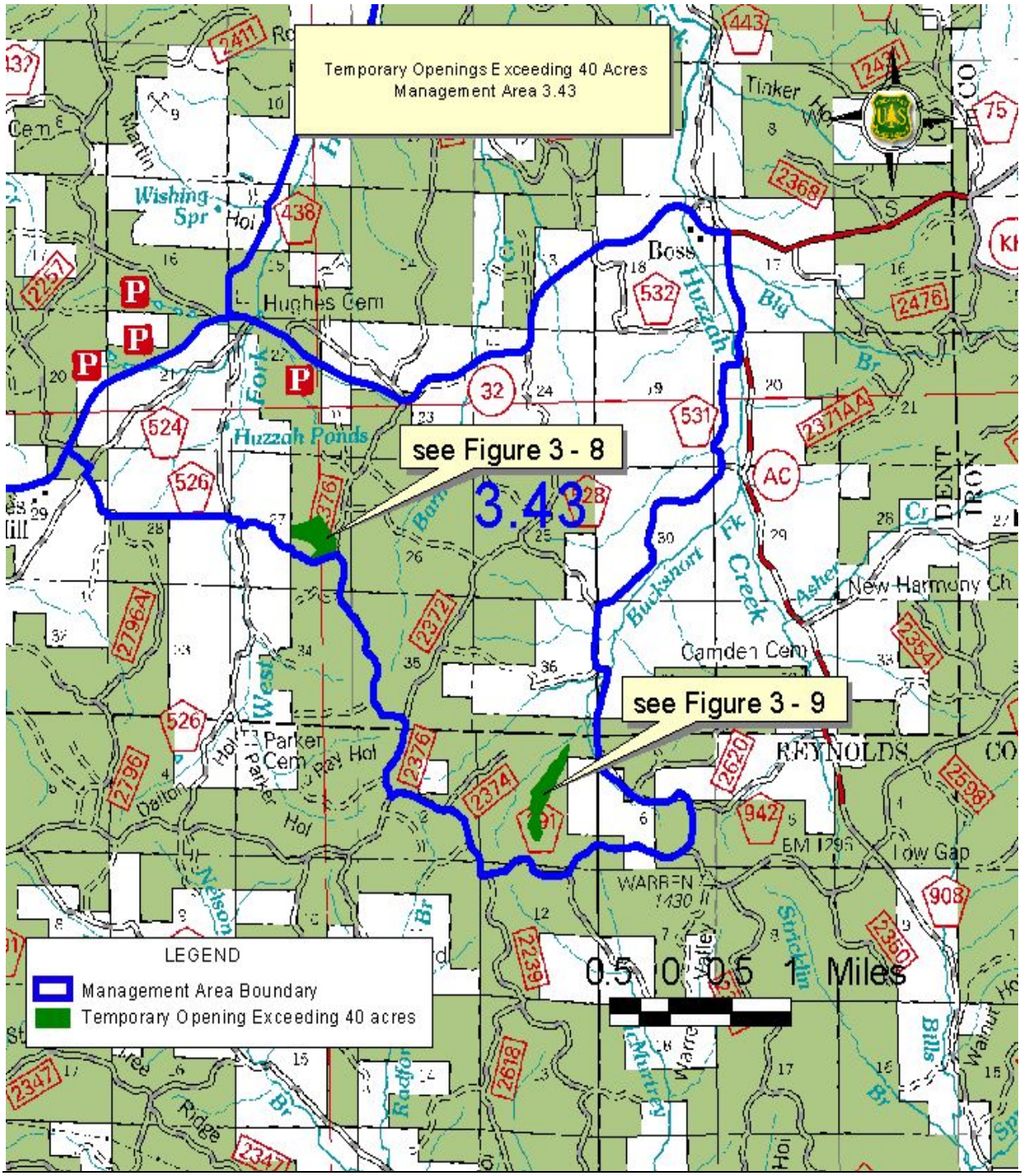


Figure 3 - 2: Temporary Openings Exceeding 40 Acres in Management Area 3.43 Under Alternative 2

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).

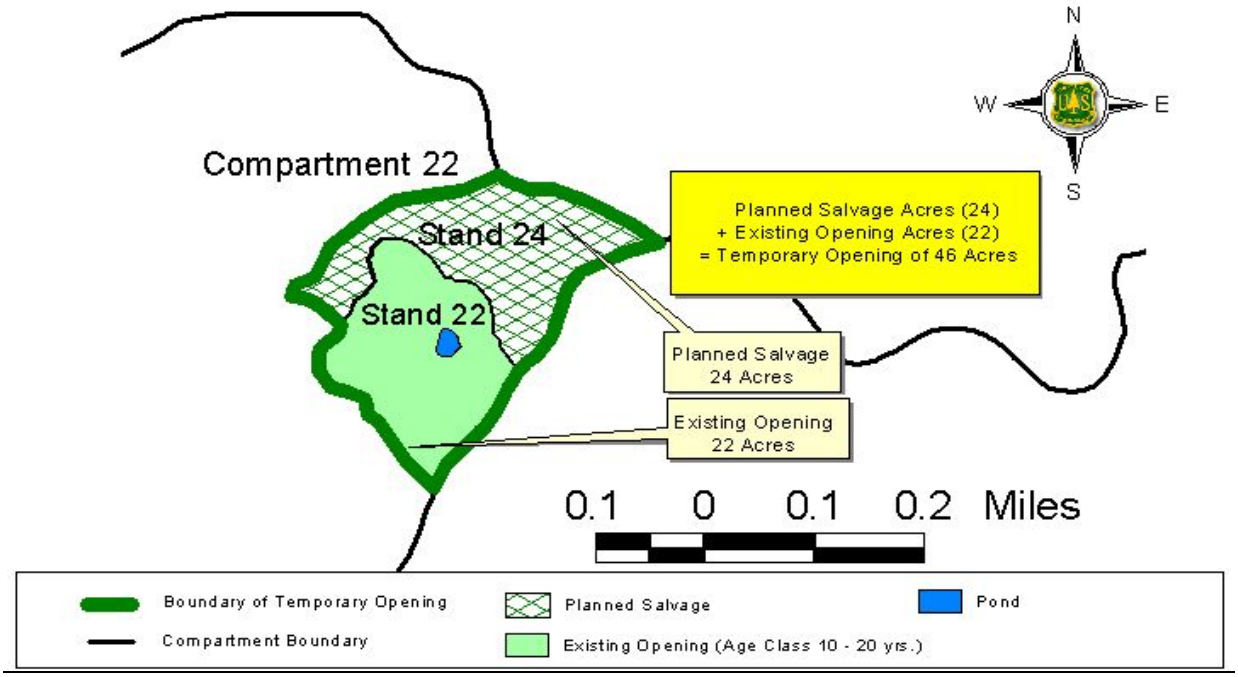


Figure 3 - 3: Temporary Opening, Compartment 22, Stands 22 and 24

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).

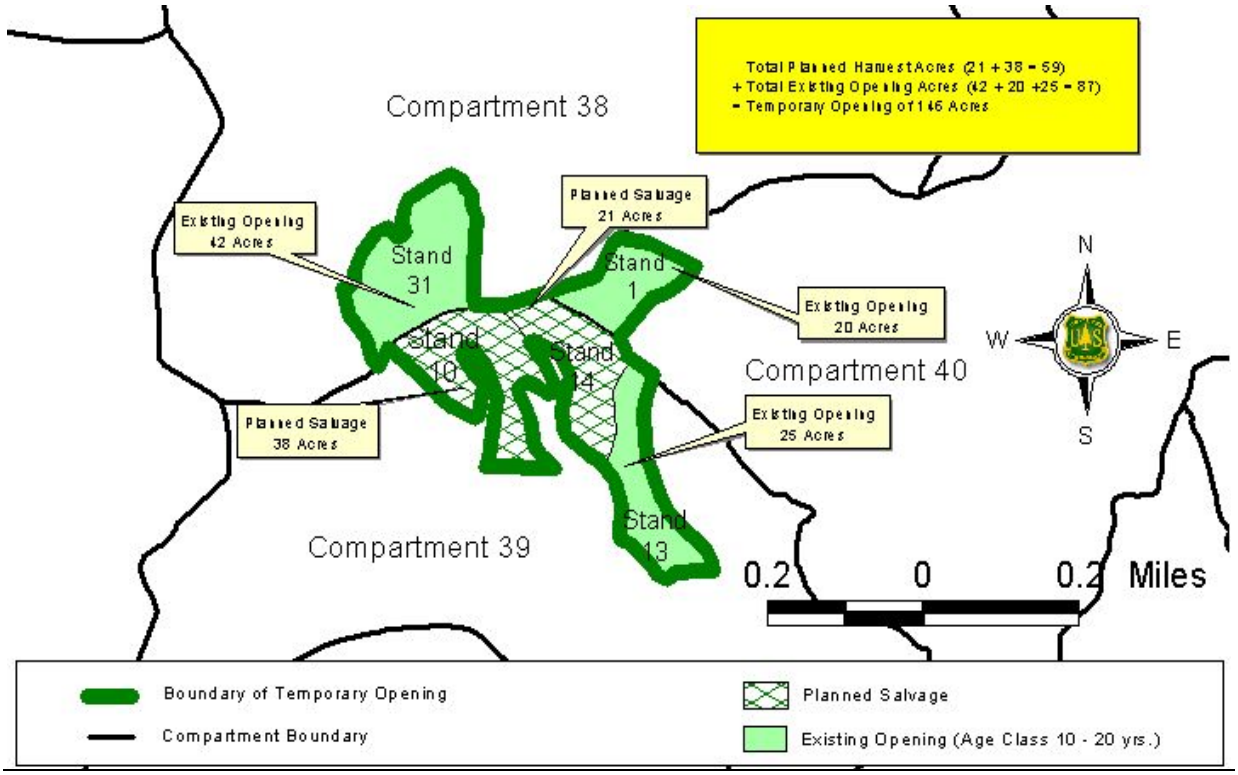


Figure 3 - 4: Temporary Opening, Compartment 38, Stand 31; Compartment 39, Stands 10, 13, and 14; Compartment 40, Stand 1

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).

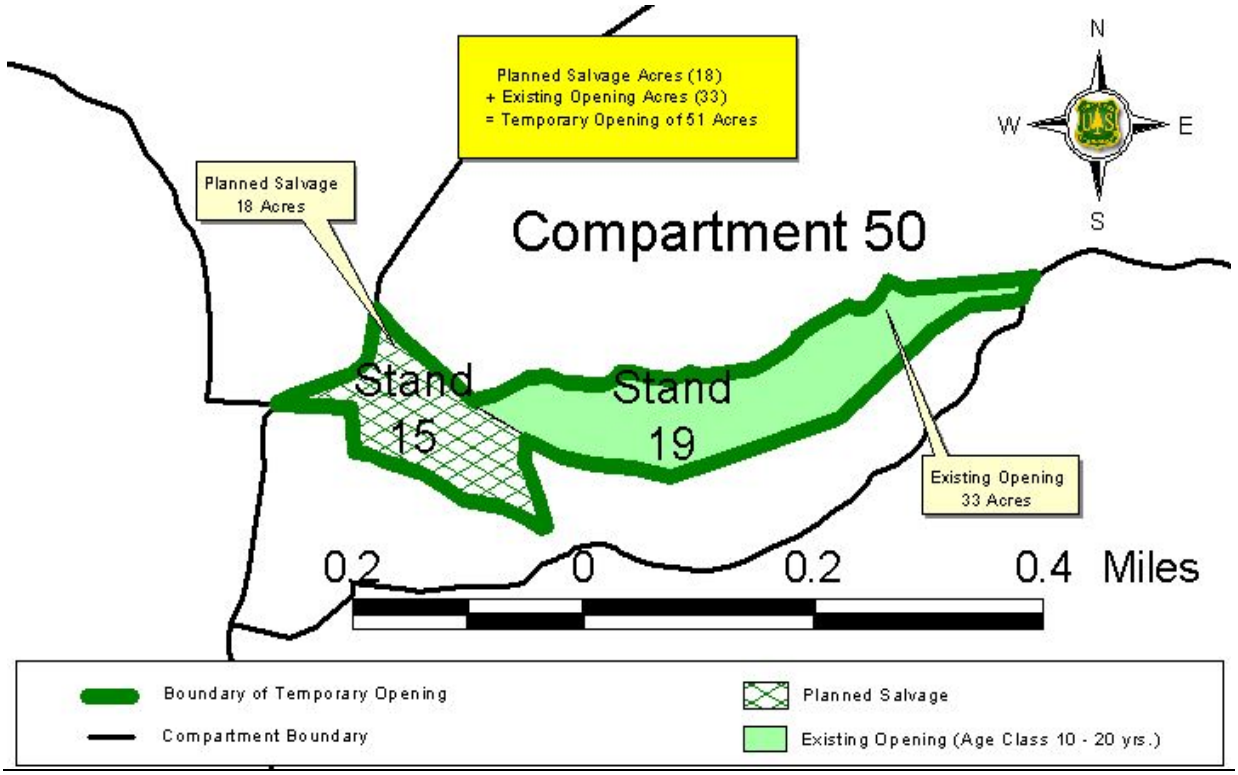


Figure 3 - 5: Temporary Opening, Compartment 50, Stands 15 and 19

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).

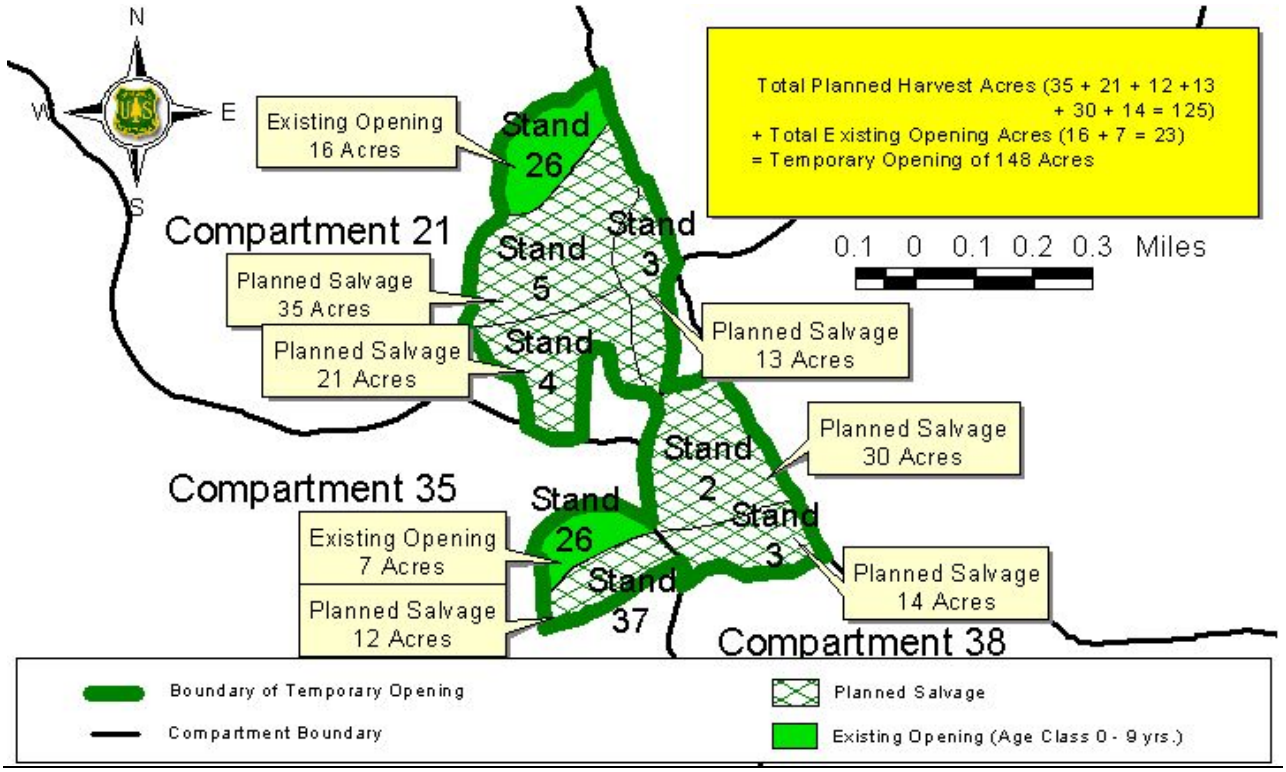


Figure 3 - 6: Temporary Opening, Compartment 21, Stands 3, 4, 5, and 26; Compartment 35, Stands 26 and 37; Compartment 38, Stands 2 and 3

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).

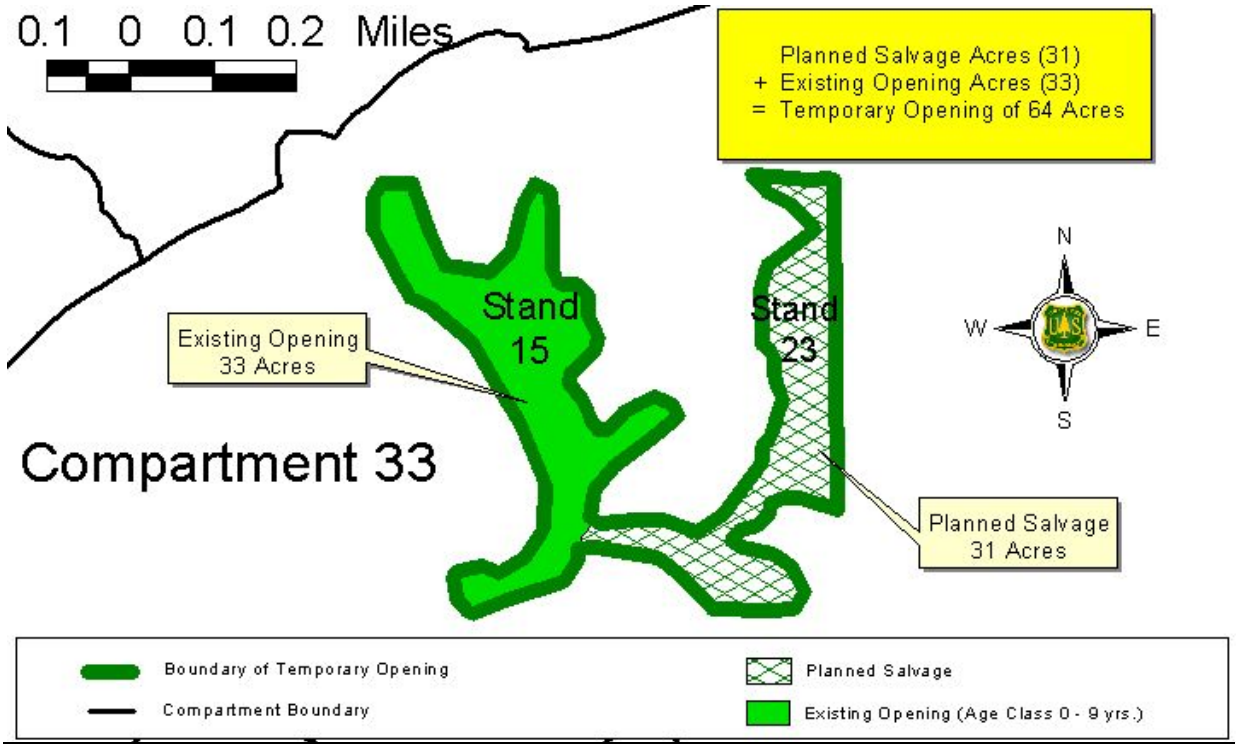


Figure 3 - 7: Temporary Opening, Compartment 33, Stands 15 and 23

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).

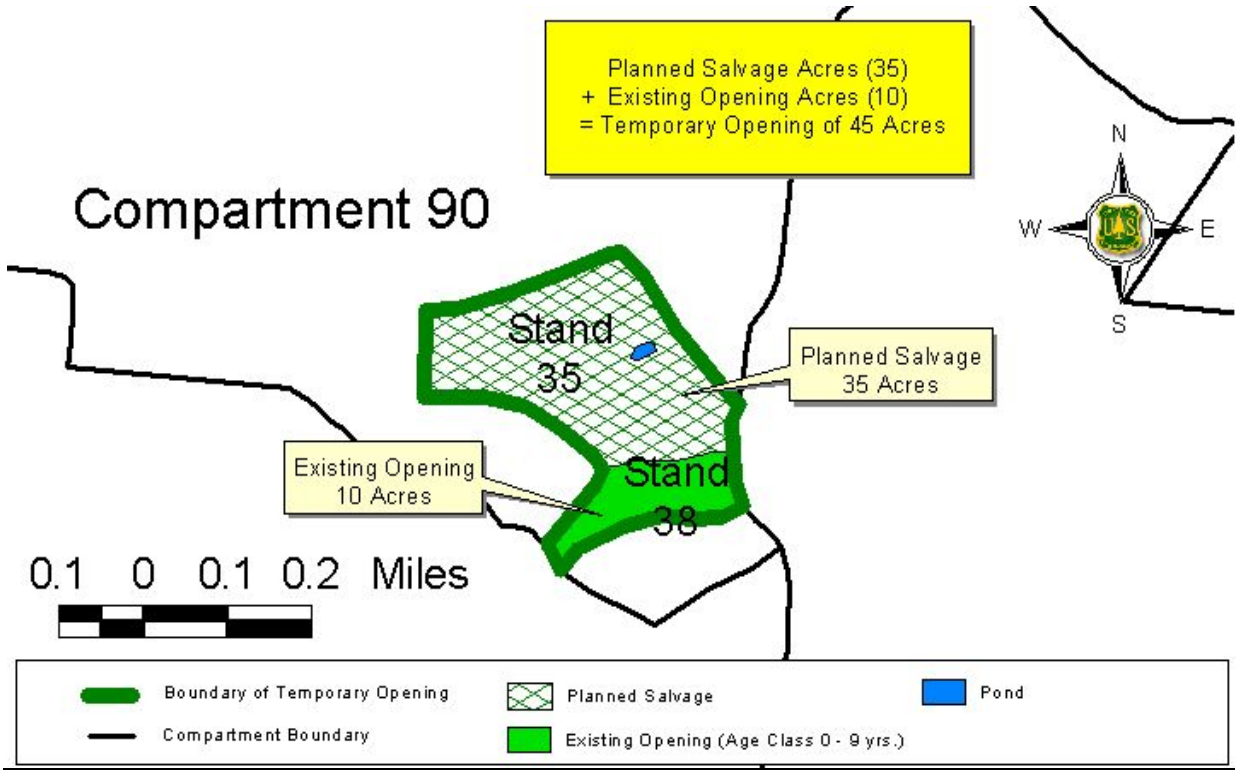


Figure 3 - 8: Temporary Opening, Compartment 90, Stands 35 and 38

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).

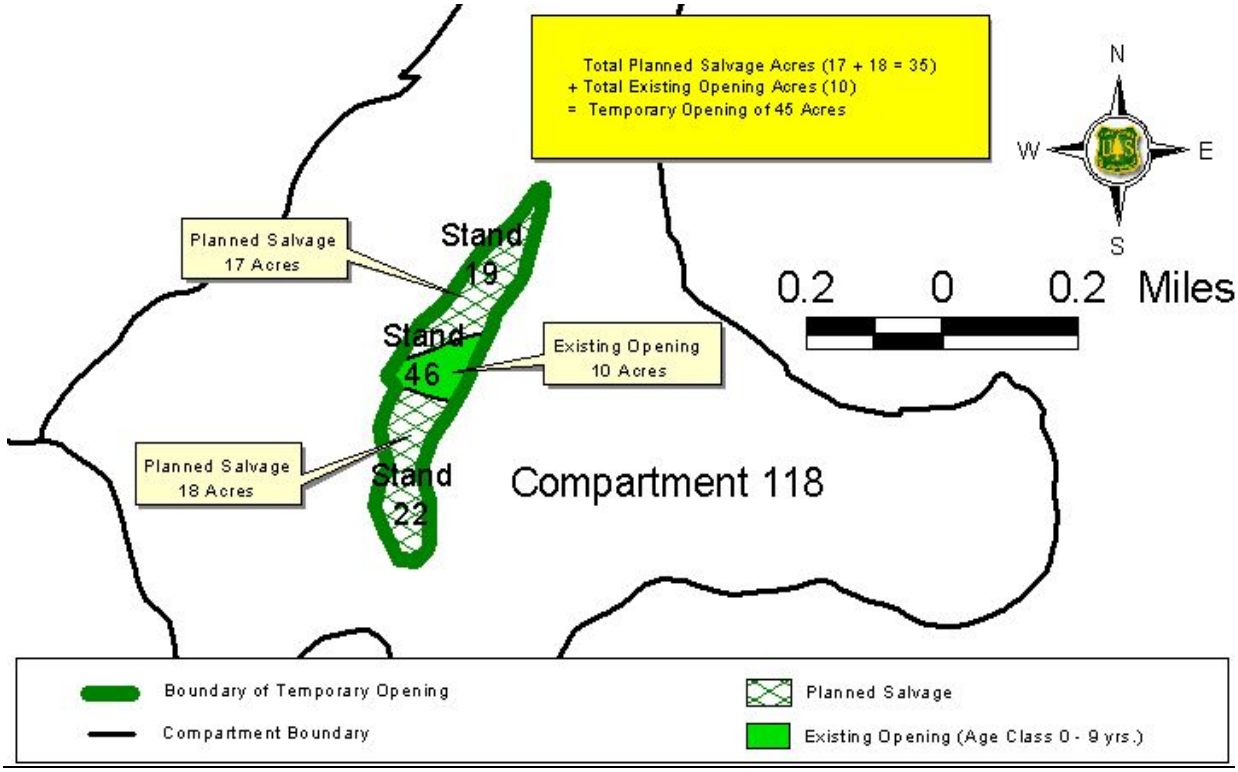


Figure 3 - 9: Temporary Opening, Compartment 118, Stands 19, 22, and 46

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.

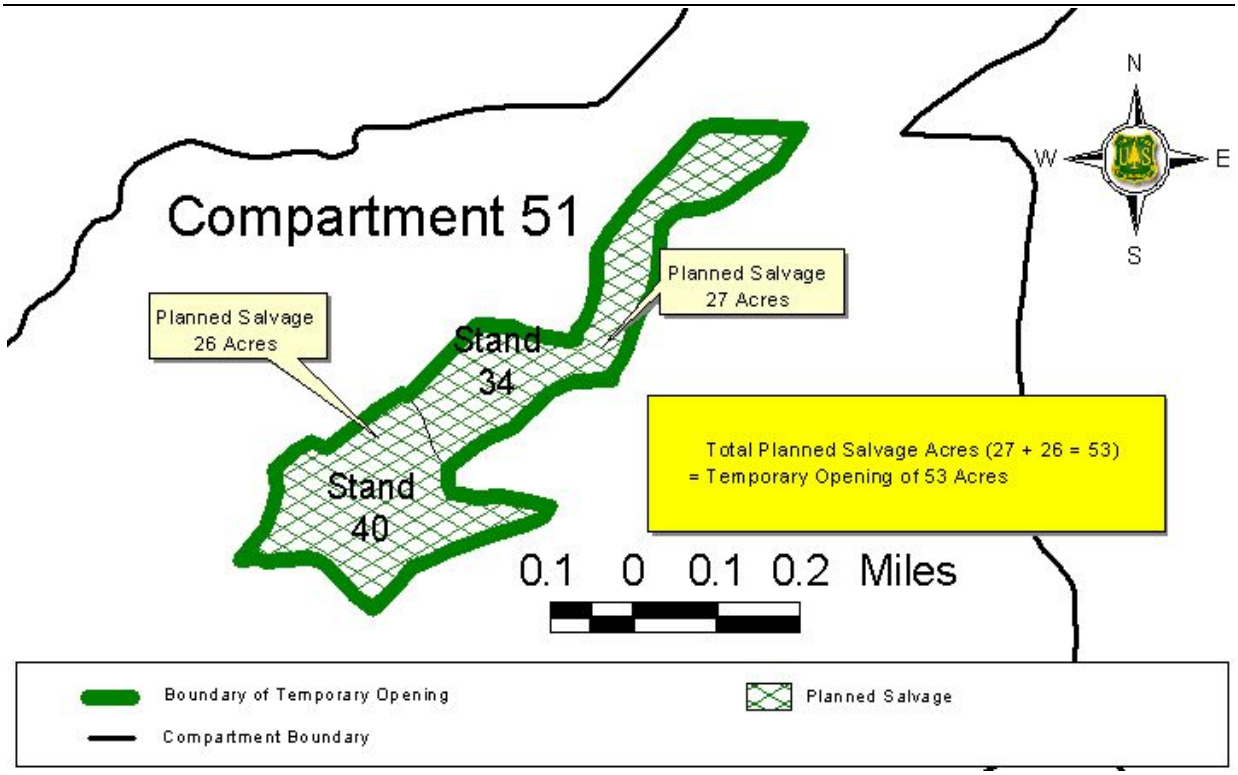


Figure 3 - 10: Temporary Opening, Compartment 51, Stands 34 and 40

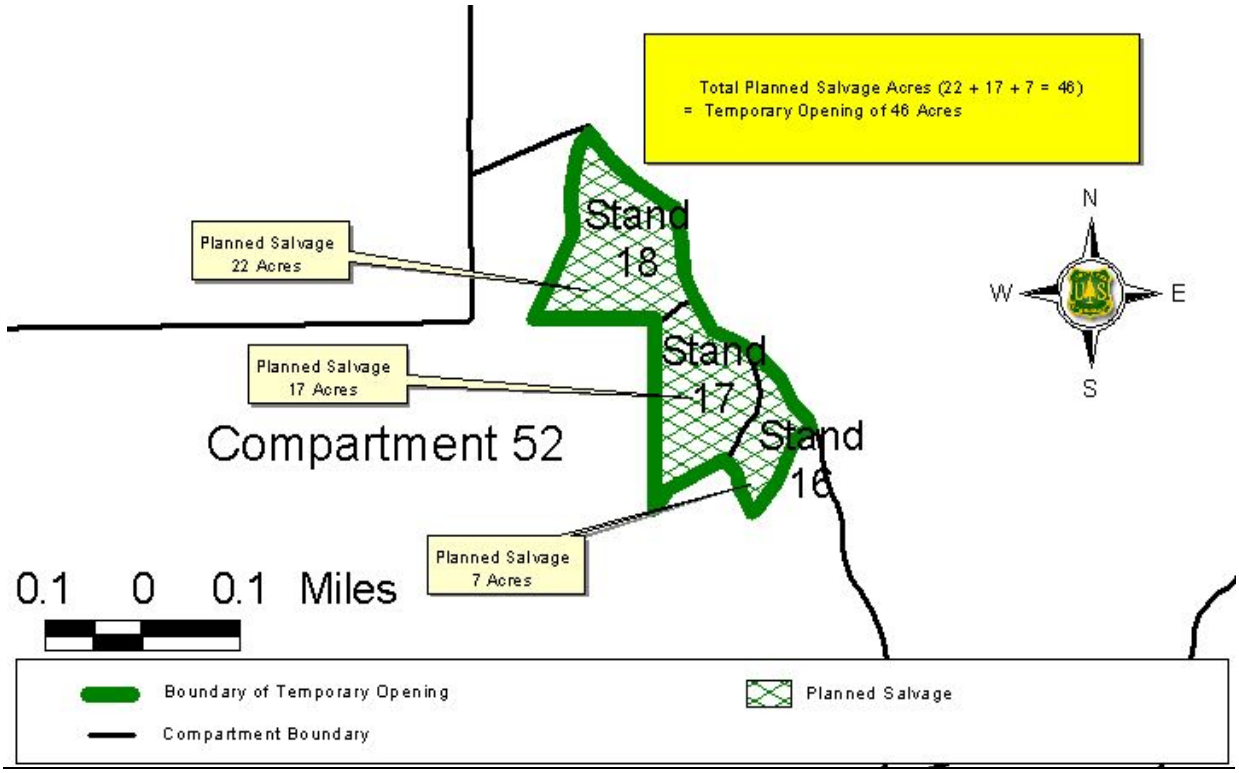


Figure 3 - 11: Temporary Opening, Compartment 52, Stands 16, 17, and 18

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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Missouri Department of Conservation, Wildlife Division, Columbia, MO

Missouri Department of Natural Resources, Jefferson City, MO

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

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APPENDIX B – GLOSSARY OF TERMS

A

Adverse Effect (to an Historic Property)

An adverse effect occurs when a federal action alters, directly or indirectly, any of the characteristics of an 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.

Advisory Council on Historic Preservation
An independent Federal agency, established under the National Historic Preservation Act of 1966 (NHPA), as amended, to advise the President and Congress on historic preservation matters, to review Federal agency historic preservation programs and policies, to provide and encourage education and training on historic preservation, and to carry out reviews of Federal agency undertakings under Section 106 of the NHPA.

Affected Environment
The baseline environment of the relative resource components.

Age Class
A distinct aggregation of trees originating from a single natural event or regeneration activity, or a group of trees, e.g. 10-year age class, as used in inventory or management.

Aggregate surface
Road surface consisting of crushed or screened graded material, such as limestone or creek gravel.

Air Quality Related Values (AQRV's)
A feature or property of an area that is (or has the potential to be) affected in some way by air pollution. General categories are: flora, fauna, soil, water cultural/historical resources, odor and visibility.

Ambient Air
The air of the surrounding outdoor environment. The air encompassing a specific geographic area.

Analysis Area
The geographical boundary of the area to be analyzed.

Animal-unit (AU)
Defines forage consumption on the basis of one standard mature 1,000-pound cow, either dry or with calf up to 6 months old; all other classes and kinds of animals can be related to this standard, e.g. a bull equals 1.25 AU, a yearling steer equals 0.6 AU.

Animal-unit-month (AUM)
The amount (780 pounds) of air-dry forage calculated to meet one animal unit's requirement for one animal unit for one month.

Annual (plant)
A plant species living and growing for only one year or season

Aquifer
An underground geological formation or group of formations that contain water, a source of ground water for wells and springs

Aquitard
A layer of low permeability that can store ground water and also transit it slowly from one aquifer to another.

Archaeological Resources Protection Act (ARPA)
Public Law 96-95, 16 USC 470a, passed in 1979, required a permit for any excavation or removal of archaeological resources from public or Indian lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed remain the property of the United States.

Area of Potential Effect
The geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. 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.

Arterial roads
Roads that provide service to large land areas and usually connect with public highways or other forest arterial roads to form an integrated network of primary travel routes. Their location and standard are often determined by a demand for maximum mobility and travel efficiency rather than specific resource management service. They are usually developed and operated for long-term land and resource management purposes and constant service.

Attainment Area
A geographic area in which levels of a criteria air pollutant meet the health-based primary standard (national ambient air quality standard, or NAAQS) for the pollutant. An area may have on acceptable level for one criteria air pollutant, but may have unacceptable levels for others. Thus, an area could be both attainment and non-attainment at the same time. Attainment areas are defined using federal pollutant limits set by EPA. There are six Criteria Pollutants; Lead (Pb), Sulfur Dioxide (SOx), Nitrogen Oxides (NOx),Ozone (O3), Particulate Matter (PM-10 and PM-2.5) and Carbon Monoxide (CO) which are regulated by EPA. A seventh pollutant, Volatile Organic Carbons (VOC's) is on the list but is not regulated by EPA at this time.

Available water holding capacity
The maximum amount of water a soil profile can hold, which can be used by plants.

B

Basal area
The area (in square feet) of the cross section of a tree stem, including the bark, generally at breast height (4.5 feet above the ground). In the aggregate, it is the total cross-sectional area of all trees on a per acre basis, and provides a measurement of how much of a site is occupied by trees, e.g. 80 sq. ft. /acre.
Biennial (plant)
A plant species that completes its life cycle, from seed germination to seed production, in two years. Also means, "to occur every two years," as in biennial burns.

Biodiverstiy
The diversity of life in an area, including the diversity of genes, species, plant and animal communities, ecosystems, and the interaction of these elements.

Biological Opinion (BO)
An official report by the USDI Fish and Wildlife Service or the National Marine Fisheries Service issued in response to a formal Forest Service request for consultation or conference. It states whether an action is likely to result in jeopardy to a species or adverse modification of its critical habitat.

Biomass
The total amount (weight) of living material in a given habitat.

Board foot
An amount of wood equivalent to a piece measuring 12” by 12” by 1”.

Browse
That part of leaf and twig growth of shrubs, woody vines and trees on which browsing animals, such as deer can feed; to consume browse.

Buffer strip
A strip of vegetation that is left unmanaged or is managed to reduce the impact that a treatment or action on one area would have on an adjacent area.

Bunch grass
Grasses of many genera which grow primarily in tufts of clumps rather than forming a sod or mat. Native warm season grasses are often referred to as “bunch grasses”.

C

Canopy
The maximum amount of water a soil profile can hold, which can be used by plants.

Carbon sequestration
Carbon sequestration in terrestrial ecosystems can be defined as the net removal of CO2 from the atmosphere into long-lived pools of carbon. The pools can be living, aboveground plants, products with a long, useful life created from plants such as lumber, living biomass in soils such as plant roots or micro-organisms or other carbon compounds in soils and deeper environments. Increasing photosynthetic carbon fixation alone is not enough. This carbon must be fixed into long-lived pools such as trees or lumber. Otherwise, one may be simply altering the size of changes in the carbon cycle, not increasing carbon sequestration. (Department of Energy)

Carrying capacity
The average number of livestock and wildlife that may be sustained on a management unit compatibly with management objectives. It is a function of site characteristics, and management goals and intensity.

Class I Area
A geographic area designated for the most stringent degree of protection from future degradation of air quality. The Clean Air Act designates as mandatory Class I areas each National Park over 6,000 acres and each Wilderness over 5,000 acres in existence as of August 7, 1977. Subsequent additions of land to those Class I areas are also considered Class I.

Class II Area
A geographic area designated for a moderate degree of protection from future degradation of air quality. Moderate increases in new pollution may be permitted in Class II areas. All Wildernesses designated after August 7, 1977 or were less than 5,000 acres are automatically Class II areas, as are all other National Forest System lands.

Classified Roads
Roads wholly or partially within or adjacent to National Forest System lands that are determined to be needed for long-term motor vehicle access, including State roads, county roads, privately owned roads, National Forest System roads, and other roads authorized by the Forest Service.

Class of animal
Description of age and sex group for a particular kind of animal, e.g., cow, calf, yearling heifer, ewe, fawn.

Complete Salvage
A method of regenerating an even-aged stand in which a new age class develops in a fully exposed microclimate after removal, in a single cutting, of all trees in a previous stand. Regeneration is from natural seeding, direct

seeding, planted seedlings, and/or advanced reproduction. Complete salvage may be done in groups or patches or in strips. In the complete salvage system, the management unit or stand in which regeneration, growth, and yield are regulated consists of the individual salvage stand (see group selection). When the primary source of reproduction, the preferred term is "over-story removal".

Complete Salvage with reserves
A salvage method in which varying numbers of reserve trees are not harvested to attain goals other than regeneration.

Code of Federal Regulations (CFRs)
A codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. The Code is divided into 50 titles that represent broad areas subject to Federal regulations. Each title is divided into chapters, which usually bear the name of the issuing agency. Each chapter is further subdivided into parts covering specific regulatory areas.

Collector road
Serves smaller land areas than a Forest arterial road and is usually connected to a Forest arterial road or public highway. Collects traffic from Forest local roads and/or terminal facilities. The location and standard are influenced by long-term multi-resource service needs as well as travel efficiency. May be operated by either constant or intermediate service, depending on land use and resource management objectives for the area served by the facility.

Compaction
In soil, the process by which soil particles are rearranged to decrease void space and bring them in closer contact with each other, thereby reducing available water capacity, aeration, and porosity and increasing bulk density.

Cool-season plant
A plant that generally makes the major portion of its growth during the late fall, winter, and spring.

Confining unit
Relatively impervious layers of rock that separate one aquifer from other aquifers.

Connected actions
Management practices or actions which 1) automatically trigger other actions that may require environmental impact statements; 2) cannot or will not proceed unless other actions are taken previously or simultaneously; or 3) are interdependent parts of a larger action and depend on the larger action for their justification.

Cover crop
A short-lived, usually annual, plant used to quickly provide vegetation on disturbed soil until native vegetation can grow back on the site. The root systems of cover crops develop quickly to help hold soil and prevent or minimize erosion from a site where soil has been exposed.

Criteria air pollutants
A group of very common air pollutants regulated by EPA on the basis of criteria (information on health and/or environmental effects of pollution). Criteria air pollutants are widely distributed all over the country.

Crown closure
The ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of the total ground area (Syn. "canopy cover" or "crown cover").

Crown density
The amount and compactness of foliage of the crowns of trees and/or shrubs.

Cumulative Impacts
The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably-foreseeable future actions regardless of what agency (Federal or non-Federal) or person

undertakes such actions. Cumulative impacts can result from usually minor but collectively significant action taking place over a period of time (40 CFR 1508.7).

D

Deciduous
Pertaining to any plant organ or group of organs that is shed naturally; perennial plants that are leafless for some time during the year.

Decommission
To remove from service a road or trail that is no longer needed.

Decomposition
Break up into constituent elements through chemical change.

Deferment
Delay of livestock grazing on an area for an adequate period of time to provide for plant reproduction, establishment of new plants, or restoration of vigor.

Deferred-rotation
A grazing system that provides for a systematic rotation of the deferment among pastures.

Dendritic Drainage Pattern
An arrangement of surface drainage in which the streams branch randomly at almost any angle.

Desired plant community (DPC)
A plant community that produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the management objectives for an ecological site.

Diameter at Breast Height (DBH)
The diameter of a tree, generally measured at 4.5 feet from the ground.

Dispersed Recreation
Lands and waters under Forest Service jurisdiction that are not developed for intensive recreation use. Dispersed areas include general undeveloped areas, roads, trails, and water areas not treated as developed sites.

Displacement
In soils, often used interchangeably with erosion. Detachment and movement of soil particles by water, wind, ice, or gravity and can be natural, human caused or both.

Diversity
The distribution and abundance of different plant and animal species within the area covered by a land and resource management plan.

Dolomite
Magnesium-rich sedimentary rock resembling limestone

Down woody debris
Woody portions of trees that have fallen to and are lying on the ground. Down woody debris include twigs, branches, logs, stumps, and whole trees that have fallen down.

Duff
The lower portion of the organic layer covering the soil, consisting of decomposed litter. The more or less firm organic layer on top of mineral soil, consisting of fallen vegetative matter in the process of decomposition, including everything from pure humus below to the litter on the surface.

E

Early successional wildlife species
Animals that use young forests or new habitats. Succession is the sequence of ecological stages beginning with grass/shrub/seedling communities and progressing to a climax forest. Early successional refers to the beginning stages such as the grass/shrub/seedling stage.

Ecological Land Type (ELT)
An area of land with a distinct combination of natural, physical, chemical and biological properties that cause it to respond in a predictable and relatively uniform manner to the application of given management practices. In a relatively undisturbed state and/or at a given stage (sere) of plant succession, and ELT is usually occupied by a predictable and relatively uniform plant community. Typical size generally ranges from about 10 to a few hundred acres.

Ecological site
Land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management. Synonymous with range site.

Ecosystem
Organisms that together with their physical environment form an interacting system and inhabit an identifiable space.

Ectomycorrhizal
symbiotic association between the stringlike mass of fungi and the roots of certain plants. This stringlike mass (called myc forms a mantle on the surface of the roots and extends into the surrounding soil and inward between the root cells. This as enables the roots to take up nutrients and moisture into the plant which might otherwise be unavailable to it.

Edge
The more or less well-defined boundary between two or more elements of the environment; for example, field/woodland.

Effect (of an action on Historic Properties)
Alteration to the characteristics of an historic property qualifying it for inclusion in, or eligibility for, the National Register.

Endangered species
Any species that is in danger of extinction throughout all or a significant part of its range. Endangered species must be designated in the Federal Register. (See “threatened species”)

Endemic
Native or confined to a certain region; having comparatively restricted distribution.

Environmental Analysis
An analysis of alternative actions and their predictable short- and long-term environmental consequences.

Environmental Assessment (EA)
A concise public document that briefly provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or to return a finding of no significant impact, aids an agency’s

compliance with NEPA when no Environmental Impact Statement is necessary, or facilitates preparation of a statement when one is necessary.

Environmental Consequences
The physical, biological, social and economic results (good or bad) of implementing a given alternative.

Ephemeral stream
A stream that flows less than 10 percent of the time, only in direct response to rainfall, with a channel that may be scoured or unscoured and is always above the water table.

Erosion
The wearing away of the land surface by running water, wind, ice and other geological agents. The detachment and removal of soil from the land surface by wind, water or gravity.

Even-aged stand
A stand of trees containing a single age class in which the range of tree ages is usually less than 10 percent of the rotation.

Even-aged silvicultural system
The application of a combination of actions that result in the creation of stands in which trees of essentially the same age row together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes) throughout the forest area. The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for regeneration and is harvested. Clear-cut, shelterwood, or seed tree cutting methods produce even-aged stands.

Existing visual conditions (EVC)
The present state of visual alteration that is measured in six degrees (untouched, unnoticed, minor disturbance, disturbed, major disturbance, drastic disturbance) of deviation from the natural landscape.

F

Fauna
The animals of a given region or period.

Filter strip
A designated area bordering streams and riparian areas where soil compaction by machinery is avoided and soil disturbance is minimized so that the sediment filtering ability of the forest floor is maintained.

Floodplain
Low land and relatively flat areas joining inland and coastal waters, including debris cones and flood prone areas of offshore islands. The minimum area included is that subject to a one percent (100-year recurrence) or greater chance of flooding in any given year.

Flora
The plants of a given region or period.

Forage
Browse and herbage that are available for food for grazing animals or be harvested for feeding. Forage production. The weight of forage that is produced within a designated period of time on a given area (e.g. pounds per acre).

Forb

A non-woody, broad-leafed plant.

Forest land
Land at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for non-forest use.

Forest Service Policy
Policy set by Forest Service Manuals and specific National Forest Land and Resource Management Plans.

Forest type
A descriptive term used to group stands of similar character, species composition, and other ecological factors.

Forest-wide Standards and Guidelines
A set of statements which define or indicate acceptable norms, specifications or quality that must be met when accomplishing an activity or practice under a given set of conditions on the Mark Twain National Forest.

Fragipan
Loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in sil sand. A fragipan appears cemented and restricts roots. When dry, it is very hard and has as higher bulk density than the ho above. When wet, it tends to rupture suddenly under pressure rather than to deform slowly.

Frequency
In reference to the Grazing Response Index, the number of times plants are defoliated during the growing season.

G

Game species
Wild animals hunted for food or sport.

Goal
A concise statement that describes a desired condition to be achieved sometime in the future. It is generally expressed in broad, general terms and usually does not have a specific date for completion.

Goods and Services
The various outputs, including on-site uses, produced from forest and rangeland resources.

Grass
A plant with long, narrow leaves having parallel veins and nondescript flowers. Stems are hollow or pithy in cross-section.

Grass-like plant
A plant that resembles a grass but has stems that are solid in cross-section, including rushes and sedges.

Grazing management
The control of grazing and browsing animals to accomplish a desired result.

Grazing preference
(1) Selection of plants, or plant parts, over others by grazing animals. (2) In the administration of public lands, a basis upon which grazing-use permits and licenses are issued.

Grazing pressure
An animal-to-forage relationship measured in terms of animal units per unit weight of forage at any instant.

Grazing Response Index (GRI)
A technique used to assess effects of the current years grazing and plan for the next year. It considers grazing frequency and intensity, and the plants' opportunity to grow or regrow before, between or after grazing periods.

Grazing system
Grazing management that defines the periods of grazing and non-grazing.

Ground water
Water residing in the interstices of soil and rock below the surface.

Group selection
A method of regenerating uneven-aged stands in which trees are removed, and new age classes are established, in small groups. The maximum width of groups is approximately twice the height of mature trees, with small openings providing microenvironments suitable for shade-tolerant regeneration and the larger openings providing conditions suitable for regeneration that is more shade-intolerant. As applied in the Carman Springs project, groups may range in size from approximately ¼ to 2 acres. In the group selection system, the management unit or stand in which regeneration, growth, and yield are regulated consists of a landscape containing an aggregation of groups (see clearcutting).

Guideline
An indication or outline of policy or conduct.

H

Habitat
The natural environment of a plant or animal. An animal's habitat includes the total environmental conditions for food, cover and water within its home range.

Habitat type
The collective area that one plant community occupies or will come to occupy as succession advances to climax.

Habitat capability
The ability of the vegetative community to provide food, cover, and water for wildlife.

Hardwood
A broad-leaved flowering tree, as distinguished from a conifer. Trees belonging to the botanical groups of *angiospermae*.

Harvest method
A cutting method by which a stand is logged. Emphasis on meeting logging requirements while concurrently attaining silvicultural objectives.

Herbaceous
A plant that does not develop persistent woody tissue above the ground (annual, biennial, or perennial), but whose aerial portion naturally dies back to the ground at the end of a growing season. Herbaceous plants include such categories as grasses, grass-like (sedges, rushes) and forbs.

Herbivore
An animal that exclusively eats plants.

High-risk trees
Trees with a high probability of dying in the immediate future.

I

Improvement cutting
A cutting made in a stand, pole-sized or larger, primarily to improve composition or quality by removing less-desirable trees of any species. As applied to the Carman Springs project, this is an intermediate harvest to promote or enhance uneven-age structure in a stand.

Increaser
A plant species of the original or climax plant community that increases in relative amount, at least for a time, under current grazing management.

Indicator species
Species that indicate the presence of certain environmental conditions, seral stages, or previous treatment.

Intensity
In reference to the Grazing Response Index, the proportion of leaves removed during a grazing period.

Infiltration
The downward entry of water into the soil.

Interdisciplinary (ID) Team
A group of two or more individuals with different training assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad enough to solve the problem. The members of the team proceed to solution with frequent interaction so that each discipline may provide insights to any stage of the problem and disciplines may combine to provide new solutions.

Intermediate treatments
A collective term for any treatment designed to enhance growth, quality, vigor, and composition of the stand after establishment or regeneration and prior to final harvest.

Intermittent stream
A stream that flows seasonally (10-90 percent of the time) in response to a fluctuating water table, with a scoured channel that is at least three feet wide.

Interpretive sites
A developed site at which a broad range of natural or cultural history is interpreted or described for the enjoyment of the public.

Intolerant species
Those plant species that do not grow well in shade (syn. Shade-intolerant species).

Introduced species
A species not a part of the original fauna or flora of a given area.

Invader
Plant species that were absent in undisturbed portions of the original vegetation of a specific range site and will invade or increase following disturbance or continued heavy grazing.

Invasive species
Species that are aggressive and tend to out-compete species native to an area or region. Normally, invasive species are also non-native or exotic, but can be native species that are off-site.

Issue
A subject or question of widespread interest identified through public participation and which relates to the management of National Forest System lands. A matter of controversy or dispute over resource management activities or land use that is well defined and/or topically discrete. Usually the causal relationship between the activity or use and the undesirable results are well defined or able to be documented. Statement of the planning issues orients the management planning process.

K

Karst
Terrain with distinctive characteristics of relief and drainage arising primarily from a higher degree of rock solubility in natural waters than is found elsewhere. Some of these characteristics are dry streams, underground drainage, eaves, and sinks.

Key area
A relatively small potion of a management unit selected because of its location, use, or grazing value as a monitoring point for grazing use. It is assumed key areas will reflect the overall acceptability of current grazing management over the whole unit.

Key species
Forage species of sufficient abundance, palatability, and sensitivity to management to use as indicators of use of associated species.

Kind of animal
An animal species or species group such as sheep, cattle, goats, deer, horses, elk , antelope.

KV Funds
Funds collected for reforestation and timber stand improvement work, or other needed resource work, on areas harvested with a timber sale (authorized by the Knutson-Vandenberg Act, passed by Congress in 1930).

L

Land use
The occupation or reservation of land or water area for any human activity or any defined purpose.

Landscape
A viewed area of land generally of large size and commonly a mosaic of landforms and plant communities irrespective of ownership or other artificial boundaries.

Late-successional forest
A forest which has developed over a long period of time with relatively minor disturbances which have not significantly interfered with the successional process, and which is composed of relatively shade-tolerant vegetation.

Life-form
Characteristic form or appearance of a species at maturity, e.g., tree, shrub, herb.

Litter
The upper portion of the organic layer covering the soil, consisting of unaltered dead remains of plants and animals whose original form is still visible.

Loess
Material transported and deposited by wind and consisting of predominantly silt sized particles.

Long-term sustained yield timber capacity
The highest uniform wood yield from lands being managed for timber production that may be sustained under specified management intensity consistent with multiple-use objectives.

M

MBF (thousand board feet)
One thousand board feet of timber.

MMBF (million board feet)
One million board feet of timber.

Management Area (MA)
A land area that has common management direction to achieve a common goal. The entire Mark Twain National Forest is divided into management areas.

Management Direction
A statement of multiple-use and other goals and objectives, the management prescriptions, associated standards and guidelines, and action plans for attaining them.

Management intensity
The management practice or combination of management practices and their associated costs designed to obtain different levels of goods and services.

Mark Twain Ecological Land Classification Terrestrial System (MT ELCTS)
Resource inventory system describing land units by which resource managers can assess capability, suitability, and management opportunities for various Forest areas. It serves as a useful reference for land management planning and project implementation

Mature tree
A tree where growth has reached the culmination of mean annual increment (economic maturity) and/or one where growth equals loss of biomass, beyond which decline and eventually mortality will occur (biological maturity)

Mitigation measure
An action taken to lessen adverse impacts or enhance beneficial effects.

Monitoring
The orderly collection, analysis, and interpretation of resource data over time to evaluate progress toward meeting management objectives.

Multiple-use
Use of range for more than one purpose, i.e., livestock grazing, recreation, wildlife production, watershed and timber production.

N

National Ambient Air Quality Standards (NAAQS)
Legal limits of atmospheric pollution established by the Environmental Protection Agency (EPA), as the concentration limits needed to protect all of the public against adverse effects on public health and welfare, with

an adequate safety margin. Primary standards are those related to health effects; secondary standards are designed to protect the public welfare from effects such as visibility reduction, soiling, material damage and nuisances. There are six criteria pollutants; Lead (Pb), Sulfur Dioxide (SOx), Nitrogen Oxides (NOx), Ozone (O3), Particulate Matter (PM-10 and PM-2.5) and Carbon Monoxide (CO). A seventh pollutant, Volatile Organic Carbons (VOC's) is on the list but is not regulated by the EPA at this time.

National Environmental Policy Act (NEPA)
Establishes a national policy to encourage productive and enjoyable harmony between humankind and the environment, to promote efforts that will prevent or eliminate damage to the environment and stimulate the health and welfare of humans, to enrich the understanding of ecological systems and natural resources important to the nation, and to establish a Council on Environmental Quality.

National Forest System Road
A road under the jurisdiction of the Forest Service and determined to be needed for long-term motor vehicle access. (Also referred to as a system road)

National Historic Preservation Act of 1966, as amended (NHPA)
16 U.S.C. 470-470w-6. An act, passed in 1966 and most recently amended in 2000 that establishes the Federal Government's policy on historic preservation and the national historic preservation program, through which the policy is implemented. Section 106 of the act requires federal agencies to consider the effects of their actions on historic properties and to seek comments from independent reviewing agencies, the Advisory Council on Historic Preservation and the State Historic Preservation Officer.

National Register Criteria
The criteria established by the Secretary of the Interior for use in evaluating the significance and eligibility of districts, sites, buildings, structures and objects for the National Register. These criteria, also termed "significance criteria", are found listed in 36 CFR Part 60.

National Register Eligible Property
Includes both properties formally determined to meet the significance criteria in accordance with regulations of the Secretary of Interior and all other properties that meet National Register criteria.

National Register of Historic Places
Register maintained by the Secretary of the Interior containing a record of districts, sites, buildings, structures, and objects that meet established National Register significance criteria as found in 36 CFR Part 60.

Native species
A species that is a part of the original fauna or flora of a given area.

Natural regeneration
An age class created from natural seeding, sprouting, suckering, or layering.

Non-attainment Area
A geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards. A single geographic area may have acceptable levels of one criteria air pollutant but unacceptable levels of one or more other criteria air pollutants; thus, an area can be both attainment and non-attainment at the same time. It has been estimated that 60% of Americans live in non-attainment areas. The six Criteria Pollutants are; Lead (Pb), Sulfur Dioxide (SOx), Nitrogen Oxides (NOx), Ozone (O3), Particulate Matter (PM-10 and PM-2.5) and Carbon Monoxide (CO). A seventh pollutant, Volatile Organic Carbons (VOC's) is on the list but is not regulated by EPA at this time.

Non-system Road
A road on National Forest System lands that is not managed as part of the Forest transportation system, such as unplanned roads, abandoned travel ways, and off-road vehicle tracks that have not been designated and managed as a trail, and those roads that were once under permit or authorization and were not decommissioned upon the termination of the authorization.

O

Objective
A clear and specific statement of planned results to be achieved within a stated time. The results indicated are those that are designed to achieve the desired condition represented by the goal. An objective is measurable and implies precise time-phase steps to be taken and resources to be used which, together, represent the basis for defining and controlling the work to be done.

Old growth
Forest ecosystems distinguished by old trees and related structural features characteristic of later stages of stand and successional development. Some have large trees, snags, large down woody material, multiple tree canopy layers, associated herb and shrub components and canopy gaps. Some of these attributes may also be found in stands in earlier stages of development or in managed stands.

Opportunity
In reference to the Grazing Response Index, the time and actual growth plants make before, between or after grazing periods.

Organic material
An accumulation of decayed and re-synthesized plant and animal residues with a high capacity for holding water and nutrients.

Overgrazing
Continued heavy grazing that exceeds the recovery capacity of individual plants in the community and creates a deteriorated range.

Overstocking
Placing a number of animals on a given area that exceeds the forage supply during the time they are present.

Over-story
Relative to even-aged stands; the mature trees that overtop the younger trees.

Over-story removal
The cutting of trees comprising an upper canopy layer in order to release trees or other vegetation in an under-story (see complete salvage).

Overuse
Using an excessive amount of the current years growth.

P

Palatability
The relish with which a particular species or plant part is consumed by an animal.

Pasture
A grazing area enclosed and separated from other areas by fencing or other barriers.

Percent stocking
The number of trees in a stand as compared to the desirable number for best growth and management, expressed as a percent.

Percolation
The flow of a liquid through a porous substance.

Perennial
A plant species having a life span of more than two years.

Perennial stream
A stream that flows year-round (more than 90 percent of the time) with a scoured channel that is always below the water line.

Phenology
The study of periodic biological phenomena that are recurrent such as flowering or seeding, especially as related to climate.

Photopoint
A point from which photos are periodically taken to monitor long-term management responses.

Plant community
An assemblage of plants occurring together at any point in time, denoting no particular ecological status.

Plant succession
The process of vegetational development whereby an area over time is occupied by different plant communities of later ecological stage.

Plant vigor
Plant health; relates to the relative robustness of a plant in comparison to other individuals of the same species.

PM-10
Particles with an aerodynamic diameter smaller than ten micrometers. Particles this size and smaller have been shown to cause problems with human health and visibility.

PM-2.5
Particles with an aerodynamic diameter of 2.5 micrometers. Particles this size and smaller have been shown to cause problems with human health and visibility.

Pole
A tree between the size of a sapling and a mature tree. As applied to the Carman Springs project, a pole is a tree with a dbh greater than 5” and less than 9”.

Potential natural vegetation (PNV)
The plant community that would develop on an ecological site if all successional sequences were completed without interference by humans under the present environmental conditions; may include naturalized non-native species.

Puddling
Act of destroying soil structure, reducing porosity and permeability. Often results from handling soil when it is in a wet, p
condition so that when it dries it becomes hard and cloddy.

R

Range (Rangeland)
Any land supporting grazable or browsable vegetation and managed as a natural ecosystem; can include grasslands, forestlands, shrublands, and pasture. “Range” is not a land use.

Range condition
The “health” of range as compared to some standard at a point in time. The standard can be defined in ecological terms or in terms of a particular use. In the ecological determination, the degree of departure from climax determines condition.

Range improvement
Any practice designed to improve range condition or allow more efficient use.

Range management
A distinct discipline founded on ecological principles with the objective of sustainable use of rangelands and related resources for various purposes.

Range Management Unit (RMU) (Allotment)
Any management area with range management objectives such as grazing allotments.

Range readiness
The defined stage of plant growth at which grazing may begin under a specific management plan.

Range site
Subdivisions of rangeland for management purposes having similar soils, climate and climax plant communities. Two or more identical range sites that are spatially separated should respond in a similar manner to the same kind of management.

Raptors
Birds of prey such as owls, hawks, and eagles.

Reasonable and Prudent Measures
Mandatory actions that must be taken by a Federal agency to minimize the impact of incidental take as exempted by the U.S. Fish and Wildlife Service in a Biological Opinion.

Recharge area
The land area that contributes water to an underground karst feature, such as a cave or spring.

Recreation Opportunity Spectrum (ROS)
A system of classifying the range of recreational experiences, opportunities, and settings available on a given area of land. The six classifications are:

> **Primitive (P)** – an unmodified environment, where trails may be present but structures are rare, and where probability of isolation from the sights and sounds of humans is extremely high.
>
> **Semi-primitive non-motorized (SPNM)** – characterized by a predominantly natural appearing landscape where isolation from the sights and sounds of humans is expected. Experiences are more solitary in nature in an environment that offers challenge and risk. Motorized use is not permitted.
>
> **Semi-primitive motorized (SPM) -** characterized by a predominantly natural appearing landscape where isolation from the sights and sounds of humans is expected. Experiences are more solitary in nature in an environment that offers challenge and risk. Motorized use is permitted.

Roaded Natural (RN) – characterized by a mosaic of different age classes appearing as a predominantly natural environment. There are few opportunities for challenge and risk and evidence of other users is prevalent. Motorized and non-motorized recreational opportunities are appropriate.

Rural (R) – area characterized by a substantially modified natural environment. Challenge and risk opportunities are not important and other users are readily evident. Motorized and non-motorized recreational opportunities are appropriate.

Urban – areas characterized by high social interaction and significant modification of the natural environment, such as city parks.

Recreation Visitor Day (RVD)
Recreational use of National Forest System land, which aggregates 12 hours. It may consist of one person for 12 hours, two people for 6 hours, or any combination.

Reforestation
The natural or artificial restocking of an area with trees.

Regeneration
Seedlings or saplings existing in a stand; or the act of establishing young trees naturally or artificially.

Regeneration cut
A cutting method by which a new age class is created. The major methods are clearcutting, seed tree, shelterwood, selection, and coppice.

Regional Haze Rule
On April 22, 1999, Vice President Gore along with the U.S. Environmental Protection Agency announced a major effort to improve air quality in national parks and wilderness areas. The Regional Haze Rule (590k PDF) calls for state and federal agencies to work together to improve visibility in 156 national parks and wilderness areas such as the Grand Canyon, Yosemite, the Great Smokies and Shenandoah. The rule requires the states, in coordination with the Environmental Protection Agency, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first State plans for regional haze are due in the 2003-2008 timeframe. Five multi-state regional planning organizations or RPO's are working together now to develop the technical basis for these plans.

Relative stand density
A measurement of how fully a site is occupied with trees in mixed species stands, which allows for variable tree sizes and species composition.

Release
A treatment designed to free young trees from undesirable, usually overtopping, competing vegetation.

Removal cut (shelterwood cut)
The last timber cut in a shelterwood regeneration, which removes the trees that have provided seed and shade for the new stand.

Reserve trees
Trees, pole-sized or larger, retained in either a dispersed or aggregated manner after a harvest (usually regeneration cut) has been completed.

Retention
See "Visual quality objective"

Riparian areas

Geographically delineated areas with distinctive resource values and characteristics that are comprised of the aquatic and riparian ecosystems, flood plains, and wetlands. They include all areas within a horizontal distance of 100 feet from the edge of perennial streams or other water bodies.

Riparian ecosystem
A transition between the aquatic ecosystem and the adjacent terrestrial ecosystem, which is identified by soil characteristics and distinctive vegetation communities that require free or unbound water.

Road Closure
Activities that restrict or limit access of motorized vehicles. The road is needed for long-term access, but the amount and timing of vehicle traffic is controlled. A common method used to close a road is a gate.

Road Construction
Activity that results in the creation of a new road where one did not exist before. The road's right-of-way would be cleared of impeding vegetation, drainage features would be installed or created, surface material would be added, and any needed signs would be installed.

Road Decommissioning
Activities that eliminate motorized vehicular travel and which help to return the roadway back to a natural state. 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.

Road Maintenance
The ongoing upkeep of a road necessary to retain or restore the road to the approved road management objective. Activities associated with road maintenance may include surface blading, replacement of surface material, mowing and limbing of roadside vegetation, cleaning and restoring drainage features, and replacing signs.

Road Maintenance Level
All National Forest System roads are assigned a maintenance level. Maintenance level defines the service provided and the maintenance required for the specific road. Factors used to determine a road's maintenance level include, but are not limited to, resource management needs, service life, user safety, volume and type of traffic, surface type, and user comfort and convenience. The following is a very brief description of the road maintenance levels:

1. Maintenance level 1 – Basic custodial care
2. Maintenance level 2 – High clearance vehicles
3. Maintenance level 3 – Suitable for passenger cars
4. Maintenance level 4 – Moderate degree of user comfort
5. Maintenance level 5 – High degree of user comfort

Road Reconstruction
Activity that results in the improvement or realignment of an existing road. Road improvement may increase a road's capacity for traffic or change its original design function. An example of road improvement would be changing the road's surface from aggregate to asphalt. Road realignment results in a new location of a road or a portion of the road and the treatment of the old roadway.

Rotation (roads)
Defined as an investment in construction activity to rebuild a road to its traffic service level, or to that which it was originally constructed.

Rotation (timber)
The number of years required to establish and grow a timber crop to a specified condition of maturity. The rotation includes a period for harvesting and stand re-establishment (usually five years).

Runoff
That part of precipitation, as well as any other flow contributions, that appear in surface streams, either perennially or intermittently.

Rutting
Soil disturbance where the soil is puddled and and the topsoil and/or a portion of the subsoil removed.

S

Sapling
As used in timber survey, trees 1.0 to 4.9 inches at DBH.

Saw timber
As used in timber survey, trees larger than 9 inches at DBH.

Scoping
The process by which significant issues relating to a proposal are identified for environmental analysis. Scoping is an integral part of environmental analysis. Scoping includes eliciting public comments on the proposal, evaluating concerns and developing alternatives for consideration. Depending on the complexity and nature of the action, scoping varies from a brief consideration of a few pertinent factors in a proposed action that may be categorically excluded to full compliance with the Council of Environmental Quality direction for a proposed action that must be documented in an environmental impact statement.

Section 106 Consultation
Consultation carried out by the Federal agency with the State Historic Preservation Officer and/or with the Advisory Council on Historic Preservation pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, and its accompanying regulations found in 36 CFR part 800. The consultation concerns the identification of historic properties, assessment of effects upon them, and consideration of alternatives to avoid or reduce those effects.

Sediment
Organic matter or soil that settles to the bottom of a liquid.

Seedlings
As used in timber survey, trees less than one inch at DBH.

Selection harvest cut
See “uneven-aged management.”

Selective grazing
The grazing of plant species, individual plants, or plant parts in preference to others.

Sensitive species
Those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: significant current or predicted downward trends in population numbers or density; or significant current or predicted downward trends in habitat capability that would reduce a species’ existing distribution.

Sensitivity level
As used in visual quality management, a particular degree or measure of viewer interest in the scenic qualities of the landscape (1 - Most sensitive; 2 - Sensitive; 3 - Least sensitive).

Shade-tolerant species
A tree or other plant species having the capacity to grow without receiving direct sunlight.

Sensitive species
Those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: significant current or predicted downward trends in population numbers or density; or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

Sensitivity level
As used in visual quality management, a particular degree or measure of viewer interest in the scenic qualities of the landscape (1 - Most sensitive; 2 - Sensitive; 3 - Least sensitive).

Shade-tolerant species
A tree or other plant species having the capacity to grow without receiving direct sunlight.

Shelterwood system
A method of regenerating an even-aged stand in which a new age class develops beneath the moderated microenvironment provided by the residual trees. The sequence of treatments can include three distinct types of cutting: 1) and optional preparatory cut to enhance conditions for seed production; 2) an establishment cut to prepare the seedbed and to create a new age class; and 3) a removal cut to release established regeneration from competition with the over-story. Cutting may be done uniformly throughout the stand, in groups or patches, or in strips.

Shrub
A plant with persistent woody stems and relatively low growth form; usually produces several basal shoots as opposed to a single bole; differs from a tree by its low stature and non-arborescent form.

Silviculture
The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Silvicultural system
A planned process whereby a stand is tended, harvested and re-established. The system name is based on the number of age classes and/or the regeneration method used.

Sinkhole
A natural depression in a land surface communicating with a subterranean passage, generally occurring in limestone regions and formed by solution or by collapse of a cavern roof.

Site preparation
A hand or mechanized manipulation of a site designed to enhance the success of regeneration. Treatments may include cutting, burning, chopping, disking, raking and scarifying. All treatments are designed to modify the soil, litter, and vegetation to create microclimate conditions conducive to the establishment and growth of desired species.

Size class
Tree size recognized by distinct ranges, usually of height or diameter.

Slash
Woody debris left after logging, pruning, thinning, or brush cutting. It includes logs, chunks, bark, branches, stumps, and broken small trees or brush.

Snag
A standing dead tree from which most of the leaves have fallen. Snags may be newly dead and appear to be a leafless tree, or not much more than a tall stump from which all the branches and bark have fallen.

Sod grasses
Grasses with stolons or rhizomes that form a turf.

Softwood
A coniferous tree. Trees belonging to the botanical group *gymnospermae.*

Soil displacement
The movement of soil particles from one place to another by erosion or management activities and/or those influences whic
in the soil structure.

Soil horizons
A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil forming processes and
differing in characteristics and properties from the adjacent layers above and below it.

> **O horizon** – Organic layer of fresh and decaying plant residue
>
> **A horizon** – The mineral horizon at or near the surface in which an accumulation of humified organic matter is mi
> mineral material. This horizon has the most organic matter accumulation, the most biological activity, and/or loss
> materials containing iron, aluminum, and clay.
>
> **B horizon** – Horizon, usually below the O, A, or E horizon, and is, in part, a transition layer from the overlying ho
> the underlying C horizon. It is characteroized by (1) accumulation of clay material, humus, and other material, (2)
> primatic, or blocky structure, and/ or (3) redder or browner colors than those in the overlying horizon.
>
> **C horizon** – Mineral horizon, excluding bedrock, that is little affected by soil forming processes and does not have
> properties found in the overlying horizon.
>
> **E horizon** – Mineral horizon in which the main feature is loss of clay particles, iron, aluminum, or combination of
>
> **R horizon** – Bedrock underlying the C horizon.

Species
A fundamental category of plant or animal classification.

Species composition
The proportions of various plant species in relation to the total on a given area.

Stand
A contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

Stand density
A quantitative, absolute measure of tree occupancy per unit of land area in much the same terms as number of trees, basal area, or volume.

Standard
A principle requiring a specific level of attainment; a rule to measure against.

State Historic Preservation Officer (SHPO)
A SHPO is designated in each state by the governor to coordinate preservation activities in that State. SHPOs are central to the national historic preservation program. Under Section 106 of the National Historic Preservation Act of 1966, as amended, and its accompanying regulations found in 36 CFR Part 800, SHPOs consult with and provide assistance to Agency officials when identifying historic properties, assessing effects upon them, and considering alternatives to avoid or reduce those effects.

State Implementation Plans (SIP)
A document prepared by each state describing existing air quality conditions and measures, which will be taken to attain and maintain National Ambient Air Quality Standards (NAAQS). EPA approved state plans for the

establishment, regulation and enforcement of air pollution standards. These are plans a state must develop pursuant to sec. 110 (d) of Title I of the CAA, to provide for attainment and maintenance of NAAQS.

Stocking density
The relationship between number of animals and area of land at any given time.

Stocking rate
The number of specific kinds and classes of animals grazing a unit of land for a specified time period.

Stream
A channel with defined bed and a bank that carries enough water flow at some time during the year to flush out leaves.

Structure
The horizontal and vertical distribution of components of a forest stand including the height, diameter, crown layers and stems of trees, shrubs, herbaceous under-story, snags, and down woody debris.

Subsoil
Technically, the B horizon.

Subsurface layer
Any surface soil horizon below the surface layer

Subsurface water
Waters contained in caves, voids, or interstices of rocks below the surface.

Succession
A series of dynamic changes by which organisms succeed one another through a series of plant community (seral) stages leading to potential natural community or climax.

Suitability
The adaptability of an area to grazing by livestock or wildlife.

Suitable timberlands
Forest lands to be managed for timber production.

Surface soil
The A, E, or combinations of those horizons.

T

Temporary Road
A road authorized by contract, permit, lease, other written authorization or emergency operation not intended to be a part of the Forest transportation system and not necessary for long-term resource management.

Terms and Conditions
Mandatory actions that must be taken by a Federal agency to implement the Reasonable and Prudent Measures of an Incidental Take Statement issued by the U.S. Fish and Wildlife Service.

Thinning
A cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or to recover potential mortality.

Threatened Plant Species

Any plant species likely to become endangered within the foreseeable future through all or a significant portion of its range, including species categorized as rare, very rare or depleted.

Threatened Species
Any species which is likely to become endangered within the foreseeable future and which has been designated in the Federal Register as threatened species.

Tiering
Tiering refers to the coverage of general matters in a broader environmental impact statement (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basin-wide program statements or ultimately site-specific statements) incorporating by reference the general discussions and concentrating solely on the issues specific to the subsequent statements or analyses is:

a. From a program, plan or policy environmental impact statement to a program, plan, or policy statement or analysis of lesser scope or to a site-specific statement or analysis.
b. From an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage (such as environmental mitigation). Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided on or not yet ripe (40 CFR 1508.28).

Timber production
The purposeful growing, tending, harvesting and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. For purposes of this document, the term *timber production* does not include production of fuelwood.

Timber stand improvement (TSI)
Usually related to activities conducted in young stands of timber to improve growth rate and form of the remaining trees. Examples include thinning, pruning, fertilization and control of undesirable vegetation.

U

Unclassified Roads
Roads on National Forest System lands that are not managed as part of the forest transportation system, such as unplanned roads, abandoned travelways, and off-road vehicle tracks that have not been designated and managed as a trail; and those roads that were once under permit or other authorization and were not decommissioned upon the termination of the authorization. The MTNF Land and Resource Management Plan uses the term “non-system roads” to define unclassified roads.

Under-story (vegetation)
Shade-tolerant plants growing below the canopy of other plants. Usually refers to grasses, forbs and low shrubs under a tree or brush canopy.

Undertaking
Any project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency or licensed or assisted by a Federal agency.

Uneven-aged methods
Methods of regenerating a forest stand and maintaining an uneven-aged structure by removing some trees in all size classes either singly, in small groups, or in strips.

Upland
The higher ground of a region, in contrast with a valley, plain, or other low-lying land.

Use
The proportion of current years forage production that is consumed or destroyed by grazing animals.

V

Variety class
A particular level of visual variety or diversity of landscape character. The three categories are:

> **Distinctive (Class A) –** Refers to unusual and/or outstanding landscape varieties that stand out from the common features in the character type.
>
> **Common (Class B) –** Refers to prevalent, usual or widespread landscape variety within a character type. It also refers to ordinary or undistinguished visual variety.
>
> **Minimal (Class C) –** Refers to little or no visual variety in the landscape. Monotonous or below average compared to the common features in the character type.

Vegetative manipulation
The change from one vegetation type to another. It can be done using a tractor, chemicals or fire. Usually done to increase forage for livestock; it can be a beneficial tool for wildlife management.

Vertical diversity
The diversity in an area that results from the complexity of the above-ground structure of the vegetation; the more tiers of vegetation and/or the more diverse the species composition, the higher the degree of vertical diversity.

Visual absorption capacity (VAC)
Indicates the relative difficulty or cost of achieving VQO's; measures the land's capacity to absorb the visual impact of management activities.

Visual distance zones
Areas of landscapes denoted by specific distances from the observer; used as a frame of reference in which to discuss landscape characteristics or human activities.

> **Foreground –** That part of a scene, landscape, etc. which is nearest to the viewer and in which detail is evident, usually up to one-quarter mile from the viewer.
>
> **Middle ground –** That part of a scene or landscape that extends from the foreground zone to ½ to 2 miles from the observer. Texture is discernible at that distance.
>
> **Background –** The distance part of a landscape; surroundings, especially those behind something, providing harmony and contrast; area located from two miles to infinity from the viewer.

Visual resource
The composite of basic terrain, geologic features, water features, vegetative patterns and land-use effect that typify a land unit and influence the visual appeal the unit may have for visitors.

Visual quality objective (VQO)
A desired level of excellence based on physical and sociological characteristics of an area. Refers to the quality of a landscape, the degree of acceptable alteration on the characteristic landscape.

> **Maximum Modification (MM) –**Human activity may dominate the characteristic landscape but should appear as a natural occurrence when viewed as background area.

Partial Retention (PR) –Human activity may be evident but must remain subordinate to the characteristic landscape.

Modification (M) – Human activity may dominate the characteristic landscape but must, at the same time, utilize naturally established form, line, color and texture. It should appear as a natural occurrence when viewed in foreground or middle ground.

Retention (R) – Human activities are not evident to the casual forest visitor

Preservation (P) – Provides for ecological change only

W

Warm-season plant
A plant that makes most or all its growth during late spring, summer or early fall and is usually dormant in winter.

Water table
The upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

Watershed
An area of land with a single drainage network.

Weed
(1) A plant growing where unwanted. (2) A plant having a negative value within a given management system.

Wetlands
Those areas that are inundated by surface or ground water often enough to support plants and other aquatic life that requires saturated or seasonally saturated soils for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas such as sloughs, potholes, wet meadows, fens, river overflows, mud flats, and natural ponds.

Wildlife habitat
The sum total of environmental conditions of a specific place occupied by a wildlife species or a population of such species.

Wildlife structure
A site-specific improvement of a wildlife or fish habitat, for example, constructed waterholes, placement of logs, old Christmas trees, etc. in a lake or pond to provide cover for fish, nest boxes for ducks, raptors, birds, bats, etc.

Woodland
A forest community characterized by over-story trees widely spaced enough to allow light to the under-story, with a ground cover of forbs and grasses.

Soil Type	Characteristics
Alred extremely cobbly loam:	
Landscape Location	Alred soils are on moderately sloping to strongly sloping narrow ridgetops and moderately steep to very steep sideslopes. They formed in cherty hillslope sediments and the underlying clayey residuum. Slopes range from 1 to 60 percent.
Stand Location	Compartment 19: nearly every stand; Compartment 20: all stands; Compartment 21: all stands; Compartment 22: nearly every stand; Compartment 23: Stand Nos. 3, 4, 6 – 17, 19 – 37; Compartment 33: Stand Nos. 1 – 7; 9 – 23; Compartment 34: nearly all stands; Compartment 35: Stand Nos. 1 – 37; Compartment 36: Stand Nos. 1 – 10, 13 – 18; Compartment 37: Stand Nos. 2 – 27, 31 – 35, 39, 40, 44, 45; Compartment 38: nearly every stand; Compartment 39: all stands; Compartment 40: nearly every stand; Compartment 41: Stand Nos. 1 – 4, 6, 7; Compartment 49: 10, 14 – 16; Compartment 50: Stand Nos. 1 – 4, 7; Compartment 52: Stand Nos. 14 – 19, 28
Permeability	Moderate (surface and upper subsurface); slow (lower subsurface)
Water-Holding Capacity	5 ½ - 9 inches
Depth	80 inches
A Horizon Depth	3 – 6 inches
Rock content in surface horizon	15 – 80
Erosion Hazard & Equipment Limitation	Moderate erosion hazard off skid trails and roads; severe hazard on skid trails and roads. Moderately suited to harvesting equipment
Potential for damage to soil by fire	Low
Potential for pond development	Possible limitations due to slope and seepage
Management Considerations	Erosion, high rock content, and shallow A horizon limit productivity

Soil Type	Characteristics
Bendavis gravelly silt loam	
Landscape Location	Backslope of hills formed in gravelly slope alluvium
Stand Location	Compartment 99: Stand Nos. 1, 4 – 17; Compartment 118: Stand Nos. 1 – 7, 18 – 23, 25 – 41, 45, 46
Permeability	Moderate
Water-Holding Capacity	3 – 6 inches

Soil Type	Characteristics
Bendavis gravelly silt loam	
Depth	20 – 40 inches
A Horizon Depth	3 inches
Rock content in surface horizon	10 – 70
Erosion Hazard & Equipment Limitation	Slight hazard off skid trails and roads up to 15 percent, moderate over 15 percent. Moderate hazard on skid roads and trails up to 15 percent, severe over 15 percent. Well suited to harvesting equipment up to 15 percent, moderately suited over 15 percent.
Potential for damage to soil by fire	Low
Potential for pond development	Severe limitation
Management Considerations	Water table present at 2 – 3 ½ feet from November thru April

Soil Type	
Bender very cobbly fine sandy loam	
Landscape Location	The Bender series (very cobbly fine sandy loam) consists of moderately deep, somewhat excessively drained soils on uplands formed in residuum from sandstone. These soils are on gently sloping to very steep uplands. Permeability is moderately rapid. Slopes range from 3 to 60 percent.
Stand Location	Compartment 19: Stand No. 1; Compartment 99: Stand Nos. 1, 3 – 7, 9, 10, 12 – 17; Compartment 118: Stand Nos. 1 – 8, 11, 13 – 23, 25 – 36, 38, 39, 45, 46
Permeability	Moderately fast in surface and upper subsurface. Very slow in lower subsurface.
Water-Holding Capacity	Very low (0 – 3 inches)
Total depth	20 – 40 inches
A Horizon Depth	2 – 6 inches
Rock content in the surface horizons	20 – 80 percent

Soil Type	
Bender very cobbly fine sandy loam	
Potential for damage from fire	Low at slopes up to 15 percent. High at slopes over 15 percent due to slope, depth, coarse fragments, and texture
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid trails and roads at slopes up to 15 percent and moderate at slopes over 15 percent. Moderate erosion hazard on skid trails and roads at slopes up to 15 percent and severe at slopes over 15 percent. Well suited to harvesting equipment at 0 – 15 percent and moderately well suited at slopes over 15 percent.
Potential for pond development	Very limited due to depth to bedrock, seepage, and slope
Management Considerations	Low available water holding capacity.

Soil Type	Characteristics
Bloomsdale silt loam	
Landscape Location	Bloomsdale soils are on narrow flood plains. Slopes are 0 to 4 percent. They formed in loamy and clayey alluvium with an increasing coarse fragment content with increasing depth.
Stand Location	Compartment 20: Stand Nos. 6 – 9; Compartment 21: Stand Nos. 3 – 5, 7 – 13, 17, 26 – 29; Compartment 22: Stand Nos. 1 – 7, 17 – 19, 30, 38 – 41; Compartment 35: Stand Nos. 2, 10; Compartment 36: 8 – 10, 14; Compartment 37: Stand Nos. 1 – 3, 11, 16, 17, 21, 22, 25
Permeability	Moderate (surface and lower subsurface); moderately fast (upper subsurface)
Water-Holding Capacity	4 – 11 inches (total)
Total depth	80 + inches
A Horizon Depth	5 – 12 inches thick
Percent rock in the surface horizon	0 – 35 percent
Erosion Hazard & Equipment Limitation	Slight hazard of erosion on and off roads and skid trails. Moderately suited for harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	Moderate limitation due to seepage
Management Considerations	Flooded for short periods most years.

Soil Type	Characteristics
Cedargap gravelly silt loam	
Landscape Location	Cedargap soils are on flood plains of small streams near active channels. The parent material consists of cherty alluvium. Slopes range from 0 to 3 percent.
Stand Location	Compartment 19: Stand Nos. 5, 10 – 12, 19; Compartment 22: Stand Nos. 28, 29; Compartment 23: Stand Nos. 11 – 13, 21, 25, 26, 28, 29, 32, 34, 36; Compartment 33: Stand Nos. 1, 10, 13, 14, 16, 17, 19, 20; Compartment 34: Stand Nos. 1 – 7, 9 – 12, 15 – 17, 19 – 21, 32 – 38, 43; Compartment 35: Stand Nos. 24 – 28, 30, 37; Compartment 36: Stand Nos. 1, 3, 4, 6; Compartment 37: Stand Nos. 1 – 4, 8, 9, 17 – 22, 32 – 35, 39, 40, 44, 45; Compartment 38: Stand Nos. 9 – 17, 23 – 25, 28, 31, 33, 34, 36 – 40; Compartment 39: Stand Nos. 1, 12, 13, 15, 16, 18, 19, 21, 22, 27; Compartment 40: Stand Nos. 7, 11, 13, 22, 24, 26, 28, 29, 31, 32
Permeability	Moderate (surface and upper subsurface); moderately slow (lower subsurface)
Water-Holding Capacity	6 – 10 inches
Total depth	60 + inches
A Horizon Depth	6 – 24 inches
Percent rock in the surface horizon	3 – 60 percent
Erosion Hazard & Equipment Limitation	Slight erosion hazard on or off skid roads and trails. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Low
Potential for pond development	Moderate limitation due to seepage
Management Considerations	Very brief, frequent to occasional flooding. Water table at 3 ½ - 5 ½ feet during the winter months.

Soil Type	Characteristics
Clarksville	
Landscape Location	Clarksville soils are on steep side slopes and narrow ridgetops. Slopes range from 1 to 70 percent. The soils formed in hillslope sediments and the underlying clayey residuum from cherty dolomite or cherty limestone.
Stand Location	Compartment 20: Stand Nos. 4 – 7; Compartment 35: Stand Nos. 1; Compartment 36: Stand Nos. 2, 15; Compartment 37: Stand Nos. 27 – 32, 34 – 40, 43; Compartment 39: Stand Nos. 25; Compartment 41: Stand Nos. 4 – 9; Compartment 49: Stand Nos. 1 – 14, 18 – 53: Compartment 50: Stand Nos. 1 – 4, 6 – 16, 18 – 30; Compartment 51: Stand Nos. 1 – 10,, 12 – 54; Compartment 52: Stand Nos. 2 – 15, 19; Compartment 53: Stand Nos. 5 – 16; Compartment 57 (all stands); Compartment 58: Stand Nos. 1 – 6; 8 – 46; Compartment 59 (all stands), Compartment 78: Stand Nos. 1 – 8, 10 – 25; Compartments 79, 80, 82, 83, 85 (all stands); Compartment 86: Stand Nos. 1 – 27, 29 – 31; Compartment

Soil Type	Characteristics
	87: Stand Nos. 1 – 12, 14 – 36; Compartment 88: Stand Nos. 1 – 29, 31 – 33; Compartment 89, 90 (all stands); Compartment 91: Stand Nos. 1 – 32; Compartment 92: Stand Nos. 1 – 11; Compartment 99: Stand Nos. 1, 3, 6, 12, 14 – 44; Compartment 100: Stand Nos. 1 – 6, 8 – 51; Compartment 118: Stand Nos. 6 – 15, 18 – 20, 37 – 44
Permeability	Moderately fast (surface and upper subsurface); moderate (lower subsurface)
Water-Holding Capacity	4 – 8 inches
Total Depth	80 + inches
A Horizon Depth	1 – 5 inches
Rock Content in the surface horizons	15 – 80 percent
Erosion Hazard & Equipment Limitation	Slight hazard up to 15 percent off skid roads and trails; moderate hazard over 15 percent. Moderate hazard on skid roads and trails up to 15 percent; severe hazard over 15 percent. Well-suited to harvesting equipment up to 15 percent; moderately suited over 15 percent
Potential of damage to soil by fire	Low to moderate
Potential for pond development	Severe limitation due to seepage and slope
Management Considerations	Shallow A horizon, skeletal rock content, severe erosion at steep slopes

Soil Type	Characteristics
Coulstone very gravelly silt loam	
Landscape Location	The Coulstone series consists of very deep, somewhat excessively drained soils of the uplands. Permeability is moderately rapid. These soils formed in colluvium and residuum from acid sandstone with lenses of cherty limestone or cherty dolomite. Slope gradients range from 5 to 60 percent.
Stand Location	Compartment 37: Stand Nos. 27, 29 – 32, 34 – 38, 43; Compartment 49: Stand Nos. 6 – 10, 29 – 32, 36 – 41, 43, 45 – 52; Compartment 50: Stand Nos. 22, 25 – 27; Compartment 51: Stand Nos. 1 – 9, 12 – 16, 18 – 30, 34 – 36, 39 – 42, 44 – 46, 48 – 52, 54; Compartment 52: Stand Nos. 13; Compartment 53: Stand Nos. 5 – 9; Compartment 57: Stand Nos. 1 – 23, 25 – 46, 51, 57, 58, 60; Compartment 58: Stand Nos. 1 – 6, 8, 10 – 12, 14, 16 – 19, 21 – 46; Compartment 59: Stand Nos. 1

	– 6, 9 – 13, 16, 28, 31; Compartment 78: Stand Nos. 2 – 4, 6, 8, 10 – 25; Compartment 79: Stand Nos. 1 – 13, 15, 17; Compartment 82: Stand Nos. 1 – 19, 25, 26, 28, 29, 31 – 33, 42, 43; Compartment 83: Stand Nos. 1 – 7, 12 – 16, 18, 20 – 25, 27, 28, 31, 33, 34, 37 – 39; Compartment 85: Stand Nos. 3 – 5; Compartment 87: Stand Nos. 2; Compartment 88: Stand Nos. 1 – 29, 31 – 33; Compartment 89: Stand Nos.2, 4 – 6; Compartment 99: Stand Nos. 1, 3 – 7, 9, 10, 12 – 25; Compartment 100: Stand Nos. 19 – 22, 25 – 32; Compartment 118: Stand Nos. 1 – 9, 11, 13 – 23, 25 – 36, 38, 39, 45, 46
Permeability	Moderately fast
Water-Holding Capacity	The available water holding capacity is low (three to six inches.
Total depth	60+ inches
A Horizon Depth	The A (surface) horizon, where most of the nutrients are located, is shallow (one to four inches).
Percent rock in the surface horizons	35 – 75 percent
Potential of damage from fire	Moderate due to slope, surface depth, coarse fragments, texture.
Erosion Hazard & Equipment Suitability	Moderate hazard off skid roads and roads and severe hazard on skid roads and roads (limitations due to slope and erodability). Moderately suited to harvesting equipment (limitations due to slope and rock fragment).
Potential for pond development	Limitation due to excess seepage.
Management Considerations	Low available water holding capacity, high rock content and shallow A horizon.

Doniphan very gravelly silt loam	(previously mapped with Baxter soils in Missouri)
Landscape Location	Doniphan soils are on side slopes and narrow ridgetops. Slopes typically range from 10 to 35 percent, but have an extreme range of 2 to 60 percent. The soils are formed in residuum from clayey shales and cherty dolomite or cherty limestone.
Stand Location	Compartment 39: Stand Nos. 25; Compartment 41: Stand Nos. 4 – 9; Compartment 49: Stand Nos. 2 – 10, 12 – 14, 18 – 40, 43 – 53; Compartment 50: Stand Nos. 1, 29; Compartment 51: Stand Nos. 1 – 10, 12 – 14, 17, 29, 30, 32 – 35, 38, 48, 53; Compartment 58: Stand Nos. 16 – 18, 20, 21, 26, 28 – 41, 43 – 45; Compartment 59: Stand Nos. 3 – 27, 31, 32
Permeability	Moderately fast (surface); moderate (subsurface)
Water-Holding Capacity	5 - 7 inches
Total depth	60+ inches
A Horizon	1 - 6 inches thick

Depth	
Percent rock in the surface horizon	25 - 75 percent
Erosion Hazard & Equipment Limitation	Moderate to severe erosion hazard off skid trails and roads (severe over 35 percent); severe hazard on skid trails and roads . Moderately to poorly suited to harvesting equipment depending on slope.
Potential of damage to soil from fire	Moderate
Potential for pond development	Severe limitations due to slope and seepage.
Management Considerations	

Soil Type	Characteristics
Elkins silt loam	Was made inactive in 1979 and may have been mistyped in Missouri.
Landscape Location	Elkins soils are on flood plains. These soils formed in acid alluvium washed from upland soils that formed in shale, sandstone, and siltstone. Slope ranges from 0 to 3 percent.
Stand Location	Compartment 57: Stand No. 59
Permeability	Moderate (surface); slow to moderate (subsurface)
Water-Holding Capacity	8 – 12 inches
Total depth	25 – 50 depth to solum, 60+ depth to bedrock
A Horizon Depth	6 – 10 inches
Percent rock in the surface horizon	0 – 5
Erosion Hazard & Equipment Limitation	Slight erosion hazard. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Low to moderate
Potential for pond development	Moderate seepage hazard.
Management Considerations	High water table possible November thru June. Occasional to frequent brief flooding possible November thru May/June.

Soil Type	Characteristics
Fourche silt loam	
Landscape Location	Fourche soils are on upland side slopes with even or slightly concave surfaces and point ridgetops. Slope gradients commonly are 5 to 9 percent but range from 2 to

Soil Type	Characteristics
Fourche silt loam	
	15 percent. The soils formed in loess and the underlying residuum from dolomite or limestone. The bedrock in some places is glauconitic or interbedded with shale.
Stand Location	Compartment 23: Stand Nos. 23; Compartment 33: Stand Nos. 4 – 6, 9, 10, 25; Compartment 34: Stand Nos.1 – 4, 19 - 21
Permeability	Moderately (surface); moderately slow (subsurface)
Water-Holding Capacity	14 – 17 inches
Total depth	60 – 100 inches
A Horizon Depth	5 – 10 inches thick
Percent rock in the surface horizon	0 – 5
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid trails and roads. Moderate hazard on skid trails and roads. Moderately well suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	Moderate up to 9 percent slope. Severe over 9 percent slope.
Management Considerations	There is a perched water table 1.5 to 3 feet below the surface at sometime from November to May in most years.

Soil Type	Characteristics
Gepp very gravelly silt loam	
Landscape Location	Gepp soils are on nearly level to steep uplands. Slopes range from 1 to 40 percent. The soil formed in clayey residuum, and in places, colluviums over cherty dolomite and limestone bedrock.
Stand Location	Compartment 118: Stand Nos. 10 - 13
Permeability	Moderate
Water-Holding Capacity	5 – 9 inches
Total depth	60 – 90 +
A Horizon Depth	4 – 8 inches thick
Percent rock in the surface horizon	10 – 75 percent
Erosion Hazard & Equipment Limitation	Slight erosion hazard on skid roads and trails. Moderate erosion hazard on skid roads and trails. Well suited to harvesting equipment.
Potential of damage to soil	Low

from fire	
Potential for pond development	Severe limitation at steeper slopes
Management Considerations	

Soil Type	Characteristics
Gladden loam	
Landscape Location	Gladden soils are on flood plains along tributary streams in narrow upland valleys. The slope gradients range from 0 to 3 percent. The soils formed in loamy alluvium.
Stand Location	Compartment 53: Stand Nos. 9; Compartment 79: Stand Nos. 3, 4, 8; Compartment 85: Stand Nos. 64, 65
Permeability	Moderate (surface, upper subsoil); moderately fast (lower subsoil)
Water-Holding Capacity	5 – 7 inches
Total depth	30 – 60 inches
A Horizon Depth	3 – 10 inches
Percent rock in the surface horizon	0 – 35 percent
Erosion Hazard & Equipment Limitation	Slight erosion hazard. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Low
Potential for pond development	Hazard of excess seepage
Management Considerations	

Soil Type	Characteristics
Goss gravelly silt loam	
Landscape Location	Goss soils are on uplands and formed in colluvium and the underyling residuum weathered from cherty limestone or cherty dolomite and some interbedded shale. Slope ranges from 1 to 70 percent.
Stand Location	Compartment 19 (nearly all stands), Compartment 20 (nearly all stands), Compartment 21 (nearly all stands), Compartment 22 (nearly all stands), Compartment 23: Stand Nos. 1, 56; Compartment 33: Stand Nos. 7, 11, 12, 14 – 16, 18, 20 – 23; Compartment 34: Stand Nos.6, 18 – 22, 25, 26, 28 – 31, 35 – 38, 40 – 42; Compartment 35: nearly all stands; Compartment 36: all stands, Compartment 37: Stand Nos. 2 – 23, 25 – 27, 31 – 33, 39, 40, 42, 43, 45; Compartment 38: Stand Nos. 1 – 10, 12, 13, 17 – 37, 41 – 43; Compartment 39: all stands; Compartment 40: Stand Nos. 1 – 5, 9 -15, 22 – 29, 33; Compartment 41: Stand Nos. 1- 4, 6, 7; Compartment 49: Stand Nos. 16, 17; Compartment 50: Stand Nos. 1 – 4, 6, 7, 21; Compartment 52: Stand Nos. 14 – 19, 28
Permeability	Moderately fast (surface, upper subsurface); moderate (lower subsurface)

Soil Type	Characteristics
Goss gravelly silt loam	
Water-Holding Capacity	3 ½ - 8 inches
Total depth	80 + inches
A Horizon Depth	2 – 8 inches thick
Percent rock in the surface horizon	5 – 75 percent
Erosion Hazard & Equipment Limitation	Slight to severe hazard of erosion depending on slope. Not well suited to harvesting equipment.
Potential of damage to soil from fire	High
Potential for pond development	Severe limitations due to slope
Management Considerations	None

Soil Type	Characteristics
Gravois silt loam	
Landscape Location	The Gravois soils are on convex ridgetops and sideslopes. Slopes range from 3 to 35 percent. These soils formed in a thin mantle of loess and pedisediment, and the underlying loamy and clayey residuum from dolomite. The contact of the contrasting material is marked by a gravelly erosional surface.
Stand Location	Compartment 19: nearly all stands; Compartment 20: nearly all stands; Compartment 21: Stand Nos. 1 – 9, 11, 13 – 15, 17 – 24, 26, 27, 29; Compartment 22: nearly all stands; Compartment 23: Stand Nos. 1, 5, 6; Compartment 33: Stand Nos. 1 – 8, 11, 12, 14 – 16, 18, 20 – 24; Compartment 34: Stand Nos. 6, 18, 22, 25, 26, 28 – 31, 35 – 38, 40 – 42; Compartment 35: nearly all stands; Compartment 36: all stands; Compartment 37: Stand Nos. 2, 4 – 23, 25 – 27, 31 – 33, 39, 40, 42, 43, 45; Compartment 38: Stand Nos. 1 – 10, 12, 13, 17 – 43; Compartment 39: nearly all stands; Compartment 40: Stand Nos. 1 – 5, 7, 9 – 28, 33; Compartment 41: 1 – 4, 6, 7; Compartment 49: Stand Nos. 16, 17; Compartment 50: Stand Nos.1 – 4, 6, 7, 21; Compartment 52: Stand Nos. 14 – 19, 28
Permeability	Moderate (surface); moderately slow (upper subsurface), slow (middle subsurface), moderately slow (lower subsurface)
Water-Holding Capacity	7 – 11 inches
Total depth	60 + inches
A Horizon Depth	3 – 7 inches thick
Percent rock in the surface horizon	0 – 10 percent
Erosion Hazard &	Slight erosion hazard off skid roads and trails; moderate erosion hazard on skid roads and trails. Moderately suited to harvesting equipment.

Soil Type	Characteristics
Gravois silt loam	
Equipment Limitation	
Potential of damage to soil from fire	Moderate
Potential for pond development	
Management Considerations	A perched water table is present at 1.5 to 3.0 feet from winter to early spring in most years.

Soil Type	Characteristics
Hildebrecht silt loam	
Landscape Location	Hildebrecht soils are on convex upland ridgetops, point ridges, heads of drains and side slopes. Slopes range from 1 to 15 percent. The soils formed in loess over residuum from dolomite.
Stand Location	Compartment 23: Stand Nos. 7, 15 – 19, 27 – 31, 35, 37
Permeability	Moderate (surface); moderately slow (subsurface above fragipan); slow (fragipan); moderately slow (below fragipan)
Water-Holding Capacity	7 – 10 inches, 4 – 6 inches above fragipan
Total depth	60 – 100 inches (solum); 10 feet or more (bedrock) 24 – 36 inches (depth to fragipan)
A Horizon Depth	2 – 7 inches
Percent rock in the surface horizon	0 - 5
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid trails and roads, moderate on skid trails and roads; Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Low
Potential for pond development	Moderate limitation up to 9 percent. Severe limitation over 9 percent
Management Considerations	Fragipan and perched water table during November thru May

Soil Type	Characteristics
Hobson	
Landscape Location	The Hobson soils typically are on gently sloping ridgetop and upper side slope positions. Some areas are on structural benchs. Slopes are dominantly 3 to 6 percent with extreme ranges of 2 to 14 percent. They formed in residuum from mixed sandstone and cherty limestone or cherty dolomite. There is sometimes a thin silty mantle, probably loess, ranging in maximum thickness to about 10

Soil Type	Characteristics
Hobson	
	inches.
Stand Location	Compartment 37: Stand Nos. 29, 36, 37, 41; Compartment 49: Stand Nos. 39 – 41, 43, 48, 49; Compartment 50: Stand Nos. 9 – 12, 14, 15; Compartment 51: Stand Nos. 47; Compartment 52: Stand Nos. 1 – 8; Compartment 58: Stand Nos. 4, 5, 9, 10, 16, 18, 20; Compartment 59: Stand Nos. 3, 4, 8, 9, 31; Compartment 78: Stand Nos. 5, 8, 13; Compartment 85: Stand Nos. 6, 7, 10, 11; Compartment 88: Stand Nos. 8 – 10; Compartment 89: Stand Nos. 5, 6
Permeability	Moderate (surface); moderately slow (subsurface above fragipan and below fragipan); slow in fragipan; very slow below 60 inches
Water-Holding Capacity	4 – 6 inches above fragipan; 6 – 9 inches (total)
Total depth	60 +; 18 – 27 inches to fragipan
A Horizon Depth	1 – 8 inches
Percent rock in the surface horizon	0 – 10 percent
Erosion Hazard & Equipment Limitation	Moderate erosion hazard off skid roads and trails, severe on skid roads and trails. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Low
Potential for pond development	Moderate hazard of excess seepage.
Management Considerations	Fragipan and perched water table from November thru May

Soil Type	Characteristics
Hogcreek silt loam	
Landscape Location	Hogcreek soils are on gently to moderately sloping ridgetops. These soils formed in hillslope sediments mixed with a component of loess and in the underlying pedisediment. Slopes range from 1 to 8 percent.
Stand Location	Compartment 99: Stand Nos. 6 – 14; Compartment 118: Stand Nos. 1, 22 – 31, 33 - 41
Permeability	Moderately fast (surface and upper subsurface); moderate (middle subsurface above fragipan); very slow (fragipan)
Water-Holding Capacity	2 – 4 inches above fragipan; 3 – 6 inches total
Total depth	20 – 40 inches total, 14 – 32 inches to fragipan
A Horizon Depth	3 – 6 inches
Percent rock in the surface horizon	0 – 35 percent
Erosion Hazard & Equipment	Slight erosion hazard off skid roads and trails, moderate hazard on skid roads and trails. Moderately suited to harvesting equipment.

Soil Type	Characteristics
Hogcreek silt loam	
Limitation	
Potential of damage to soil from fire	Low
Potential for pond development	
Management Considerations	Fragipan and perched water table during winter and early spring months.

Soil Type	Characteristics
Lebanon silt loam	
Landscape Location	The Lebanon soils occupy gently to moderately sloping upland positions with gradients of 2 to 14 percent but gradients commonly are 2 to 6 percent. The regolith consists of approximately 18 to 26 inches of loess underlain by cherty limestone residuum. The contact of the contrasting material is marked by a cherty old erosional surface in which the fragipan has developed.
Stand Location	Compartment 20: Stand No. 6; Compartment 36: Stand Nos. 12, 15; Compartment 37: Stand Nos. 29, 36, 37, 41; Compartment 41: Stand Nos. 7, 8; Compartment 49: 39 – 41, 43, 48, 49; Compartment 50: Stand Nos. 9 – 12, 14, 15; Compartment 51: Stand Nos. 47; Compartment 52: Stand Nos. 1 – 14, Compartment 57: Stand Nos. 24, 50, 57 – 59; Compartment 58: Stand Nos. 4, 5, 10, 16, 18, 20; Compartment 59: Stand Nos. 3, 4, 8, 9, 31; Compartment 78: Stand Nos. 5, 8, 9, 13; Compartment 80: Stand Nos. 14, 15, 21; Compartment 82: Stand Nos. 5, 13, 21; Compartment 83: Stand Nos. 29 - 32; Compartment 85: Stand Nos. 6, 7, 10 – 18, 20 – 25, 31 – 34, 38 – 40, 47, 58, 68, 69; Compartment 86: Stand Nos. 11, 14 – 18, Compartment 87: Stand Nos. 25, 27 – 30, 35; Compartment 88: Stand Nos.8 – 10; Compartment 89: Stand Nos. 5, 6; Compartment 91: Stand Nos. 1, 4, 10 – 12, 16; Compartment 92: Stand Nos. 6 – 10; Compartment 99: Stand Nos. 21, 22, 25; Compartment 100: Stand Nos. 22 - 25
Permeability	Moderate above the fragipan, very slow in fragipan, slow below fragipan
Water-Holding Capacity	3 – 5 inches above fragipan; 4 – 7 inches total
Total depth	60 + inches; 18 – 26 inch depth to fragipan
A Horizon Depth	3 – 9 inches
Percent rock in the surface horizon	0 – 25
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails up to 9 percent slope; moderate erosion hazard over 9 percent. Moderate erosion hazard on skid roads and trails up to 9 percent, severe hazard over 9 percent. Moderately suited to harvesting equipment in dry weather and soil conditions; poorly suited in wet soil conditions.
Potential of damage to soil from fire	Low to moderate
Potential for pond development	Moderate to high hazard due to seepage.
Management	Fragipan in the profile; perched water table above fragipan possible from

Soil Type	Characteristics
Lebanon silt loam	
Considerations	December thru March.

Soil Type	Characteristics
Lecoma silt loam	
Landscape Location	Lecoma soils are on gently sloping to strongly sloping stream terraces and foot slopes. Slopes range from 1 to 15 percent. The soil formed in alluvium and colluvium derived predominantly from sandstone.
Stand Location	Compartment 118: Stand Nos. 26, 27
Permeability	Moderate
Water-Holding Capacity	10 – 13 inches
Total depth	60 + inches
A Horizon Depth	3 – 12 inches
Percent rock in the surface horizon	0 - 10
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails; moderate hazard on skid roads and trails. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	Moderately limited due to seepage and slope
Management Considerations	None

Soil Type	Characteristics
Midco cherty loam	
Landscape Location	Midco soils occupy narrow strips of first bottoms along streams. Slope gradients range from l to 4 percent. They formed in recent alluvium derived largely from upland soils underlain by cherty dolomite and sandstone.

Soil Type	Characteristics
Midco cherty loam	
Stand Location	Compartment 20: Stand Nos. 6 – 9; Compartment 37: Stand Nos. 29, 32, 34; Compartment 41: Stand Nos. 7, 9; Compartment 49: Stand Nos. 5, 6, 18 – 22, 24; Compartment 50: Stand Nos. 1, 8 – 13, 18 – 23, 26, 28, 29; Compartment 51: Stand Nos.10, 16 – 19, 21, 22, 25 – 33, 35 – 37, 42, 44, 46, 49 – 53; Compartment 52: Stand Nos. 3, 13; Compartment 53: Stand Nos. 8, 9, 12; Compartment 57: Stand Nos. 15 – 17, 19, 21, 29 – 32, 36 – 39, 42, 44, 47, 48, 51 – 54, 56 – 60; Compartment 58: Stand Nos. 1, 2, 4, 6, 8 – 10, 12, 15 – 17, 19, 22, 24, 25, 31, 35, 42, 45; Compartment 59: Stand Nos. 5, 13, 15, 18, 23, 24; Compartment 78: Stand Nos. 2, 5 – 7, 21; Compartment 79: Stand Nos. 1, 2, 10 – 12, 14, 15, 17, 19, 22, 30, 32 – 34; Compartment 80: Stand Nos. 8 – 10, 13, 14, 16, 18 – 20, 22 – 25, 27, 33; Compartment 82: Stand Nos.2, 8, 15, 16, 19, 29 – 32, 35 – 37; Compartment 83: Stand Nos. 8 – 11, 16, 17, 20, 25, 41, 48 – 51; Compartment 85: Stand Nos. 5, 6, 9, 12 – 15, 17 – 21, 24, 26 – 35, 37 – 46, 48 – 52, 54 – 57, 61, 64 – 69; Compartment 86: Stand Nos. 4, 8 – 10, 12, 13, 19, 20, 22 – 27, 29; Compartment 87: Stand Nos. 5, 7, 12, 24, 26, 27, 30, 31, 35; Compartment 88: Stand Nos. 2 – m5, 8 – 10, 13, 15, 16, 21 – 23, 28, 29, 31, 32; Compartment 89: Stand No. 1; Compartment 90: Stand Nos. 1 – 4, 6, 8 – 18, 21, 22, 24 – 29, 33, 38 – 40; Compartment 91: Stand Nos. 1 – 3, 6 – 10, 12 – 14, 16, 18 – 20, 22 – 26, 28, 30, 33; Compartment 99: Stand Nos. 2, 3, 18, 25 – 35, 38, 39, 41 – 43; Compartment 100: Stand Nos. 2, 4 – 17, 19, 20, 25, 26, 28, 30, 34, 35, 38, 41 – 43, 45, 46, 48 – 51; Compartment 118: Stand Nos. 10, 11
Permeability	Moderate to moderately rapid
Water-Holding Capacity	1 – 3 inches
Total depth	Solum depth: 1 – 10 inches; depth to bedrock: 60+ inches
A Horizon Depth	1 – 10 inches thick
Percent rock in the surface horizon	20 - 80
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails, moderate hazard on skid roads and trails. Well suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	High hazard due to seepage
Management Considerations	Very brief, occasional floodings

Miscellaneous water	
Stand Location	Compartment 78: Stand Nos.1, 2, 5, 9; Compartment 89: Stand Nos. 1; Compartment 90: Stand Nos. 6, 22, 24 – 26, 40

Soil Type	Characteristics
Moniteau silt loam	
Landscape Location	Moniteau soils are on flood plains and formed in alluvium. Slope commonly ranges from 0 to 3 percent, but may range to 5 percent.
Stand Location	Compartment 51: Stand Nos. 27, 50; Compartment 88: Stand Nos. 20, 21
Permeability	Moderately slow (surface); slow (subsurface)
Water-Holding Capacity	10 – 12 inches
Total depth	40 – 60 inches
A Horizon Depth	7 inches
Percent rock in the surface horizon	0 - 5
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails, moderate hazard on skid roads and trails. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	Slight hazard of excess seepage.
Management Considerations	In undisturbed areas there is an apparent water table that has an upper limit of 0 to 1 foot during November to May in most years.

Soil Type	Characteristics
Nixa very gravelly silt loam	
Landscape Location	Nixa soils are on ridgetops and sideslopes of uplands. Slope gradients range from 1 to 35 percent. The soil formed in loamy residuum weathered from cherty limestone.
Stand Location	Compartment 41: Stand Nos.7; Compartment 49: Stand Nos. 1 – 4, 7, 9 – 14, 24 – 30, 32 – 35, 37 – 45, 48 – 50; Compartment 51: Stand Nos. 3, 4, 10, 16, 19, 20, 30 – 32, 34, 39 -45, 50; Compartment 53: Stand Nos. 10; Compartment 57: Stand Nos. 4, 5, 9, 16, 24, 36, 47, 48; Compartment 58: Stand Nos. 1, 9, 10, 12, 14 – 16, 19 – 21, 23, 33, 34, 36, 40, 44; Compartment 59: Stand Nos. 9, 31; Compartment 78: Stand Nos. 1 – 4, 6, 8, 11; Compartment 79: Stand Nos. 12, 13; Compartment 82: Stand Nos. 3, 21, 23, 26, 27, 33, 34, 41, 42; Compartment 83: Stand Nos. 4 – 6, 24, 25, 28, 32, 33, 37, 40, 43 – 50; Compartment 85: Stand Nos. 1 – 6, 60; Compartment 87: Stand Nos. 2; Compartment 88: Stand Nos. 1, 2, 7, 8, 13 – 16, 18 – 23, 25, 31 – 33; Compartment 89: Stand Nos. 2, 5; Compartment 99: Stand Nos. 14 – 16, 20, 21; Compartment 100: Stand Nos. 25, 27 – 29, 30, 36 - 38
Permeability	Moderately slow above the fragipan, very slow in the fragipan
Water-Holding Capacity	4 – 7 inches total; 2 – 5 inches above fragipan
Total depth	Depth to fragipan: 14 – 27 inches, 60 – 80 inches total
A Horizon Depth	0 – 3 inches

Soil Type	Characteristics
Nixa very gravelly silt loam	
Percent rock in the surface horizon	15 - 60
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails up to 15 percent, moderate over 15 percent. Moderate erosion hazard on skid roads and trails up to 9 percent, severe over 9 percent. Moderately suited to harvesting equipment in dry soil conditions, poorly suited in wet soil conditions
Potential of damage to soil from fire	Low
Potential for pond development	Moderate to high limitation due to seepage.
Management Considerations	Fragipan in the profile, very shallow A hroizon

Soil Type	Characteristics
Poynor gravelly silt loam	
Landscape Location	Poynor soils are on narrow ridgetops and steep side slopes. These soils formed in gravelly colluvium weathered from dolostone or limestone and the underlying cleyey residuum weathered from shale. Slopes range from 1 to 60 percent.
Stand Location	Compartment 99: Stand Nos. 1, 4 – 17; Compartment 118: Stand Nos. 1 – 7, 12 – 14, 18 – 23, 25 – 41, 45, 46
Permeability	Moderate (surface); moderately slow (subsurface)
Water-Holding Capacity	4 – 7 inches
Total depth	60+ inches
A Horizon Depth	1 – 7 inches thick
Percent rock in the surface horizon	15 - 25
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid trails and roads; moderate on skid trails and roads up to 8 percent, severe over 8 percent. Well suited to harvesting equipment up to 15 percent.
Potential of damage to soil from fire	Low
Potential for pond development	Moderate to severe limitations due to seepage and slope (at higher grades)
Management Considerations	

Soil Type	Characteristics

Soil Type	Characteristics
Relfe very gravelly sandy loam	
Landscape Position	Relfe soils are on nearly level to gently sloping flood plains. Slope gradients range from 0 to 3 percent. They formed in gravelly alluvium.
Stand Location	Compartment 36: Stand Nos. 9, 10, 13; Compartment 99: Stand Nos. 1, 3 – 7, 11, 15 – 17; Compartment 118: Stand Nos. 4, 5, 10 – 22, 25 – 27, 29 – 32, 34, 35, 39 - 46
Permeability	Moderate (surface), moderately rapid to rapid (subsurface)
Water-Holding Capacity	1 – 2 inches
Total depth	60+ inches
A Horizon Depth	6 – 9 inches
Percent rock in the surface horizon	35 – 75
Erosion Hazard & Equipment Limitation	Slight erosion hazard. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	Very limited (seepage)
Management Considerations	Very low available water holding capacity. Very brief occasional to frequent floods.

Soil Type	Characteristics
Riverwash	
Landscape Location	Made up of alluvial materials deposited on flood plains along streams and rivers. Materials consist of large stones, cherty gravel, and sand that are well graded in some areas and mixed in others.
Stand Location	Compartment 53: Stand Nos. 8, 9; Compartment 59: Stand Nos. 21 – 24; Compartment 89: Stand Nos. 1, 29
Permeability	Moderately rapid to rapid
Water-Holding Capacity	1 – 2 inches
Total depth	60+ inches
Management Considerations	Long, frequent floods and water tables with an upper limit of 0 – 2 feet and lower limit of > 6.0 feet from October to July

Soil Type	Characteristics
Rockland	
Landscape Position	Occurs in areas where ledges, bouldersized float rock, and outcrops of bedrock cover more than 25 percent of the surface. The outcrops and ledges are dolomite, and the large float rocks are mainly sandstone. Slopes are usually > 9 percent and on south slopes. Between the bedrock, ledges, or float rock, soil material is present

	but variable.
Stand Location	Compartment 50: Stand Nos. 22, 23, 26; Compartment 51: Stand Nos. 37, 41, 42, 53; Compartment 57: Stand Nos. 8, 9, 15 – 18, 20 – 23, 25, 26, 28, 51: Compartment 86: Stand Nos. 4, 29

Soil Type	Characteristics
Rueter very gravelly silt loam	
Landscape Location	Rueter soils are on steep side slopes and narrow ridgetops. Slope gradients range from 3 to 70 percent, but are dominantly 15 to 50 percent. These soils formed in residuum and colluvium from cherty limestone or interbedded sandstone and cherty dolomite.
Stand Location	Compartment 19: nearly every stand; Compartment 20: all stands; Compartment 21: all stands; Compartment 22: nearly every stand; Compartment 23: Stand Nos. 3, 4, 6 – 17, 19 – 37; Compartment 33: Stand Nos. 1 – 7; 9 – 23; Compartment 34: nearly all stands; Compartment 35: Stand Nos. 1 – 37; Compartment 36: Stand Nos. 1 – 10, 13 – 18; Compartment 37: Stand Nos. 2 – 27, 31 – 35, 39, 40, 44, 45; Compartment 38: nearly every stand; Compartment 39: Stand Nos. 1 – 14, 18 – 25; Compartment 40: Stand Nos. 1 – 5, 7 – 11, 16 – 30, 33; Compartment 41: Stand Nos. 1 – 4, 6, 7; Compartment 49: 10, 14 – 16; Compartment 50: Stand Nos. 1 – 4, 6, 7, 21; Compartment 52: Stand Nos. 14 – 19, 28; Compartment 118: Stand Nos. 10 - 13
Permeability	Moderate (surface and upper subsurface); moderately slow (lower subsurface)
Water-Holding Capacity	4 – 9 inches
Total Depth	80+
A Horizon Depth	2 – 6 inches
Percent rock in the surface horizons	15 - 80
Erosion Hazard & Equipment Limitation	Moderate erosion hazard off skid roads and trails; severe hazard on skid roads and trails. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond construction	Severe limitation due to seepage and slope
Management Considerations	None

Soil Type	Characteristics
Scholten	
Landscape Location	The Scholten soils are on slopes and ridges on a rolling to gently rolling landscape at the heads of drains. These soils formed in colluvium or hillslopes sediments and the underlying residuum weathered from cherty limestone. Slopes are 1 to 45 percent.
Stand	Compartment 99: Stand Nos. 1, 4 – 17; Compartment 118: Stand Nos. 1 – 7, 10,

Soil Type	Characteristics
Location	12 – 14, 18 – 23, 25 – 46
Permeability	Moderate (surface); moderately slow (subsurface above and below fragipan), slow to very slow in fragipan
Water-Holding Capacity	1 – 3 inches above fragipan; 3 – 7 inches total
Total depth	80+ inches 14 – 36 inches to fragipan
A Horizon Depth	6 inches
Percent rock in the surface horizon	5 - 65
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails; moderate on skid roads and trails. Well suited to harvesting equipment in dry soil conditions, poorly suited in moist soil conditions.
Potential of damage to soil from fire	Moderate
Potential for pond development	Severe limitation due to seepage
Management Considerations	Fragipan in profile. Perched water table at 1 ½ - 3 feet from November thru April

Soil Type	Characteristics
Sharon silt loam	
Landscape Location	Sharon soils are on nearly level to gently undulating flood plains. Slope gradients commonly are less than 2 percent but range from 0 to 4 percent. Sharon soils formed in silty, acid alluvium.
Stand Location	Compartment 85: Stand No. 65 Compartment 91: Stand Nos. 6, 13, 16, 19, 23
Permeability	Moderate
Water-Holding Capacity	14 – 16 inches
Total depth	60+
A Horizon Depth	15 – 32 inches
Percent rock in the surface horizon	0 – 5
Erosion Hazard & Equipment Limitation	Slight erosion hazard; moderately suited to harvesting equipment
Potential of damage to soil from fire	Moderate
Potential for pond	High limitation due to excess seepage.

Soil Type	Characteristics
development	
Management Considerations	Possible high water table 3 – 6 feet March thru June

Soil Type	Characteristics
Sonsac very cobbly silt loam	
Landscape Location	Sonsac soils are on moderately sloping to steep upland side slopes. They have formed hillslope sediments and the underlying residuum derived from limestone that has a high chert content and is primarily Ordovician or Mississippian in age. Slopes range from 5 to 70 percent.
Stand Location	Compartment 23: Stand Nos. 19 – 21, 24, 26, 28 – 30, 32 – 36; Compartment 33: Stand Nos. 19 – 22; Compartment 34: Stand Nos. 3, 5 – 16, 25 – 29, 31 – 34; Compartment 38: Stand Nos. 6 – 10, 12 – 19, 22 – 24, 32, 33, 36, 37; Compartment 39: Stand Nos. 1, 4, 6, 12 – 19, 21 – 27; Compartment 40: Stand Nos. 2 – 4, 7 – 17, 19 – 21, 28, 29, 31, 32; Compartment 41: Stand Nos. 1, 3, 4
Permeability	Moderate (surface and upper subsurface); moderately slow (lower subsurface)
Water-Holding Capacity	2 ½ - 5 inches
Total depth	20 - 40
A Horizon Depth	1 – 5 inches
Percent rock in the surface horizon	2 – 70
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails and moderate on skid roads and trails at slopes up to 15 percent. Moderate erosion hazard off skid roads and trails and severe hazard on skid roads and trails at slopes > 15 percent. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Low
Potential for pond development	Limited due to seepage, depth to bedrock, and slope at steeper grades
Management Considerations	Low available water holding capacity

Soil Type	Characteristics
Tonti silt loam	
Landscape Location	Tonti soils are nearly level to moderately sloping upland ridges of the Ozark Highlands and other areas with cherty limestone bedrock. Slopes range from 1 to 12 percent, but dominantly are less than 8 percent.
Stand Location	Compartment 99: Stand Nos. 7 – 14; Compartment 118: Stand Nos. 1, 22 – 31, 33 - 41
Permeability	Moderate above the fragipan, very slow in the fragipan, and slow below the fragipan.
Water-Holding Capacity	2 – 4 inches above the fragipan, 5 – 10 inches total
Total depth	60 + inches; 15 – 31 inches to fragipan

Soil Type	Characteristics
Tonti silt loam	
A Horizon Depth	3 – 9 inches
Percent rock in the surface horizon	0 – 35 percent
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails; moderate on skid roads and trails. Moderately well suited to harvesting equipment in dry soil conditions.
Potential of damage to soil from fire	Low
Potential for pond development	Moderate limitation due to seepage and slope at higher slopes.
Management Considerations	Fragipan and perched water table at 1 ½ to 3 feet depth in the profile from December thru April.

Soil Type	Characteristics
Viraton silt loam	
Landscape Location	Viraton soils are on gently sloping and moderately sloping broad ridgetops, foot slopes and strath terraces. Slope gradients are typically less than 5 percent but range from 1 to 20 percent. They formed loamy sediments and the underlying residuum or colluvium from cherty limestone.
Stand Location	Compartment 50: Stand Nos. 20, 22, 23, 26; Compartment 51: Stand Nos. 53; Compartment 59: Stand Nos. 22, 23; Compartment 82: Stand Nos. 9; Compartment 85: Stand Nos. 18 – 22, 48, 61; Compartment 89: Stand Nos. 1; Compartment 90: Stand Nos. 16, 35; Compartment 91: Stand Nos. 14, 16, 23 – 26, 28, 30, 31, 33; Compartment 100: Stand Nos. 5, 6, 10 – 12, 40 – 43, 50, 51; Compartment 118: Stand Nos. 9 - 12
Permeability	Moderate above the fragipan, very slow in the fragipan and moderately slow below the fragipan.
Water-Holding Capacity	3 – 4 inches above fragipan, 5 – 7 ½ inches total
Total depth	60 + inches, fragipan depth at 18 – 33 inches
A Horizon Depth	3 – 8 inches thick
Percent rock in the surface horizon	0 - 25
Erosion Hazard & Equipment Limitation	Slight erosion hazard off skid roads and trails; moderate on skid roads and trails; moderately suited to harvesting equipment in periods of dry soil conditions.
Potential of damage to soil from fire	Low
Potential for pond	Limitations due to fragipan

Soil Type	Characteristics
development	
Management Considerations	High water table possible November thru June. Presence of fragipan from 1 ½ - 2 ½ feet below surface.

Soil Type	Characteristics
Westerville silt loam	
Landscape Position	Westerville soils are on low terraces. The slope gradient is 0 to 3 percent. The soils formed in alluvium.
Stand Location	Compartment 85: Stand Nos. 9, 29. 30, 63, 65, 66
Permeability	Moderate
Water-Holding Capacity	10 – 12 inches
Total depth	Solum depth: 6 – 24 inches; depth to bedrock:
A Horizon Depth	6 – 14 inches thick
Percent rock in the surface horizon	0 - 10
Erosion Hazard & Equipment Limitation	Slight hazard of erosion. Moderately suited to harvesting equipment.
Potential of damage to soil from fire	Moderate
Potential for pond development	Moderate hazard of excess seepage.
Management Considerations	Brief, occasional flooding. High water table possible at 1 – 3 feet from November thru May.

Soil Type	Characteristics
Wideman fine sand	
Landscape Location	Wideman soils are on flood plains and natural levees along streams in the Ozark Highlands of Arkansas and Missouri. The flood plains are often dissected by old channels, now inactive. Slopes are usually less than 3 percent but range from 0 to 5 percent. Wideman soils formed in sandy alluvium with thin strata of finer texture.
Stand Location	Compartment 53: Stand Nos. 8, 9; Compartment 59: Stand Nos. 21 – 24; Compartment 89: Stand Nos. 1; Compartment 90: Stand Nos. 29
Permeability	Moderately rapid to rapid
Water-Holding Capacity	4 – 12 inches
Total depth	80+ inches
A Horizon Depth	2 – 9 inches
Percent rock in the surface	0 - 10

Soil Type	Characteristics
Wideman fine sand	
horizon	
Erosion Hazard & Equipment Limitation	Slight hazard of erosion. Well suited to harvesting equipment.
Potential of damage to soil from fire	High due to texture and coarse fragments
Potential for pond development	High limitation
Management Considerations	Very brief occasional to frequent flooding.

Description and Parameters

File: CROOKED CREEK.QSP
DataPath: c:

Start Year: 2004
Transactions: 22
Alternatives: 3
Partners: 1

Last Modified: 3/1/2004
Discount Rate: 4.000
Inflation Rate: 2.000

Partners

USFS	USFS

Alternatives

Alternative 1	No Action
Alternative 2	Proposed Action
Alternative 3	Reduced Final Harvest with Natural Regeneration only

All Partners *Alternative 1*

Discount Rate: 4.000

Cash Flows (number)	0
PV-Costs ($)	NA
PV-Benefits ($)	NA
Present Net Value ($)	NA
B/C Ratio	NA
Investment Length (years)	NA
Net Annual Equivalent ($)	NA
Composite Rate of Return (percent)	NA
Internal Rate of Return (percent)	NA

All Partners *Alternative 2*

Discount Rate: 4.000

Cash Flows (number)	14
PV-Costs ($)	-$1,266,245.05
PV-Benefits ($)	$1,791,712.94
Present Net Value ($)	$525,467.89
B/C Ratio	1.41
Investment Length (years)	11
Net Annual Equivalent ($)	$59,981.66
Composite Rate of Return (percent)	7.33
Internal Rate of Return (percent)	NA

All Partners *Alternative 3*

Discount Rate: 4.000

Cash Flows (number)	12
PV-Costs ($)	-$1,001,373.82
PV-Benefits ($)	$1,647,885.88
Present Net Value ($)	$646,512.06
B/C Ratio	1.65
Investment Length (years)	6
Net Annual Equivalent ($)	$123,329.87
Composite Rate of Return (percent)	13.00
Internal Rate of Return (percent)	168.54

USFS *Alternative 1*

Discount Rate: 4.000

Cash Flows (number)	0
PV-Costs ($)	NA
PV-Benefits ($)	NA
Present Net Value ($)	NA
B/C Ratio	NA
Investment Length (years)	NA
Net Annual Equivalent ($)	NA
Composite Rate of Return (percent)	NA
Internal Rate of Return (percent)	NA

USFS *Alternative 2*

Discount Rate: 4.000

Cash Flows (number)	14
PV-Costs ($)	-$1,266,245.05
PV-Benefits ($)	$1,791,712.94
Present Net Value ($)	$525,467.89
B/C Ratio	1.41
Investment Length (years)	11
Net Annual Equivalent ($)	$59,981.66
Composite Rate of Return (percent)	7.33

Forest: Mark Twain NF Salem Ranger
Analyst: Bryan & Massengale
File: CROOKED CREEK.QSP
Title: Crooked Creek Analysis Area EA

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Internal Rate of Return (percent)	NA

USFS ***Alternative 3*** **Discount Rate:** 4.000

Cash Flows (number)	12
PV-Costs ($)	-$1,001,373.82
PV-Benefits ($)	$1,647,885.88
Present Net Value ($)	$646,512.06
B/C Ratio	1.65
Investment Length (years)	6
Net Annual Equivalent ($)	$123,329.87
Composite Rate of Return (percent)	13.00
Internal Rate of Return (percent)	168.54

Forest: Mark Twain NF Salem Ranger District
Analyst: Bryan & Massengale
File: CROOKED CREEK.QSP

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All Partners

Discount Rate %: 4.0000

	Alternative 1	Alternative 2	Alternative 3
B/C Ratio	NA	1.41	1.65
Cash Flows (number)	0	14	12
Composite Rate of Return (percent)	NA	7.33	13.00
Internal Rate of Return (percent)	NA	NA	168.54
Investment Length (years)	NA	11	6
Net Annual Equivalent ($)	NA	$59,981.66	$123,329.87
Present Net Value ($)	NA	$525,467.89	$646,512.06
PV-Benefits ($)	NA	$1,791,712.94	$1,647,885.88
PV-Costs ($)	NA	-$1,266,245.05	-$1,001,373.82

USFS

Discount Rate %: 4.0000

	Alternative 1	Alternative 2	Alternative 3
B/C Ratio	NA	1.41	1.65
Cash Flows (number)	0	14	12
Composite Rate of Return (percent)	NA	7.33	13.00
Internal Rate of Return (percent)	NA	NA	168.54
Investment Length (years)	NA	11	6
Net Annual Equivalent ($)	NA	$59,981.66	$123,329.87
Present Net Value ($)	NA	$525,467.89	$646,512.06
PV-Benefits ($)	NA	$1,791,712.94	$1,647,885.88
PV-Costs ($)	NA	-$1,266,245.05	-$1,001,373.82

Alternative: Alternative 2

ar	CYear	Description	Quantity	Cost	Benefit	Partner
0	2004	road design (Roads)	8.40 miles	$8,400.00		USFS
0	2004	road construction (Roads)	8.40 miles	$50,400.00		USFS
0	2004	hazardous fuel reduction (fuels)	5,956.00 acres	$208,460.00		USFS
0	2004	open woodland development (wildlife)	2,445.00 acres	$85,575.00		USFS
1	2005	sale prep (timber sale(s))	5,904.00 acres	$238,384.04		USFS
1	2005	oak sawtimber (timber sale(s))	12,728.00 mbf		$1,844,821.78	USFS
2	2006	open woodland development (wildlife)	2,445.00 acres	$91,723.23		USFS
3	2007	pine posts (timber sale(s))	1,809.00 mbf		$20,074.15	USFS
4	2008	site prep (reforestation)	3,129.00 acres	$377,450.25		USFS
4	2008	open woodland development (wildlife)	2,445.00 acres	$98,313.18		USFS
5	2009	stocking survey (reforestation)	3,129.00 acres	$18,608.30		USFS
6	2010	plant pine (reforestation)	667.00 acres	$91,990.11		USFS
6	2010	non-sys road closure (Roads)	10.10 miles	$3,731.13		USFS
11	2015	pine release (reforestation)	667.00 acres	$102,575.46		USFS

Forest: Mark Twain NF Salem Ranger District
Analyst: Bryan & Massengale
File: CROOKED CREEK.QSP

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Alternative: Alternative 3

	CYear		Quantity	Cost	Benefit	Partner
0	2004	road design (Roads)	8.40 miles	$8,400.00		USFS
0	2004	road construction (Roads)	8.40 miles	$50,400.00		USFS
0	2004	hazardous fuels reduction (fuels)	5,956.00 acres	$208,460.00		USFS
0	2004	open woodland development (wildlife)	2,445.00 acres	$85,575.00		USFS
1	2005	sale prep (timber sale(s))	5,609.00 acres	$226,472.91		USFS
1	2005	oak sawtimber (timber sale(s))	11,696.00 mbf		$1,695,241.63	USFS
2	2006	open woodland development (wildlife)	2,445.00 acres	$91,723.23		USFS
3	2007	pine posts (timber sale(s))	1,809.00 mbf		$20,074.15	USFS
4	2008	site prep (reforestation)	2,167.00 acres	$261,404.50		USFS
4	2008	open woodland development (wildlife)	2,445.00 acres	$98,313.18		USFS
5	2009	stocking survey (reforestation)	2,167.00 acres	$12,887.24		USFS
6	2010	non-sys road closure	10.10 miles	$3,731.13		USFS

COST ***USFS***

Alternative:	*Alternative 2*	*Category*		*Year(s)*	*Quantity*	*Value*	*Rate(%)*	*Base*	*Update*
hazardous fuel reduction		fuels	One time	0	5,956.00 acres	$35.00	1.50	2004	3/3/2004
Notes: New									
pine release		reforestation	One time	11	667.00 acres	$105.00	1.50	2004	3/17/200
Notes: New									
plant pine		reforestation	One time	6	667.00 acres	$112.00	1.50	2004	3/17/200
Notes: New									
site prep		reforestation	One time	4	3,129.00 acres	$105.00	1.50	2004	3/17/200
Notes: New									
stocking survey		reforestation	One time	5	3,129.00 acres	$5.00	1.50	2004	3/17/200
Notes: New									
non-sys road closure		Roads	One time	6	10.10 miles	$300.00	1.50	2004	3/18/200
Notes: New									
road construction		Roads	One time	0	8.40 miles	$6,000.00	1.50	2004	3/3/2004
Notes: New									
road design		Roads	One time	0	8.40 miles	$1,000.00	1.50	2004	3/3/2004
Notes: New									
sale prep		timber sale(s)	One time	1	5,904.00 acres	$39.00	1.50	2004	3/18/200
Notes: New									
open woodland development		wildlife	Periodic	0-5 by 2	2,445.00 acres	$35.00	1.50	2004	3/3/2004
Notes: New									

Alternative:	*Alternative 3*	*Category*		*Year(s)*	*Quantity*	*Value*	*Rate(%)*	*Base*	*Update*
hazardous fuels reduction		fuels	One time	0	5,956.00 acres	$35.00	1.50	2004	3/3/2004
Notes: New									
site prep		reforestation	One time	4	2,167.00 acres	$105.00	1.50	2004	3/17/200
Notes: New									
stocking survey		reforestation	One time	5	2,167.00 acres	$5.00	1.50	2004	3/17/200
Notes: New									
non-sys road closure		Roads	One time	6	10.10 miles	$300.00	1.50	2004	3/18/200
Notes: New									

Forest: Mark Twain NF Salem Ranger District
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road construction	Roads	One time	0	8.40 miles	$6,0000.00	1.50	2004	3/3/2004
New								
road design	Roads	One time	0	8.40 miles	$1,000.00	1.50	2004	3/18/200
Notes: New								
sale prep	timber sale(s)	One time	1	5,609.00 acres	$39.00	1.50	2004	3/17/200
Notes: New								
open woodland development	wildlife	Periodic	0-5 by 2	2,445.00 acres	$35.00	1.50	2004	3/3/2004
Notes: New								

BENEFIT ***USFS***

Alternative:	***Alternative 2***	***Category***		***Year(s)***	***Quantity***	***Value***	***Rate(%)***	***Base***	***Update***
oak sawtimber		timber sale(s)	One time	1	12,728.00 mbf	$140.00	1.50	2004	3/17/200
Notes: New									
pine posts		timber sale(s)	One time	3	1,809.00 mbf	$10.00	1.50	2004	3/18/200
Notes: New									

Alternative:	***Alternative 3***	***Category***		***Year(s)***	***Quantity***	***Value***	***Rate(%)***	***Base***	***Update***
oak sawtimber		timber sale(s)	One time	1	11,696.00 mbf	$140.00	1.50	2004	3/18/200
Notes: New									
pine posts		timber sale(s)	One time	3	1,809.00 mbf	$10.00	1.50	2004	3/18/200
Notes: New									

0	2004	USFS	-$352,835.00	$0.00	-$352,835.00
Year Total:			**-$352,835.0**	**$0.00**	**-$352,835.0**
1	2005	USFS	-$238,384.04	$1,844,821.78	$1,606,437.74
Year Total:			**-$238,384.0**	**$1,844,821.78**	**$1,606,437.**
2	2006	USFS	-$91,723.23	$0.00	-$91,723.23
Year Total:			**-$91,723.23**	**$0.00**	**-$91,723.23**
3	2007	USFS	$0.00	$20,074.15	$20,074.15
Year Total:			**$0.00**	**$20,074.15**	**$20,074.15**
4	2008	USFS	-$475,763.44	$0.00	-$475,763.44
Year Total:			**-$475,763.4**	**$0.00**	**-$475,763.4**
5	2009	USFS	-$18,608.30	$0.00	-$18,608.30
Year Total:			**-$18,608.30**	**$0.00**	**-$18,608.30**
6	2010	USFS	-$95,721.24	$0.00	-$95,721.24
Year Total:			**-$95,721.24**	**$0.00**	**-$95,721.24**
11	2015	USFS	-$102,575.46	$0.00	-$102,575.46
Year Total:			**-$102,575.4**	**$0.00**	**-$102,575.4**
0	2004	USFS	-$352,835.00	$0.00	-$352,835.00
Year Total:			**-$352,835.0**	**$0.00**	**-$352,835.0**
1	2005	USFS	-$226,472.91	$1,695,241.63	$1,468,768.72
Year Total:			**-$226,472.9**	**$1,695,241.63**	**$1,468,768.**
2	2006	USFS	-$91,723.23	$0.00	-$91,723.23
Year Total:			**-$91,723.23**	**$0.00**	**-$91,723.23**
3	2007	USFS	$0.00	$20,074.15	$20,074.15
Year Total:			**$0.00**	**$20,074.15**	**$20,074.15**
4	2008	USFS	-$359,717.69	$0.00	-$359,717.69
Year Total:			**-$359,717.6**	**$0.00**	**-$359,717.6**

Forest: Mark Twain NF Salem Ranger District
Analyst: Bryan & Massengale
File: CROOKED CREEK.QSP
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Alternative: Alternative 3

Year	*CYear*	*Partner*	*Cost*	*Benefit*	*Net*
5	2009	USFS	-$12,887.24	$0.00	-$12,887.24
Year Total:			**-$12,887.24**	**$0.00**	**-$12,887.24**
6	2010	USFS	-$3,731.13	$0.00	-$3,731.13
Year Total:			**-$3,731.13**	**$0.00**	**-$3,731.13**

		Alternative 2	Alternative 3
0	2004	-$208,460.00	-$208,460.00

USFS **COST** **reforestation**

Year		Alternative 2	Alternative 3
4	2008	-$377,450.25	-$261,404.50
5	2009	-$18,608.30	-$12,887.24
6	2010	-$91,990.11	$0.00
11	2015	-$102,575.46	$0.00

USFS **COST** **Roads**

Year		Alternative 2	Alternative 3
0	2004	-$58,800.00	-$58,800.00
6	2010	-$3,731.13	-$3,731.13

USFS **COST** **timber sale(s)**

Year		Alternative 2	Alternative 3
1	2005	-$238,384.04	-$226,472.91

USFS **COST** **wildlife**

Year		Alternative 2	Alternative 3
0	2004	-$85,575.00	-$85,575.00
2	2006	-$91,723.23	-$91,723.23
4	2008	-$98,313.18	-$98,313.18

USFS **BENEFIT** **timber sale(s)**

Year		Alternative 2	Alternative 3
1	2005	$1,844,821.78	$1,695,241.62
3	2007	$20,074.15	$20,074.15

BIOLOGICAL ASSESSMENT and EVALUATION
FEDERALLY LISTED SPECIES

Mark Twain National Forest

Salem Ranger District
Crawford and Dent Counties, Missouri

Crooked Creek Project

INTRODUCTION

The purpose of this Biological Assessment/Evaluation (BAE) is to document the potential effects that planned management activities associated with this project may have upon federally proposed, endangered, or threatened species and their habitats within the Mark Twain National Forest. The objectives of this BAE are:

- **a)** to ensure that Forest Service actions do not contribute to a loss of viability or cause a trend toward federal listing of any species;
- **b)** to comply with the requirements of the Endangered Species Act and ensure that actions of Federal agencies do not jeopardize or adversely modify critical habitat of federally listed or proposed species;
- **c)** to provide a process and standard by which to ensure that threatened, endangered, proposed, and sensitive species receive full consideration in the decision making process;
- **d)** and to ensure compliance with Reasonable and Prudent Measures and associated Terms and Conditions outline in the June 23, 1999 Biological Opinion on the Impacts of Forest Management and Other Activities to the Gray Bat, Bald Eagle, Indiana Bat, and Mead's Milkweed on the Mark Twain National Forest, Missouri.

The analysis presented in the Mark Twain National Forest Programmatic Biological Assessment (September 1998) is not repeated in this BAE, however it is incorporated by reference along with the Biological Opinion on the Impacts of Forest Management and Other Activities to the Gray Bat, Bald Eagle, Indiana Bat, and Mead's Milkweed on the Mark Twain National Forest, Missouri prepared by the U.S. Fish and Wildlife (June 1999).

Effects determinations for each species are summarized at the end of this document.

PROPOSED MANAGEMENT ACTION

Summary of Proposed Action: The Salem Ranger District is proposing to improve forest health, enhance wildlife habitat, and provide additional recreational opportunities in the Crooked Creek Analysis Area. The proposed action is needed due to declining

habitat diversity, declining forest health and vigor, and to meet desired future conditions as identified in the Mark Twain National Forest Land and Resource Management plan (LRMP), also known as the Forest Plan.

Project Location: The Crooked Creek Project is located in Crawford and Dent counties Missouri on USGS Quadrangles Short Bend, Howes Mill Spring, Viburnum West and Greeley within the Meramec River drainage (Hutchins Creek, Huzzah Creek, and Crooked Creek). The center of the project is approximately 37/42/00 by 91/15/00 (See attached maps).

Project Management Prescription Area: 3.4-1, 2, 3

Project Area Size: approximately 23,217 acres of Forest Service managed lands

Land Type Associations in Project Area: Oak Hickory Hills (HM), Oak Pine Hills (HL)

The alternatives that are being considered for implementation within the Crooked Creek Analysis Area are as follows:

Alternative 1 (No Action)

This alternative would initiate no new active management within the analysis area. This alternative provides a baseline (reference point) against which to describe the environmental effects of the two action alternatives being considered. This is a viable alternative and responds to concerns of those who want no active management to occur in the analysis area beyond what is currently ongoing as the result of natural processes, routine maintenance or current management direction. Existing term grazing permits would be allowed to expire.

Alternative 2 (Proposed Action)
This alternative would utilize commercial timber harvesting as a means for achieving forest health and vigor. This alternative would allow forest stands to be treated commercially by using the final harvets, seedtree, shelterwood, sanitation/salvage cut, overstory removal, selection with groups, and thinning methods. Some temporary openings created by proposed final harvest would be greater than 40 acres where proposed final harvest occurs next to existing final harvest temporary openings that are from 0 to 20 years old. Some firewood removal would also be allowed. Natural regeneration and pine planting would occur. These methods would achieve stand conditions that would favor regeneration of desirable tree species such as shortleaf pine, white oak, post oak, and hickory.

Several forest stands, including many timber harvest units, would be burned with prescribed fire to improve wildlife habitat and reduce hazardous fuels that may increase as a result of silvicultural treatments and may occur due to the level of tree mortality, wind and ice damage, understory growth, and past fire exclusion and to encourage pine and oak regeneration. Prescribed burning would most likely occur during the spring and fall seasons. In some cases, stands may be prescribe burned more than once in order to achieve open woodland conditions and a more herbaceous understory and improve the grass, forb, and shrub components of the ground cover.

Wildlife habitat would also be improved by hand cutting and/or mowing of existing open and semi-open habitat in order to remove competing vegetation, including several small dolomite glades, and the maintenance of existing waterholes. Some of the open and semi-open habitat areas will be burned on a 3 to 4 year rotation to encourage the proliferation of native grasses and forbs. In addition, term grazing permits will be re-issued with allotment management plans (that comply with the Forest Plan) for three existing grazing allotments.

The Forest Service in partnership with Missouri Department of Conservation would continue to maintain five lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah cutoff pond number 3, and Gnuse pond. The Forest Service proposes fish stocking, fish habitat improvements (including fish structures, fertilization, liming), and dam maintenance and reconstruction (including draining and deepening Howe's Mill Lake), for the five lakes and ponds managed for flat water fishing opportunities. This action will maintain existing flat water fishing opportunities for public fishing.

Some actions require other actions in order to be accomplished. These actions will be considered in the environmental analysis of this project.

Fire Lines: Existing roads and natural fire-breaks would be used whenever possible. New fire line construction would be necessary in some areas.

Proposed Road Work: There are 40 Forest Service system roads within the management areas, with a combined length of 52.5 miles. The analysis area contains approximately 36.3 square miles of National Forest System land. National Forest system roads within the analysis area vary from 0.1 miles to over 6 miles in length. The Crooked Creek project has 8.4 miles of system roads that need reconstruction before they can be used to access project activities. The other 44.1 miles of system road need routine maintenance, such as replacing surface material, surface blading, improving drainage features, removing brush from right-of-ways, and cleaning culverts. In addition to system roads, there are non-system roads on National Forest System land in the analysis area. The condition of these roads is usually fair to poor because no road improvement or maintenance work has ever been done. Approximately 55 miles of these non-system roads would be closed.

Alternative 3 (Reduced Final Harvest with Natural Regeneration Only)

This alternative would be the same as Alternative 2 <u>except</u> there would be 295 acres less of final harvest (reduced final harvest) and there would be no pine planting (natural regeneration only). Proposed final harvest next to existing temporary openings that would result in final harvest temporary openings greater than 40 acres are dropped in this alternative.

Table 1. Alternative Activity Comparison Table

	Alt.1	Alt.2	Alt. 3
Silvicultural Methods	**Acres**	**Acres**	**Acres**
Final Harvest	0	932	637
Seed Tree	0	26	26
Shelterwood	0	1332	1332
Uneven Aged	0	1706	1706
Over-story Removal	0	122	122
Sanitation	0	580	580
Thin	0	1206	1206
Reforestation	**Acres**	**Acres**	**Acres**
Natural Regeneration	0	2462	2167
Pine Planting	0	667	0
Timber Stand Improvement	**Acres**	**Acres**	**Acres**
Crop Tree Release	0	0	0
Prescribed Fire		**Acres**	**Acres**
Open woodland development	0	2445	2445
Hazardous fuel reduction	0	5956	5956
Transportation	Miles	**Miles**	**Miles**
Temporary	0	25	23
Reconstruction	0	8.4	8.4
Soil and Water	**Each**	**Each**	**Each**
Dump Clean-up	0	5	5
Non-system closure	0	55	55
Range/Wildlife	**Acres**	**Acres**	**Acres**
Grazing	0	345	345
Fertilize	0	345	345
Mechanical-Hand Cut, Mow, and Waterhole Maintenance	0	1375	1375
Fisheries *	**Acres**	**Acres**	**Acres**
Pond Rehab	0	16	16
Stock Fish	0	16	16

* Includes Howe's Mill Lake Deepening, Fish Structures, and Howe's Mill South Spillway

CONSULTATION HISTORY

In 1984, the Forest Service requested formal consultation with the US Fish and Wildlife Service (FWS) on the Mark Twain National Forest Land and Resource Management Plan (Forest Plan). On August 8, 1985 FWS issued a non-jeopardy biological opinion for seven federal species. In 1998, the Forest Service reinitiated programmatic consultation for continued implementation of the Forest Plan. Further consultation was needed to incorporate information gathered about federal threatened and endangered species over the past decade. A programmatic Biological Assessment (BA) that included ten federal species was submitted to FWS in September 1998. Determinations of no effect or not likely to adversely affect were made for six of the ten species. These determinations were concurred with by FWS during informal consultation. On June 23, 1999 FWS issued a non-jeopardy Biological Opinion that included the other four federal species.

SPECIES CONSIDERED AND EVALUATED

The threatened, endangered, proposed and candidate species addressed in this BE were identified in cooperation with the US Fish and Wildlife Service. Using information from field surveys and other knowledge of species distribution, species habitat requirements, reasons for species decline, limiting factors, and analysis area habitat conditions, the Mark Twain National Forest list of federally listed animals and plants in Missouri (updated 12/29/03), Forest GIS records and MO Dept. of Conservation records were reviewed for species that could potentially be affected under the action considered, including taking no action (see attached listing of MTNF Proposed, Endangered, Threatened and Candidate Species animal and plant species (PETC), (Table 2). Federally listed threatened and endangered species, species proposed for federal listing, and species proposed for federal candidate listing that may potentially be affected by this project were examined using the following existing available information:

1. Reviewing the list of PETC animal and plant species known or likely to occur on the Mark Twain National Forest, and their habitat preferences. This review included the U.S. Fish and Wildlife Service current list of endangered, threatened, proposed and proposed candidate species for the Forest.

2. Consulting element occurrence records (EOR's) for TES species as maintained by the Missouri Department of Conservation (MDC), and the Forest.

3. Consulting with individuals in the private and public sector who are knowledgeable about the area and its flora and/or fauna.

4. Reviewing Forest BE Program data for PETC species with known or potential habitat within Landtype Associations (LTAs) within analysis area.

5. Reviewing sources listed in the reference portion of this report.

6. Reviewing the results of past field surveys that may have been conducted in the area.

A "step down" process was followed to eliminate species from further analysis and focus on those species that may be affected by proposed project activities. Species not eliminated are then analyzed in greater detail. Results of this "step down" analysis process are displayed in the Occurrence Analysis Results (OAR) column of Table 2. First, the range of a species was considered. Species' ranges on the Forest are based on county records, but are refined further when additional information is available, such as

more recent occurrences documented in scientific literature or in Natural Heritage databases. Many times range information clearly indicates a species will not occur in the analysis area due to the restricted geographic distribution of most PETC species. When the analysis area is outside a known species range, that species is eliminated from further consideration by being coded as OAR code "1". For this project, 4 species were eliminated from further consideration because the analysis area is not within the species known range.

From existing site surveys in the analysis area, species were eliminated from further consideration because of: 1) lack of suitable habitat in the analysis area, (OAR code "2"); and 2) for aquatic species, the species or habitat is known downstream, but outside identified geographic bound of cumulative effects analysis area (OAR code "7"). For this project, 2 additional MTNF species were eliminated from further consideration because of one of the above reasons (see Table 2).

TABLE 2. MARK TWAIN NATIONAL FOREST Proposed, Endangered, Threatened and Candidate Species

Common Name-Species	Designation	Habitat	OAR*
Mammals			
Indiana bat- *Myotis solalis*	Endangered	Caves/forested areas, Forest wide, Cave Hollow Cave	6
Gray bat – *Myotis grisescens*	Endangered	Caves/riparian areas near caves, Forest wide, Cook;s cave	6
Birds			
Bald Eagle- *Haliaeetus leucocephalus*	Threatened	Near large bodies of water, Forest wide	6
Fishes			
Topeka shiner- *Notropis topeka*	Endangered	Large streams, slight to moderate current over sandy bottom, also gravel or silt. May coexist with scaly sand darter, Ouachita darter, speckled chub, or Sabine shiner, Cedar Creek Unit	1
Insects			
Hine's emerald dragonfly- *Somatochlora hineanan*	Endangered	Calcareous or limestone/dolomite wetlands and shallow, spring-fed steams draining into wet meadows and cattail marshes, Salem, Potosi, Hou/Rolla RD, Barton, Bates, Grasshopper Hollow fens	4
Clams (mussels, unionids)			
Curtis' pearlymussel – *Epioblasma florentina*	Endangered	Large river drainages with moderate current, Doniphan, PB RD, Black, Castor, Little Black River, Cane Creek	1
Pink mucket pearlymussel – *Lampsilis abrupta*	Endangered	Large river drainages with gravelly bottoms, Don/11Pt, Potosi, PB RD, lower Big, Meramec, Osage, Little Black, St. Francis, Black	8
Scaleshell mussel – *Leptodea leptodon*	Endangered	Large rivers in mud, Hou/Rolla RD, Auxvasse Creek, Big, Gasconade, Meramec Rivers	7
Snails			
Tumbling Creek cavesnail – *Antrobia culveri*	Endangered	Cave aquatic systems, Ava RD	1
Amphibians			
Ozark hellbender - *Cryptobranchus allenganiensis bishopi*	Candidate	Large river drainages, Willow Springs Unit, Don/11Pt RD, Black and N. Fork White	1
Plants			
Running buffalo clover – *Trifolium stoloniferum*	Endangered	Open woods along streams, Forest wide introduced, Fred'town wild	3
Mead's milkweed – *Asclepias meadii*	Threatened	Igneous, chert glades; prairies, Potosi/Fred'town RD, Bell Mnt wilderness	2

Coding for Occurrence Analysis Results (OAR)

LEGEND FOR TES LIST:

OCCURRENCE ANALYSIS RESULTS (OAR) CODES:

1 = Project located out of known species range.
2 = Lack of suitable habitat for species in analysis area.
3 = Habitat present, species was searched for during field survey, but not found.
4 = Species occurs in analysis area, but outside of activity area.
5 = Field survey located species in activity area.
6 = Species not seen during field survey, but possibly occurs in activity area based on habitat observed or field survey not conducted when species is recognizable.
7 = Aquatic species or habitat known or suspected downstream of project/activity area, but outside identified geographic bounds of water resource cumulative effects analysis area (defined as point below which sediment amounts are unquantifiable).
8 = Aquatic species or habitat known or suspected downstream of project/activity area, but inside identified geographic bounds of water resource cumulative effects analysis area.

The "analysis area" is defined as the area in which activities associated with one or more of the alternatives could potentially have a direct, indirect, or foreseeable cumulative effect upon a federal species or habitat in which the species is likely to occur.

The following species are not evaluated further in this BAE for the following reasons:

Topeka shiner (*Notropis topeka*)- the analysis area is not within the documented range of this species. It is found in only a few drainages north of the Missouri River approximately 90 miles north of the analysis area. The district that has potential to affect this species or its habitat is Cedar Creek.

Curtis' pearlymussel (*Epioblasma florentina)*- the analysis area is not within the documented watersheds of this species. It is found in the Black, Castor, Little Black River, and Cane Creek. The Black River locations are approximately 65 miles SE of the analysis area. The districts that have potential to affect this species or its habitat are Doniphan and Poplar Bluff.

Scaleshell mussel (*Leptodea leptodon)*- The species is recorded in the Meramec River downstream of the analysis area, but is outside of the identified geographic bounds of water resource cumulative effects analysis area. It is recorded from Auxvasse Creek, Big, Gasconade, and Meramec Rivers. The Gasconade River locations are approximately 42 miles NW of the analysis area. The districts that have potential to affect this species or its habitat are Houston/Rolla and Potosi/Fredericktown.

Tumbling Creek cavesnail (*Antrobia culveri)*- the analysis area is not within the documented range of this species. It is known from one privately owned cave located in Taney County approximately 114 miles SW of the analysis area. The district that has potential to affect this species or its habitat is Ava.

Ozark hellbender (*Cryptobranchus allenganiensis bishopi)*- the analysis area is not within the documented watersheds of this species. It persists in the Current, Black and N. Fork of the White Rivers. The Current River locations are approximately 23 miles south of the analysis area. The districts that have the potential to affect this species or its habitat are Willow Springs and Doniphan/Eleven-Point.

Mead's milkweed (*Asclepias meadii)*- the analysis area is not with the documented range of this species and suitable igneous glade/prairie habitat is not known to occur within the analysis area. It is located approximately 18 miles east of the analysis area. The district that has the potential to affect this species or its habitat is Potosi/Fredericktown.

The following species or their habitat could potentially be affected by actions in the analysis area, and potential effects to these species are displayed in this Biological Evaluation:

Gray bat (*Myotis grisescens*)
Indiana bat (*Myotis sodalis*)
Bald eagle (*Haliaeetus leucocephalus*)
Hine's emerald dragonfly (*Somatochlora hineanan)*
Running buffalo clover (*Trifolium stoloniferum)*
Pink mucket pearlymussel (*Lampsilis abrupta).*

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 LTA's 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 project influence area.

SURVEY INFORMATION

In preparation of this BAE, site-specific surveys within the analysis area were combined with a general knowledge of the habitats that are likely or known to occur within the project influence areas. Sarah Bradley (USFS biologist) conducted biological field surveys of the analysis area on 5/14/02, 5/23/02, 12/11/02, 4/29/03, 5/12/03, 8/13/03, 8/14/03, and 12/18/03. These surveys were cursory in nature and focused on determining the habitat conditions within the analysis area and locating potential habitat for wildlife species.

Botanical surveys are also being conducted by a contract botanist (Alan Brant) from September 2003 to September 2004 and results of those surveys have been reviewed as part of this BE. These botanical surveys are focusing on the drainages within the analysis area (generally considered areas of highest potential for rare plant communities).

Additional special habitat information such as seep, fen, and glade locations was collected by Angie Sites, Larry Ness (USFS Forestry Technicians) John Bryan, and David Massengale (USFS Foresters) during their extensive heritage resource and prescription field surveys within the analysis area and reviewed during the preparation of this BE.

Other surveys not specific to this project have been conducted in the vicinity of the analysis area. For example, in partnership with Mark Twain National Forest and others, the Missouri Department of Conservation has been very aggressive in conducting species surveys and maintaining data on both listed and common species. The Missouri Heritage Database not only includes specific locations of plant and animal species, but also includes occurrences of unique and/or rare natural communities. Many of these communities are suitable habitat for sensitive species. This database provides an excellent and up-to-date source of information on occurrences of TES species.

The Missouri Fish and Wildlife Information System (MOFWIS) includes information on over 700 species of animals and plants (life history, status, known & possible locations, etc.). This database is also an excellent source of information regarding possible locations of TES species on Mark Twain National Forest.

Species' experts in Missouri have also been very aggressive in publishing excellent reference material that includes species' locations in the state as well as potential habitat. Publications include: Missouri Wildflowers, Missouri Orchids, Field Guide to Missouri Ferns, Walk Softly Upon the Earth (lichens & mosses), Steyermark's Flora of Missouri, Flora of Missouri, Volume 1, Butterflies and Moths of Missouri, The Crayfish of Missouri, The Fishes of Missouri, Naiades of Missouri, Birds of Missouri, and The Amphibians and Reptiles of Missouri. All these publications were consulted during evaluation of potential effects to sensitive species within the Crooked Creek Analysis area.

The Nature Conservancy maintains Element Stewardship Abstracts and Element Global Rankings that give specific information on species' locations, habitats, threats, propagation, life history, etc. The Natureserve website contains distribution and status information on a variety of species and natural communities. These data sources were also consulted when analyzing potential effects of implementing alternatives in the Crooked Creek Analysis area.

In addition to the extensive fieldwork done in preparation of the Missouri Heritage and MOFWIS databases and the publications, there are numerous field surveys conducted annually or as part of research projects in Missouri. The Mark Twain National Forest also has conducted surveys in partnership with others, or on its own. A sampling of these, include but are not limited to:

- Annual mid-winter eagle surveys – Current River
- Annual eagle nest surveys
- Forest bat surveys (cave, fall, summer, winter, mist-net, harp-trap, Anabat)
- Missouri Breeding Bird Atlas
- Missouri Breeding Bird Survey Routes
- Cave Research Foundation Biological Inventories
- Gardner & Gardner Cave Inventories
- Botanical Surveys
- Naiades survey 1980-1982

All these surveys are relevant to the Crooked Creek Analysis area. While not all of them were conducted specifically on the Crooked Creek Analysis area, they provide information concerning suitable habitats for various species on this district.

Specialists in biology, soils, timber, and heritage resources conducted field visits throughout the analysis area during the pre-NEPA phase of planning, and during project planning. These visits were conducted at various times of the year for various reasons.

The information available on TES locations and potential habitats in the Crooked Creek Analysis area is of sufficient quantity, quality, and relevance to make an accurate and complete analysis of potential effects on TES species in the Crooked Creek Analysis area. I believe enough information is available to make a reasoned management decision. Therefore, additional surveys are not needed for this project decision.

In summary, this analysis of effects upon federally listed species is based upon information obtained during the field surveys that have been conducted in the vicinity of this project, as well as an assumption that habitat for the species addressed in detail may exist within the project influence area.

ENVIRONMENTAL BASELINE

Gray bat

General habitat requirements – Gray bats roost in colonies in a wide variety of caves throughout the year. Because of their high dependence upon caves for roosting and reproduction, this species is most vulnerable to activities that could disturb or negatively alter their cave environment. Foraging habitat for gray bats generally consists of forested riparian areas and/or over open water of rivers or lakes, generally up to 12 miles from their caves (U.S. Forest Service 1998). For both foraging and roosting, gray bats are generally restricted to areas in close proximity to rivers, lakes, and large streams.

Distribution on the MTNF – There are at least 14 known gray bat caves on Mark Twain National Forest, including one on the Salem District (U.S. Forest Service 1998). In addition, there are other gray bat caves on private lands adjacent to the National Forest. There is no critical habitat (as defined by the Endangered Species Act) for the gray bat on the Mark Twain National Forest.

Mist netting for forest bats was conducted in the spring-fall of 1997, 1998, 1999, 2001, and 2003 on several Mark Twain National Forest locations, including the Salem and Potosi/Fredericktown District. A few gray bats were caught at several locations. Harp trapping has also been done at known gray bat cave entrances in the fall of 1997, 1998, 1999, and 2001. Gray bats were also caught during these efforts. Population counts are conducted at gray bat caves in cooperation with the Missouri Department of Conservation bat biologist.

Occurrence within project area – No gray bats have been documented within the analysis area and no suitable caves are known to occur within the analysis area. The closest known gray bat cave lies approximately 16 miles to the north. Given the distribution and proximity of gray bats known from within the vicinity of the analysis area, it would not be surprising to find gray bats within the analysis area. Gray bats could potentially use any of the larger perennial streams as foraging habitat. The likelihood of a gray bat colony occurring in the analysis area is considered low due to the fact that no caves are know within the analysis area. According to the BE Program, 12 acres of suitable gray bat foraging habitat occurs within the analysis area. MOFWIS identified

this species as occurring or likely to occur in Crawford and Dent Counties within the Meramec drainage.

Indiana bat

General habitat requirements – The Indiana bat occupies a wide variety of roost sites and environments. During the hibernation period (generally November- March), the Indiana bat roosts in caves where it is protected from winter temperature extremes. Outside the winter period, however, the Indiana bat frequents areas outside its caves and utilizes standing snags, trees with loose bark, and occasionally abandoned buildings as roost sites and maternity colony sites. Generally, the male's summer roost trees are located with 5 miles of an Indiana bat occupied cave, in forested areas with some canopy gaps that allow moderate sunlight to warm roost trees. In Missouri, all the known female maternity roost trees have been located north of the Missouri River in the upper two tiers of counties within the prairie regions of Missouri, and not near or on the Mark Twain National Forest. Another fairly close known maternity colony is in Illinois, along the Mississippi River corridor. In June 2003, a pregnant Indiana bat was captured during mist net surveys at Silver Mines Recreation Area on the Mark Twain National Forest in Madison County, approximately 50 miles east of the Crooked Creek analysis area. This was the first documented record of a reproductively active female Indiana bat from the Mark Twain National Forest.

Distribution on the MTNF –The entire Mark Twain National Forest is within the documented range of the Indiana bat throughout the year. There are only two known Indiana bat hibernacula (caves) documented on the Mark Twain National Forest, one of which is located on the Potosi-Fredericktown District that adjoins the Salem District. When not hibernating, roosting male and female Indiana bats may occur anywhere on the National Forest where suitable habitat as described previously exists. However, in 5 years of spring-fall mist netting on the Mark Twain National Forest, no male Indiana bats have been captured. To date, 4 reproductively active female Indiana bats have been documented near the National Forest and in June 2003, a pregnant Indian bat was captured on the National Forest, indicating that maternity colonies may exist on the National Forest. However, none of these captures have led to the discovery of maternity colonies. Four of the five reproductively active females captured closest to the NF were found within 5 miles of significant Indiana bat hibernaculum. None of the National Forest has been designated by the USFWS as critical habitat for this species.

Occurrence within project area – No Indiana bats have been documented within the analysis area; however, the BE Program identified several acres of suitable foraging/roosting habitat within the analysis area. The closest know Indiana bat hibernacula is approximately 8 miles east of the analysis area. Reproductively active female Indiana bats have been documented from Iron and other nearby counties, with the closest being approximately 33 east miles of the analysis area. The closest documented maternity colonies are in Illinois, approximately 100 miles east of the analysis area. MOFWIS identified this species as occurring or likely to occur in Crawford and Dent Counties within the Meramec drainage.

Bald Eagle

General habitat requirements – Year-round, bald eagles are most often associated with areas near large bodies of water such as rivers, lakes and reservoirs. In the winter, bald eagles tend to congregate in these areas and roost communally, often in a tree in a ravine or other wind-protected areas. In the summer, bald eagles prefer to nest in a floodplain forest in which the largest, stoutest, tree or a coniferous or dead tree are most often selected as the nest tree. Once a nest tree is established, bald eagles may use it for several years. Usually, the nest site has a clear flight patch to a water source and is within 0.5 mile of water.

Distribution on the MTNF – Bald eagles are frequently observed singly or in small groups along major water bodies and rivers on the Mark Twain National Forest during the winter months. Associated with these wintering sites are reports of communal night and day roosts, however, none of these roosts have been reported from the National Forest. There are several bald eagle nest locations near the National Forest, however, none known on the Forest. However, potential for nesting eagles does exist in the habitats that are frequently utilized by the species in the winter months.

Occurrence within project area –The best potential habitat for bald eagle roosts and nests would be along the East and West Fork of Huzzah Creek and the edges of the larger perennial streams with/near the analysis area. No bald eagle roosts or nests are known to occur with the analysis area and none of the streams contained within the analysis area are likely to be large enough in size to support wintering or nesting bald eagles. The closest known bald eagle roost site and nest sites are 59 miles S and 22 miles SW respectively from the analysis area.

Bald eagles have been seen within/near the analysis area during the winter. This in not surprising since many bald eagles over-winter along the Meramec River and are often wide ranging during the winter months as they forage for food. However, even during the winter months, eagles would most likely be found near a large stream or lake.

The BE program did not identify any suitable habitat for the species within the analysis area. MOFWIS identified this species as occurring or likely to occur in Crawford and Dent Counties within the Meramec drainage.

Hine's Emerald Dragonfly

General habitat requirements – Hine's emerald dragonfly lives in wetlands dominated by grass or grass-like plants and fed primarily by water from a mineral source, or fens. Two important habitat characteristics common to sites occupied by this species are that the sites be fed by groundwater with shallow water moving through vegetation, and the presence of underlying dolomitic or calcareous limestone. Generally, these sites are also open with nearby or adjacent forest. Open areas provide places for the species to forage while forest areas provide shade and protection for roosting dragonflies. Preserving the natural hydrology and water quality of these sites are key to maintaining habitat for this species where it exists.

Distribution on the MTNF – This species was first discovered on the MTNF in August 1999, and prior to that discovery, had been assumed to occur north of the National Forest. Since the first discovery on the National Forest, an additional 12 sites that harbor this

species have been recorded on or near the MTNF (Vogt, 2004). All of these sites represent calcareous fens and open wetland areas typical of the habitat expected for this species.

Occurrence within project area – This species has been documented in Bates Hollow within the analysis area. There are other recently discovered fens within the analysis area that are suitable habitat and many of them have not yet been surveyed for this species.

The BE Program did not identify any other suitable habitat for this species within the analysis area. MOFWIS identified this species as occurring or likely to occur in Crawford and Dent Counties within the Meramec drainage.

Running Buffalo Clover

General habitat requirements – Running buffalo clover may have once been fairly widespread in Missouri, where it likely flourished along streams and bison trails. The species prefers semi-shaded woods and depends upon slight levels of disturbance. The species does not occur in areas of full sun. It is likely dispersed by the droppings of free-ranging herbivores and may have benefited from periodic burning that historically would have created open woodlands (U.S. Forest Service 1998).

Distribution on the MTNF – While it may have historically occurred on the National Forest, today, no naturally occurring wild populations are known on the MTNF. However, through an inter-agency cooperative effort, the species has been reintroduced to sites on the National Forest, none of which are located on the Salem District. These sites will be surveyed in 2004 to determine if the introduced populations still exist.

Occurrence within project area – There are no known occurrences of this species within the analysis area. The closest known site for this species is approximately 16 miles N of the analysis area. Potential habitat for the species would most likely be found along the perennial streams within the analysis area, especially where burning or some other prior disturbance has created semi-open conditions. However, no individuals of this species have been located so far during extensive botanical surveys of stream corridors during 2003 and 2004 by Alan Brant. The BE Program did not identify any suitable habitat for this species within the analysis area. MOFWIS did not identify this species as occurring or likely to occur in Crawford and Dent Counties within the Meramec drainage.

Pink mucket pearlymussel

General habitat requirements – This species is associated with large rivers with gravel-cobble substrate.

Distribution on the MTNF –The pink mucket persists in the Current River, Meramec River, and the Black River (below the dam). It's viability in the Meramec basin is questionable, but may be influenced by activities occurring in the headwaters of the Meramec River (U.S. Forest Service 1998). Part of the analysis area occurs in the Huzzah watershed, which is within the headwaters of the Meramec.

Occurrence within project area – No known sites for this aquatic species occur within the analysis area. The closest know site for this species is approximately 55 air miles (100 river miles) NE of the analysis area in the Meramec River.

The BE Program did not identify any suitable habitat for this species within the analysis area. MOFWIS identified this species as occurring or likely to occur in Crawford and Dent Counties within the Meramec drainage.

EFFECTS OF THE PROPOSED MANAGEMNT ACTIONS

Gray Bat

Direct Effects (Alternatives 1-3): Since no gray bats are known to occupy the analysis area and the closest known gray bat record is approximately 16 miles N of the analysis area, none of the activities proposed for implementation in Alternatives 1-3 would be expected to have a direct effect upon any gray bats or their occupied habitat. None of these activities would likely be directly impacting any known caves or individual gray bats.

Indirect Effects (Alternative 1): Under Alternative 1, there may be an indirect effect upon potential habitat for this species. The anticipated die-off of trees due to lack of treatment may contribute to more intense wildland fires within the analysis area. Fuels would build-up within the forested stands as they succumb to disease and insects. Should an intense wildland fire occur within the analysis area as a result of lack of treatment of forest stands, it could contribute to increased soil loss and sedimentation of streams in the analysis area. Negative impacts upon the water quality of these streams could have an adverse effect upon the aquatic insects within the stream, and therefore, indirectly affect the prey base for the gray bats. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area, however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered “reasonably certain to occur”.

Alternative 1 would also not implement any activities, such as erosion control, dump removal, and non-system road closure, which could have an indirect beneficial effect upon the water quality of the streams within the analysis area.

Alternative 1 would not have any indirect effect upon caves known or likely to be occupied within the analysis area because no caves are known to occur within the analysis area.

Cumulative Effects (Alternative 1): Based upon known past, present, and foreseeable effects, Alternative 1 is not expected to contribute to an adverse cumulative effect upon the gray bat or its habitat. The MTNF caves constitute only 9% of the gray bat caves in Missouri and land use practices and activities that may impact the remaining gray bat caves are outside the control of the Forest Service.

Under Alternative 1, no new activities would contribute to the cumulative effect of soil movement into streams. However, the current effects occurring within the watersheds of the analysis area as the result of existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would also not be minimized under Alternative 1. Therefore, while there are not any anticipated cumulative adverse effects resulting from the implementation of Alternative 1, there also are no anticipated cumulative beneficial effects, either, because this alternative would not involve a change in the existing conditions within the watersheds and no change in existing water quality, which has an influence on the availability food for the gray bat.

NEPA Cumulative Effects (Alternative 1): 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. No new activities would contribute to the cumulative effect of soil movement into streams. However, the current effects occurring within the watersheds of the analysis area as the result of existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would also not be minimized under Alternative 1. Therefore, while there are not any anticipated cumulative adverse effects resulting from the implementation of Alternative 1, there also are no anticipated cumulative beneficial effects, either, because this alternative would not involve a change in the existing conditions within the watersheds and no change in existing water quality, which has an influence on the availability food for the gray bat.

Summary of BO Compliance (Alternative 1): The June 23, 1999 Biological Opinion requires compliance with Terms and Conditions developed to protect and maintain the gray bat and its habitat on the MTNF. Alternative 1 complies with those Terms and Conditions as follows:

- The alternative is not likely to result in disturbance to any gray bat caves.
- The alternative does not inhibit ongoing monitoring of gray bat populations.
- The alternative does not impact the 20 acres of designated old growth around occupied gray bat caves.
- The alternative does not involve or influence controlled burning activities that may impact gray bat caves.

Determination of Effect and Rationale (Alternative 1): Alternative 1 would have *no direct effect* and *is not likely to indirectly adversely affect* the gray bat or potential habitat for this species. The potential for indirect effects upon the prey base for this species may be increased under this alternative because no activities would occur to improve the health and conditions of forested stands within the analysis area, making them susceptible to intense wildland fires, insect outbreaks, disease, or other forces that could lead to diminished water quality. However, this potential cannot be measured and may be considered speculative. The implementation of Alternative 1 is expected to have *no cumulative adverse effect* upon the gray bat because it is not expected to influence potential recovery of this species throughout its range and would be in compliance with the FWS BO Terms and Conditions.

If a gray bat is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Indirect Effects (Alternatives 2-3): The activities proposed have some potential for indirect effects upon gray bats by indirectly affecting the water quality of streams within the analysis area. Negative impacts upon the water quality of these streams could have an adverse effect upon the aquatic insects within the stream, and therefore, indirectly affect the prey base for the gray bats.

Activities with the greatest potential for impacts upon water quality involve those activities that would disturb the soil surface. In these alternatives, these activities include temporary road construction, road reconstruction, skidding and dragging associated with commercial removal of merchantable timber, the construction of dozerlines, and, to a lesser degree, erosion control activities, glade restoration, fishing pond rehabilitation, wildlife habitat improvement, and grazing.

However, several protective measures have been incorporated into these alternatives that will minimize any potential for soil movement during these activities. With implementation of these protective measures, no soil movement is expected to occur at rates that would adversely affect the water quality of adjacent streams, and therefore, the prey base for gray bats. Past monitoring of similar projects on the MTNF has indicated that soil movement levels were well within the allowable soil loss established in the Forest Plan (U.S. Forest Service 2002).

There is also potential for indirect impacts upon gray bats that may be occupying undiscovered or unknown caves within the analysis area. This potential is considered very low due to the fact that no caves are known to occur within the analysis area and none were located during various field surveys of the analysis area. However, should a cave be located, its entrance will be protected from disturbance by a 100’ buffer zone.

Prescribed burning activities proposed within the analysis area may create drift smoke in the vicinity of occupied gray bat caves. However, with implementation of parameters that will favor smoke dispersal, it is not likely that this smoke will settle heavily in areas that contain known gray bat caves. Considering the fact that the closest known gray bat site is 16 miles from the analysis area, it is highly unlikely that it would be impacted by any prescribed burning activities. Prescribed burning activities will be conducted in a manner to ensure that smoke does not accumulate heavily in areas likely to be occupied by Indiana or gray bats.

Some of the activities proposed in these alternatives may also have an indirect beneficial effect upon potential habitat for the gray bat. Under these alternatives, some activities would occur that may enhance the water quality of streams within the analysis area, and therefore, improve habitat for gray bat prey (aquatic insects). Activities that would improve water quality include non-system road closure, dump removal, and erosion control activities. All of these proposed activities would improve potential habitat for gray bats.

Cumulative Effects (Alternatives 2-3): Based upon known past, present, and foreseeable effects, Alternatives 2 and 3 are not expected to contribute to an adverse cumulative effect upon the gray bat or its habitat. The MTNF caves constitute only 9% of

the gray bat caves in Missouri and land use practices and activities that may impact the remaining gray bat caves are outside the control of the Forest Service. Management activities proposed in Alternatives 2 and 3 are not likely to contribute to activities that may adversely impact any gray bat caves or their foraging habitat. The current effects occurring within the watersheds of the analysis area as the result of existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would be reduced under Alternative 2 and 3. Therefore, these activities may result in cumulative beneficial effects by helping to improve water quality within the analysis area.

NEPA Cumulative Effects (Alternatives 2-3): 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, are not likely to contribute to activities that may adversely impact any gray bat caves or their foraging habitat. The current effects occurring within the watersheds of the analysis area as the result of existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would be reduced under Alternative 2 and 3. Therefore, these activities may result in cumulative beneficial effects by helping to improve water quality within the analysis area.

Summary of FWS BO Compliance (Alternatives 2-3): The June 23, 1999 Biological Opinion (U.S. Fish and Wildlife Service 1999) requires compliance with Terms and Conditions developed to protect and maintain the gray bat and its habitat on the MTNF. The activities proposed in Alternatives 2 and 3 comply with those Terms and Conditions as follows:

- The alternatives are not likely to result in disturbance to any gray bat caves.
- The alternatives do not inhibit ongoing monitoring of gray bat populations.
- The alternatives do not impact the 20 acres of designated old growth around occupied gray bat caves.
- Prescribed burning activities proposed will comply with BO terms and conditions.

Determination of Effect and Rationale (Alternatives 2-3): Implementation of activities proposed in Alternatives 2 and 3 are *not likely to have an adverse effect* upon gray bats or their habitat. No direct or indirect disturbance to known gray bat caves or their foraging habitat is anticipated as a result of any of these activities. While the potential does exist for undiscovered gray bat caves to be in the analysis area, based upon past surveys, this potential is considered very low. Any foraging gray bats or their foraging habitat that may be within the analysis area are not likely to be impacted by the proposed activities. The implementation of Alternatives 2 and 3 would be expected to have no cumulative effects upon gray bats because they do not jeopardize recovery of the species and is in compliance with USFSW BO terms and conditions.

If a gray bat is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Indiana Bat

Direct Effects (Alternative 1): Alternative 1 would not be expected to have any direct effects upon Indiana bats during their hibernation or fall and spring swarming periods (generally October thru April), or upon their hibernacula because no hibernacula are known to occur within or near the analysis area. The closest hibernaculum (Cave Hollow Cave) is approximately 8 miles from the analysis area and, therefore, neither it, nor the habitat likely to be used for spring and fall "swarming" (generally 5 miles from a hibernaculum) would be affected by this alternative. There is also no potential hibernation habitat within the analysis area, since no caves have been located. Therefore, no direct effect upon wintering habitat for the Indiana bat is anticipated as the result of implementation of Alternative 1.

Indiana bats may occur within the analysis area during their summer roosting period (generally May thru September). During this time, Indiana bats may be using trees within the analysis area as roosts and maternity colonies. If so, the bats are vulnerable to activities that may disturb these roost trees, such as tree felling, burning, etc. Under Alternative 1, no activities are proposed that would directly disturb any suitable Indiana bat roost trees and 0 acres of forested habitat would be directly affected by this alternative. Therefore, there are no anticipated direct effects upon Indiana bat summer habitat if Alternative 1 is implemented.

Indirect Effects (Alternative 1): The activities proposed in Alternative 1 are not expected to have any indirect effect upon Indiana bat hibernating, or fall/spring swarming habitat for the same reasons as stated above for the potential for direct effects.

However, there are indirect effects upon Indiana bat summer roosting and foraging habitat that are anticipated if Alternative 1 is implemented. These indirect effects include changes in the availability and quality of suitable foraging habitat for Indiana bats within the analysis area, as well as changes in the availability of suitable roost trees within the analysis area.

Under Alternative 1, no activities would occur within the analysis area that would improve the health and resistance of existing forest stands. Many of these stands are currently suffering from or highly susceptible to infestations of red oak borers and other insects. If no treatment occurs within these stands, it is anticipated that several hundred acres may affected by these insect infestations, resulting in die-off of many oaks, particularly scarlet and black oaks (J. Bryan, pers.comm.). In the short-term, this may improve foraging and roosting habitat for the Indiana bat, because it would result in more open canopied stands and a high number of standing dead trees that could be used as roosts and maternity sites. Over the long-term, however, if no treatment occurs, these stands are likely to gradually succeed to more closed canopy conditions, especially with the exclusion of fire. Closed canopy (> 70%) would be considered less than optimum foraging habitat for Indiana bats.

The anticipated die-off of trees due to lack of treatment may also contribute to more intense wildland fires within the analysis area. Fuels would build-up with the forested stands as they succumb to disease and insects. Intense wildland fires would have the potential of creating large areas of < 30% canopy cover, which would not be considered

suitable Indiana bat foraging habitat. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area, however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered "reasonably certain to occur".

Overall, Alternative 1 is not expected to improve habitat conditions within the analysis area for the Indiana bat. While there would be no direct loss of existing foraging habitat within the analysis area, implementation of Alternative 1 may still contribute to an indirect loss of foraging habitat within the analysis area by failure to treat currently overstocked, unhealthy forest stands. Under Alternative 1, existing waterholes would not be maintained, eventually leading to a decrease in the availability of upland water sources. The availability of roost trees within the analysis area is anticipated to remain relatively constant or increase, since this alternative would allow existing forest stands to continue to mature and create conditions likely to lead to an increase in the number of dying trees within analysis area.

According to the BE Program, Alternative 1 will affect suitable Indiana bat foraging habitat as follows:

Acres Destroyed	Acres Reduced	Acres Maintained	Acres Created	Acres Enhanced
0	0	4980	0	0

Cumulative Effects (Alternative 1): Based upon known past, present, and foreseeable effects, the implementation of Alternative 1 is not likely to have an adverse cumulative effect upon the Indiana bat or its habitat. This alternative would not have any cumulative effect upon cave use by Indiana bats because it does not affect any habitat within 5 miles of a known Indiana bat cave. None of the activities proposed in this alternative would contribute to a permanent loss of foraging habitat for Indiana bats. Continued conversion of private forestland to agriculture or residences within the range of the Indiana bat may result in the cumulative loss of foraging and roosting habitat over the long term, however, these activities on private lands are not within the jurisdiction of the U.S. Forest Service and are not necessarily influenced by this proposal.

However, failure to take actions that would improve the resistance of forest stands to insects, wildfire, and disease may lead to a cumulative short-term loss of some suitable foraging habitat within the analysis area, however, this loss would be offset by the availability of suitable foraging habitat elsewhere in the analysis area, since not all stands would likely be vulnerable to these forces.

NEPA Cumulative Effects (Alternative 1): 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 not likely to have an adverse cumulative effect upon the Indiana bat or its habitat. This alternative would not have any cumulative effect upon cave use by Indiana bats because it does not affect any habitat within 5 miles of a known Indiana bat cave. None of the activities proposed in this alternative would contribute to a permanent loss of foraging habitat for Indiana bats. Continued conversion of private forestland to agriculture or residences within the range of the Indiana bat may

result in the cumulative loss of foraging and roosting habitat over the long term, however, these activities on private lands are not within the jurisdiction of the U.S. Forest Service and are not necessarily influenced by this proposal.

However, failure to take actions that would improve the resistance of forest stands to insects, wildfire, and disease may lead to a cumulative short-term loss of some suitable foraging habitat within the analysis area, however, this loss would be offset by the availability of suitable foraging habitat elsewhere in the analysis area, since not all stands would likely be vulnerable to these forces.

Summary of BO Compliance (Alternative 1): The June 23, 1999 Biological Opinion requires compliance with Terms and Conditions developed to protect and maintain the Indiana bat and its habitat on the MTNF. Alternative 1 complies with those Terms and Conditions as follows:

- All known Indiana bat caves remain protected from human disturbance.
- The alternative does not impact the designated old growth and mature forest around Indiana bat caves.
- The alternative complies with minimum basal area and leave tree requirements specified in the BO and FLRMP.
- The alternative will not involve activities within 0.25 mile of a known Indiana bat maternity site or any Area of Influence (AOI) for Indiana bats.
- The alternative will not affect management recovery strategies for caves or lands on or adjacent to the MTNF.
- There are no prescribed burning activities proposed.
- The alternative does not affect ongoing Indiana bat monitoring, surveys or research activities.
- The alternative will not exceed allowable "take" during any given fiscal year because it does not implement any activities that would directly affect forested habitat.

Determination of Effect and Rationale (Alternative 1): Alternative 1 would have *no direct effect* and *is not likely to indirectly adversely affect* the Indiana bat or potential habitat for this species. The potential for indirect effects upon some potential habitat for this species may be increased under this alternative because no activities would occur to improve the health and conditions of forested stands within the project area, making them susceptible to intense wildland fires, insect outbreaks, disease, or other forces. However, this potential cannot be measured and may be considered speculative. The implementation of Alternative 1 is expected to have *no cumulative adverse effect* upon the Indiana bat because it is not expected to influence potential recovery of this species throughout its range and would be in compliance with the FWS BO Terms and Conditions.

If an Indiana bat is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated

Direct Effects (Alternatives 2-3): The activities proposed in Alternatives 2-3 would not be expected to have any direct effects upon Indiana bats during their hibernation or fall and spring swarming periods (generally October thru April), or upon their hibernacula because no hibernacula are known to occur within or near the analysis area. The closest

hibernaculum (Cave Hollow Cave) to the project area is approximately 8 miles from the analysis area and, therefore, neither it, nor the habitat likely to be used for spring and fall "swarming" (generally 5 miles within a hibernaculum) would be impacted by any of the proposed activities in Alternatives 2-3. There is also no potential hibernation habitat within the analysis area, since no caves have been located. Therefore, no direct effect upon wintering habitat for the Indiana bat is anticipated as the result of activities proposed in Alternatives 2-3.

There is a potential for directly impacting Indiana bats, however, during their summer roosting period (generally May thru September). Activities proposed that may have a direct adverse effect upon Indiana bats include timber harvesting, temporary road construction, prescribed burning, dozerline construction, glade restoration, and wildlife habitat improvement. These activities all have the potential of impacting bats that may be roosting in trees during the summer, particularly trees with characteristics that make them favorable for bat use. These direct adverse impacts could be the killing of roosting bats when trees are felled or burned, or abandonment of roost sites caused by disturbance created by activities associated with these treatments.

Many of the stands that would be affected by tree felling activities or prescribed burning contain suitable potential roost trees for Indiana bats. Stands proposed for timber harvesting and prescribed burning would have the greatest potential for suitable roost trees, because these stands tend to have larger diameter, older trees than stands and areas proposed for wildlife habitat improvement, or glade restoration. The number of acres of forested habitat that would be treated in these alternatives and that offers potential summer habitat for Indiana bats can be found in Tables 3 and 4.

Table 3. As of April 13, 2004, forested acres offering suitable habitat for Indiana bat use that would be affected by Alternative 2 (Acres per FY is estimated).

Treatment	Forest Total Acres Incid Take Allowed Each FY	Total Ac Proposed in Analysis Area	FY 2004		FY 2005		FY 2006		FY 2007		FY 2008	
			Crooked Cr	Forest Total	Crooked Cr	Forest Total	Crooked Cr	Forest Total	Crooked Cr	Forest Total	Crooked Cr	Forest Total
TIMBER HARVEST	**20,000**	5,904	710	**7261**	2315	**7210**	1587	**5621**	1292	**4974**	0	*
ROAD CN-Road Recon.	**25**	12	3	**9**	3	**22**	3	**22**	3	**22**	0	*
RX FIRE-Prescribed burning	**12,000**	8,401	0	**9375**	526	**11162**	2552	**9322**	3810	**7380**	941	*
SW IMP-rd closures and dump cleanup	**150**	68	17	**59**	17	**25**	17	**17**	17	**17**	0	*
WL HAB IMP-thin stands	**2000**	547	198	**445**	349	**848**	0	**9**	0	**12**	0	*

Table 4. As of April 13, 2004, forested acres offering suitable habitat for Indiana bat use that would be affected by Alternative 3 (Acres per FY is estimated).

Treatment	Forest Total Acres Incid Take Allowed Each FY	Total Ac Proposed in Analysis Area	FY 2004		FY 2005		FY 2006		FY 2007		FY 2008	
			Crooked Cr	Forest Total	Crooked Cr	Forest Total	Crooked Cr	Forest Total	Crooked Cr	Forest Total	Crooked Cr	Forest Total
TIMBER HARVEST	**20,000**	5584	710	**7261**	1995	**6890**	1587	**5621**	1292	**4974**	0	*
ROAD CN-Road Recon.	**25**	12	3	**9**	3	**22**	3	**22**	3	**22**	0	*
RX FIRE-Prescribed burning	**12,000**	8,401	0	**9375**	526	**11162**	2552	**9322**	3810	**7380**	941	*
SW IMP-rd closures and dump cleanup	**150**	68	17	**59**	17	**25**	17	**17**	17	**17**	0	*
WL HAB IMP-thin stands	**2000**	547	198	**445**	349	**848**	0	**9**	0	**12**	0	*

*Indiana bat take database computes cumulative take acres only up to year 2007.

In order to minimize the potential for this direct adverse impact upon summer roosting Indiana bats, several protective measures have been incorporated into Alternatives 2 and 3. These protective measures (refer to Appendix B) would protect the majority of trees that offer the best potential roosting and maternity habitat for Indiana bats. For example, most unmerchantable dead trees (generally, the best dead trees for Indiana bat use are unmerchantable because they are hollow or decayed) will be retained in all timber harvest units. Other trees to be protected include all shagbark and shellbark hickories, sycamores, and lightning-struck trees. In addition, a minimum basal area of trees will be retained in these units to provide a future supply of roost trees and for protection of existing roost trees from windthrow. By implementing these protective measures, the risk of directly harming a roosting Indiana bat during timber harvest activities is greatly reduced. Activities such as glade restoration and wildlife habitat improvement would also strive to protect these trees when possible and would not be likely to impact very many suitable roost trees since they would involve tree felling on only a few acres.

There is potential that an occupied roost tree may be burned and individual bats harmed. It is likely, however, that should an occupied roost tree begin to burn or smoke accumulations become too heavy, that the bats would fly out of the tree to an adjacent, unburned area. Given the fact that the proposed prescribed burn areas are surrounded by adjacent, forested habitat of similar composition, this is not considered an unlikely scenario, since suitable roost trees are likely scattered across the forested area. It is also assumed that the loss of suitable roost trees to burning activities would be offset by the creation of new snags as a result of the burn, allowing a continual supply of suitable roost trees within the prescribed burn area over the long term.

Other activities proposed within these alternatives such as dump cleanup, erosion control, grazing, waterhole maintenance, and fishing pond rehabilitation, would not be expected to have a direct adverse effect upon Indiana bats because they would not likely involve any felling or disturbance to suitable roost trees.

Indirect Effects (Alternatives 2-3): The activities proposed in Alternatives 2-3 are not expected to have any indirect effect upon Indiana bat hibernating, or fall/spring swarming habitat for the same reasons as stated above in direct effects.

However, there are indirect effects upon Indiana bat summer roosting and foraging habitat that are anticipated if Alternatives 2 or 3 are implemented. Alternatives 2 and 3 are similar with alternative 3 having approximately 295 acres less of timber harvest. These indirect effects include changes in the availability and quality of suitable foraging habitat for Indiana bats within the analysis area, as well as changes in the availability of suitable roost trees within the analysis area. Activities proposed within these alternatives that are likely to contribute to these indirect effects include timber harvesting, temporary road construction, prescribed burning, glade restoration, and waterhole maintenance. Some of these indirect effects may be adverse, while others would be beneficial.

Adverse indirect effects may be created by timber harvest activities that would result in a temporary loss of suitable foraging habitat or connectivity among a colony's home range. Foraging habitat may be indirectly adversely affected when timber harvesting results in less than a 30% canopy closure (U.S. Forest Service 2002). Activities in Alternative 2 and 3 that are likely to create stands in this condition include timber harvesting that uses the clear cut with reserve trees technique. Temporary road construction also may slightly reduce foraging habitat if temporary roads are created in existing suitable foraging habitat. However, these temporary roads may also be used as travel corridors for foraging Indiana bats.

In some cases, foraging habitat may be indirectly improved by timber harvesting, glade restoration, wildlife habitat improvement, and prescribed burning. Many of the forest stands within the project have a greater than 100 basal area and are considered heavily stocked and dense. Several of these stands would be treated in these alternatives with methods that would reduce this basal area. Studies have shown that Indiana bats tend to prefer more open, less heavily stocked forest stands for foraging habitat; generally forest stands with 50-70% canopy cover are considered optimum for Indiana bat foraging (U.S. Forest Service 1998). These canopy conditions would be created by timber harvesting implementing the thinning techniques, wildlife habitat improvement, and possibly by glade restoration activities. The other techniques that would be used for timber harvesting (shelterwood cut, sanitation/salvage cut/overstory removal, and selection with groups) would be expected to leave a > 40% canopy cover, which would be considered suitable Indiana bat foraging habitat, yet not optimum.

Prescribed burning may also indirectly improve foraging habitat for Indiana bats. Prescribed burning, especially when an area is burned repetitively over the long term, would create a more open, woodland-type stand, in many of the stands currently heavily stocked. This effect would be similar to some of the mechanical treatments that would create a more open canopy of 50-70%. Prescribed burning has further indirect benefits to Indiana bats when done at a landscape level because it creates a mosaic pattern of open and less open forest with a scattered distribution of snags and dying trees. This mosaic often creates more opportunities for Indiana bats to select from a variety of roost tree settings and foraging habitat conditions, and generally creates a higher quality, more long-term foraging and roosting habitat (U.S. Forest Service 1998).

There is also potential for indirect impacts upon Indiana bats that may be occupying undiscovered or unknown caves within the analysis area. This potential is considered very low due to the fact that no caves are known to occur within the analysis area and none were located during various field surveys of the analysis area. However, should a cave be located, its entrance will be protected from disturbance by a 100' buffer zone.

Prescribed burning activities proposed within the analysis area may create drift smoke in the vicinity of occupied Indiana bat caves. However, with implementation of parameters that will favor smoke dispersal, it is not likely that this smoke will settle heavily in areas that contain known Indiana bat caves. Considering the fact that the closest known Indiana bat site is 8 miles from the analysis area, it is highly unlikely that it would be impacted by any prescribed burning activities. Prescribed burning activities will be conducted in a manner to ensure that smoke does not accumulate heavily in areas likely to be occupied by Indiana or gray bats.

According to the BE Program, Alternative 2 will affect suitable Indiana bat foraging habitat as follows:

Acres Destroyed	Acres Reduced	Acres Maintained	Acres Created	Acres Enhanced
0	882	0	2793	4499

According to the BE Program, Alternative 3 will affect suitable Indiana bat foraging habitat as follows:

Acres Destroyed	Acres Reduced	Acres Maintained	Acres Created	Acres Enhanced
0	655	0	2793	4499

Other activities that may have an indirect beneficial effect upon the Indiana bat that are proposed in Alternatives 2 and 3 are the maintenance of permanent waterholes. The availability of upland water sources is an important factor in creating suitable Indiana bat habitat, since research has indicated that Indiana bats frequent upland waterholes and road ruts regularly during the summer months, particularly if they are pregnant or lactating (L. Mills, pers. comm).

Old growth has already been designated within the analysis area. While designation of old growth may preclude the development of better foraging habitat because most old growth stands tend to approach > 100% canopy cover, it will likely increase the availability of suitable roost trees within the analysis area, particularly for maternity use. Old growth could also provide areas with wooded corridors that may be important landscape features for Indiana bat movement and foraging (Murray and Kurta, 2004). Old growth areas will eventually develop a structure that includes many large diameter trees. Some of these trees would likely become suitable for maternity roosts. Most of the old growth that has been designated is located in bottomland areas, along riparian zones and most maternity roosts have been found in elm-ash-cottonwood communities, typical of riparian zones. Studies of maternity habitat in Missouri have recommended that forest

management practices favor creation and retention of suitable roost trees and include a component of old growth (U.S. Forest Service 1998).

Cumulative Effects (Alternatives 3 and 4): Based upon known past, present, and foreseeable effects, the implementation of Alternatives 2 and 3 are not likely to have an adverse cumulative effect upon the Indiana bat or its habitat. These alternatives would not have any cumulative effect upon cave use by Indiana bats because they do not affect any habitat within 5 miles of a known Indiana bat cave. None of the activities proposed in these alternatives would contribute to a permanent loss of foraging habitat for Indiana bats. Continued conversion of private forestland to agriculture or residences within the range of the Indiana bat may result in the cumulative loss of foraging and roosting habitat over the long term, however, these activities on private lands are not within the jurisdiction of the US Forest Service and are not necessarily influenced by this proposal. Some of the activities proposed in Alternatives 2 and 3 may lead to a cumulative short-term loss of some habitat components considered desirable for Indiana bats, however, this negative impact would be offset by the creation and enhancement of several thousand acres or foraging habitat. For example, the loss of some suitable foraging habitat for Indiana bat as the result of some cutting techniques would be offset by the increase and enhancement of suitable foraging habitat created by thinning or prescribed burning techniques.

NEPA Cumulative Effects (Alternatives 2-3): 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, not likely to have an adverse to have a cumulative effect upon the Indiana bat or its habitat in the analysis area or elsewhere.

These alternatives would not have any cumulative effect upon cave use by Indiana bats because they do not affect any habitat within 5 miles of a known Indiana bat cave. None of the activities proposed in these alternatives would contribute to a permanent loss of foraging habitat for Indiana bats. Continued conversion of private forestland to agriculture or residences within the range of the Indiana bat may result in the cumulative loss of foraging and roosting habitat over the long term, however, these activities on private lands are not within the jurisdiction of the US Forest Service and are not necessarily influenced by this proposal. Some of the activities proposed in Alternatives 2 and 3 may lead to a cumulative short-term loss of some habitat components considered desirable for Indiana bats, however, this negative impact would be offset by the creation and enhancement of several thousand acres or foraging habitat. For example, the loss of some suitable foraging habitat for Indiana bat as the result of some cutting techniques would be offset by the increase and enhancement of suitable foraging habitat created by thinning or prescribed burning techniques.

Summary of BO Compliance (Alternatives 2 and 3): The June 23, 1999 Biological Opinion requires compliance with Terms and Conditions developed to protect and maintain the Indiana bat and its habitat on the MTNF. Alternatives 2 and 3 comply with those Terms and Conditions as follows:

- All known Indiana bat caves remain protected from human disturbance.
- The alternatives do not impact the designated old growth and mature forest around Indiana bat caves.

- The alternatives comply with minimum basal area and leave tree requirements specified in the BO and FLRMP.
- The alternatives will not involve activities within 0.25 mile of a known Indiana bat maternity site or any Area of Influence (AOI) for Indiana bats.
- The alternatives will not affect management recovery strategies for caves or lands on or adjacent to the MTNF.
- Prescribed burning activities proposed will comply with BO terms and conditions.
- The alternatives do not affect ongoing Indiana bat monitoring, surveys or research activities.
- The alternatives will not exceed allowable "take" during any given fiscal year.

Determination of Effect and Rationale (Alternatives 2 and 3): Because some of the activities proposed in Alternatives 2 and 3 may result in felling, knocking over, burning, or other disturbance to suitable roost trees while they may be occupied by Indiana bats, as well as temporarily reduce the availability of suitable foraging habitat for this species where it presently occurs, Alternatives 2 and 3 *may have an adverse effect* upon the Indiana bat and/or its habitat. While the potential for adverse impacts to the Indiana bat as a result of these kinds of activities is considered very low, it is not considered negligible and discountable because of the several hundred acres that would be treated by activities that may be potentially adverse. However, many of the activities proposed in Alternatives 2 and 3 may also have a beneficial indirect effect upon the Indiana bat and its habitat.

If an Indiana bat is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Bald Eagle

Direct Effects (Alternatives 1-3): There are no known records for bald eagles within the analysis area. No nests or roosts have been identified within the analysis area. Therefore, the activities proposed in Alternatives 1-3 would not be expected to have any direct effects upon known bald eagle nests or roosts. Protective measures incorporated into these alternatives would also protect any potential nest or roost trees where they would most likely occur (along larger perennial streams) because these measures would restrict any activities from occurring within the floodplains of these streams.

Indirect Effects (Alternative 1): There would be no prescribed burning or tree felling implemented under Alternative 1 and so, potential habitat for bald eagle would likely remain either in its current condition and be affected only by natural events such as windstorm, wildland fire, insect outbreaks, etc.

With implementation of Alternative 1, there may be an increased risk in insect infestations within potential habitat for bald eagles, because no activities would occur that would improve the resistance of forest stands that may currently be in an unhealthy condition. However, this would not be expected to have a measurable impact upon potential bald eagle habitat within the project area because most of the stands susceptible

to oak decline and insect infestations are in upland areas, and not within the riparian zones.

The anticipated die-off of trees due to lack of treatment may contribute to more intense wildland fires within the analysis area. Fuels would build-up with the forested stands as they succumb to disease and insects. Such a wildland fire has the potential of negatively impacting habitat for the bald eagle by killing large areas of standing timber along riparian zones and throughout the analysis area. However, the chances of such a wildland fire occurring would be hard to predict and therefore, these indirect effects may not be "reasonably certain to occur".

Cumulative Effects (Alternative 1): Based upon known past, present, and foreseeable activities, this alternative is not expected to have a cumulative effect upon the bald eagle or its habitat. However, many of the watersheds and riparian corridors upon which this species depends for food, communal roosting, and nesting are under the control of private landowners and therefore, there is the possibility that actions by private individuals could negatively impact habitat occupied by this species. If this occurred, there is potential for lands along streams within the National Forest and within the analysis area to become more important for bald eagle recovery. However, since Alternative 1 will not involve activities that would reduce or destroy riparian habitat that is likely to be used by this species, it would not be expected to contribute to this potential cumulative effect.

NEPA Cumulative Effects (Alternative 1): 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. However, many of the watersheds and riparian corridors upon which this species depends for food, communal roosting, and nesting are under the control of private landowners and therefore, there is the possibility that actions by private individuals could negatively impact habitat occupied by this species. If this occurred, there is potential for lands along streams within the National Forest and within the analysis area to become more important for bald eagle recovery. Since Alternative 1 will not involve activities that would reduce or destroy riparian habitat that is likely to be used by this species, it would not be expected to contribute to this potential cumulative effect.

Summary of BO Compliance (Alternative 1): The June 23, 1999 Biological Opinion requires compliance with Terms and Conditions developed to protect and maintain the bald eagle and its habitat on the MTNF. Alternative 1 complies with those Terms and Conditions as follows:

- The alternative does not inhibit ongoing annual surveys for bald eagles.
- The alternative does not impact any known winter roost sites.
- The alternative does not occur within the 0.25 miles of old growth designated along water's edge adjacent to known wintering areas.
- The alternative does not impact super-canopy trees along major riverways or lakes.
- The alternative does not involve or influence controlled burning activities that may impact bald eagles.

Determination of Effect and Rationale (Alternative 1): Alternative 1 would have *no direct effect* and *is not likely to indirectly adversely affect* the bald eagle or potential

habitat for this species. The potential for indirect effects upon its potential habitat (riparian forest) may be increased under this alternative because no activities would occur to improve the health and conditions of forested stands within the analysis area, making them susceptible to intense wildland fires, insect outbreaks, disease, or other forces that could lead to loss of forested conditions in riparian areas. However, this potential cannot be measured and may be considered speculative. The implementation of Alternative 1 is expected to have *no cumulative adverse effect* upon the bald eagle because it is not expected to influence potential recovery of this species throughout its range and would be in compliance with the FWS BO Terms and Conditions.

If a bald eagle nest or communal roost is discovered within the analysis area, consultation with the US Fish and Wildlife Service will be re-initiated for this project.

Indirect Effects (Alternatives 2-3): The greatest potential of a bald eagle occurring in the analysis area would be in the winter, when perhaps a transient bird may perch along a stream in the analysis area. Should such an eagle perch or pass through a proposed timber harvest or prescribed burning area during the time of treatment, it may be slightly disturbed by the human activity in the area, felling of trees, noise, or smoke, however, this disturbance would not be likely to adversely affect these birds since they are very mobile and perch in a variety of locations during the winter months.

There is some potential for loss of a suitable bald eagle roost tree if it occurs in upland areas where timber harvesting and other timber treatments and prescribed burning are proposed, however, this is not a high potential given that eagles prefer to roost along major bodies of water and not in upland areas. The retention of at least 15 basal area of canopy trees in all the treated areas, (as specified in Protective Measures in Appendix B), would also help to offset any loss of potential bald eagle roost/nest trees from these treatments by still providing some roosting habitat.

Activities that do not involve timber felling and burning are expected to have no impact upon bald eagles or their habitats.

Cumulative Effects (Alternatives 2-3): Based upon known past, present, and foreseeable activities, these alternatives are not expected to have a cumulative effect upon the bald eagle or its habitat. However, many of the watersheds and riparian corridors upon which this species depends for food, communal roosting, and nesting are under the control of private landowners and therefore, there is the possibility that actions by private individuals could negatively impact habitat occupied by this species. If this occurred, there is potential for lands along streams within the National Forest and within the analysis area to become more important for bald eagle recovery. However, since Alternatives 2-3 will not involve activities that would reduce or destroy riparian habitat that is likely to be used by this species, they would not be expected to contribute to this potential cumulative effect.

NEPA Cumulative Effects (Alternatives 2-3): 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, is expected to maintain habitat conditions similar to the current conditions. However, many of the watersheds and riparian corridors upon which this species depends for food, communal roosting, and nesting are under the control of private landowners and therefore, there is the possibility

that actions by private individuals could negatively impact habitat occupied by this species. If this occurred, there is potential for lands along streams within the National Forest and within the analysis area to become more important for bald eagle recovery. However, since Alternatives 2-3 will not involve activities that would reduce or destroy riparian habitat that is likely to be used by this species, they would not be expected to contribute to this potential cumulative effect.

Summary of BO Compliance (Alternatives 2-3): The June 23, 1999 Biological Opinion requires compliance with Terms and Conditions developed to protect and maintain the bald eagle and its habitat on the MTNF. Alternatives 2-3 comply with those Terms and Conditions as follows:

- The alternatives do not inhibit ongoing annual surveys for bald eagles.
- The alternatives do not impact any known winter roost sites.
- The alternatives do not occur within the 0.25 miles of old growth designated along water's edge adjacent to known wintering areas.
- The alternatives do not impact super-canopy trees along major riverways or lakes.
- Prescribed burning activities proposed will comply with BO terms and conditions.

Determination of Effect and Rationale (Alternatives 2-3): Activities proposed in Alternatives 2-3 are *not likely to adversely affect* bald eagles or their roosting or nesting habitat. The activities would not impact habitat known to be used for nesting or winter communal roosting. There is potential for a transient, wintering bald eagle to occur within the analysis area, however, *transient winter use of the area is not likely to be affected* by any activities proposed in Alternatives 2-3. The implementation of Alternatives 2-3 are expected to have *no cumulative adverse effect* upon the bald eagle because they are not expected to influence potential recovery of this species throughout its range and would be in compliance with FWS BO terms and conditions.

If a bald eagle nest or communal roost is discovered within the analysis area, consultation with the US Fish and Wildlife Service will be re-initiated for this project.

Hine's Emerald Dragonfly

Direct Effects (Alternative 1): This species is documented within the analysis area on private land within Bates Hollow. There are also scattered fens within the analysis that could be potential habitat for this species. Alternative 1 would not implement any activities that may have a direct effect upon occupied or potential habitat for this species.

Indirect Effects (Alternative 1): With implementation of alternative 1, there may be an indirect effect upon potential habitat for this species. The anticipated die-off of trees due to lack of treatment may contribute to more intense wildland fires within the analysis area. Fuels would build-up with the forested stands as they succumb to disease and insects. Intense wildland fires would have the potential of burning over fens within and adjacent to the analysis area. This burning would most likely improve habitat conditions for this species, unless it occurred during a period of excessive drought or was of such intensity that it damaged the soils and root systems within the fen.

Intense wildland fires could indirectly affect potential habitat for the Hine's emerald dragonfly by changing the water quality or alter the waterflow through fens. Should an intense wildland fire occur within the analysis area as a result of lack of treatment of forest stands, it could contribute to increased soil loss and sedimentation of fens in the analysis area. Changes in water movement and availability could potentially have an indirect adverse effect upon nearby fens. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area, however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered "reasonably certain to occur".

Cumulative Effects (Alternative 1): Based upon known past, present, and foreseeable activities, this alternative is not expected to have a cumulative effect upon this species or its habitat. Because of its dependence upon wetlands, fens, and similar habitats, the Hine's dragonfly is most vulnerable to activities that may result in the destruction of these habitats, alter the hydrology of the habitats, or contaminate their water sources. Many such activities are occurring on lands controlled by private landowners by individuals who refuse to follow restrictions developed in order to protect these habitats. Implementation of activities proposed in Alternative 1, however, would not result in any disturbance or degradation of habitat known to be occupied by Hine's emerald dragonfly, and therefore, is not expected to contribute to any cumulative adverse effects upon this species.

NEPA Cumulative Effects (Alternative 1): 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. Because of its dependence upon wetlands, fens, and similar habitats, the Hine's dragonfly is most vulnerable to activities that may result in the destruction of these habitats, alter the hydrology of the habitats, or contaminate their water sources. Many such activities are occurring on lands controlled by private landowners by individuals who refuse to follow restrictions developed in order to protect these habitats. Implementation of activities proposed in Alternative 1, however, would not result in any disturbance or degradation of habitat known to be occupied by Hine's emerald dragonfly, and therefore, is not expected to contribute to any cumulative adverse effects upon this species.

Summary of BO Compliance (Alternative 1): The 1998 Mark Twain National Forest Programmatic Biological Assessment did not address this species. The June 23, 1999 Biological Opinion did not address this species. Therefore, programmatic consultation has not been requested for this species, and there are no Reasonable and Prudent Measures or Terms and Conditions with which to comply.

Determination of Effect and Rationale (Alternative 1): Alternative 1 would have *no direct effect* and *is not likely to indirectly adversely affect* the Hine's emerald dragonfly or potential habitat for this species. The potential for indirect or cumulative adverse effects upon some potential habitat for this species may be increased under this alternative because no activities would occur to improve the health and conditions of forested stands within the project area, making them susceptible to intense wildland fires,

insect outbreaks, disease, or other forces. However, this potential cannot be measured and may be considered speculative. The implementation of Alternative 1 is expected to have *no cumulative adverse effect* upon the Hine's emerald dragonfly because it is not expected to influence potential recovery of this species throughout its range.

If a Hine's emerald dragonfly is found within the analysis area (other than the existing documented location), consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Direct Effects (Alternatives 2-3): This species is documented within the analysis area on private land within Bates Hollow. There is suitable habitat for this species within the analysis area in the form of scattered fens on National Forest and private lands. The only activities proposed in Alternatives 2-3 that could directly impact potential individuals and habitat for the Hine's emerald dragonfly would be prescribed burning. There are fens located within some of the prescribed burning units and the Bates Hollow location is within 100 yards of a proposed burn. Prescribed burning that includes fens or is adjacent to the private land in Bates Hollow where this species is documented, would occur from November-April, when adults would not be present. Larva occur in streamlet and crayfish burrows and may become less active during this period as well, crawling into tight spaces from late fall to early spring. Prescribed burn also would not occur at times when these fens are likely to be adversely impacted by this activity (that is, on days when the fen is completely dry) because prescribed burns are not typically done during periods of extreme dry weather that would create these conditions. More than likely, burning would occur when the fens still have some wet soil, creating a "top" burn of vegetation but leaving the substrate and roost systems intact. Such a burn would likely have a rejuvenating effect upon the fens and could increase the availability of suitable habitat for this species, because many of these fens are being overtaken by encroaching wood vegetation. To benefit Hine's emerald dragonflies, these fens should be left in a grassy, open condition, and this condition may be maintained by periodic burning (P.Nelson, pers.comm.).

The remaining activities associated with these alternative, such as timber harvesting, temporary road construction, grazing, etc, would not be expected to have any direct impact upon fens because none of these activities would occur within 100 feet of a known fen.

Indirect Effects (Alternatives 2-3): Although botanical surveys identifying the location of fens and other rare habitats will be completed within the analysis area before proposed management activities are initiated, there is always a slight potential that an undiscovered fen occurs in the analysis area and could be indirectly affected by activities occurring with 100 feet of it, prior to its discovery. Such activities could be the felling of trees during timber harvesting, construction of temporary roads and dozerline for prescribed burn, etc. However, this potential for indirect effects upon an undiscovered fen is considered very low since a botanist and others will survey most of the area.

Potential habitat for the Hine's emerald dragonfly can also be indirectly affected by activities that may change the water quality or alter the waterflow through fens. In these alternatives, activities such as temporary road construction, road reconstruction, skidding and dragging associated with commercial removal of merchantable timber, the

construction of dozerlines and, to a lesser degree, waterhole maintenance, fishing pond rehabilitation, erosion control activities, glade restoration, grazing, and wildlife habitat improvement have the potential of disturbing soils, which may lead to increased sedimentation of adjacent streamcourses or fens. By restricting these activities within 100 feet of a fen, however, it is expected that the water quality within the fens will be protected by the 100 foot buffer that would act as a filter strip. Protective measures in the burn plan will be included to prevent contamination of water in fens from chemicals used in aerial ignition and petroleum products in drip torch fuel. These measures will include no hand lighting with drip torches within 100 feet of a fen and no aerial ignition within 100 yards of a fen. Fen locations will be identified on burn plan maps.

Timber harvest activities that result in the removal of the majority of the overstory could increase the amount of water movement on and beneath the soil surface, since fewer trees would be available to absorb this water through their root systems. Such changes in water movement and availability could potentially have an indirect adverse effect upon nearby fens. This increase in water would be offset, somewhat, however, by the proliferation of stump sprouts originating from the cut trees and more open, drier conditions created by overstory removal, as well as by the 100 foot buffer zone around existing fens.

Several protective measures have been incorporated into these alternatives that will minimize the potential for soil movement from activities proposed. With implementation of these protective measures, no soil movement is expected to occur at rates that would adversely affect the water quality of adjacent fens. Past monitoring of similar projects on the MTNF has indicated that soil movement levels were well within the allowable soil loss established in the Forest Plan (U.S. Forest Service 2002).

Cumulative Effects (Alternatives 2-3): Based upon known past, present, and foreseeable activities, these alternatives are not expected to have a negative cumulative effect upon this species or its habitat. Because of its dependence upon wetlands, fens, and similar habitats, the Hine's dragonfly is most vulnerable to activities that may result in the destruction of these habitats, alter the hydrology of the habitats, or contaminate their water sources. Many such activities are occurring on lands controlled by private landowners by individuals who refuse to follow restrictions developed in order to protect these habitats. Implementation of activities proposed in Alternatives 2-3, however, would not result in any degradation of habitat known to be occupied by Hine's emerald dragonfly, and therefore, is not expected to contribute to any cumulative adverse effects upon this species. The prescribed burning of fen habitat within the analysis area, however, over the long-term, may have a beneficial cumulative effect by maintaining and possibly increasing the potential habitat for this species within its range.

NEPA Cumulative Effects (Alternatives 2-3): 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 habitat for this species within the analysis area. Because of its dependence upon wetlands, fens, and similar habitats, the Hine's dragonfly is most vulnerable to activities that may result in the destruction of these habitats, alter the hydrology of the habitats, or contaminate their water sources. Many such activities are occurring on lands controlled by private landowners by individuals who refuse to follow restrictions developed in order to protect these habitats. Implementation of activities proposed in Alternatives 2-3,

however, would not result in any degradation of habitat known to be occupied by Hine's emerald dragonfly, and therefore, is not expected to contribute to any cumulative adverse effects upon this species. The prescribed burning of fen habitat within the analysis area, however, over the long-term, may have a beneficial cumulative effect by maintaining and possibly increasing the potential habitat for this species within its range.

Summary of BO Compliance (Alternatives 2-3): The 1998 Mark Twain National Forest Programmatic Biological Assessment did not address this species. The June 23, 1999 Biological Opinion did not address this species. Therefore, programmatic consultation has not been requested for this species, and there are no Reasonable and Prudent Measures or Terms and Conditions with which to comply.

Determination of Effect and Rationale (Alternatives 2-3): The implementation of Alternatives 2-3 would have no impact upon known populations of Hine's emerald dragonfly and *is not likely to adversely affect* potential habitat for this species. Potential habitat for this species includes fens within the analysis area, however, these fens will be protected from potentially soil disturbing activities with a 100' buffer zone. Other activities proposed in these alternatives would be expected to have either no adverse impact upon fens or would have a beneficial effect upon fens, and therefore, upon potential habitat for this species. The implementation of Alternatives 2-3 *would not contribute to an adverse cumulative effect* upon this species or its habitat, but may have a *cumulative beneficial effect* upon this species by increasing the suitability of fens for this species by reducing woody vegetation competition in formerly open fens.

If a Hine's emerald dragonfly is found within the analysis area (other than the existing documented location), consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Running Buffalo Clover

Direct Effects (Alternatives 1-3): Activities proposed in Alternatives 1-3 would not be expected to have any direct effects upon running buffalo clover because it is not known from the analysis area and has not been found during botanical surveys of the analysis area.

Indirect Effects (Alternative 1): With implementation of Alternative 1, there may be an increased risk in insect infestations within potential habitat for running buffalo, because no activities would occur that would improve the resistance of forest stands that may currently be in an unhealthy condition. As stands become infested by insects or disease, they would gradually become more open and likely create favorable short-term conditions for running buffalo clover. However, this would not be expected to have a measurable impact upon potential habitat within the analysis area because most of the stands susceptible to oak decline and insect infestations are in upland areas, and not within the riparian zones.

The anticipated die-off of trees due to lack of treatment may also contribute to more intense wildland fires within the analysis area. Fuels would build-up with the forested

stands as they succumb to disease and insects. Intense wildland fires would have the potential of creating large areas of little canopy cover, which would likely benefit running buffalo clover. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area, however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered "reasonably certain to occur".

Overall, Alternative 1 is not expected to improve habitat conditions within the analysis area for the running buffalo clover. Under Alternative 1, there would be no implementation of activities that would benefit this species, such as prescribed burning.

Cumulative Effects (Alternative 1): Based upon known past, present, and foreseeable activities, this alternative is not expected to have a cumulative effect upon this species or its habitat. While once likely widespread across Missouri, the habitat for running buffalo clover continues to decrease as open woodlands along streams on private lands continue to be converted to agriculture and urban development. Where riparian corridors are not developed, habitat for the species across its range is vulnerable to the ongoing maturation of forests, minus the periodic disturbances such as burning, that likely historically maintained its habitat. The cumulative effect of riparian corridor development and management unfavorable to running buffalo clover on private lands could result in a net loss of suitable habitat for this species. Implementation of Alternative 1, however, would not likely contribute to the cumulative effect of loss of suitable habitat.

NEPA Cumulative Effects (Alternative 1): 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. While once likely widespread across Missouri, the habitat for running buffalo clover continues to decrease as open woodlands along streams on private lands continue to be converted to agriculture and urban development. Where riparian corridors are not developed, habitat for the species across its range is vulnerable to the ongoing maturation of forests, minus the periodic disturbances such as burning, that likely historically maintained its habitat. The cumulative effect of riparian corridor development and management unfavorable to running buffalo clover on private lands could result in a net loss of suitable habitat for this species. Implementation of Alternative 1, however, would not likely contribute to the cumulative effect of loss of suitable habitat.

Summary of Compliance with BO (Alternative 1): The June 23, 1999 Biological Opinion did not address this species because a determination of "May Affect – Not Likely to Adversely Affect" was made in the programmatic BA, and the FWS concurred with this determination for running buffalo clover. Therefore, the Biological Opinion does not address this species, and there are no Reasonable and Prudent Measures or Terms and Conditions with which to comply.

Determination of Effect and Rationale (Alternative 1): Alternative 1 would have *no direct effect* and *is not likely to indirectly adversely affect* the running buffalo clover or potential habitat for this species. The potential for indirect effects upon some potential habitat for this species may be increased under this alternative because no activities would occur to improve the health and conditions of forested stands within the analysis

area, making them susceptible to intense wildfires, insect outbreaks, disease, or other forces. However, this potential cannot be measured and may be considered speculative. The implementation of Alternative 1 is expected to have *no cumulative adverse effect* upon the running buffalo clover because it is not expected to influence potential recovery of this species throughout its range.

If running buffalo clover is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Indirect Effects (Alternatives 2-3): There may be adverse indirect effects upon potential habitat for this species where activities that cause soil disturbance occur along bottomlands and riparian zones occur. However, protective measures incorporated into this project would minimize this potential adverse effect by restricting or minimizing the activities that would be allowed to occur within floodplains of streams. In some cases, the light soil disturbance created by a skidder or dozer and the opening of the forest canopy associated with timber felling has been believed to be responsible for the maintenance of habitat for some populations of running buffalo clover (U.S. Forest Service 1998).

Potential habitat for running buffalo clover along the perennial streams within the analysis area may be indirectly benefited by prescribed burning. On the MTNF, one of the most probable limiting factors for running buffalo clover is loss of open woodlands as forest have grown denser and loss of periodic fire (U.S. Forest Service 1998). Reintroduction of fire to potential habitat areas would likely improve habitat conditions for this species.

Aside from the beneficial effects of prescribed burning, and the unlikely adverse effects created by soil disturbance associated with dozerline construction, road reconstruction, dump cleanup, wildlife habitat improvement, grazing, and erosion control activities within potential habitat for this species, no other activities proposed in Alternatives 2 and 3 are anticipated to have any effect upon potential habitat for this species. Glade restoration and waterhole maintenance activities would not occur in suitable potential habitat for this species since these activities would occur on the higher elevations and uplands.

Cumulative Effect (Alternatives 2 and 3): Based upon known past, present, and foreseeable activities, this alternative is not expected to have a cumulative effect upon this species or its habitat. While once likely widespread across Missouri, the habitat for running buffalo clover continues to decrease as open woodlands along streams on private lands continue to be converted to agriculture and urban development. Where riparian corridors are not developed, habitat for the species across its range is vulnerable to the ongoing maturation of forests, minus the periodic disturbances such as burning, that likely historically maintained its habitat. The cumulative effect of riparian corridor development and management unfavorable to running buffalo clover could result in a net loss of suitable habitat for this species. Implementation of Alternatives 2 and 3, however, would not likely contribute to the cumulative effect of loss of suitable habitat. In contrast, some soil disturbance, the opening of the overstory, and prescribed burning of lower slopes and along streamcourses would potentially improve habitat for this species.

NEPA Cumulative Effects (Alternatives 2-3): 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 habitat for this species within the analysis area. While once likely widespread across Missouri, the habitat for running buffalo clover continues to decrease as open woodlands along streams on private lands continue to be converted to agriculture and urban development. Where riparian corridors are not developed, habitat for the species across its range is vulnerable to the ongoing maturation of forests, minus the periodic disturbances such as burning, that likely historically maintained its habitat. The cumulative effect of riparian corridor development and management unfavorable to running buffalo clover could result in a net loss of suitable habitat for this species. Implementation of Alternatives 2 and 3, however, would not likely contribute to the cumulative effect of loss of suitable habitat. In contrast, some soil disturbance, the opening of the overstory, and prescribed burning of lower slopes and along streamcourses would potentially improve habitat for this species.

Summary of Compliance with BO (Alternatives 2 and 3): The June 23, 1999 Biological Opinion did not address this species because a determination of "May Affect – Not Likely to Adversely Affect" was made in the programmatic BA, and the FWS concurred with this determination for running buffalo clover. Therefore, the Biological Opinion does not address this species, and there are no Reasonable and Prudent Measures or Terms and Conditions with which to comply.

Determination of Effect and Rationale (Alternatives 2-3): Implementation of Alternatives 2 and 3 *are not likely to adversely affect* running buffalo clover. No habitat known to support this species is known to occur within the analysis area. Any anticipated adverse effects to potential habitat for this species would be negligible and offset by the beneficial effects these alternatives would have upon potential habitat.

If running buffalo clover is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated.

Pink mucket pearlymussel

Direct Effects (Alternatives 1-3): Pink mucket pearlymussel has not been documented from within the analysis area. The closest know site for this species is approximately 55 air miles (100 river miles) NE of the analysis area in the Meramec River.
None of the activities proposed would directly impact the Meramec River, so there are expected to be no direct effects upon this species or its habitat.

Indirect Effects (Alternative 1): Under Alternative 1, there may be an indirect effect upon potential habitat for this species. The anticipated die-off of trees due to lack of treatment may contribute to more intense wildland fires within the analysis area. Fuels would build-up within the forested stands as they succumb to disease and insects. Should an intense wildland fire occur within the analysis area as a result of lack of treatment of forest stands, it could contribute to increased soil loss and sedimentation of the headwaters of the Meramec River. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area,

however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered “reasonably certain to occur”.

Alternative 1 would also not implement any activities, such as erosion control, dump removal, and non-system road closure, which could have an indirect beneficial effect upon the water quality of the headwaters of the Meramec River.

Cumulative Effects (Alternative 1): Based upon known past, present, and foreseeable activities, this alternative is not expected to have a cumulative effect upon this species or its habitat. The pink mucket pearlymussel is vulnerable to practices that cause soil movement on private and public lands, as this soil movement often leads to increases in sediment loads within the streams and rivers, and can adversely impact the species. The continued development of private land for homes, recreation residences, unmanaged timber harvests, and other uses may (if not done conscientiously) contribute to sediment and pollution loads in the watersheds occupied by the species.

Under Alternative 1, no new activities would contribute to the cumulative effect of soil movement into streams. However, the current effects occurring within the watershed as the result of existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would also not be minimized under Alternative 1. Therefore, while there are not any anticipated cumulative adverse effects resulting from the implementation of Alternative 1, there also are no anticipated cumulative beneficial effects, either, because this alternative would not involve a change in the existing conditions within the watersheds.

NEPA Cumulative Effects (Alternative 1): 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. The pink mucket pearlymussel is vulnerable to practices that cause soil movement on private and public lands, as this soil movement often leads to increases in sediment loads within the streams and rivers, and can adversely impact the species. The continued development of private land for homes, recreation residences, unmanaged timber harvests, and other uses may (if not done conscientiously) contribute to sediment and pollution loads in the watersheds occupied by the species.

Under Alternative 1, no new activities would contribute to the cumulative effect of soil movement into streams. However, the current effects occurring within the watershed as the result of existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would also not be minimized under Alternative 1. Therefore, while there are not any anticipated cumulative adverse effects resulting from the implementation of Alternative 1, there also are no anticipated cumulative beneficial effects, either, because this alternative would not involve a change in the existing conditions within the watersheds.

Summary of Compliance with BO (Alternative 1): The June 23, 1999 Biological Opinion did not specifically address the pink mucket pearlymussel because a determination of “May Affect – Not Likely to Adversely Affect” was made in the MTNF programmatic BA. The FWS concurred with this determination for this species, and formal consultation was not required. Therefore, the Biological Opinion does not address

this species, and there are no Reasonable and Prudent Measures or Terms and Conditions with which to comply.

Determination of Effect and Rationale (Alternative 1): Alternative 1 would have *no direct effect* and *is not likely to indirectly adversely affect* the pink mucket pearlymussel or potential habitat for this species. The potential for indirect effects upon its potential habitat (headwater of the Meramec River) may be increased under this alternative because no activities would occur to improve the health and conditions of forested stands within the analysis area, making them susceptible to intense wildland fires, insect outbreaks, disease, or other forces that could lead to diminished water quality. However, this potential cannot be measured and may be considered speculative. The implementation of Alternative 1 is expected to have *no cumulative adverse effect* upon the pink mucket pearlymussel because it is not expected to influence potential recovery of this species throughout its range and would be in compliance with the MTNF Programmatic BA.

If a pink mucket pearlymussel is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated

Indirect Effects (Alternatives 2-3): Aquatic species that occupy or may occupy the Meramec River watershed, such as pink mucket pearlymussel, are most susceptible to the effects that activities occurring within the watershed may have upon water quality. The 1998 MTNF BA indicated that activities within the headwaters of the Meramec, particularly Courtois and Huzzah Creeks, may strongly influence downstream habitat conditions for this species.

Activities with the greatest potential for impacts upon water quality involve those activities that would disturb the soil surface. In these alternatives, these activities include temporary road construction, road reconstruction, skidding and dragging associated with commercial removal of merchantable timber, the construction of dozerlines, and, to a lesser degree, waterhole maintenance, erosion control activities, glade restoration, and grazing.

However, several protective measures have been incorporated into these alternatives that will minimize any potential for soil movement from these activities. With implementation of these protective measures, no soil movement is expected to occur at rates that would adversely affect the water quality of adjacent streams, and therefore, the habitat for pink mucket pearlymussel. Past monitoring of similar projects on the MTNF has indicated that soil movement levels were well within the allowable soil loss established in the Forest Plan (U.S. Forest Service 2002).

Some of the activities proposed in these alternatives may also have an indirect beneficial effect upon potential habitat for the pink mucket pearlymussel. Under these alternatives, some activities would occur that could enhance the water quality of streams within the analysis area, and therefore, improve water quality in the Meramec River watershed. Activities that would improve water quality include dump removal, erosion control activities, and non-system road closure. Old growth designation has already occurred in the analysis areas and could benefit potential habitat for pink mucket pearlymussel, because much of this designated old growth is within riparian areas and along streamcourses.

Cumulative Effects (Alternative 2-3): Based upon known past, present, and foreseeable activities, this alternative is not expected to have a cumulative effect upon this species or its habitat. In addition to activities occurring as part of this project, this species is also vulnerable to practices that cause soil movement on private and public lands, as this soil movement often leads to increases in sediment loads within the streams and rivers, and can adversely impact the species. The continued development of private land for homes, recreation residences, unmanaged timber harvests, and other uses may (if not done conscientiously) contribute to sediment and pollution loads in the watersheds occupied by the species.

Within the analysis area, approximately 12% of the private land base has been developed for agricultural and residential uses, which typically have the greatest potential for soil movement and disturbance. With the remaining 88% representing either National Forest or forested private lands, it does not appear that conversion from forested to unforested conditions is contributing significantly to deterioration of the watersheds within the analysis area. However, much of the 12% on private not in forested conditions does occur in bottomlands and along riparian areas, since these are often the most easily cultivated and developed areas, therefore, activities within this 12% of the land base may be having more of an effect upon the watersheds than may be presented by simple comparison of percentage of forest versus non-forest within the analysis area.

The activities that are planned on the Mark Twain National Forest are designed and implemented in a manner to minimize soil movement off-site, and would not be expected to contribute to any deterioration of habitat for these species. Because these activities would occur primarily within upland areas, and not bottomlands, they would not be expected to contribute to any cumulative effects being created by activities occurring on private lands that may impact the pink mucket pearlymussel or its habitat.

NEPA Cumulative Effects (Alternatives 2-3): Based upon known past, present, and foreseeable activities, these alternatives are not expected to have a negative cumulative effect upon this species or its habitat. In addition to activities occurring as part of this project, this species is also vulnerable to practices that cause soil movement on private and public lands, as this soil movement often leads to increases in sediment loads within the streams and rivers, and can adversely impact the species. The continued development of private land for homes, recreation residences, unmanaged timber harvests, and other uses may (if not done conscientiously) contribute to sediment and pollution loads in the watersheds occupied by the species.

Within the analysis area, approximately 12% of the private land base has been developed for agricultural and residential uses, which typically have the greatest potential for soil movement and disturbance. With the remaining 88% representing either National Forest or forested private lands, it does not appear that conversion from forested to unforested conditions is contributing significantly to deterioration of the watersheds within the analysis area. However, much of the 12% on private not in forested conditions does occur in bottomlands and along riparian areas, since these are often the most easily cultivated and developed areas, therefore, activities within this 12% of the land base may be having more of an effect upon the watersheds than may be presented by simple comparison of percentage of forest versus non-forest within the analysis area.

The activities that are planned on the Mark Twain National Forest are designed and implemented in a manner to minimize soil movement off-site, and would not be expected to contribute to any deterioration of habitat for these species. Because these activities would occur primarily within upland areas, and not bottomlands, they would not be expected to contribute to any cumulative effects being created by activities occurring on private lands that may impact the pink mucket pearlymussel or its habitat.

Summary of FWS BO Compliance (Alternatives 2-3): The June 23, 1999 Biological Opinion did not specifically address the pink mucket pearlymussel because a determination of "May Affect – Not Likely to Adversely Affect" was made in the MTNF programmatic BA. The FWS concurred with this determination for this species, and formal consultation was not required. Therefore, the Biological Opinion does not address this species, and there are no Reasonable and Prudent Measures or Terms and Conditions with which to comply.

Determination of Effect and Rationale (2-3): Activities proposed in Alternatives 2-3 are *not likely to adversely affect* the pink mucket pearlymussel or its habitat. These alternatives would not involve conducting activities within the floodplains of the Meramec River or its major tributaries. Activities proposed have incorporated protective measures to minimize the potential for soil erosion and deposition in the watershed of the Meramec River, considered suitable habitat for the pink mucket pearlymussel. Given that the closest known record for this species is approximately 55 air miles (100 river miles) NE from the analysis area in the Meramec River, it is not likely that any of the activities proposed within the analysis area will have direct, indirect, or cumulative effects upon known populations of this species. Some of the activities proposed in Alternatives 2-3 *may have a beneficial effect* upon potential habitat for this species because they will improve existing sources of soil erosion and/or stream degradation.

If a pink mucket pearlymussel is found within the analysis area, consultation with the US Fish and Wildlife Service for this project will be re-initiated

SUMMARY OF DETERMINATIONS

The summary of determinations below is based upon the proposed management action as described in this BAE. *Should any change in the proposed management action as outlined in this BAE occur after the date that this evaluation is signed, all effects upon these federally-listed species may warrant re-evaluation before project implementation may continue.* Changes that would require a re-evaluation of effects upon these species include but may not be limited to:

- inability or failure to implement one or more of the protective measures outlined in this evaluation;
- any change in the proposed action that may increase the potential for adverse effects upon federal species beyond what has been disclosed in this evaluation;
- unknown or previously unaddressed federal species or their habitats are discovered in the project influence area.

Alternative 1

Species	Species present in analysis area?	Habitat present in analysis area?	Habitat affected by project?	Determination
Indiana bat	**Possible**; may roost in suitable trees in the analysis area; may forage 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	**Possible**; may forage over streams in analysis area	**Yes**; suitable foraging habitat available along perennial streams in 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 dragonfly	**Possible**; documented nearby	**Yes**; fens 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**
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**

Alternatives 2-3

Species	Species present in project area?	Habitat present in project area?	Habitat affected by project?	Determination
Indiana bat	**Possible**; may roost in suitable trees in the analysis area; may forage 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.
Gray bat	**Possible**; may forage over streams in the analysis area	**Yes**; suitable foraging habitat available along perennial streams in the analysis area	**Not likely;** protective measures incorporated to protect riparian habitat	**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**
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**

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SUPPLEMENT TO THE BIOLOGICAL ASSESSMENT and EVALUATION
FOR

FEDERALLY LISTED SPECIES

Mark Twain National Forest

Salem Ranger District
Crawford and Dent Counties, Missouri

Crooked Creek Project

INTRODUCTION/ SURVEYS

North Central Research Station (Sybill Amelon and crew) conducted mist net surveys for bats on various days between July 7 and July 26, 2004 on the Salem Ranger District, Mark Twain National Forest (Appendix A). The ten areas surveyed were mainly small wildlife ponds within and adjacent to the Crooked Creek Project Area (Map 1). Six of the survey areas were within the project area and four were adjacent to the project area.

Gray Bat

Two female gray bats were captured, one on 7/8/04, 2.6 miles northeast of the Crooked Creek Project Area and one on 7/14/04, within the project area (Map 1). These bats were not tracked.

Indiana Bat

A post-lactating female Indiana bat was captured on 7/7/04 at a small wildlife pond in T34NR2W section 9, 3.7 miles northeast of the Crooked Creek Project Area. A transmitter was placed on her and she was tracked for over a week until 7/20/04 when there was no longer a signal at night. The trackers were unable to pick up her signal during the day due to access problems, so her roost tree(s)/roosting spot(s) were not found. She foraged almost every night over the Viburnum Trend Riding Area, which is a private ATV/MC riding area approximately 4 miles from the project area. She also foraged over FS and Doe Run property in the vicinity of the lead recycling facility and over a tailings pond owned by Cominco. (Map 1).

An adult male Indiana bat was captured on 7/8/04 on a non-system road near a small wildlife pond in T34NR2W section 8, .2.6 miles northeast of the project area. A transmitter was place on him and he was tracked for over a week until 7/20/04 when there was no longer a signal at night. The trackers were unable to pick up his signal during the day due to access problems, until 7/20/04 when his signal was tracked to a tree in a tailings pond. There was no signal that night, so it is assumed he dropped his transmitter in the tree. He foraged over FS and Doe Run property in the vicinity of the lead recycling facility and over a tailings pond owned by Cominco. (Map 2).

Another adult male Indiana bat was captured on 7/23/04 on a small wildlife pond in T33NR3W section 1, within the Crooked Creek Project Area. A transmitter was placed

on him and he was tracked for over a week until 8/5/04 when the transmitter was found at the base of a roost tree. He roosted in 5 different trees, all on FS and foraged mainly over FS in uplands and over old fields on FS and private. Enough data was collected for S. Amelon to run through a program she has to determine home range. Although he used 5 different trees, he roosted in one tree every day for a week. This tree was located in an area that had burned in a wildland fire on May 17, 2000. (Map 3)

Environmental Baseline

Gray Bat

Occurrence within the project area- The BE dated 4/13/04 states "it would not be surprising to find gray bats within the analysis area" and the effects to this species and its habitat were discussed in the BE. The capture of two gray bats during the mist net survey (one within the project area) indicates that gray bats are foraging within the analysis area. Gray bats are documented traveling several miles each night from their roost caves to forage (Amelon, pers. comm.). These captured bats could have easily traveled from a documented gray bat cave outside of the analysis area.

Effects of the Proposed Management Actions

Gray Bat

Alternative 1- There is no change to the direct, indirect, cumulative effects discussion, summary of BO compliance, and determination of effect and rationale for Alternative 1 in the BE dated 4/13/04.

Alternatives 2 and 3 (Direct Effects)- There would be no impact to known gray bat caves, since none are known to occur within the analysis area. Foraging gray bats would not likely be impacted by proposed management activities within the analysis area that take place during the day since they generally roost in caves during the day. The capture site of one of the gray bats is adjacent to a proposed prescribed burn (Map 4). Some prescribed burns, especially the larger burns proposed, could possibly produce smoke and flames throughout the night. Some areas may temporarily be unsuitable for foraging gray bats. Foraging gray bats could easily avoid these areas since they are known to travel several miles each night to forage. Smoke would be in the area for a relatively short period and prescribed burns are normally conducted during burn periods that are conducive to smoke dispersal. Wildlife ponds, perennial streams, and uplands would continue to be available for foraging after proposed management activities are implemented.

Alternatives 2 and 3 (Indirect, cumulative, summary of BO compliance)- There is no change to the indirect and cumulative effects discussion and summary of BO compliance for these alternatives from the BE dated 4/13/04.

Alternatives 2 and 3 (Determination of Effect and Rational)- Implementation of activities proposed in Alternatives 2 and 3 are *not likely to have an adverse effect* upon gray bats or their habitat. No direct or indirect disturbance to known gray bat caves is anticipated as a result of any of these activities. While the potential does exist for undiscovered gray bat caves to be in the analysis area, based upon past surveys, this potential is considered very low. Any foraging gray bats or their foraging habitat that

may be within the analysis area may be temporarily impacted by proposed activities during implementation, especially prescribed burns that continue into the night. Foraging gray bats could easily avoid these areas during implementation of proposed management activities since they are known to travel several miles each night to forage. Wildlife ponds, perennial streams, and uplands would continue to be available for foraging after proposed management activities are implemented. The implementation of Alternatives 2 and 3 would be expected to have no cumulative effect upon gray bats because the alternatives do not jeopardize recovery of the species and their implementation is in compliance with USFW BO terms and conditions.

Environmental Baseline

Indiana Bat

Occurrence within the project area- A male Indiana bat has been captured within the Crooked Creek Project Area. This male also roosted and foraged within the project area. A post lactating female Indiana bat and another male Indiana bat were also captured 3.7 and 2.6 miles respectively NE of the project area.

Effects of the Proposed Management Actions

Indiana Bat

Alternative 1- There is no change to the direct, indirect, cumulative effects discussion, summary of BO compliance, and determination of effect and rationale for Alternative 1 in the BE dated 4/13/04.

Alternatives 2 and 3 (Direct Effects)- The activities proposed in Alternatives 2-3 still would not be expected to have any direct effects upon Indiana bats during their hibernation or fall and spring swarming periods (generally October thru April), or upon their hibernacula because no hibernacula are known to occur within or near the analysis area. The closest hibernaculum (Cave Hollow Cave) is 8 miles away.

There is still a potential for directly impacting Indiana bats, however, during their summer roosting period (generally May thru September). Activities proposed that could have a direct adverse effect upon Indiana bats include timber harvesting, temporary road construction, prescribed burning, dozerline construction, glade restoration, and wildlife habitat improvement. These activities all have the potential of impacting bats that may be roosting in trees during the summer, particularly trees with characteristics that make them favorable for bat use. These direct adverse impacts could be the killing of roosting bats when trees are felled or burned, or abandonment of roost sites caused by disturbance created by activities associated with these treatments. Three of the documented roost trees of a male Indiana bat occur within a proposed final harvest and/or prescribed burn unit (Map 5).

The 4/13/04 BE refers to several protective measures that have been incorporated into these alternative to minimize the potential for this direct adverse impact upon summer roosting Indiana bats. One additional protective measure will be incorporated- not only will the known roost trees be retained during timber harvest activities (since they are all

dead trees), they will be identified as reserve trees when the unit is marked. Known roost trees within proposed prescribe burn units will be protected by raking the fuel away from the base of the trees before ignition of the burn unit to help prevent the known roost trees from igniting during the prescribed burn.

Alternatives 2 and 3 (Indirect, cumulative, summary of BO compliance)- There is no change to the indirect and cumulative effects discussion and summary of BO compliance for these alternatives from the BE dated 4/13/04.

Alternatives 2 and 3 (Determination of Effect and Rational)- Because an Indiana bat had been captured within the project area (and also roosted and foraged within the project area) and some of the activities proposed in Alternatives 2 and 3 may result in felling, knocking over, burning, or other disturbance to suitable roost trees while they may be occupied by Indiana bats, as well as temporarily reduce the availability of suitable foraging habitat for this species where it presently occurs, Alternatives 2 and 3 *may have an adverse effect* upon the Indiana bat and/or its habitat. While the potential for adverse impacts to the Indiana bat as a result of these kinds of activities is considered very low, it is not considered negligible and discountable because of the several hundred acres that would be treated by activities that may be potentially adverse and because a male Indiana has been captured within the project area. However, many of the activities proposed in Alternatives 2 and 3 may also have a beneficial indirect effect upon the Indiana bat and its habitat.

Update to Summary of Determinations
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 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 dragonfly	**Possible**; documented nearby	**Yes**; fens 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**
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**

Alternatives 2-3

Species	Species present in project area?	Habitat present in project 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.
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**
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**

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Biological Evaluation
Regional Forester Sensitive Species
and Species of Concern

Crooked Creek Project
Salem Ranger District
Mark Twain National Forest

(This BE includes species from the 02/29/00 R-9 list with maintenance on 10/20/03)

INTRODUCTION

Project Name: Crooked Creek

Analysis area Size: approximately 23,217 acres of Forest Service managed lands

Landtype Associations: Oak Hickory Hills (HM), Oak Pine Hills (HL)

Management Areas: 3.4-1, 2, 3

Counties: Crawford, Dent

Watershed: Meramec

Legal Description: See maps

The purpose of this Biological Evaluation (BE) is to document the potential effects that planned management activities associated with this project may have upon Regional Forester's Sensitive Species (RFSS) and other Species of Concern that are found on the Mark Twain National Forest (MTNF). The objectives of this BE are:

e) to ensure that Forest Service actions do not contribute to a loss of viability on the Mark Twain National Forest or cause a trend toward federal listing of any species;
f) to comply with the requirements of the Forest Land and Resource Management Plan and ensure that actions do not jeopardize the continued existence of these species on the National Forest;
g) and to provide a process and standard by which to ensure that these species receive full consideration in the decision making process.

Site-specific effects determinations for each species are summarized at the end of this document.

PROPOSED MANAGEMENT ACTIONS

Summary of Proposed Action: The Salem Ranger District is proposing to improve forest health, enhance wildlife habitat, and provide additional recreational opportunities in the Crooked Creek Analysis Area. The proposed action is needed due to declining habitat diversity, forest health and vigor, and to meet desired future conditions as identified in the Mark Twain National Forest Land and Resource Management plan (LRMP), also known as the Forest Plan.

The alternatives that are being considered for implementation within the Crooked Creek Analysis Area are as follows:

Alternative 1 (No Action)

This alternative would initiate no new active management within the analysis area. This alternative provides a baseline (reference point) against which to describe the environmental effects of the two action alternatives being considered. This is a viable alternative and responds to concerns of those who want no active management to occur in the analysis area beyond what is currently ongoing as the result of natural processes, routine maintenance or current management direction. Existing grazing term permits would be allowed to expire.

Alternative 2 (Proposed Action)
This alternative would utilize commercial timber harvesting as a means for achieving forest health and vigor. This alternative would allow forest stands to be treated commercially by using the final harvets, seedtree, shelterwood, sanitation/salvage cut, overstory removal, selection with groups, and thinning methods. Some firewood removal would also be allowed. Some temporary openings created by proposed final harvest would be greater than 40 acres where proposed final harvest occurs next to existing final harvest temporary openings that are from 0 to 20 years old. Natural regeneration and pine planting would occur. These methods would achieve stand conditions that would favor regeneration of desirable tree species such as shortleaf pine, white oak, post oak, and hickories.

Several forest stands, including many timber harvest units, would be burned with prescribed fire to improve wildlife habitat and reduce hazardous fuels that may increase as a result of silvicultural treatments and may occur due to the level of tree mortality, wind and ice damage, understory growth, and past fire exclusion and to encourage pine and oak regeneration. Prescribed burning would most likely occur during the spring and fall seasons. In some cases, stands may be prescribe burned more than once in order to achieve woodland conditions and a more herbaceous understory and improve the grass, forb, and shrub components of the ground cover.

Wildlife habitat would also be improved by hand cutting and/or mowing of existing open and semi-open habitat in order to remove competing vegetation, including several small dolomite glades and the maintenance of existing waterholes. Some of the open and semi-open habitat areas will be burned on a 3 to 4 year rotation to encourage the proliferation of native grasses and forbs. In addition, term grazing permits will be re-issued with allotment management plans (that comply with the Forest Plan) for three existing grazing allotments.

The Forest Service in partnership with Missouri Department of Conservation would continue to maintain five lakes and ponds for fisheries: Howes Mill Lake, Howes Mill Pond, Howes Mill South, Huzzah cutoff pond number 3, and Gnuse pond. The Forest Service proposes fish stocking, fish habitat improvements (including fish structures, fertilization, liming), and dam maintenance and reconstruction (including draining and deepening Howe's Mill Lake), for the five lakes and ponds managed for flat water fishing opportunities. This action will maintain existing flat water fishing opportunities for public fishing.

Soil and water improvements include cleanup of five dumps and closure of approximately 55 miles of non-system roads.

Some actions require other actions in order to be accomplished. These actions will be considered in the environmental analysis of this project.

Fire Lines: Existing roads and natural fire-breaks would be used whenever possible. New fire line construction would be necessary in some areas.

Proposed Road Work: There are 40 Forest Service system roads within the management areas, with a combined length of 52.5 miles. The analysis area contains approximately 36.3 square miles of National Forest System land. National Forest system roads within the analysis area vary from 0.1 miles to over 6 miles in length. The Crooked Creek project has 8.4 miles of system roads that need reconstruction before they can be used to access project activities. The other 44.1 miles of system road need routine maintenance, such as replacing surface material, surface blading, improving drainage features, removing brush from right-of-ways, and cleaning culverts. In addition to system roads, there are non-system roads on National Forest System land in the analysis area. The condition of these roads is usually fair to poor because no road improvement or maintenance work has ever been done.

Alternative 3 (Reduced Final Harvest with Natural Regeneration Only)
This alternative would be the same as Alternative 2 <u>except</u> there would be 320 acres less of final harvest (reduced final harvest) and there would be no pine planting (natural regeneration only). Proposed final harvest next to existing temporary openings that would result in final harvest temporary openings greater than 40 acres are dropped in this alternative.

Table 1. Alternative Activity Comparison Table

	Alt.1	Alt.2	Alt. 3
Silvicultural Methods	**Acres**	**Acres**	**Acres**
Final Harvest	0	932	637
Seed Tree	0	26	26
Shelterwood	0	1332	1332
Uneven Aged	0	1706	1706
Over-story Removal	0	122	122
Sanitation	0	580	580
Thin	0	1206	1206

Reforestation	**Acres**	**Acres**	**Acres**
Natural Regeneration	0	2462	2142
Pine Planting	0	667	0
Timber Stand Improvement	**Acres**	**Acres**	**Acres**
Crop Tree Release	0	0	0
Prescribed Fire		**Acres**	**Acres**
Open woodland development	0	2445	2445
Hazardous fuel reduction	0	5956	5956
Transportation	Miles	**Miles**	**Miles**
Temporary	0	25	23
Reconstruction	0	8.4	8.4
Soil and Water	**Each**	**Each**	**Each**
Dump Clean-up	0	5	5
Non-system closure	0	55	55
Range/Wildlife	**Acres**	**Acres**	**Acres**
Grazing	0	345	345
Fertilize	0	345	345
Mechanical-Hand Cut, Mow, and Waterhole Maintenance	0	1375	1375
Fisheries *	**Acres**	**Acres**	**Acres**
Pond Rehab	0	16	16
Stock Fish	0	16	16

* Includes Howe's Mill Lake Deepening, Fish Structures, and Howe's Mill South Spillway

SPECIES CONSIDERED AND EVALUATED

Regional Forester Sensitive species (RFSS) considered for the Crooked Creek BE are those known or likely to occur on Mark Twain National Forest. The Regional Forester's Sensitive Species list was first issued on March 8, 1994. An updated RFSS list was issued on February 29, 2000 with list maintenance on 10/20/03. As a result, the Mark Twain National Forest portion of the updated RFSS list contains 112 species of plants and animals. Of these 112 species, 53 species 21 animals, 32 plants) are likely or known to occur on the Salem Ranger District (see Table xx, Appendix A).

In May 2001, the Mark Twain National Forest completed a Supplemental Information Report on RFSS. The analysis demonstrates how the 1986 Mark Twain National Forest Land and Resource Management Plan (Forest Plan) provides for ecological conditions that may lead to ensuring viable populations of these sensitive species. It concluded that the current Forest Plan adequately addresses habitat needs of all the species included on the list. By following the standards and guidelines in the current Forest Plan, the Mark Twain National Forest will provide habitat conditions conducive to maintaining viability of these

species. The SIR is on file at the Supervisor's Office in Rolla and is hereby incorporated by reference. Population trends for RFSS can be found in the "Monitoring Report for DFC, MIS, Federal TEP, & RFSS Mark Twain National Forest (October 2003)".

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 project area were done to determine which species to evaluate in this BE.

The "analysis area" is defined as the area in which activities associated with one or more of the alternatives could potentially have a direct, indirect, or foreseeable cumulative effect upon a RFSS species or species of concern or habitat in which the species is likely to occur.

RFSS and species of concern evaluated in the Crooked Creek BE are those species that

a) are documented within the analysis area,

b) have suitable habitat within the analysis area, or

c) may be affected by project activities.

RFSS and species of concern that are known or likely to occur in Crawford and Dent counties in the Meramec River drainage or with documented occurrences or potential habitat in the Oak Hickory Hills (HM) and Oak Pine Hills (HL) LTA's, but which do not have suitable habitat in the analysis area or that the project will not affect, were not evaluated further.

The following table shows **species evaluated** and their possible location in or near the analysis area.

Table 1. 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 & 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

Table 1. 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 & MOFWIS, but have not been documented within the analysis area)

Scientific Name	Common Name	Species Group	Suitable Habitat in Analysis Area
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
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

Table 1. 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 & MOFWIS, but have not been documented within the analysis area)**			
Scientific Name	**Common Name**	**Species Group**	**Suitable Habitat in Analysis Area**
Silene regia	Royal catchfly	Plant	Glades
Solidago gattingerii	Gattinger's goldenrod	Plant	Glades
Spiranthes ovalis var. erostellata	Ladies' tresses	Plant	Fens
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)

There is **no designated essential habitat, either occupied or unoccupied** for any regional sensitive species in the Crooked Creek Analysis area.

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) and are shown in Table 3A.

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 2. Additional Species of Concern known or 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 & 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

Table 2. Additional Species of Concern known or 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 & MOFWIS, but have not been documented within the analysis area)			
Scientific Name	**Common Name**	**Species Group**	**Suitable Habitat in Analysis Area**
Epioblasma triquetra	Snuffbox	Mollusk	Meramec drainage
Fusconaia ebena	Ebonyshell	Mollusk	Meramec drainage
Plethobasus cyphyus	Sheepnose	Mollusk	Meramec drainage

SURVEY INFORMATION

In preparation of this BE, site-specific surveys within the analysis area were combined with a general knowledge of the habitats that are likely or known to occur within the project influence areas. Sarah Bradley (USFS biologist) conducted biological field surveys of the project area on 5/14/02, 5/23/02, 12/11/02, 4/29/03, 5/12/03, 8/13/03, 8/14/03, and 12/18/03. These surveys were cursory in nature and focused on determining the habitat conditions within the analysis area and locating potential habitat for wildlife species.

Botanical surveys are also being conducted by a contract botanist (Alan Brant) from September 2003 to September 2004 and results of those surveys have been reviewed as part of this BE. These botanical surveys are focusing on the drainages within the analysis area (generally considered areas of highest potential for rare plant communities).

Additional special habitat information such as seep, fen, and glade locations was collected by Angie Sites, Larry Ness (USFS Forestry Technicians) John Bryan, and David Massengale (USFS Foresters) during their extensive heritage resource and prescription field surveys within the analysis area and reviewed during the preparation of this BE.

Other surveys not specific to this project have been conducted in the vicinity of the analysis area. For example, in partnership with Mark Twain National Forest and others, the Missouri Department of Conservation has been very aggressive in conducting species surveys and maintaining data on both listed and common species. The Missouri Heritage Database not only includes specific locations of plant and animal species, but also includes occurrences of unique and/or rare natural communities. Many of these communities are suitable habitat for RFFS. This database provides an excellent and up-to-date source of information on occurrences of TES species. **Missouri Heritage database has documented occurrences of RFSS species in the Crooked Creek Analysis area.**

The Missouri Fish and Wildlife Information System (MOFWIS) includes information on over 700 species of animals and plants (life history, status, known & possible locations, etc.). This database is also an excellent source of information regarding possible locations of TES species on Mark Twain National Forest.

Species' experts in Missouri have also been very aggressive in publishing excellent reference material that includes species' locations in the state as well as potential habitat. Publications include: Missouri Wildflowers, Missouri Orchids, Field Guide to Missouri Ferns, Walk Softly Upon the Earth (lichens & mosses), Steyermark's Flora of Missouri, Flora of Missouri, Volume 1, Butterflies and Moths of Missouri, The Crayfish of Missouri, The Fishes of Missouri, Naiades of Missouri, Birds of Missouri, and The Amphibians and Reptiles of Missouri. All these publications were consulted during evaluation of potential effects to RFSS species and Species of Concern in the Crooked Creek Analysis area.

The Nature Conservancy maintains Element Stewardship Abstracts and Element Global Rankings that give specific information on species' locations, habitats, threats, propagation, life history, etc. The Natureserve website contains distribution and status information on a variety of species and natural communities. These data sources were also consulted when analyzing potential effects of implementing alternatives in the Crooked Creek Analysis area.

In addition to the extensive fieldwork done in preparation of the Missouri Heritage and MOFWIS databases and the publications, there are numerous field surveys conducted annually or as part of research projects in Missouri. The Mark Twain National Forest also has conducted surveys in partnership with others, or on its own. A sampling of these, include but are not limited to:

- Annual mid-winter eagle surveys – Current River
- Annual eagle nest surveys
- Forest bat surveys (cave, fall, summer, winter, mist-net, harp-trap, Anabat)
- Missouri Breeding Bird Atlas
- Missouri Breeding Bird Survey Routes
- Cave Research Foundation Biological Inventories
- Gardner & Gardner Cave Inventories
- Botanical Surveys
- Naiades survey 1980-1982

All these surveys are relevant to the Crooked Creek Analysis area. While not all of them were conducted specifically on the Crooked Creek Analysis area, they provide information concerning suitable habitats for various species on this district.

Specialists in biology, soils, timber, heritage resources conducted field visits throughout the analysis area during the pre-NEPA phase of planning, and during project planning. These visits were conducted at various times of the year for various reasons.

The information available on TES locations and potential habitats in the Crooked Creek Analysis area is of sufficient quantity, quality, and relevance to make an accurate and complete analysis of potential effects on TES species in the Crooked Creek Analysis area. I believe enough information is available to make a reasoned management decision. Therefore, additional surveys are not needed for this project decision.

EXISTING CONDITION

Riparian/bottomland hardwood associated species.

Species that prefer riparian habitat tend to be most dependent upon periodic flooding to maintain their habitat. As a result, these species are generally limited to the transition zone between the stream or river's edge and the bottom of slopes. These species tend to prefer damp, rich soils, or the washed, scoured surface of streambanks or bottomland hardwoods. In some cases, the break in canopy created naturally by the stream or river corridor is a preferred element of this habitat.

Species occurrence within project area – One RFSS that is frequently associated with riparian habitat has been documented within the analysis area.

During his field surveys of the analysis area in 2003 and 2004, Alan Brant found *Juglans cinerea* (butternut) within the analysis area. These sites were on National Forest along James Branch. All of the specimens observed during these surveys were either diseased or dead.

According to BE Program one riparian/bottomland hardwood-associated species has potential habitat in the analysis area. However, based upon a review of the MTNF Heritage CD (10/28/03 ver. 1.3) and results of field surveys conducted for this project, this species is not known within the analysis area. Suitable habitat, as calculated by the BE Program does occur in the analysis area as follows:

Riparian and bottomland hardwood Species	**Total Acres Suitable Habitat in Analysis Area (based upon BE Program)**
Dendroica cerulea	58

(BE Program Report, run 11/19/03)

MoFWIS or other references have reported other species as known or likely in the counties surrounding the analysis area, but these species have not been documented in the analysis area. These species are *Carex cherokeensis, Dryopteris goldiana,* and *Platanthera flava var. herbiola*

Stream/River-associated species (Meramec drainage).

The species dependent upon streams or rivers are primarily aquatic organisms such as fish, mussels, and amphibians. These species spend all or most of their life cycle in aquatic environment. As a result, these species are most susceptible to activities that threaten the water quality of these streams by altering the temperature, oxygen or pH levels of the stream, as well as other factors. Many cold and warm water streams form the boundaries and intersect the Mark Twain National Forest.

Species occurrence within analysis area – No RFSS or Species of Concern frequently associated with streams/rivers have been documented in the analysis area.

According to BE Program, some stream/river-associated species have potential habitat in the analysis area or in the watershed within which the analysis area occurs. However, based upon a review of the MTNF Heritage CD (10/28/03 ver. 1.3) and results of field surveys conducted for this project, none of these species are known within the analysis area. Suitable habitat, as calculated by the BE Program for some of these species, does occur in the analysis area as follows:

Stream/River Species	Total Acres Suitable Habitat in Analysis Area (based upon BE Program)
Stenonema bednariki	201
Plethobasus cyphyus	87
Epioblasma triquetra	201

MoFWIS or other references have reported other species as known or likely in the counties in the analysis area within the Meramec watershed, but these species have not been documented in the analysis area. These species are *Cryptobranchus alleganiensis, Crystallaria asprella, Cycleptus elongates, Cumberlandia monodonta, Elliptio crassidens, Fusconaia ebena, Platygobio gracilis.*

Open, grassland-associated species.

Habitat for these species generally occurs in the form of large open areas with some scattered trees and brush.

Species occurrence within analysis area – No RFSS or Species of Concern frequently associated with openings, grasslands have been documented in the analysis area.

According to BE Program, one open grassland-associated species has potential habitat in the analysis area. However, based upon a review of the MTNF Heritage CD (10/28/03 ver. 1.3) and results of field surveys conducted for this project, this species is not known within the analysis area. Suitable habitat, as calculated by the BE Program does occur in the analysis area as follows:

Open/Grassland Species	Total Acres Suitable Habitat in Analysis Area (based upon BE Program)
Lanius ludovicianus migrans	3

(BE Program Report , run 11/19/03)

MoFWIS or other references have reported other species as known or likely in the counties in the analysis area within the Meramec watershed, but these species have not been documented in the analysis area. These species are *Aimophila aestivalis* and *Circus cyaneus.*

Glade-associated species

Glade species are generally restricted or associated with limestone and igneous glade complexes. These glade complexes are characterized by exposed bedrock, shallow soils, and herbaceous vegetation. These glade habitats were likely historically maintained in an open, grassy condition by periodic fire, but today, many are being overtaken by woody vegetation as a result of decades of fire suppression. The plant community that occupies these glades is often influenced by the geology of the bedrock, with igneous glades often supporting different plant communities than limestone glades.

Species occurrence within analysis area – No RFSS or Species of Concern frequently associated with glades have been documented in the analysis area.

According to BE Program, one glade-associated species has potential habitat in the analysis area. However, based upon a review of the MTNF Heritage CD (10/28/03 ver. 1.3) and results of field surveys conducted for this project, this species is not known within the analysis area. Suitable habitat, as calculated by the BE Program does occur in the analysis area as follows:

Glade Species	**Total Acres Suitable Habitat in Analysis Area (based upon BE Program)**
Solidago gattingerii	4

(BE Program Report, run 11/19/03)

MoFWIS or other references have reported other species as known or likely in the counties in the analysis area within the Meramec watershed, but these species have not been documented in the analysis area. These species are *Aimophila aestivalis, Agalinis skinneriana, Echinacea simulata, Scutellaria bushii,* and *Silene regia.*

Seep, fen, spring-associated species

The seep habitat required by these species can often be found at the heads of perennial streams and around the edges of fens or springs. These seeps are characterized by the presence of groundwater leaching to the soil surface. They are similar to spring and fen habitats, but generally are much smaller in size and more shaded than fens and have slower moving water over a larger area than springs. In some cases, these seeps occur in acid soils, while others occur in calcareous soils. The acidic seeps frequently have a different plant community than calcareous seeps.

A fen could be considered a type of wetland. It is dominated by grass or grass-like plants and fed primarily by water from a mineral source. They are nearly always located adjacent to perennial streams in bottomland areas. The water flow through these fens is often slow and flowing through dense vegetation. The fen habitats are often adjacent to forest edge. Many fens are becoming dominated by encroaching woody vegetation. Periodic flooding or fire may maintain the grassy/open condition of these fens.

Species occurrence within analysis area – Three species frequently associated with seeps, fens, springs have been documented in the analysis area. These species are *Carex sterilis, Carex stricta,* and *Parnassia grandifolia.*

Carex sterilis and *Carex stricta* have been documented in Dent County on private land in seeps, fens in Bates Hollow. Alan Brant also tentatively identified these species as occurring in Dent County in Fortune Hollow and Thorny Hollow on National Forest lands in fens during his field surveys of the analysis area in 2003 and 2004. These sites will be surveyed during the growing season to confirm species identification.

During his field surveys of the analysis area in 2003 and 2004, Alan Brant found *Parnassia grandifolia* within the analysis area. These sites were on National Forest in fens in Crawford and Dent Counties along James Branch, Fortune Hollow and Thorny Hollow. He found hundreds of plants in these areas.

According to BE Program, one seep, fen, and spring associated species has potential habitat in the analysis area. However, based upon a review of the MTNF Heritage CD (10/28/03 ver. 1.3) and results of field surveys conducted for this project, this species is not known within the analysis area. Suitable habitat, as calculated by the BE Program does occur in the analysis area as follows:

Seep/Fen/Spring Species	**Total Acres Suitable Habitat in Analysis Area (based upon BE Program)**
Spiranthes ovalis var. erostellata	12

(BE Program Report, run 11/19/03)

MoFWIS or other references have reported other species as known or likely in the counties in and surrounding the analysis area, but these species have not been documented in the analysis area. These species are *Ophiogomphis westfalli, Anemone quinquefolia, Aster dumosus var. strictior, Campanula aprinoides, Carex buxbaumii, Carex decomposita, Menyanthes trifoliate, Phlox maculata ssp. Pyramidalis, Carex tetanica, Ludwigia microcarpa, Sphagnum centrale* and *Campylium stellatum.*

Miscellaneous wetland associated species

This category includes species that do not necessarily occur in seeps, fens or springs, but rather prefer standing water or open, wet, sunny soil. Examples of such habitat are

margins and shallow water of wildlife and sinkhole ponds, roadside ditches and low, wet places in open fields.

Species occurrence within project area – No RFSS or Species of Concern frequently associated with miscellaneous wetlands have been documented in the analysis area.

According to BE Program, miscellaneous wetland-associated species have potential habitat in the analysis area. However, according to Dave Moore, Forest Botanist/Ecologist, nine species have been reported in the counties in and surrounding the analysis area, but these species have not been documented in the analysis area. These species are *Carex cherokeensis, Carex decomposita, Carex fissa* var. *fissa, Carex straminea, Carex triangularis, Juncus debilis, Potamogeton pulcher, Schoenoplectus purshianus,* and *Torreychloa pallida.*

Cliff-associated species

Habitat for these species generally occurs in the form of cliffs, bluffs or large exposures of bedrock that may be either wet or dry.

Species occurrence within analysis area – No RFSS or Species of Concern frequently associated with this habitat have been documented in the analysis area.

According to BE Program, no cliff-associated species have potential habitat in the analysis area. However, according to Dave Moore, Forest Botanist/Ecologist, five species have been reported in the counties in and surrounding the analysis area, but these species have not been documented in the analysis area. These species are *Aster furcatus, Aster macrophyllus, Calamagrostis porteri* var. *insperata, Metzgeria furcata,* and *Sullivantia sullivantii.*

EFFECTS OF THE PROPOSED ACTION AND ALTERNATIVES

Riparian/bottomland hardwood associated species.

Direct Effects **Alternative 1-** This alternative would not be expected to have any direct effect upon riparian/bottomland hardwood-associated species because it would not involve any activities within riparian/bottomland hardwood habitat.

Alternatives 2 and 3- There is some potential that prescribed burning may directly impact some *Juglans cinerea* individuals. These individuals are diseased and would not likely survive longterm, regardless of whether or not they are impacted by prescribed burning activities.

Indirect Effects **Alternative 1-**With implementation of Alternative 1, there may be an increased risk in insect infestations within riparian/bottomland hardwood areas, because no activities would occur that would improve the resistance of forest stands that may currently be in an unhealthy condition. As insects or disease infest~~s~~ stands, the stands would gradually become more open and likely create a change in conditions, creating more open, drier habitats. However, this would not be expected to have a measurable

impact upon riparian/bottomland hardwood habitat within the analysis area because most of the stands susceptible to oak decline and insect infestations are in upland areas, and not within these zones.

The anticipated die-off of trees due to lack of treatment may also contribute to more intense wildland fires within the analysis area. Fuels would build-up within forest stands as they succumb to disease and insects. Intense wildland fires would have the potential of creating large areas of little canopy cover, which would likely impact riparian/bottomland hardwood species. Exclusion of controlled burns within these stands would also increase the potential for wildland fires to become intense and difficult to control.

Alternatives 2 and 3- Generally speaking, none of the activities proposed in Alternatives 2 and 3 should have an indirect impact upon riparian habitat for these species because of protective measures that have been incorporated into the proposed project. With implementation of these protective measures, a no cut zone will be designated within riparian zones along perennial and intermittent streams. Other protective measures will minimize impacts to unique habitats that frequently occur in riparian zones, such as seeps, fens.

There is potential for some riparian/bottomland hardwood habitat to be indirectly affected by prescribed burning proposed in this alternative since some of this burning and dozer line construction will occur in these areas. Generally, these areas are not directly fired unless necessary for reinforcement of control lines. If not directly fired, these areas would be less impacted since the fires would generally "back" down the slope into the areas and self-extinguish. Even if directly fired, however, these areas should not be heavily impacted since firing would not occur on extreme fire weather days when fires would burn hottest and be most likely to damage riparian/bottomland hardwood habitats. Known sites of RFSS species will be avoided during fireline construction.

Cumulative Effects **All Alternatives-** While once likely widespread across Missouri, high quality habitat for riparian/bottomland hardwood species continues to decrease as riparian zones along streams on private lands continue to be converted to agriculture and urban development. The cumulative effect of riparian corridor development and management unfavorable to the RFSS riparian species could result in a net loss of suitable habitat for these species. The implementation of the Alternatives, 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 and would not likely contribute to the cumulative effect of loss of suitable habitat.

Quantification of Habitat Acres Affected The following table quantifies the number of acres of suitable habitat that would be *directly* affected by Alternatives 2 and 3. Because Alternative 1 would not involve any management activities that would directly alter the forest condition, it has been assumed that the acres of suitable habitat within the project area for these species are not directly affected by this alternative. These numbers are based solely upon the Mark Twain National Forest BE Program 11/19/03.

Only species identified by the BE Program as having suitable habitat within the project area are listed.

Riparian/bottomland hardwood Species	Total Acres Suitable Habitat in Analysis Area	Acres of Suitable Habitat in Analysis Area Affected by Alternative									
		Destroyed		Reduced		Created		Enhanced		Maintained	
		Alt. 2	**Alt. 3**	**Alt. 2**	**Alt. 3**	**Alt. 2**	**Alt. 3**	**Alt. 2**	**Alt. 3**	**Alt. 2**	**Alt. 3**
Dendroica cerulea		0	0	0	0	0	0	0	0	58	58
Juglan cinerea		0	0	0	0	0	0	0	0	787	684

Determination of Effect and Rationale

Alternative 1- The implementation of Alternative 1 is expected to have ***no impact*** upon any riparian/bottomland hardwood-associated RFSS and Species of Concern because it would involve no direct or indirect disturbance to riparian habitats within the analysis area.

Alternatives 2 and 3- The activities proposed in Alternatives 2 and 3 ***may impact individuals of*** *Juglans cinerea* ***but are not likely to cause a loss of viability or a trend toward federal listing.*** This species is known to occur in the analysis area and occurs within stands proposed for activities that may impact them or their occupied habitat.

The activities proposed in Alternatives 2 and 3 may also impact suitable potential habitat for other riparian/bottomland hardwood-associated RFSS or Species of Concern because they involve prescribed burning and some soil disturbance within riparian zones.

Stream/River-associated species

Direct Effects **Alternative 1-** This alternative would have no direct impact upon any stream/river-associated RFSS or Species of Concern because it does not involve implementation of any activities.

Alternatives 2 & 3- Neither of these alternatives would be expected to have a direct impact upon any stream/river associated RFSS or Species of Concern because none of these species have been documented from National Forest lands in which proposed activities would occur.

Indirect Effects

Alternative 1- Under Alternative 1, there may be an indirect effect upon habitat for aquatic species. The anticipated die-off of trees due to lack of treatment may contribute to more intense wildland fires within the analysis area. Fuels would build-up within the forested stands as they succumb to disease and insects. Should an intense wildland fire

occur within the project area as a result of lack of treatment of forest stands, it could contribute to increased soil loss and sedimentation of streams and rivers within the analysis area. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area, however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered "reasonably certain to occur".

Alternative 1 would also not implement any activities, such as erosion control, dump rehabilitation, and road decommissioning, which could have an indirect beneficial effect upon the water quality of some streams within the analysis area.

Alternatives 2 and 3- Aquatic RFSS and Species of Concern that occupy or may occupy the Meramec River and other perennial streams within the analysis area are most susceptible to the effects that activities occurring within their watersheds may have upon water quality. Activities with the greatest potential for impacts upon water quality involve those activities that would disturb the soil surface. In Alternatives 2 and 3, these activities include the construction of dozerlines, erosion control activities, temporary road construction, road reconditioning, skidding, and dragging associated with commercial removal of merchantable timber.

However, several protective measures have been incorporated into Alternatives 2 and 3 that would minimize any potential for soil movement from proposed management activities. With implementation of these protective measures, no soil movement is expected to occur at rates that would adversely affect the water quality of adjacent streams, and therefore, the habitat stream/river-associated species. Past monitoring of similar projects on the MTNF has indicated that soil movement levels were well within the allowable soil loss established in the Forest Plan (U.S. Forest Service 2002).

Some of the activities proposed in both alternatives may also have an indirect beneficial effect upon potential habitat for stream/river-associated species. In both alternatives, some activities would occur that may enhance the water quality of streams within the project area, and therefore, improve water quality in the streams and rivers within the project area. Activities that would improve water quality include dump rehabilitation (some of which are located near streams), erosion control activities, and road decommissioning. All of these proposed activities would improve potential habitat for aquatic species.

Cumulative Effects **Alternative 1-** Aquatic species are vulnerable to practices that cause soil movement on private and public lands, as this soil movement often leads to increases in sediment loads within the streams and rivers, and can adversely impact the species. The continued development of private land for homes, recreation residences, unmanaged timber harvests, and other uses may (if not done conscientiously) contribute to sediment and pollution loads in the watersheds occupied by theses species.

Under Alternative 1, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would involve no new activities that would contribute to the cumulative effect of soil movement into streams. However, the current effects occurring within the watershed as the result of

existing erosion from unregulated roads, streambank destabilization, and water contamination from garbage dumps would also not be minimized under Alternative 1. Therefore, while there are not any anticipated cumulative adverse effects resulting from the implementation of Alternative 1, there also are no anticipated cumulative beneficial effects, either, because this alternative would not involve a change in the existing conditions within the watersheds.

Alternatives 2 and 3- In addition to activities occurring as part of this project, aquatic species are also vulnerable to practices that cause soil movement on private and public lands, as this soil movement often leads to increases in sediment loads within the streams and rivers, and can adversely impact the species. The continued development of private land for homes, recreation residences, unmanaged timber harvests, and other uses may (if not done conscientiously) contribute to sediment and pollution loads in the watersheds occupied by the species.

Within the project area, approximately 20% of the land base has been developed for agricultural and residential uses, which typically have the greatest potential for soil movement and disturbance. With the remaining 80% representing either National Forest or forested private lands, it does not appear that conversion from forested to unforested conditions is contributing significantly to deterioration of the watersheds within the project area. However, much of the 20% not in forested conditions does occur in bottomlands and along riparian areas, since these are often the most easily cultivated and developed areas, therefore, activities within this 20% of the land base may be having more of an effect upon the watersheds than may be presented by simple comparison of percentage of forest versus non-forest within the analysis area.

The activities that are planned in 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, are designed and implemented in a manner to minimize soil movement off-site, and would not be expected to contribute to any deterioration of habitat for these species. Because these activities would occur within the 80% of the forested area and are primarily within upland areas, and not bottomlands, they would not be expected to contribute to any cumulative effects being created by activities occurring on private lands that may impact aquatic RFSS or Species of Concern or their habitat.

Quantification of Habitat Acres Affected The following table quantifies the number of acres of suitable habitat that would be *directly* affected by Alternatives 2 and 3. Because Alternative 1 would not involve any management activities that would directly alter the forest condition, it has been assumed that the acres of suitable habitat within the analysis area for these species are not directly affected by this alternative. These numbers are based solely upon the Mark Twain National Forest BE Program, 11/18/03.

Only species identified by the BE Program as having suitable habitat within the analysis area are listed.

	Total Acres	

Stream/River Species	Suitable Habitat in analysis Area	Acres of Suitable Habitat in Analysis Area Affected by Alternative									
		Destroyed		Reduced		Created		Enhanced		Maintained	
		Alt. 1	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**
Stenonema bednariki		0	0	0	0	0	0	0	0	201	201
Plethobasus cyphyus		0	0	0	0	0	0	0	0	87	87
Epioblasma triquetra		0	0	0	0	0	0	0	0	201	201

Determination of Effect and Rationale

Alternative 1- The implementation of Alternative 3 is expected to have ***no impact*** upon any stream/river-associated RFSS and Species of Concern because it would not likely lead to or involve any disturbance to aquatic habitats within the analysis area.

Alternatives 2 and 3- The activities proposed in Alternatives 2 and 3 are expected to have ***no impact*** upon stream/river-associated RFSS and Species of Concern because none of these species have been documented within or adjacent to stands proposed for treatments and their aquatic habitat is likely to be adequately protected by protective measures that have been incorporated into the Proposed Actions for these two alternatives.

Open, grassland-associated species

Direct Effects

Alternative 1: This alternative would be expected to have no impact upon any open, grassland-associated RFSS or Species of Concern because it does not involve any activities that may impact habitat or known sites for these species.

Alternatives 2 and 3- No open, grassland-associated RFSS or Species of Concern have been documented from within stands proposed for treatments under these two alternatives, hence there would be no direct effects to these species.

Indirect Effects **Alternative 1**- This alternative would have no indirect effect upon open, grassland-associated species or their potential habitat because it would not involve any activities that would disturb or enhance open, grassland habitat. There is some potential for an increase in insect and disease outbreaks within the project area if Alternative 1 is implemented, which could enhance open, grassland habitat by increasing the intensity of wildland fires and/or contribute to a loss of large areas of forest overstory, however, this potential is difficult to predict.

Alternatives 2 and 3- Implementation of Alternatives 2 and 3 would enhance open, grassland-associated species habitat through the use of prescribed burning and mowing of existing openings. These activities could lead to an increase in the abundance of grasses and forbs in the openings. Prescribed burning in forest stands would increase the grasses and forbs in the understory. These activities would indirectly benefit these species. None of the other activities proposed in Alternatives 2 and 3 would be expected to have an adverse indirect impact upon habitat for open, grassland-associated species.

Cumulative Effects **All Alternatives-** Open, grassland habitat that is suitable for these species tends to occur in large areas of prairie, pasture, and old fields. The implementation of any of these Alternatives, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would not contribute measurably to an increase or decrease in open, grassland habitat within the analysis area and would not be expected to have a cumulative effect upon the species that are likely to occupy such habitats.

Quantification of Habitat Acres Affected The following table quantifies the number of acres of suitable habitat that would be *directly* affected by Alternatives 2 and 3. Because Alternative 1 would not involve any management activities that would directly alter the forest condition, it has been assumed that the acres of suitable habitat within the analysis area for these species are not directly affected by this alternative. These numbers are based solely upon the Mark Twain National Forest BE Program, 11/19/03.

Only species identified by the BE Program as having suitable habitat within the analysis area are listed.

Grassland Species	**Total Acres Suitable Habitat in Project Area**	**Acres of Suitable Habitat in Project Area Affected by Alternative**									
		Destroyed		Reduced		Created		Enhanced		Maintained	
		Alt. 1	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**
Lanius ludovicianus migrans		0	0	0	0	0	0	3	3	0	0

Determination of Effect and Rationale **Alternative 1-** The implementation of Alternative 1 is expected to have ***no impact*** upon any open, grassland-associated RFSS and Species of Concern because no activities are proposed that are likely to impact these species or their habitat.

Alternatives 2 and 3- The some activities proposed in Alternatives 2 and 3 are expected to have a ***beneficial effect*** upon open, grassland-associated RFSS and Species of Concern

because mowing and prescribed burning would enhance/maintain habitat used by these species.

Glade-associated species

Direct Effects **Alternative 1-** This alternative would be expected to have no impact upon any glade-associated RFSS or Species of Concern because it does not involve any activities that would directly impact habitat or known sites for these species. Under Alternative 1, there would be no implementation of activities that would benefit glade species, such as glade restoration or prescribed burning.

Alternatives 2 and 3 – There are no glade-associated RFSS or Species of Concern sites documented within stands proposed for treatment in these Alternatives, and therefore, there are expected to be no impacts upon individual species with implementation of these Alternatives.

Indirect Effects **Alternative 1-** With implementation of Alternative 1, there may be an increased risk in insect infestations within the analysis area, because no activities would occur that would improve the resistance of forest stands that may currently be in an unhealthy condition. As insects or disease infest stands, they would gradually become more open and likely create favorable short-term conditions for glade species.

The anticipated die-off of trees due to lack of treatment may also contribute to more intense wildland fires within the analysis area. Fuels would build-up with the forested stands as they succumb to disease and insects. Intense wildland fires would have the potential burning over glades within and adjacent to the project area. This burning would most likely improve habitat conditions for this species, unless it occurred during a period of excessive drought or was of such intensity that it damaged the soils and root systems within the glade. However, the chances of such a wildland fire occurring would be hard to predict and therefore, these indirect effects may not be “reasonably certain to occur”.

Alternatives 2 and 3- There are many stands proposed for activities in this alternative that contain suitable glade habitat for some of these species and this habitat would be directly impacted by activities such as prescribed burning and handcutting of encroaching vegetation. These activities would likely benefit any RFSS or species of concern that occupy these glades by improving the conditions of the glade and reducing competition from encroaching vegetation within the glade, particularly red cedars. Other activities proposed in these alternatives would not be expected to impact glade habitat due to the incorporation of protective measures into the proposed action. These protective measures would protect glades from soil disturbance and other activities that could negatively impact any RFSS or Species of Concern within them.

Cumulative Effects **All Alternatives-** When considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, these alternatives are not expected to have a cumulative effect upon glade-associated species or their habitat. Much of the habitat that may be or once was occupied by glade-associated RFSS and Species of Concern is under the control of private landowners or other agencies, and therefore, there is the possibility that actions by

those groups could negatively impact habitat occupied by this species. The loss of original prairie habitat to agricultural uses, coupled with decades of fire-suppression in habitats formerly fire-maintained, as well as widespread use of herbicides and insecticides, may continue to contribute to the loss of glade-associated species. If this occurs, there is potential for lands within the National Forest and within the project area to become more important for these species' recovery. However, since none of these alternatives will involve activities that would reduce or destroy habitat that may be used by this species, they would not be expected to contribute to this potential cumulative effect.

Quantification of Habitat Acres Affected The following table quantifies the number of acres of suitable habitat that would be *directly* affected by Alternatives 2 and 3. Because Alternative 1 would not involve any management activities that would directly alter the forest condition, it has been assumed that the acres of suitable habitat within the analysis area for these species are not directly affected by this alternative. These numbers are based solely upon the Mark Twain National Forest BE Program, 11/19/03.

Glade Species	**Total Acres Suitable Habitat in Analysis Area**	**Acres of Suitable Habitat in Analysis Area Affected by Alternative**									
		Destroyed		Reduced		Created		Enhanced		Maintained	
		Alt. 1	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**
Solidago gattingerii		0	0	0	0	0	0	4	4	0	0

Determination of Effect and Rationale

Alternative 1- The implementation of Alternative 1 is expected to have ***no impact*** upon any glade-associated RFSS and Species of Concern because it would not likely lead to or involve any disturbance to glade habitats within the analysis area.

Alternatives 2 and 3- The some activities proposed in Alternatives 2 and 3 are expected to have a ***beneficial effect*** upon open, grassland-associated RFSS and Species of Concern because prescribed burning and handcutting of encroaching woody vegetation would enhance/maintain habitat used by these species.

<u>Seep/Fen-associated species</u>

Direct Effects **Alternative 1-** Alternative 1 would not implement any activities that are expected to have a direct effect upon seep/fen-associated RFSS or species of concern.

Alternatives 2 and 3- There is potential that some *Carex sterilis, Carex stricta, Parnassia grandifolia* individuals may be impacted by prescribed burning. There are several fens,

seeps, and springs located within some of the prescribed burning units, some of which contain these species. However, prescribed burning would not occur at times when these seeps and fens are likely to be adversely impacted by this activity (that is, on days when the fens or seeps are completely dry) because prescribed burns are not typically done during periods of extreme dry weather that would create these conditions. More than likely, burning would occur when the areas still have some wet soil, creating a "top" burn of vegetation but leaving the substrate and root systems intact. Such a burn could have a rejuvenating effect upon these areas and could increase the availability of suitable habitat for seep/fen/spring-associated species, because many of these areas are being overtaken by encroaching woody vegetation. To benefit many of these species, fens should be maintained in a grassy, open condition, and this condition may be maintained by periodic burning.

Other than prescribed burning, the remaining activities associated with these two alternatives would not be expected to have any direct impact upon fens/seeps/springs because of protective measures that have been incorporated into the Proposed Action for these alternatives. These protective measures would restrict potentially damaging activities from occurring within 100 feet of a known fen/seep/spring.

Indirect Effects **Alternative 1-** Under Alternative 1, there may be an indirect effect upon potential habitat for these species. The anticipated die-off of trees due to lack of treatment may contribute to more intense wildland fires within the project area. Fuels would build-up with the forested stands as they succumb to disease and insects. Intense wildland fires would have the potential burning over fens within and adjacent to the project area. This burning would most likely improve habitat conditions for these species, unless it occurred during a period of excessive drought or was of such intensity that it damaged the soils and root systems within the fen.

Potential habitat for seep/fen/spring-associated species can also be indirectly affected by intense wildland fires that change the water quality or alter the waterflow through fens. Should an intense wildland fire occur within the analysis area as a result of lack of treatment of forest stands, it could contribute to increased soil loss and sedimentation of fens/seeps/springs in the analysis area. Changes in water movement and availability could potentially have an indirect adverse effect upon nearby fens/seeps/springs. Exclusion of controlled prescribed burning within these stands would also increase the potential for wildland fires to become intense and difficult to control. The chances of a wildland fire occurring within the analysis area, however, are virtually impossible to predict, and so, these possible indirect effects may be considered speculative and are not considered "reasonably certain to occur".

Alternatives 2 and 3- Although botanical surveys identifying the location of fens and other rare habitats are on-going within the project area, there is always a slight potential that an undiscovered fen occurs in the project area and could be indirectly affected by activities occurring with 100 feet of it, prior to its discovery. Such activities could be the felling of trees during mechanical timber treatments or construction of dozer line, etc. However, this potential for indirect effects upon an undiscovered fen is considered very low since most of the area has been thoroughly surveyed by a botanist and others.

Potential habitat for seep/fen/spring-associated species could also be indirectly affected by activities that may change the water quality or alter the waterflow through fens. In these alternatives, activities such as the construction of dozerlines, erosion control activities, and decommissioning of roads have the potential of disturbing soils that may lead to increased sedimentation of adjacent streamcourses or fens/seeps/springs. By restricting these activities within 100 feet of a fen, however, it is expected that the water quality within these areas will be protected by the 100 foot buffer that would act as a filter strip.

Mechanical timber treatments and harvest that result in the removal of the majority of the overstory could increase the amount of water movement on and beneath the soil surface, since few trees would be available to absorb this water through their root systems. Such changes in water movement and availability could potentially have an indirect adverse effect upon nearby seeps, springs, and fens. This increase in water would be offset, somewhat, however, by the proliferation of stump sprouts originating from the cut trees and more open, drier conditions created by overstory removal, as well as by the 100 foot buffer zone.

However, several protective measures have been incorporated into these alternatives that will minimize the potential for soil movement from proposed management activities. With implementation of these protective measures, no soil movement is expected to occur at rates that would adversely affect the water quality of adjacent seeps, springs, and fens. Past monitoring of similar projects on the MTNF has indicated that soil movement levels were well within the allowable soil loss established in the Forest Plan (U.S. Forest Service 2002). By restricting management activities within 100' of a seep, spring, or fen, the potential for waterflow alteration should be minimized. Protective measures in the burn plan will be included to prevent contamination of water in fens from chemicals used in aerial ignition and petroleum products in drip torch fuel. These measures will include no hand lighting with drip torches within 100 feet of a fen and no aerial ignition within 100 yards of a fen. Fen locations will be identified on burn plan maps.

Cumulative Effects **All Alternatives-** Because of its dependence upon wetlands, fens, and similar habitats, the seep/fen/spring-associated species are most vulnerable to activities that may result in the destruction of these habitats, alter the hydrology of the habitats, or contaminate their water sources. Many such activities are occurring on lands controlled by private landowners and on both private and public lands by individuals who refuse to follow restrictions developed in order to protect these habitats. When considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, the implementation of Alternatives 1, 2 and 3, however, would not result in any degradation of habitat known to be occupied by seep/fen/spring-associated RFSS or Species of Concern, and therefore, is not expected to contribute to any cumulative adverse effects upon these species.

Quantification of Habitat Acres Affected The following table quantifies the number of acres of suitable habitat that would be *directly* affected by Alternatives 2 and 3. Because Alternative 1 would not involve any management activities that would directly alter the forest condition, it has been assumed that the acres of suitable habitat within the analysis area for these species are not directly affected by this alternative.

These numbers are based solely upon the Mark Twain National Forest BE Program, 11/19/03.

Seep/Fen/Spring Species	**Total Acres Suitable Habitat in Analysis Area**	**Acres of Suitable Habitat in Analysis Area Affected by Alternative**									
		Destroyed		Reduced		Created		Enhanced		Maintained	
		Alt. 1	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**
Spiranthes ovalis var. erostellata		0	0	0	0	0	0	12	12	0	0

Determination of Effect and Rationale

Alternative 1- The implementation of Alternative 1 is expected to have ***no impact*** upon any seep/fen/spring-associated RFSS or Species of Concern because it does not implement activities that are likely to disturb known sites or potential habitat for these species.

Alternatives 2 and 3- The activities proposed in Alternatives 2 and 3 ***may impact individuals of*** *Carex sterilis, Carex stricta,* and *Parnassia grandifolia* ***but are not likely to cause a loss of viability or a trend toward federal listing.*** These species are known to occur in the analysis area and occur within stands proposed for activities that may impact them or their occupied habitat. The prescribed burning activities proposed in these alternatives could enhance existing and potential suitable habitat for these species and provide a ***beneficial effect*** by helping to keep the areas open and reduce competition from encroaching woody vegetation.

Miscellaneous wetland associated species

Direct Effects

Alternative 1- **This alternative would have no direct impact upon any miscellaneous wetland associated RFSS or Species of Concern because it does not involve implementation of any activities.**

Alternatives 2 & 3- Neither of these alternatives would be expected to have a direct impact upon any miscellaneous wetland associated RFSS or Species of Concern because none of these species have been documented from National Forest lands in which proposed activities would occur.

Indirect Effects **Alternative 1-** This alternative would have no indirect effect upon miscellaneous wetland associated species or their potential habitat because it would not involve any activities that would disturb or enhance wetland habitat.

Alternatives 2 and 3- Implementation of Alternatives 2 and 3 would enhance wetland habitat primarily through maintanence of existing waterholes, and less so through the use of prescribed burning of existing fields. These activities could lead to an increase in the abundance of grasses and forbs in the openings. None of the other activities proposed in Alternatives 2 and 3 would be expected to have an adverse indirect impact upon habitat for miscellaneous wetland species.

Cumulative Effects **All Alternatives-** Miscellaneous wetlands that are suitable for these species tend to occur in small areas of pasture and old fields, and along the margins of waterholes. The implementation of any of these Alternatives, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would not contribute measurably to an increase or decrease in wetland habitat within the analysis area and would not be expected to have a cumulative effect upon the species that are likely to occupy such habitats.

Quantification of Habitat Acres Affected The following table quantifies the number of acres of suitable habitat that would be *directly* affected by Alternatives 2 and 3. Because Alternative 1 would not involve any management activities that would directly alter the forest condition, it has been assumed that the acres of suitable habitat within the analysis area for these species are not directly affected by this alternative.

Misc Wetland Species	**Total Acres Suitable Habitat in Project Area**	**Acres of Suitable Habitat in Project Area Affected by Alternative**									
		Destroyed		Reduced		Created		Enhanced		Maintained	
		Alt. 1	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**	**Alt. 1**	**Alt. 2**
Carex cherokeensis		0	0	0	0	0	0	43	43	0	0
Carex decomposita		0	0	0	0	0	0	43	43	0	0
Carex fissa var. fissa		0	0	0	0	0	0	43	43	0	0
Carex straminea		0	0	0	0	0	0	43	43	0	0
Carex triangularis		0	0	0	0	0	0	43	43	0	0
Juncus debilis		0	0	0	0	0	0	43	43	0	0
Potamogeton pulcher		0	0	0	0	0	0	43	43	0	0
Schoenoplectus purshianus		0	0	0	0	0	0	43	43	0	0
Carex cherokeensis		0	0	0	0	0	0	43	43	0	0

Alternative 1- The implementation of Alternative 1 is expected to have ***no impact*** upon any wetland- associated RFSS and Species of Concern because no activities are proposed that are likely to impact these species or their habitat.

Alternatives 2 and 3- The same activities proposed in Alternatives 2 and 3 are expected to have a ***beneficial effect*** upon wetland-associated RFSS and Species of Concern because mowing, prescribed burning and waterhole maintenance would enhance/maintain habitat used by these species.

Cliff species

Direct Effects Alternative 1- This alternative would have no direct impact upon any cliff-associated RFSS or Species of Concern because it does not involve implementation of any activities.

Alternatives 2 & 3- Neither of these alternatives would be expected to have a direct impact upon any cliff-associated RFSS or Species of Concern because none of these species have been documented from National Forest lands in which proposed activities would occur.

Indirect Effects **Alternative 1**- This alternative would have no indirect effect upon cliff-associated species or their potential habitat because it would not involve any activities that would disturb or enhance their habitat.

Alternatives 2 and 3- No activities proposed in Alternatives 2 and 3 would be expected to have an adverse indirect impact upon habitat for cliff-associated species.

Cumulative Effects **All Alternatives-** Cliffs that are suitable for these species tend to occur on moist to dry, north-facing, >50º slopes of various substrates. The implementation of any of these alternatives, when considered in conjunction with known past, present, and foreseeable activities on both private and public lands in the analysis area, would not contribute measurably to an increase or decrease in cliff habitat within the analysis area and would not be expected to have a cumulative effect upon the species that are likely to occupy such habitats.

SUMMARY OF DETERMINATIONS

The summary of determinations below is based upon the proposed management action as described in this evaluation. *Should any significant change in the proposed management action as outlined in this evaluation occur after the date that this evaluation is signed, all effects upon these species may warrant re-evaluation before project implementation may continue.* Changes that would require a re-evaluation of effects upon these species include but may not be limited to:

- any change in the proposed action that may increase the potential for adverse effects upon RFSS or Species of Concern beyond what has been disclosed in this evaluation;

- unknown or previously unaddressed RFSS or Species of Concern are discovered in the project area.

Species Habitat Group	Species documented from project area?	Habitat present in project area?	Habitat affected by proposed action?	Determination		
				Alternative 1	Alternative 2	Alternative 3
Riparian, bottomland hardwood-associated Species	Yes	Yes	Alternative 1 - No Alternatives 2 & 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 & 3- Not likely	No impact	No impact	No impact
Grassland-associated Species	Yes	Yes	Alternative 1 - No Alternatives 2 & 3 – yes	No impact	Beneficial impact	Beneficial impact
Glade-associated Species	No	Yes	Alternative 1 – No Alternatives 2 & 3 – Yes;	No impact	Beneficial impact	Beneficial impact
Seep/Fen-associated Species	Yes	Yes	Alternative 1 – No Alternatives 2 & 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 & 3 – Yes;	No impact	Beneficial impact	Beneficial impact
Cliff face/bare rock	No	Yes	Alternative 1 - No Alternatives 2 & 3- Not likely	No impact	No impact	No impact

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Preparer

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Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
MAMMALS					
1	Eastern small-footed bat	Eastern small-footed bat	FT, Cassville, southern MO	Caves, tunnels buildings	
BIRDS					
2	Bachman's sparrow	Bachman's sparrow	All but PB	Rare summer resident, glades, open pine woods, old fields, clearcuts, Ozark plateau	
3	Cerulean warbler	Cerulean warbler	All MT units in the Ozarks	Bottomland and moist slope forests with uneven canopy of scattered large trees.	
4	American peregrin falcon	American peregrin falcon	Meramec, Gasconade, Mississippi Rivers historically	Mature, wooded riparian with cliffs	Hacked in STL, KC, Springfield
5	Migrant loggerhead shrike	Migrant loggerhead shrike	All MT units, could occur statewide	Uncommon permanent resident of grasslands with scattered shrubs and trees	
6	Swainson's warbler	Swainson's warbler	Don/11-pt District- Current, 11-pt Rivers; PB- Black River	Rare summer resident in giant cane along rivers in southern tier of MO counties	
AMPHIBIAN					
7	Eastern hellbender	Eastern hellbender	H/R, Sal/Pot- Ozark plateau rivers that drain into the MO. and Miss. Rivers	Under large, flat rocks in large, clear, permanent streams, common in Missouri	

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
8	Ozark hellbender	Ozark hellbender	Black and N. Fork White River systems; Willow, Don/11Pt RD.	Large, clear permanent streams, endemic to S. MO and N. AR	Federal candidate
REPTILES					
9	Alligator snapping turtle	Alligator snapping turtle	PB	Mississippi and other large rivers, sloughs and oxbows	
FISH					
10	Crystal darter	Crystal darter	Historically in the Gasconade, Meramec, Black, St. Francis, and Little Rivers. Probably only occurs in Black (Dunklin County)and Gasconade Rivers (Gasconade County) now.	Open channels of large, clear streams having low to moderate gradients and extensive stretches of largely silt-free sand and small gravel substrate	
11	Blue sucker	Blue sucker	Common and widely distributed in the MO and Mississippi Rivers and lowland section of the St. Francis River. Also recorded in the Black and Current Rivers	Deep, swift channels of large rivers over a bottom of sand, gravel or rock, most often where the channel is constrict by natural or artificial obstructions	New

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
12	Blacknose shiner	Blacknose shiner	Prairie streams of upper Osage (Benton, Dade, Hickory, St. Clair counties) and in tribs of lower Missouri River (Pettis, Callaway, Montgomery), Upper Big Piney and Gasconade Rivers (Texas, Wright)	Small moderately clear prairie streams in quiet pools with considerable amount of aquatic vegetation and bottoms of muck and organic debris and in quiet, heavily vegetated pools and backwaters of Ozark streams	
13	Ozark shiner	Ozark shiner	Found only in the Ozark uplands of southern MO and northern AR. White, Eleven Point, Current, Black, St. Francis (Marble Creek). Probably extirpated from Black and 11-Pt. Last stronghold is Current and Jacks Fork	Clear streams with high gradients and permanent strong flow mainly near riffles over a silt free bottom	
14	Sabine shiner	Sabine shiner	Black River in Butler county	Large moderately clear river with a predominance of sand, small gravel substrate	

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
15	Bluestripe darter	Bluestripe darter	Endemic to MO, Osage and Gasconade systems of the northern ozarks. Historically in the Sac, Maries and Little Piney rivers	Large creeks and small rivers, along margins of pools with silt free substrate and dense cover	
16	Longnose darter	Longnose darter	Historically in the White River in Stone and Taney counties and the St. Francis River and Lake Wappapello in Madison and Wayne counties. Recently collected in St. Francis at Fish Trap on FT unit	Medum to large Ozark rivers in pools and backwater with little current and firm substrate.	
17	Stargazing darter	Stargazin g darter	One of the rarest fish in MO. Current River in Ripley county and Black River in Butler county	Large, clear rivers in the transition zone between the Ozark Highlands and lowlands of the Miss embayment	
18	Eastern slim minnow	Eastern slim minnow	Historically in White, Black, St. Francis and Castor Rivers. Recently only from the Black River in Butler county and the Castor River in Bollinger county	Clear, swift streams with silt free sand and gravel substrate	
MOLLUSKS					
19	Spectacle case	Spectacle case	Meramec, Gasconade, Osage, Bourbeuse, Salt Rivers and Joachim Creek	Stable bottom of large rocks or boulders	

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
20	Western fanshell	Western fanshell	Locally abundent in the St. Francis, Spring, and Black Rivers, rare in the Current and Meramec	Shallow water with mixed gravel and mud	
21	Ouachita kidneyshell	Ouachita kidneyshell	Widespread south of MO River but seldom locally abundent. St. Francis, Black, Current, N. Fork White	Medium rivers with a substrate of gravel-mud and gravel with a moderate current in fairly shallow water, in riffles	
22	Purple lilliput	Purple lilliput	St. Francis, Black, Current, N. Fork White, Spring River	Gravel with sand	
23	Bluff vertigo	Bluff vertigo	Huzzah Creek	Caves and wet sites, bluffs along Huzzah	
INSECTS					
24	Micro caddisfly	Micro caddisfly	Endemic to MO, 11-Pt	Known only from Greer Spring	
25	Westfall's snaketail	Westfall's snaketail	Endemic to interior highlands, documented on Salem, Potosi, Fredtown Hou/Rolla, Ava, Willow	Fens, clear rocky rivers with gravel bars, high quality water and stable flow	New
26	A springtail	A springtail	Endemic to MO, Ava, 11-Pt	Wet caves	

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
27	A heptageniid mayfly	A heptageniid mayfly	Documented in the Huzzah on private within Potosi RD boundaries. Current, 11-Pt, Meramec, Black, White, St. Francis, Gasconade Rivers and the Headwater diversion	Slow to moderate flowing, cool, unpolluted, medium to large rivers	New
INVERTEBRATES					
28	Central MO cave amphipod	Central MO cave amphipod	Hou/Rolla-Phelps, Pulaski counties; Potosi-Washington county	Caves	
29	An isopod	An isopod	Poplar Bluff-Wayne county	Known only from a spring/seep in Wayne county	
30	Salem cave crayfish	Salem cave crayfish	Meramec, Gasconade, Osage, Current, 11-Pt, Spring Rivers	Cave streams, subterranean lakes, large springs	
31	Coldwater crayfish	Coldwater crayfish	11- Pt and Spring Creek	Coarse gravel and rock in swift, shallow water. Most abundent crayfish in the 11-Pt River	
32	A crayfish	A crayfish	White River drainage	Small clear creeks having a stable substrate of bedrock, rubble and coarse gravel	
33	Big Creek crayfish	Big Creek crayfish	St. Francis River in Iron, Madison and Wayne counties, most abundant in Big Creek and tribs	Headwater species in small high gradient rocky creeks in cavities under rocks, in riffles or in shallow silt-free pools	

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
34	White River Midget crayfish	White River Midget crayfish	Upper White River drainage in Barry, Christian, Stone, Taney counties	Clear, rocky, gravelly headwater creeks, spring branches and cave streams	
35	Cavernicolous harvestman	Cavernicolous harvestman	Know only from Turner Spring Cave in Oregon Co	Caves	
36	Onondaga Cave amphipod	Onondaga Cave amphipod	Salem, 11-Pt	Wet caves	
PLANTS					**Counties per Moore's Spreadsheet**
1	Purple false foxglove	Purple false foxglove	Ava/Cas, Sal/Pot	Prairies, dry open woods, glades, SW MO, scattered statewide	Barry, Iron, Shannon, Taney
2	Wood anemone	Wood anemone	Salem RD, Medley hollow fen, lower NE slope near creek	Moist, shaded north slope near fens, wet areas	Shannon
3	Tradescant aster	Tradescant aster	Butler and Howell counties in a meadow	Wet meadows, fens	Butler, Howell, Reynolds
4	Forked aster	Forked aster	Willow Springs, Houston, Don/11Pt units	Moist, rocky ledges of bluffs along streams in the Ozarks	Douglas, Ozark, Shannon, Texas
5	Large-leaf aster	Large-leaf aster	Willow Springs (one site on the MT)	Dry, open woods with bluffs/outcrops	Howell, Shannon, Texas
6	Ofer Hollow reedgrass	Ofer Hollow reedgrass	Houston, Willow Springs, Don/11-Pt in Douglas, Ozark and Texas counties	Rocky, wooded ravines and rocky open slopes	Douglas, Howell, Iron, Laclede, Oregon, Ozark, Shannon, Texas, Wright
7	Bush's poppy mallow	Bush's poppy mallow	Ava/Cass, Houston	Rocky, open woods and borders of glades and White river drainage	Barry, Ozark, Pulaski, Stone, Taney

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
8	Marsh bellflower	Marsh bellflower	Salem Rd, Big creek in Shannon county and Grasshopper Hollow in Reynolds county	Swampy meadows and fens	None
9	Buxbaum's sedge	Buxbaum's sedge	Butler county	Fens	Butler, Howell, Reynolds
10	Cherokee sedge	Cherokee sedge	Butler county	Low, wet woods (flatwoods)	Butler, Christian, Dent, Taney
11	Fibrous-root sedge	Fibrous-root sedge	Cass, Taney, Barry counties	Rich woods, wooded limestone slopes along steams	None
12	Epiphytic sedge	Epiphytic sedge	Salem, Don/11-Pt	On bases of shrubs in sinkhole ponds in SE Ozarks	Dent, Howell, Oregon, Texas, Reynolds, Ripley, Shannon
13	Sedge	Sedge	Phelps, Laclede, Taney, Jasper counties	Uncommon and widely scattered, moist depressions of upland prairies, disturbed marshy areas, low areas along roads and railroads, seems to prefer disturbed areas	Laclede, Ozark, Phelps
14	Large sedge	Large sedge	SE MO in Mississippi lowlands, uncommon	Swamps and bottomland forests	Butler, Ripley, Wayne
15	Sedge	Sedge	SE MO, Butler county	Rich, lowland woods or dry sandy wooded slopes and knolls	None

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
16	Dioecious sedge	Dioecious sedge	E Ozarks, Dent, Reynlds, St. Francis counties	Fens	Dent, Shannon, St. Francis
17	Straw sedge	Straw sedge	Shannon county	Sinkhole ponds	Shannon
18	Tussock sedge	Tussock sedge	Maries, Reynolds- Bee Fork, Shannon-Big Creek	Fens	Carter, Dent, Howell, Wayne, Reynolds, Shannon, St. Francis
19	Rigid sedge	Rigid sedge	Ava/Cass/WS and St. Francis county	Fens	Dent, St.Francis
20	Fox sedge	Fox sedge	Poplar Bluff RD, Camden, Wayne, Butler, Stoddard, Scott, New Madrid counties	Mississippi lowlands, swamps, openings of bottomland forests, wet depressions along roads, sometimes emergent	Butler, Wayne
21	Ozark chinquapin	Ozark chinquapin	Ava/Cass/WS, Howell county, White River drainage	Glades, dry ridges, acid soils	Baryy, Howell, Stone
22	Southern cayaponia	Southern cayaponia	Poplar Bluff RD, Camden, Wayne, Butler, Stoddard, Scott, New Madrid counties	Mud creek only	None
23	Ivy treebine	Ivy treebine	SW MO, McDonald to Ozark counties	Limestone bluffs along streams	Barry, Ozark, Stone, Taney
24	Trelease's larkspur	Trelease's larkspur	SW MO-Ava/Cass	Glades and bald knobs	Barry, Stone, Taney
25	Open-ground Whitlow grass	Open-ground Whitlow grass	Fredtown, Salem RD in Madison and Reynolds counties	Low, rocky woods	Madison, Reynolds
26	Log fern	Log fern	Carter county	Sinkholes and spring branches	Carter, Howell, Oregon

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
27	Goldie's woodfern	Goldie's woodfern	Madison county	Shaded, spring-fed branches	Bollinger, Madison, Perry, Texas, Wright
28	Yellow coneflower	Yellow coneflower	Central and Western Ozarks in Ozark, Phelps, Pulaski, Wright, Cedar, Barry counties	Limestone glades, barrens, and bald knobs	None
29	Wavy-leaf purple coneflower	Wavy-leaf purple coneflower	Hou/Rolla, Salem, Potosi, Don/11-Pt, PB RD's	Glades, savannas, roadsides	None
30	Small-flower thoroughwort	Small-flower thorough wort	Dunklin, Butler, Riply counties	Swamps, low meadows, wet prairies	Butler, Ripley
31	Pale (rough) avens	Pale (rough) avens	Wayne county	Wet areas, low woods	Shannon, St. Genevieve
32	Featherfoil	Featherfoil	Salem, PB, Don/11-Pt	Sinkhole ponds, tupelo swamps, SE MO	Bollinger, Butler, Reynolds, Ripley, Wayne
33	Whorled pennywort	Whorled pennywort	Ozark county	Moist banks of spring-fed steams	Ozark
34	Larged whorled pogonia	Larged whorled pogonia	St. Francis, St. Genevieve, Oregon, Butler, Stoddard counties	Mesic upland forests on acidic substrate, in bottoms and on lower slopes of ravines, dry upland forests on chert and sandstone	Butler, Oregon, St. Genevieve, St.Francis
35	Butternut	Butternut	All MT units	Rich woods, base of slopes, riparian	
36	Weak rush	Weak rush	Ripley county in Little Barren Creek	Little Barren Creek in the water	Ripley
37	Small-fruit seedbox	Small-fruit seedbox	Oregon county	Spring branches, swampy meadows	Oregon

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
38	Baldwin's milkvine	Baldwin's milkvine	Ava/Cass/WS, Houston, Don/11Pt	Open, rocky woods, edges of glades, along streams	Barry, Christian, Ozark, Phelps, Shannon, Stone, Taney, Wright
39	Bog buckbean	Bog buckbean	Reynolds county- Bee Fork	Fens	Reynolds
40	Large-leaved grass-of-parnassus	Large-leaved grass-of-parnassus	East and south, central Ozarks, Salem, Potosi/Fredtown, WS, Don/11Pt	Springs, fens, north facing bluffs, calcareous seeps	Carter, Crawford, Dent, Douglas, Howell, Iron, Oregon, Ozark, Reynolds, Shannon, Texas, Washington
41	Mudbank paspalum	Mudbank paspalum	S. and W. MO and STL in Barton, Jasper, Howell, Butler, Dunklin, St. Louis counties	sloughs, banks of streams and margins of ponds, also ditches, usually emergent aquatic	uncommon, know only from historical collections. Butler, Howell
42	Carolina phlox	Carolina phlox	Carter county	Low woods along Big Barren Creek	Carter
43	Spotted phlox (wild sweet william)	Spotted phlox (wild sweet william)	Iron, Dent, Reynolds, Carter counties	Fens	Carter, Dent, Iron, Reynolds, St. Genevieve
44	Knotweed leaf-flower	Knotweed leaf-flower	Stone county	Limestone glades	Stone
45	Yellow-fringe orchid	Yellow-fringe orchid	Historically- Ripley, Iron counties; currently Stoddard county	Edges of spring branches and sinkhole ponds	Carter, Iron, Ripley, St. Francis, Wayne
46	Small green woodland orchid	Small green woodland orchid	St. Francis, Bollinger, Wayne, Carter, Butler counties	Acid seeps and sinkhole pond edges	Bollinger, Butler, Carter, St. Francis, Wayne

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
47	Southern rein orchid	Southern rein orchid	Howell, Shannon, Wayne counties	Low, wet woods and bottomlands bordering streams	Shannon, Wayne
48	Pale green orchid	Pale green orchid	SE MO- Howell county	Wet woods and bottomlands bordering streams	Butler, Howell, Iron
49	Halberd-leaf tearthumb	Halberd-leaf tearthumb	Stoddard county	Wet, sandy swales of spring branches	None
50	Spotted pondweed	Spotted pondweed	Ozark uplands in Iron, Dent, Reynolds, Shannon counties	Sinkhole ponds	Bollinger, Bulter, Carter, Dent, Howell, Iron, Oregon, Reynolds, Ripley, Shannon, Texas, Wayne
51	Nuttall's oak	Nuttall's oak	SE MO in New Madrid and Butler counties	Bottomlands, low wet woods	
52	Harvey beakrush	Harvey beakrush	SW MO in St. Clair, Newton counties	Sandstone glades	Christian, Douglas
53	Orange coneflower	Orange coneflower	Iron, Shannon, Greene, Barton, Jasper, Newton	Moist openings, ledges, low woods	Benton, AR
54	Narrow-leaf pink	Narrow-leaf pink	Butler county near Mud Creek	Upland oak-hickory woods	Bulter
55	Gibbous panic grass	Gibbous panic grass	Oregon county	Sinkhole pond edges	Oregon, Perry
56	Canby bulrush	Canby bulrush	Oregon county	Sinkhole ponds including Tupelo Gum pond	Oregon

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
57	Weakstalk bulrush	Weakstalk bulrush	Washington county	Occurs in an artificial lake, emergent aquatics along margins of lake, probably brought by waterfowl	Washington
58	Bush's skullcap	Bush's skullcap	Ava/Cass/WS, Hou/Rol, Don/11Pt	Glades and bald knobs	Carter, Christian, Dent, Douglas, Howell, Oregon, Ozark, Pulaski, Taney
59	Royal catchfly	Royal catchfly	All but Cedar Creek	Rocky, open woods, glade edges, savannas	Barry, Carter, Christian, Dent, Douglas, Howell, Laclede, Oregon, Ozark, Phelps, Pulaski, Shannon, Stone, Taney, Texas, Washington, Wright
60	Gattinger's goldenrod	Gattinger's goldenrod	All but Cedar Creek	Glades, bald knobs	Christian, Laclede, Perry, Pulaski, Oregon, Ozark, Riply, St. Francis, Stone, Taney, Washington, Wright

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
61	Ladies' tresses	Ladies' tresses	Jackson, Reynolds, Boone, Buchanan, Iron, Franklin, Butler, Camden counties	Low, rich woods, terraced slopes along streams	Bollinger, Butler, Iron, Oregon, Perry, Phelps, Reynolds, Taney, Washington
62	Sullivantia	Sullivantia	Willow Springs, Don/11-Pt, Salem on private in Shannon county	Moist, shaded north facing slopes	Douglas, Howell, Shannon
63	Pale manna grass	Pale manna grass	Phelps, Reynolds, Shannon, Howell, Wayne, Butler, Scott counties; 11-Pt district	Swamps and margins of sinkhole ponds and spring branches, often emergent aquatic	Barry, Shannon
64	Ozark spiderwort	Ozark spiderwort	Ava/Cassville RD	Rich, rocky, wooded slopes and ledges in the White River drainage	Barry, Christian, Howell, Ozark, Stone, Taney
65	Ozark trillium (wake robin)	Ozark trillium (wake robin)	Ava/Cass, Don/11Pt in Barry, Lawrence, Shannon counties	Thin, cherty, acid soils of shallow draws	Barry, Howell, Shannon
66	Yellowleaf tinker's-weed	Yellowleaf tinker's-weed	Maries, Butler, Benton counties	West and south facing limestone slopes along Gasconade river, NE bluffs along Cole Camp Creek	None
67	Ozark cornsalad	Ozark cornsalad	Cass county in the White River drainage	Glades	Benton and Carroll- AR
68	Northern arrow-wood	Northern arrow-wood	Oregon county in Hurrican Creek	Gravel bars along small streams	Oregon

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.

	Common Name	Common Name	MT Units, Counties, Rivers	Habitat	Remarks
69	Barren strawberry	Barren strawberry	Texas, Dallas, Douglas counties; Jack's Fork, Shannon county- across from Medley Hollow fen, Salem RD	Shaded, moist humus of steep wooded north facing slopes and ledges near the base of bluffs	Douglas, Shannon, Texas
70	Netted chainfern	Netted chainfern	Barton, Butler, Stoddard, Lawrence counties	Swampy, wet, wooded areas	Butler, Carter
NON-VASCULAR					
71	Yellow starry fen moss	Yellow starry fen moss	Reynolds county in Grasshopper Hollow fen, Brant found in fen during Oak decline botanical survey in vicinity of Little Creek in Dent county (Salem RD)	Fens	None
72	Moss	Moss	11-Pt on Little Barren Creek in Ripley county	On roots or bases of trees, shrubs, or fallen twigs or rocks in swamps; submerged at high water; also margins of lakes, ponds, waerholes, or slow moving brooks in wooded swamps	None
73	Forked liverwort	Forked liverwort	Howell, Madison, Iron counties, Bell Mtn glades	Pioneer plant, occurs on bare rock or bare bark	None
74	Moss	Moss	Madison county on Fredtown unit	On calcareous rock in moist, shaded areas, generally on cliffs	None
75	Narrow-leaf peatmoss	Narrow-leaf peatmoss	Poplar Bluff in Pump Hollow	Bogs, wet ledges, sandy creek banks	None

Table 1A- RFSS for the Mark Twain National Forest as of 2/29/00 with list maintenance on 10/20/03.					
	Common Name	**Common Name**	**MT Units, Counties, Rivers**	**Habitat**	**Remarks**
76	Sphagnum	Sphagnum	11-Pt in Shannon and Oregon counties, Brant found in southern branch of Clear Creek in Washington county (Potosi RD) during botanical survey	Bogs, wet ledges, sandy creek banks	None

TABLE 2A . Additional Species of Concern in Missouri as of January 2003			
Common Name	**Scientific Name**	**Species Group**	**Suitable Habitat, Watershed**
Elephantear	*Elliptio crassidens*	Mollusk	Meramec, Osage
Snuffbox	*Epioblasma triquetra*	Mollusk	Bourbeuse, Meramec, St. Francois
Ebonyshell	*Fusconaia ebena*	Mollusk	Meramec, Mississipppi, Osage, Little Black
Sheepnose	*Plethobasus cyphyus*	Mollusk	Meramec
Lake sturgeon	*Acipenser fulvescens*	Fish	Missouri, Mississippi, Osage, Gasconade
Swamp darter	*Etheostoma fusiforme*	Fish	Allred Lake, Cane Creek- Butler County
Harlequin darter	*Etheostoma histrio*	Fish	Streams and ditches in SE MO
Goldstripe darter	*Etheostoma parvipinne*	Fish	Romine Spring- Butler County
Redfin darter	*Etheostoma whipplei*	Fish	Spring River- Jasper and Barton Counties
Spring cavefish	*Forbesichthys agassizi*	Fish	A spring in Scott County
Cypress minnow	*Hybognathus hayi*	Fish	Lower Black, St. Francois in backwaters
Taillight shiner	*Notropis maculatus*	Fish	Lower Black, St. Francois, Allred Lake- sloughs
Mountain madtom	*Noturus eleutherus*	Fish	Black, St. Francois, Current
Flathead chub	*Platygobio gracilis*	Fish	Missouri, Mississippi
Central mudminnow	*Umbra limi*	Fish	Mississippi- sloughs, swamps
Western chicken turtle	*Deirochelys reticularia miaria*	Reptile	SE MO- swamps, sloughs, ditches
Western fox snake	*Elaphe vulpina vulpina*	Reptile	N MO- wet prairies, marshes
Blanding's turtle	*Emydoidea blandingii*	Reptile	N MO- marshes, sloughs, ponds, ditches
Yellow mud turtle	*Kinosternon f. flavescens*	Reptile	SW MO- rivers, sloughs, lakes, ponds
Illinois mud turtle	*Kinosternon f. spooneri*	Reptile	NE MO- rivers, sloughs, lakes, ponds
Mississippi green water snake	*Nerodia cyclopion*	Reptile	Extirpated
American bittern	*Botaurus lentiginosus*	Bird	Uncommon transient- marshes
Northern harrier	*Circus cyaneus*	Bird	Uncommon transient- marshes, prairies

TABLE 2A . Additional Species of Concern in Missouri as of January 2003			
Common Name	**Scientific Name**	**Species Group**	**Suitable Habitat, Watershed**
Snowy egret	*Egretta thula*	Bird	Rare transient- marshes, flooded fields
King rail	*Rallus elegans*	Bird	Rare transient- marshes and swamps
Greater prairie chicken	*Tympanuchus cupido*	Bird	Prairie in the Osage plains
Barn owl	*Tyto alba*	Bird	Rare permanent resident- open country With abandoned buildings
Black-tailed jackrabbit	*Lepus californicus*	Mammal	SW MO- open plains, prairie
Mountain lion	*Puma concolor*	Mammal	Dense cover in areas with few humans, Recently more sightings in the state
Spotted skunk	*Spilogale putorius*	Mammal	Statewide- open prairie, brushy areas

APPENDIX F

BIODIVERSITY

In January 1993, the Council on Environmental Quality published "Incorporating Biodiversity Considerations into Environmental Impact Analysis under the National Environmental Policy Act." Pages 6-8 of that report outlined eleven general principles intended to help managers and planners identify biodiversity concerns and seek solutions in specific situations as agencies pursue their diverse mandates. The eleven principles (with one additional principle) and how they relate to the Crooked Creek project are:

1. Take a "big picture" or ecosystem view.

The Ozark-Ouachita Highlands Assessment (OOHA) examined the terrestrial resources of the Ozark-Ouachita Highlands as a complete unit, 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 mountains) between the Appalachians and the Rockies.

Prehistoric and Historic Ecological Changes

American Indians influenced vegetation patterns through their use of fire.

European settlers began making dramatic changes to the land commencing in the 1830's through land clearing and the suppression of fire; settlers also had an impact on animals by reducing certain habitats and by over-hunting.

Because people have been a constant influence on plant communities and ecosystems of the Highlands for thousands of years, ideas of "natural" (i.e. not human-influenced) conditions need to be reviewed carefully, even challenged.

Status and Trends of Vegetation

As measured by Advanced Very High-Resolution Radiometer data, oak-hickory forest is the most extensive vegetation type of the Assessment area, covering 15 million acres or 36% of the area. Oak-pine forest is the second most extensive within the region, with 4.4 million acres (11% of the Assessment area).

Non-industrial private forest (NIPF) owners hold 68% of the 22.89 million acres of timberland in the Assessment area; forest industry owns 11%. Thus, private and corporate landowners together hold more than 79% of the timberland. The remaining 21% consists of public timberlands, three-fourths of which are within the national forests.

The abundance of oak in the Ozark-Ouachita Highlands is matched by only two other regions in the United States: the Central Appalachian and Eastern Broadleaf Forest (Continental) Provinces.

The annual net growth of hardwoods and softwoods is more than double the annual removals. Since the 1970's, forested area has increased in five of the six Forest Inventory and Analysis (FIA) survey regions in the Highlands and, in some instances, dramatically.

Silvicultural Practices

Upland hardwood forests consist of relatively shade tolerant species that typically are best suited to even-aged management. Except for one case in Missouri, the few successful examples of uneven-aged management in upland oak forests required aggressive chemical control of competing hardwoods.

Shortleaf pine forests can be managed with a variety of even-aged or uneven-aged methods, but successful regeneration under single-tree selection typically requires chemical and/or mechanical control of competing vegetation. Natural regeneration also depends upon the co-occurrence of good seed crops, suitable seedbeds, and sufficient light.

Clearcutting declined in national forests from 27,729 acres in 1988 to 698 acres in 1996, a 97.5% decline. This decline in clearcutting was the single most significant trend on national forests in the Assessment area.

Reproduction cutting on the national forests using the seed tree method averaged 2,382 acres/year (8.6% of the 1988 clearcutting level) from 1991 through 1996. During the same period, the area harvested using shelterwood method an average 3,157 acres/year (11.4% of the 1988 clearcutting level).

The largest increase of a silvicultural method on the national forests was in the use of the single-tree selection. This increase was due more to singe-tree selection being the exact opposite of clearcutting rather than to any particular advantages for either pine or oak-hickory silviculture. Together, the Ozark and Ouachita National Forests applied single-tree selection on an average of 8,916 acres annually from 1991 through 1995.

Herbicide application for site preparation declined on the national forests from 12,705 acres in 1988 to 2,132 acres in 1997, an 83% decline over a 10-year period. Conversely, acres burned in site preparation on the Ouachita National Forest increased from 536 acres in 1989 to 3,137 acres in 1997. Each year, more acres were burned than in the previous year. This trend suggests that the limits to using prescribed fire for site preparation have not yet been reached.

The use of prescribed burning as a tool for managing intermediate stands has increased nearly four-fold over the past 5 years and exceeded 100,000 acres in 1997 (due primarily to actions on the Ouachita National Forest). The Ouachita National Forest has increased the use of prescribed burning to restore shortleaf pine-bluestem grass communities over extensive areas of the western Ouachitas to sustain wildlife habitat diversity and to encourage natural regeneration.

Plant and Animal Populations

Of the 333 plants and animals with viability concerns in the Ozark-Ouachita Highlands, 35 are imperiled (having 20 or fewer known populations) or critically imperiled (5 or fewer known populations). More than half (53%) of the species with viability concerns in the Ozark-Ouachita Highlands are known to occur only on national forest lands; about one-third of these species are known to occur only on private lands.

Sixteen species in the Ozark-Ouachita Highlands are federally listed as threatened or endangered. Available data for game species in the Highlands show that most populations have increased or remained stable since 1970.

North American Breeding Survey data revealed 21 of 90 species in the Ozark-Ouachita Highlands have declined significantly from 1966 to 1996. Six species showed a significant increase during the same period.

Biological Threats to Forest Resources

The European gypsy moth, a defoliator of hardwood trees, has been found in the Assessment area. The outbreaks have been minor, and eradication has been successful. Scientists expect that a general infestation might reach the Assessment area between 2025 and 2050.

Red imported fire ants are invading the Assessment area from the south and are expected to continue a gradual northward expansion. Eradication is probably impossible.

The southern pine beetle is indigenous to the southern part of the Assessment area. Serious outbreaks will continue to occur. These outbreaks are cyclic and related to stand age and density of pine trees in a stand.

Knapweeds, invasive non-native plants, have been present for several decades on some roadsides in southern Missouri. There are health concerns for humans and livestock related to this plant.

Purple loosestrife, a serious pest in wetlands, is present in the Assessment area and may spread.

The Crooked Creek Analysis Area is within the Meramec River watershed, and the Oak-Pine Hills and Oak-Hickory Hills Land Type Associations, Ozark Highlands Section, Eastern Broadleaf Forest (Continental) Province, Hot Continental Division, and Humid Temperate Domain (Land Type Association is from the Mark Twain Forest Plan and the section, province, division and domain come from the Ecoregions and Subregions of the United States, USDA, 1994). For a description of the Ozark-Ouachita Highlands Section, see pages 17-1 through 17-2 of the Ecological Subregions of The United States: Section Descriptions, WO-WSA, USDA Forest Service, July 1994.

The analysis area is composed of oak-pine forest in various successional stages. Historic and natural disturbance factors include frequent low intensity fires, with infrequent high intensity (or stand replacement) fires; windstorms and tornadoes; insect/disease mortality; occasional summer

drought or late spring frost; ice storms; and flash flooding in intermittent drainages and permanent streams.

OOHA states that people have lived in the Highlands for over 11,000 years; the earliest known inhabitants were the Paleo Indians. There is evidence that people were using the watersheds prior to 8000 BC as a hunting area. For the next 9000 years or so, the area was apparently used off and on by small bands for seasonal hunting and foraging. Caves and rock shelters were used as temporary homes. During the latter part of this time period, base camps may have been set up in river bottoms, from which small hunting/foraging parties spread out over the country. From the Archaic to Woodland times, small garden plots of cultivated plants may have supplemented the basic diet of wild foods. There is evidence that bear, deer, raccoon, rabbits and other small animals were hunted. Because the population was relatively low and use was not concentrated at one site for a long time, there would have been little impact to the environment. The principal prehistoric cultural periods that characterize human occupation of the Highlands prior to European exploration are as follows: Paleo Indian (11,500 BP [years before the present date] to 10,500 BP), Archaic (9,900 BP to 2,000 BP), Woodland (2,000 BP to 1,150 BP), and Mississippi (1,150 BP to AD 1,650). The Spanish expedition of Hernando de Soto (1539-1543) marked the first European exploration of the Highlands. French explorers and fur traders came to the region in the late 1600's.

During most of the Early Historic Period (around 1700 AD), "the semi permanent Osage villages were located in the Western Prairie Region," (west central Missouri) "and no other Indians were utilizing the Southwest Drainage Region...." The Osages "never had permanent villages in the region." As native peoples were pushed westward due to expanding European settlement, some tribes moved through and settled temporarily in Missouri (early 1800's).

The people who moved into the Highlands in the late 18th and early 19th centuries were attracted by opportunities to acquire timberland and by the availability of free open range on unclaimed public land. Land acquisition records indicate that many of the rough upland areas were settled between the 1880's and the 1930's. Traditional uses include small farming or cattle raising; hunting, fishing and trapping; and removal of various kinds of wood products. More uses that are recent include recreational hiking and driving. Most of the original forest cover was completely cut over by the early 1900's. Extensive overgrazing and annual burning followed the logging boom as people tried to make a living through livestock or farming. Most of the forested bottomlands were cleared for production of row crops.

Starting in the mid-1930's, land was acquired by state and federal agencies. Federal lands within the Highlands include over 164,000 acres of lands managed by the National Park Service, over 66,000 acres of national wildlife refuges, about 673,000 acres of lakes managed by the U.S. Army Corps of Engineers, two military bases, and 4.4 million acres of national forests. State lands include 65 State parks, 32 wildlife management areas, 5 State historic sites, 5 conservation areas, and 2 National Guard areas. Protection from annual burning, open range grazing, and indiscriminate logging resulted in re-growth of the oak-hickory/oak-pine forest communities. Shortleaf pine was planted in many abandoned fields. Closure of hunting seasons, protection of habitat, and active programs brought deer, turkey, beaver, otter and grouse among other species, back from the brink of extirpation. Other species (elk, wolves, bison, and red-cockaded

woodpecker) were not so lucky and are now absent from the state. Still other species became extinct (passenger pigeon and Carolina parakeet) in part due to human activities.

Fire suppression in the 1930's and later led to changes in community type and species composition in many areas. Closed-canopy forest replaced open woodland and woody species started growing in glades.

In all of the alternatives, several things will remain the same: The state and county highways and roads will continue to exist. Natural disturbances, such as windstorm, ice storms, frosts, and insects/disease, will continue to affect the analysis area. Fire protection will continue because it is a policy of the Forest Service to protect resources from wildfire and because the proximity of private lands and dwellings makes it imperative. The local economy will continue to rely on wood products, which will be removed from private lands as well as other public lands. Hunting, fishing, trapping and other recreational pursuits will continue.

The action alternatives are intended to use traditional kinds of disturbances (primarily prescribed fire and careful logging) in an environmentally sensitive way to create and maintain natural communities in all their successional stages. Out of this will come a sustainable supply of goods and services.

2. Protect communities and ecosystems.

The Upper and Lower Ozark sections of the Ozarks Natural Division (MDC) have been continuously available for habitation by and evolution of plants, animals and communities since the end of the Paleozoic era (200 million years ago). The great geologic age and physiographic diversity make the Ozarks by far the most biologically diverse area in the state of Missouri and one of the most significant centers of biodiversity in North America. A large percent of biodiversity is found in smaller/rarer communities such as caves, springs, sinkholes, glades, etc.

The oak-hickory/oak-pine forest with all its successional stages is the primary community in the analysis area. There are some stands of mixed oak-pine and shortleaf pine within the analysis area. There are subtle differences in vegetation depending on Ecological Land Type (ELT) (slope and aspect). For instance, broad ridges and southwest slopes are warmer and drier and support more pine and white oak. North slopes are moister and are suitable for a slightly different assemblage of herbaceous plants along with a higher component of hardwood trees. Special habitats within this analysis area include: riparian areas, bottomland hardwood forests, glades, shortleaf pine forest, ponds, old growth, springs, seeps and fens.

The 3.4 management prescription provides "a managed forest which emphasizes wildlife habitat diversity to maintain and enhance populations of native and naturalized vertebrates" (page IV-115 Forest Plan). ELT present in the analysis area include: high flood plains and low terraces with deep well-drained soils (ELT 3), upland intermittent drainages with deep cherty soils (ELT 5 and 6), gently sloping to moderately steep colluvial slopes below ELT 16, 17, 18 (ELT 7), ridgetops with deep cherty soils (ELT 11), ridgetops with deep cherty fragipan soils (ELT 14), south and west slopes with deep soils (ELT 17), north and east slopes with deep soils (ELT 18), and rock outcrop/dolomite glade (ELT 21). Natural vegetative communities are described on

pages IV-14 through IV-17 of the Forest Plan. Communities which exist within the analysis area include: mesic bottomland forest, dry bottomland forest, dry-mesic bottomland forest, mesic forest, dry chert forest, xeric chert forest, dry-mesic chert forest, and dolomite glade.

Alternative 1 would mean that only natural disturbances would occur. All communities present would continue to exist, although the amount of each community type might fluctuate over time. Fire protection would keep wildfires to a minimum. Open woods would only exist where the soil is poor. The oak-hickory-pine communities would continue to grow and mature, 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 percent of the area would eventually be in mature and old growth successional stages with a small amount of early successional stages present. Roads would still exist, be maintained, and used.

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 in the two action alternatives, through a combination of commercial harvest and prescribed burns.

Successional stages of the oak-hickory-pine communities would be created several ways. In Alternatives 2 and 3, stand treatments would create early successional stages of oak-pine forest, with openings up to 40 acres. Individual tree selection harvests would create small openings similar to those caused by natural tree mortality. These acres would have some value for early successional species, while at the same time maintaining a largely unbroken canopy of forest preferred by mid-successional species. Designation of old growth has already occurred and would ensure late successional communities would be available into the future.

3. Minimize fragmentation. Promote the natural pattern and connectivity of habitats.

The analysis area is approximately 50% National Forest System land intermixed with large areas of private land. The National forest land is approximately 96% forested and approximately 88% of the private land is forested. The forested areas are composed of several forest types in varying successional stages. Approximately 12% of the private land in the analysis area is grazed, cultivated, or residential land. Overall, approximately 84% of the analysis area is forested.

Adjacent lands include additional National Forest System lands all around the analysis area. Adjacent private lands are in all directions also.

Many county roads cross the analysis area. A possible barrier to movement between sections of the analysis area is Highway 32.

Principle #1 discusses how human actions have changed the landscape over time.

The pattern created by natural disturbances is probably a combination of a large number of small openings created by death of individual trees or small groups of trees, scattered natural openings where soil is poor, and a few large openings in the canopy created by windstorm or wildfire.

Canopy closure probably varied from moderate to heavy depending on the soil type, weather

conditions, and other disturbance factors. There were probably open woods on most ridgetops and south- and west-facing slopes, more dense woods on north- and east-facing slopes, and bottomland hardwoods in the riparian corridors. The forest probably had a naturally occurring variety of age classes, sizes and species distribution. The actions proposed in Alternatives 2 and 3 are designed to minimize adverse impact from insects and disease on forest vegetation and to imitate this variety of age classes, sizes and species distribution. No permanent changes in land use are planned (i.e., the forest areas will remain forested), and there would not be any conversion of one species to another.

Permanent openings on National Forest System Land (within the analysis area) are limited to approximately 900 acres of open field and small brushy openings. Open woods would be created through cutting and prescribed burning of approximately 9,600 acres in Alternatives 2 and 3.

Temporary openings of several sizes would be created through timber stand treatments in Alternatives 2 and 3. Regeneration harvest of up to 40 acres would be created by even-aged cutting methods. Many small openings would be created through single-tree selection. All these openings would consist of regenerating oak, hickory, pine and associated trees; i.e., small fruiting trees such as dogwood; shrubs and vines such as blackberry and greenbrier; and annual and perennial forbs and grasses. As the regenerating trees grow, the lower vegetation would slowly be shaded out and eventually the opening would cease to exist. These temporary openings reduce the amount of continuous forest canopy (but are still part of the forest community) and provide early successional habitat for a short period (up to 10 years).

Temporary edges would be created where even-aged harvest adjoins mature forest. These temporary edges would be young forest against immature or mature forest and would last for about 10-20 years (or until the new regenerating stand grows tall enough to function as immature forest). There would be no new permanent edges created.

Current old growth designations have already been done in all alternatives and were selected, as much as possible, to create blocks of continuous old growth habitat and provide travelways along drainages. In Alternative 1, the entire area would continue to grow older since no vegetation manipulation would be done.

Prescribed fire proposed in Alternatives 2 and 3 would help to reduce fuel loading and to increase the amount of grasses and forbs on the forest floor.

The OOHA report states that the Assessment area has grown rapidly in recent decades and continues to do so. Between 1970 and 1996, its population increased 48%, while Missouri grew by 15%, and the Nation grew by 31%. Recent (1990-96) population growth seems to be most strongly associated with metropolitan status, presence on national forests lands, and high rates of in-migration. In-migration of new residents contributed nearly 80% of the estimated population growth in the Assessment area as a whole and 83 to 98% of the estimated growth in groups of nonmetropolitan counties containing lands of one or more of the Highlands' national forests.

Private land uses are likely to remain much the same as in the past 10 years (homes,

outbuildings, pastures, hayfields, and small woodlots). If timber prices remain high, it is likely that cutting on private land will continue or increase in amount and intensity. It is also possible that additional woodland would be cut and/or bulldozed to create permanent pasture.

4. Promote native species. Avoid introducing non-native species.

Natural vegetative communities are described on pages IV-14 through IV-17 of the Forest Plan. Communities and management areas, which exist within the analysis area, are described in #2 above. Perpetuation of a healthy and diverse oak-hickory/oak-pine/pine forest community is one of the primary goals for this analysis area.

There would be no intentional introduction of non-native species in any alternative. In addition, there would be no management of native species on inappropriate sites in any of the alternatives. The oak-hicky-pine communities and their successional stages would be maintained in the action alternatives. The temporary openings created through even-aged management in Alternatives 2 or 3 would create opportunities for naturalized non-native annual and perennial plants such as ox-eye daisy, Queen Anne's lace, and foxtail. However, native annual and perennial plants would also be found in those areas.

5. Protect rare and ecologically important species.

Effects of the three proposed alternatives upon twelve federally-listed species were evaluated in a Biological Assessment/Evaluation (BAE) prepared for this analysis (Appendix E) The BAE determined that Alternative 1 would either have “no effect” or would “not likely adversely affect” any of the twelve listed species, including Indiana bat. It determined that Alternatives 2 and 3 would have “no effects” upon six species and “are not likely to adversely affect” five other species. The BAE determined that Alternatives 2 and 3 “may adversely affect” the Indiana bat. However, none of the effects disclosed in the BAE for the Indiana bat would be beyond those previously evaluated at a programmatic level on the Mark Twain National Forest with the US Fish and Wildlife Service (US Forest Service 1998; US Fish and Wildlife Service 1999).

Effects of the three proposed alternatives upon Regional Forester’s Sensitive Species (RFSS) and other Species of Concern were evaluated in a BAE prepared for this analysis (Appendix E) The BAE determined that Alternative 1 would have “no impact” upon any RFSS or Species of Concern. It determined that Alternatives 2 and 3 would have “no impact’ upon RFSS or Species of Concern using primarily streams/river habitats, a beneficial impact for species using primarily open/grassland and glade habitats, and that Alternatives 2 and 3 “may impact individuals or habitat but will not likely contribute to a trend towards federal listing or loss of population viability” for RFSS or Species of Concern that are using seep/fen habitats.

In March 2001, the Forest Service completed a Supplemental Information Report (SIR) regarding information on plethodontid (lungless salamanders). The report was revised in May 2001. The report was made in response to public concern about recent articles describing the decline of these species and effects of silvicultural treatments on salamander populations. The SIR concludes that the 1986 Forest Plan addressed habitat needs for these species and acknowledged the importance of mature/over-mature forest with dead, downed, and rotten

woody debris. The Forest Plan requires a certain percent of the Forest be maintained in mature and old growth forest, and protects special habitats such as springs, seeps, fens, fishless ponds, caves, and glades that may harbor salamander species. The Missouri Forest Ecosystem Project (MOFEP) is conducting inventory and monitoring of herptofauna (including salamanders) in the Ozarks. The results of MOFEP are being carefully reviewed for their applicability to projects on this district. The May 21, 2001, SIR is hereby incorporated by reference.

There is concern that populations of neotropical migrant bird species (many of which nest within the Forest boundaries) have been declining over the last decade. Suspected causes are loss of wintering habitat and fragmentation of breeding habitat. Studies of several species have been initiated to better determine causes of population declines.

Missouri has established a Neotropical Bird Working Group composed of experts from the Missouri Department of Conservation, Mark Twain National Forest, North Central Forest Experiment Station, and the University of Missouri. The Missouri Working Group is a part of the national Partners in Flight (PIF) effort and was created to evaluate threats to these species in Missouri and develop a list of species of concern for Missouri. The group has drafted this list, which is ranked according to the threats to the species in Missouri, the United States, and throughout their range. Results of this preliminary list show the top three birds of concern in Missouri are: Swainson's warbler (riparian/cane), Bachman's sparrow (glades/savannas/open pine woods), and dickcissel (openland).

Species included on the list of concern occur in all habitat types from openland to brushy areas to woodlands to mature woodland to riparian. Initial evidence indicates the species with lowest numbers are associated with floodplain, tall grass prairie, and shrub habitat, not upland forest habitat. Floodplain and shrub habitats are available in the analysis area. Temporary brushy openings of varying sizes would be created through even-aged and uneven-aged regeneration harvest. The work of this group highlights the fact that breeding habitat for neotropical migratory birds includes all successional stages and all types of habitat and is not only large areas of unbroken woodland.

PIF completed the Bird Conservation Plan for the Ozark-Ouachitas (Physiographic Region 19) in August 2000. This report states, “Therefore, maintaining the forested landscapes needed to support source populations of forest birds is probably the single most important contribution that the physiographic area can make to the conservation of non-game birds.” And “…active restoration and management of those habitats” (i.e., pine savannas and bottomland hardwood forests) “across their range is warranted.” PIF also state that grass-shrub or early successional forest species “can be provided for by idling agricultural lands, even-aged timber management, or restoration of glade and savanna habitats….Acreage needs of early successional species must be balanced with the needs of mature forest species also in need of conservation attention.” To summarize, **“**In general, recommendations focus on maintaining the region’s largely forested landscapes and large blocks of forest to keep source populations intact, restoring landscapes or blocks where potential currently exists, and balancing forest age classes within those areas so that the needs of species requiring a variety of successional stages all can be met.”

The most recent research by North Central Forest Experiment Station suggests the type of

landscape that surrounds an area has much to do with what effects occur on neotropical migrant songbirds. This research has shown that landscapes which are fragmented by large blocks of agriculture (pastures and crops) or human development (subdivisions, shopping malls, towns, businesses, etc) and have only a small proportion of forest, such as southern Illinois, show the greatest negative impacts on neotropical songbirds from cowbirds and possibly other nest predators.

On the other hand, landscapes that are primarily forest with only a small proportion of permanent agriculture or human development, such as the analysis area, show very little negative effects from cowbirds and possibly other nest predators. Detrimental effects appear to be more a result of conversion of forest to permanent non-forest uses rather than a result of manipulation of forest vegetation to create various successional states. Research is continuing to accumulate more data and refine these conclusions. There would be no conversion of forest to permanent non-forest uses in any alternative.

Other research recently conducted in southern Indiana suggests that brood success for some neotropical migrant birds is less when they nest adjacent to forest openings of any kind (clearcuts or permanent openings). The reasons for this are cowbirds' parasitism and nest predation. These results are, as stated in the paper, not statistically significant for any of the species but are significant for others. The question remains, are these results related to decreased populations of the species studied or are the increased parasitism/predation rates not significant in terms of population fluctuations. Because there are neotropical migrant species which prefer the type of brushy habitat created by even-age management, a combination of careful placement of even-age management harvest and of larger blocks of forest interior/old growth should provide habitat for all of the native Missouri migrants, as required by the Forest Plan. Old growth design was made considering size and placement to maximize contiguous area of native over-mature forest.

A comparison of data from 2 years of bird monitoring (1992 and 1993) from managed versus unmanaged areas of the Mark Twain National Forest shows that most neotropical migrants which might be considered "forest interior" species can be found in similar frequency in both the managed and unmanaged areas. The managed area includes plots adjacent to clearcuts of various ages and sizes, as well as commercial thinning. The unmanaged area is within Wilderness, where only natural disturbance occurs. Only one species was found in the unmanaged (worm-eating warbler), but not in the managed. Two species (black and white warbler and Kentucky warbler) were found only in the managed plots, but not in the unmanaged. The remaining nine species were found in the managed plots at the same or higher frequency than the unmanaged, with one exception. The summer tanager was found more frequently in the unmanaged than managed. While 2 years of data is not enough to conclusively prove any hypothesis, it does suggest that manipulation of forest cover to provide different successional stages does not preclude use by "forest interior" neotropical migrant birds.

It also appears from recent research, but is not yet proven, that areas such as the analysis area have greater bird reproduction than mortality; therefore, these areas might have surplus birds to move to areas which have greater mortality than reproduction (such as southern Illinois). Research is also continuing to determine whether birds from southern Missouri actually move to

southern Illinois.

Alternative 1 would provide an abundance of mature to old growth oak/hickory/pine forest. However, much of the analysis area is less than 1 mile from private lands with permanent agricultural openings. This could limit the suitability of this habitat for those species that require larger blocks of forest interior. The primary method to develop shrub habitat is to conduct even-age management harvest; and since none of this would occur, shrub habitat would be very scarce. Even on private land, most of the open habitat is in grazed fescue pasture with very little shrub development. These neotropical migrants who depend on this habitat for breeding (e.g., blue-winged warbler, white-eyed vireo, prairie warbler, yellow-breasted chat, etc.) would find very little suitable habitat on National Forest within the analysis area. There would be no fragmentation of forestland by non-forest land uses and only natural fragmentation of forest types, communities, age-classes and successional stages.

Alternatives 2 and 3 would have several large blocks of old growth forest, areas of single-tree and group selection harvest creating small openings in the canopy, and areas of shrubby habitat created through even-age regeneration harvest. Single-tree selection harvests and areas of no treatment would create a variety of canopy closures from light to moderate to dense. This, in turn, would allow a wide variation in amounts and types of ground flora available throughout the analysis area. This would provide suitable habitat for a wide variety of neotropical migrant species, although numbers of each species might be lower or higher than in other alternatives due to the amount of each habitat available. Mature forest species would be lower, "gap" species would be slightly higher and shrub species would be slightly higher.

In Alternatives 2 and 3, there would be no fragmentation of forestland by non-forest land uses, only fragmentation of forest types or communities, and some fragmentation of forest age-classes and successional stages. The differing age-classes and successional stages would leave the forest matrix intact and would continue to provide the mosaic of age-classes and successional stages common in the area for the past 20-30 years.

The OOHA project analyzed data from the PIF program, the North American Breeding Bird Survey (NABBS), and the National Audubon Society’s Watchlist (NASW). Forty-one (26%) of 157 species of birds that breed within the Assessment area are classified as priority species by PIF. Analysis of the NABBS reveals that 21 of 90 bird species in the Ozark-Ouachita Highlands have significantly declined in abundance during the period 1966-96. Six of the species had significant population increases. Twenty-five of the 90 species on the NASW occur within the Ozark-Ouachita Highlands.

The three lists of birds with management concerns have some species in common but also differ in many ways. The priority species list and the Audubon Watchlist are based on similar criteria but applied at different scales (the Ozark Highlands Plateau and the United States, respectively). These two lists consist of a mix of resident, short-distance and long-distance migrants, but are dominated by neotropical migratory birds. By contrast, the list of species in the region with population declines is a more balanced mix of resident, short-distance and long-distance migrants.

Most bird species, including most species with management concerns in the Assessment area, primarily use forest and shrub/sapling habitats. Some species with management concerns inhabit savannas and glades. Shrub/sapling birds exhibit some of the steepest population declines in the region but, in general, are still more abundant or broadly distributed than some forest birds with management concerns.

Landscape composition and pattern significantly affect the reproductive success and status of forest bird populations in the Assessment area. Productivity, source-sink status of populations and levels of nest predation or brood parasitism are related to landscape patterns in forest cover. Strong regional patterns in the productivity of some songbirds in midwestern forests occur because of the great variation in the amount of forest cover. No single silvicultural practice can be generalized as good or bad for birds. Any silvicultural system will create habitat for some species while degrading habitats for others. Land management for species conservation should consider patterns and practices at both the landscape scale and stand scale. A diversity of forest management practices will meet the habitat needs of songbirds better than any one practice. The mix of practices will largely determine the abundance of individual species.

6. Maintain unique or sensitive environments.

See #2 for information about special communities.

The anticipated effects of each of the three proposed alternatives upon a variety of specialized habitats are disclosed on page 3-84 of the EA.

7. Maintain or mimic natural ecosystem processes.
and
8. Maintain or mimic naturally occurring structural diversity.

See also discussions in #2, #3, and #6 above. Historic and natural disturbance factors include fairly frequent low intensity fires, with infrequent high intensity (or stand replacement) fires; windstorms and tornadoes; occasional summer drought and/or late spring frosts; insect/disease mortality; and flash flooding in intermittent drainages and permanent streams. These disturbances formed a mosaic of successional stages of the oak-hickory/oak-pine forest. Small openings resulting from windthrow, insect/disease, or natural mortality were probably frequent, with larger openings caused by stand-replacement fires, drought, frost and tornadoes were probably infrequent across the landscape. In addition, soil fertility helped determine the species composition and density of vegetation. Poorer soils had less density of tree species and more herbaceous understories, while richer soils had a higher density of tree species along with a varied mid-story of shrubs and small trees and less herbaceous ground cover.

Actions that create the larger stand-replacement openings include even-age harvest techniques of clearcut, seedtree, overstory removal, and shelterwood seedcut. Uneven-age management harvest (either single-tree or group selection) would create the smaller and more numerous openings typical of most natural disturbances. Prescribed burning of selected area would recreate and maintain open woods conditions prevalent on ridges, southwest slopes, and poor soils. Designation of old growth allows formation of the older, late successional stages that have

been lacking since the late 1800's and early 1900's.

Information on many ecosystem processes (such as hydrologic regimes, nutrient flows, and inter-species relationships) is sparse, particularly as relates to the Missouri Ozarks.

Alternative 1 would come the closest to allowing natural processes to operate. There would still be human-caused impacts, but they would be caused by activities other than those proposed in this EA.

Both uneven-age and even-age management would occur in Alternatives 2 and 3, creating openings up to 40 acres. Prescribed burning to encourage growth of herbaceous ground cover would occur in Alternatives 2 and 3. Old growth already designated within the analysis area would be allowed to develop in Alternative 1.

9. Protect genetic diversity.

"To preserve genetic adaptations, species should be maintained in natural habitats across their natural ranges, and plants and animals for reintroduction should be selected from ecologically similar areas as close to the restoration site as feasible" (p. 7, CEQ).

Only natural vegetative disturbances or human-caused wildfires would affect the analysis area in Alternative 1. The area would move toward a higher percent in mature or old growth successional stages with very little in early successional stages. Populations of species adapted to hot, sunny and dry conditions would likely decrease and populations of species adapted to more shady, cool, and somewhat more moist conditions would likely increase. In this case, genetic adaptations would be more difficult for those decreasing populations and easier for those increasing populations.

There would be no attempt to physically move any plant or animal species from somewhere else into the analysis area in any alternative. However, Alternatives 2 and 3 attempt to maintain the type and amount of disturbance which create a mix of "natural habitats" within the oak-hickory-pine ecosystem as well as minimize adverse impacts from insects and disease on forest vegetation. A range of successional stages would be provided (see discussions in #2, 7, and 8) and non-native species would be discouraged (see discussion under #4). By maintaining the range of successional stages of communities on appropriate sites, genetic variations and the ability to adapt are also maintained.

10. Restore ecosystems, communities, and species.

Species extirpated from Missouri within historic times include: red and gray wolf, cougar, red-cockaded woodpecker, elk, and bison.

The Missouri Department of Conservation is responsible for wildlife populations. They are currently conducting a study to determine feasibility of and public sentiment concerning possible reintroduction of Woodland Elk. No other plans are being made to reintroduce any other species.

Species successfully recovered or reintroduced in the Lower Ozarks from the 1930's until the present include: deer, turkey, beaver, ruffed grouse, and river otter.

Some species that are relatively uncommon in Missouri are naturally moving back into the state. In the past several years, black bear and armadillo sightings have been more frequent in the Lower Ozarks and near the analysis area. It appears that both these species are expanding their ranges by moving into southern Missouri from adjoining states. The Missouri Department of Conservation has a Black Bear Management Plan but has no immediate plans to actively reintroduce bears to the state. They are monitoring bear sightings and responding to situations where bears and people come in conflict. Armadillos make recurring attempts to move north and are usually decimated during extended periods of extremely cold weather. The last several winters in south Missouri have been relatively mild, allowing the expansion of armadillo populations.

Natural communities that have been altered or reduced within historic times in this area include: open woods and old growth. Forests with woodier understory plants have gradually replaced open woods typical of poor soils and/or ridgetops as fire protection kept out frequent low-intensity fires. Old growth forests were almost completely wiped out during the logging boom of the late 1800's and early 1900's.

See #2, 5, 6, 7, and 8 for discussions of how natural communities would be affected by each alternative.

11. Monitor for biodiversity impacts. Acknowledge uncertainty. Be flexible.

Because ecosystems are so complex and the interrelationships so difficult to understand, there is extensive research being done on various aspects of ecosystem composition, structure and function. In Missouri, efforts are underway by the Missouri Department of Conservation, Missouri Department of Natural Resources, United States Geological Survey, USDI National Park Service, USDA Forest Service, the Missouri Universities, and other organizations or private businesses to study many of these subjects. The Missouri Resource Assessment Project (MoRAP) is measuring the effects of forest management on many species of animals and plants. This work is ongoing. The OOHA was a study completed of the Ozark-Ouachita Highlands. It measured the areas from the socio-economic conditions to the terrestrial vegetation and wildlife.

At the present time, there are no studies being done specifically within the analysis area. This area would be available for future research and studies under all alternatives.

Alternatives 2 and 3 all contain provisions for monitoring. In addition, normal contract administration monitors actions carried out under a contract. District staff normally make unscheduled visits to different areas to informally monitor compliance with specifications and the results of various activities.

12. Incorporate human needs.

Several objectives of the Forest Plan incorporate human needs as a part of management of the ecosystem. In particular, the 3.4 Management Prescription mentions as some of its purposes “to provide dispersed recreation opportunities" to provide for moderate to high production of other resources such as timber products, recreation, forage and minerals (Forest Plan, p. IV-115).

These objectives can be met by maintaining traditional uses while providing for changing societal needs within the limits of ecosystem capability.

See discussion under #1 about traditional uses.

Traditional uses such as hunting, fishing, hiking, berry-picking and horseback riding would still be possible under any alternative. Driving for pleasure would still be possible in all alternatives. Game species such as doves, rabbits, quail and deer that prefer early successional habitats would be less abundant in Alternative 1; therefore, hunting success might be lower for these species. Game species such as turkey, raccoon, and squirrel, which prefer mid to late successional habitats, would be more abundant in Alternative 1; thus leading to the possibility of higher hunter satisfaction. Conversely, in Alternatives 2 and 3, early successional species (and hunting success) would be relatively higher and late successional species relatively lower than in Alternative 1.

The existing road system would still exist in all alternatives. However, in Alternative 1 there would be only minor maintenance. Some roads might deteriorate to the point of being drivable only by 4-wheel drive vehicles or ATV's. Reconstruction of existing roads would be done in Alternatives 2 and 3 keeping them drivable by most vehicles.

Wood products removed in Alternatives 2 and 3 would be enough to supply an average large-size local mill for about 2 years. Personal use firewood would be available with a permit in Alternatives 2 and 3. With no commercial cutting in Alternative 1, personal use firewood would be limited to permits to cut hazard trees and possibly downed trees along roads. All alternatives maintain the opportunity to provide goods and services in the future.

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ALT 2

				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
3.4-1	19	2	1													1							990		17		
		4	8				8															1926	538	4	17	10	50
		6	6							6												1960	326	5	14	8	80
		13	13							13												1963	326	5	18	6	80
		15	13							13												1965	328	5	17	10	80
		16	12							12												1963	326	5	18	8	80
		17	17							17												1961	326	5	17	8	80
	20	2	7							7												1964	329	5	18	10	80
		3	66							66												1959	448	3	14	10	80
		7	15			15					15											1924	598	3	18	12	40
		10	1													1							990		14		
	21	1	8							8			8									1961	326	5	14	8	80
		2	8							8			8									1966	326	5	14	8	80
		3	16	13							13	13	16									1916	537	1	17	12	20
		4	21	21							21	21	21									1911	539	1	18	14	20
		5	39	35							35	35	39									1912	538	4	18	12	20
		6	21			12					12	12	21									1961	327	5	14	10	30
		7	20										20									1960	447	3	17	10	
		8	26										26									1961	328	5	18	10	
		9	13										13									1911	599	3	18	12	
		10	1										1			1							980		5		
		11	28			28					28		28									1921	598	3	18	12	40
		12	22										22									1922	539	1	17	11	
		13	34										34									1963	449	5	17	12	
		14	26										26									1962	447	5	14	10	
		15	17										17									1962	447	5	18	10	
		16	1										1			1							990		14		
		17	24										24									1917	597	4	18	14	
		18	16										16									1900	598	4	18	12	
		19	24			24					24		24									1926	597	3	14	14	30
		20	2										2									1972	596	5	14	5	
		21	2										2									1967	326	5	14	8	
		22	11										11									1922	537	1	17	10	
		23	21			21					21		21									1923	548	4	18	12	40
		24	15										15									1973	446	5	17	8	
		25	10										10									1916	538	5	18	13	
		26	16										16									1996	530	9	18	0	
		27	15			7					7		15									1961	447	3	18	10	30
		28	4										4									1922	597	3	5	13	
		29	7										7									1916	549	4	17	12	
	22	1	1										1			1							990		5		
		2	7										7									1928	539	7	17	12	
		3	33										33									1963	446	5	17	8	
		4	15										15									1919	538	1	17	10	
		5	23										23									1987	511	5	17	1	
		6	22							22			22									1981	323	5	17	1	80
		7	26										26									1926	538	4	18	14	
		12	1										1			1							990		14		
		13	12			12					12		12									1919	539	1	17	14	40
		14	3										3									1967	326	5	14	8	
		15	23			23					23		23									1926	539	4	18	16	40
		16	26							26												1981	322	5	14	3	80
		17	16			16					16		16									1928	539	1	17	12	40
		18	15			15					15		15									1922	538	4	18	14	30
		19	20			20					20		20									1923	539	1	17	14	40
		20	17				17															1923	539	4	18	14	60
		23	1													1							990		14		
		24	24	24							24	24										1916	537	1	17	16	20
		25	14					14														1916	597	4	17	14	
		29	25				25				25											1936	598	4	18	10	
		30	19				19				19											1923	539	7	17	12	
		31	16				16															1922	539	1	14	12	
		32	27							27												1964	329	5	14	10	

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
	23	1	26										26									1919	539	1	17	12	
		2	2										2			2							990		21		
		3	2										2			2							990		21		
		4	20										20									1942	538	1	17	10	
		5	21										21									1916	538	1	17	13	
		6	30										30									1929	539	3	17	18	
		7	25				25						25									1929	538	4	17	12	60
		8	8										8									1939	539	3	18	14	
		9	40										40									1922	537	1	17	16	
		10	28										28									1939	598	7	18	12	
		11	30										30									1920	539	4	17	14	
		12	27										27									1926	518	3	17	12	
		13	40			15					15		40									1936	539	3	17	12	
		14	20			10					10		20									1924	539	1	18	14	
		15	37				37						37									1929	599	7	17	12	
		16	20										20									1993	533	5	18	0	
		17	8										8									1915	519	3	14	12	
		18	8			8					8		8									1922	549	7	17	12	
		19	38										38									1932	537	3	17	12	
		20	31										31									1929	539	4	18	13	
		21	40										40									1933	517	3	17	10	
		22	2										2			2							980		14		
		23	2										2			2							980		14		
		24	1										1									1959	424	3	18	6	
		25	6										6			6							980		3		
		26	5										5			5							980		7		
		27	24										24			24			24	24	24		990		14		
		28	20										20									1927	517	3	17	12	
		29	25										25									1926	539	4	18	16	
		30	20										20									1931	539	1	17	14	
		31	23										23									1929	539	4	14	14	
		32	30										30									1996	533	5	17	1	
		33	32										32									1929	599	4	18	14	
		34	12										12									1927	597	3	5	10	
		35	29										29									1919	539	1	17	12	
		36	22										22									1922	539	1	17	12	
		37	12										12									1927	539	4	18	11	
		38	1										1			1						1991	990		14	0	
	33	1	42				20						42									1921	539	1	17	14	
		2	33										33									1923	539	1	17	14	
		3	20				20						20									1920	539	1	14	14	
		4	26										26									1993	533	5	18	0	
		5	40										40									1919	539	3	17	14	
		6	23										23									1989	533	5	18	2	
		7	44			44					44		44									1917	539	4	14	14	
		8	1										1			1							990		14	0	
		9	15										15									1928	599	4	17	12	
		10	31										31									1993	593	5	18	0	
		11	21										21									1921	599	4	18	14	
		12	34										34									1916	599	4	18	14	
		13	34										34									1992	533	5	18	0	
		14	22										22									1925	539	1	17	14	
		15	33										33									1996	533	5	14	1	
		16	27										27									1923	599	4	17	12	
		17	13										13									1938	797	3	3	10	
		18	22										22									1915	549	4	18	11	
		19	7										7			7							990		3	0	
		20	24										24									1923	599	4	18	14	
		21	38										38									1911	539	4	18	14	
		22	33				33						33									1929	539	1	17	12	
		23	31	31							31	31	31									1932	539	1	14	12	
		24	2										2			2							990		14	0	
		25	2										2									1921	599	3	17	16	
	34	1	61										61			61			61	61	61		990		7	0	
		2	10										10			10							990		7	0	

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		3	40										40									1919	797	3	3	14	
		4	8										8									1927	599	4	18	16	
		5	28										28									1945	599	5	5	16	
		6	39										39									1942	539	5	18	16	
		7	24										24									1951	539	5	17	14	
		8	15										15									1927	539	1	18	16	
		9	40										40									1996	533	5	17	1	
		10	15			15					15		15									1916	539	4	18	14	
		11	14			14					14		14									1930	538	1	17	12	
		12	34			34					34		34									1922	599	4	18	14	
		13	36										36									1928	539	4	18	14	
		14	26										26									1921	539	4	18	16	
		15	44										44									1919	598	4	17	12	
		16	29										29									1994	533	5	18	0	
		17	37										37									1930	538	3	17	12	
		18	42										42									1922	538	1	17	12	
		19	20										20									1921	538	1	18	16	
		20	15										15									1924	538	1	17	14	
		21	30										30									1924	538	4	18	16	
		22	25										25									1922	537	3	18	14	
		23	34	34							34	34	34									1923	539	1	17	14	
		24	1										1			1							990		11	0	
		25	32					32			32		32									1921	539	4	18	16	
		26	39										39									1917	539	1	17	12	
		27	14										14									1924	539	1	18	18	
		28	19										19									1994	533	5	18	0	
		29	25										25									1931	538	4	17	14	
		30	16							16			16									1975	326	5	17	8	80
		31	41										41									1938	539	5	18	14	
		32	29	29							29	29	29									1928	539	1	17	14	
		33	28										28									1932	539	1	17	14	
		34	26										26									1931	599	6	5	14	
		35	22	22							22		22									1905	539	6	18	16	
		36	26										26									1930	599	6	17	16	
		37	25										25									1939	599	5	17	14	
		38	35	35							35		35									1931	519	3	18	12	
		39	22							22			22									1975	326	5	17	6	80
		40	16										16									1931	598	4	17	14	
		41	19							19			19									1974	323	5	14	3	80
		42	23										23									1923	538	3	18	14	
		43	5										5			5							980		17	2	
		44	2										2			2							990		14	0	
		45	1										1			1						1991	990		7	0	
		46	5																			1920	538	1	17	10	
	35	4	12				12															1916	598	4	11	12	50
		5	16							16												1963	328	5	17	10	
		9	21					21														1928	538	3	18	12	
		14	18				18															1919	597	4	18	10	
		16	19							19												1965	325	5	17	8	
		17	12								12											1920	597	3	17	12	
		18	12							12												1965	446	5	11	8	
		19	8								8											1963	537	3	11	12	
		20	13	13							13											1913	548	4	18	12	
		28	12	12							12	12										1920	598	3	17	12	
		29	16						16													1923	517	7	17	12	
		37	12	12							12	12										1931	537	3	17	14	
		41	22												22	22							980		5		
	36	3	21			21					21											1938	538	3	18	14	30
		4	25					25														1923	538	4	18	12	
		6	12					12														1946	537	5	17	12	
		7	6					6														1925	537	3	18	12	
		8	23						23													1937	538	5	18	12	
		9	12						12													1926	537	1	17	10	
		11	1													1							990		18		
		17	5					5														1931	537	3	17	12	

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		18	9						9													1919	537	1	14	12	
	37	6	48							48												1962	326	5	17	8	80
		8	12												12	12						1926	597	3	17	14	
		9	30			30					30				30							1912	598	4	18	14	
		10	3	3							3	3			3							1919	597	4	11	10	
		11	33	33							33	33			33							1949	538	5	17	12	
		12	11												11	11						1935	538	3	14	12	
		13	18												18	18						1978	446	5	17	6	
		15	9												9	9						1978	324	5	17	6	
		16	45												45	45						1918	537	4	18	16	
		17	48												48	48						1923	538	5	17	14	
		18	32				32															1929	538	1	17	14	60
		20	13							13												1960	326	5	14	8	80
		21	17												17	17							990		5		
		25	22	22							22	22										1918	597	4	17	12	20
		31	14												14	14						1939	516	5	14	10	
		33	27			27					27											1927	538	3	18	14	40
		37	8												8	8						1935	518	3	14	12	
		39	28	28							28	28										1926	539	1	17	14	20
		41	1													1							990		14		
		42	1													1							990		14		
		43	1													1							990		14		
		46	25			25					25											1920	538	1	12	17	40
	38	1	5							5			5									1973	446	5	14	8	80
		2	33	30							30		33									1917	539	3	18	14	20
		3	16	14							14		16									1911	539	3	18	14	20
		4	15						3				15									1919	539	3	18	14	60
		5	29							29			29									1961	326	5	14	8	80
		6	32										32									1994	533	5	18	1	
		7	31										31									1930	539	3	18	14	
		8	26			26					26		26									1910	519	3	14	12	40
		9	36										36									1922	539	4	18	14	
		10	32										32									1994	533	5	17	0	
		11	4										4										990		3		
		12	29										29									1917	599	4	5	12	
		13	27										27									1926	599	3	17	14	
		14	13										13									1994	533	5	18	0	
		15	22										22									1994	593	5	17	0	
		16	32										32									1926	549	3	5	14	
		17	7										7									1933	539	5	17	10	
		18	9										9									1944	539	3	18	12	
		19	30										30									1937	539	3	17	14	
		20	20										20									1924	599	3	18	14	
		21	22	20							20		22									1925	539	3	18	12	20
		22	50										50									1943	539	3	18	10	
		23	16										16									1950	539	5	18	12	
		24	35										35									1948	539	3	17	10	
		25	34										34									1948	539	3	17	12	
		26	18						18				18									1944	539	3	17	12	60
		27	10							10			10									1974	326	5	18	8	80
		28	37			37					37		37									1932	539	3	18	12	
		29	30										30									1991	533	5	18	0	
		30	16										16									1926	539	3	18	14	
		31	40										40									1992	533	5	18	0	
		32	40			40					40		40									1942	539	3	14	12	40
		33	26										26									1942	539	3	18	14	
		34	27										27									1945	539	3	17	12	
		35	16										16									1916	539	4	18	14	
		36	21										21									1922	539	3	17	14	
		37	30										30									1930	539	3	18	16	
		38	38			38					38		38									1916	539	3	18	14	40
		39	25										25									1993	533	5	17	0	
		40	30										30									1927	539	4	18	14	
		41	18			18					18		18									1912	539	1	17	14	40
		42	16										16									1969	539	3	18	10	

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		43	18						3				18									1937	539	3	17	14	60
	39	6	27				27															1911	539	3	17	14	50
		7	25				25															1911	539	3	18	12	50
		9	36			36					36											1911	539	3	18	14	40
		10	40	38							38	38										1911	539	3	14	12	20
		14	23	21							21	21										1911	539	3	14	14	20
		15	17				17															1935	539	4	18	14	70
		16	24				24															1938	539	3	17	12	60
		17	12				12															1938	539	3	14	12	70
	40	5	27	27							27	27										1936	599	3	14	12	
		6	1													1							990				
		12	43			43					43											1937	539	6	14	16	
		21	38				38															1904	539	1	14	14	
		26	28				28															1921	539	3	17	12	
		27	31				31															1938	549	5	17	12	
		30	10	10							10	10										1942	539	1	14	14	
	41	2	8				8															1966	599	3	11	12	50
		3	10				10															1938	599	3	17	14	50
		6	11				11															1955	539	3	11	14	50
	49	1	4										4									1941	537	7	11	15	
		2	6										6									1948	597	3	17	14	
		3	5										5									1921	538	1	18	14	
		4	19										19									1941	598	5	18	14	
		5	8										8									1932	597	3	6	12	
		6	25										25									1996	530	5	17	0	
		7	10										10									1949	539	5	17	12	
		9	12				12															1938	538	1	17	12	50
		10	10				10															1961	537	3	11	12	50
		11	4													4							980		11	2	
		13	42				42															1936	538	3	14	12	50
		18	5													5							980		7	2	
		19	2													2	2	2					990		5		
		26	2													2							990		17		
		27	9				9															1935	537	4	11	10	50
		28	31				31															1922	539	1	17	12	50
		29	34																			1934	539	4	18	12	
		30	9										9									1931	538	4	18	12	
		31	16								16		16									1939	544	2	17	8	
		32	23										23									1932	539	4	18	16	
		33	33										33									1934	537	3	18	12	
		34	29										29									1948	537	5	11	10	
		35	24										24									1919	538	1	17	12	
		36	22										22									1932	597	7	18	11	
		37	27	25							25	25	27									1931	599	4	11	12	
		38	42										42									1948	599	5	18	12	
		39	34				34						34									1927	539	1	17	14	
		40	42										42									1929	539	1	17	12	
		41	22				22						22									1956	538	5	11	10	
		42	1										1			1							990		11		
		43	34										15									1950	538	5	14	12	
		44	17																			1924	538	1	17	12	
		45	45																			1953	537	5	18	10	
		46	46																			1947	539	3	17	10	
		47	8																			1945	538	5	18	12	
		48	23	21							21	21										1926	538	1	17	12	20
		50	16	14							14	14										1939	539	1	11	12	20
	50	5	2													2							990		14		
		6	14							14												1978	326	5	14	5	80
		7	24			24					24											1916	538	3	18	14	40
		9	19						2													1915	599	7	18	10	60
		10	37				37															1915	599	4	17	12	60
		11	18						3													1929	539	4	18	12	60

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		12	17						3													1933	539	5	17	12	70
		13	14							14												1978	326	5	17	5	80
		14	13			13					13											1930	599	7	18	12	40
		15	18	18							18	18										1946	519	3	17	12	20
		17	1													1							990		14		
		20	30				30															1922	599	1	14	17	60
		21	27						3													1920	579	4	18	14	60
		22	28	22							22	22										1926	539	4	17	14	20
		23	2													2							980		17	2	
		24	1													1							980		17	2	
		27	25			25					25											1927	599	4	18	14	40
		28	1													1							970		5	2	
	51	1	19										19									1936	599	4	18	14	
		2	15										15									1942	548	5	17	14	
		3	14				7						14									1926	539	4	18	14	50
		4	29				29						29									1935	598	3	17	14	50
		5	13										13									1939	538	5	18	14	
		6	14										14									1930	598	3	17	10	
		7	17										17									1936	539	5	18	12	
		8	26										26									1928	538	1	17	10	
		9	22	20							20	20	22									1949	539	5	15	11	20
		10	25										25									1936	598	3	3	12	
		11	4										4			4							980		18	2	
		12	14										14									1951	539	7	18	10	
		13	9				9						9									1936	537	3	15	16	50
		14	14										14									1923	598	3	17	12	
		15	25			25					25		25									1952	598	5	18	12	40
		16	29										29									1953	598	5	17	12	
		17	17										17									1936	799	3	5	10	
		18	10										10									1965	327	5	5	10	
		19	35										35									1967	446	5	18	8	
		20	12										12									1948	596	5	18	10	
		21	25										25									1942	599	5	18	10	
		22	19										19									1969	326	5	17	8	80
		23	6							6			6									1961	329	5	15	10	80
		24	22										22									1962	326	5	18	6	80
		25	36										36									1973	446	3	17	8	80
		26	38										38									1962	326	5	17	8	80
		27	31										31									1946	518	3	18	12	
		28	18										18									1943	518	3	18	10	
		29	21										21									1936	518	3	17	0	
		30	26										26									1946	549	5	18	12	
		31	31										31									1937	538	5	17	12	
		32	45										45									1928	539	4	17	12	
		33	33										33									1941	539	5	17	12	
		34	27	27							27	27	12									1930	539	1	15	14	
		36	12										12									1984	322	5	17	0	
		40	26	26							26	26	15									1941	598	3	15	12	
		41	34				34																				
		43	17										17									1946	598	5	18	12	
		44	20										20									1983	323	5	17	0	
		48	15										15									1983	322	5	18	0	
		54	10										10									1940	597	3	17	12	
		55	21				21						12									1920	598	3	15	11	
	52	2	33			33					33											1921	597	3	14	10	
		5	11							11												1962	329	5	14	10	80
		10	22						22													1944	537	5	18	14	
		11	26						26													1940	538	5	18	12	
		12	16						16													1941	538	5	18	12	
		15	23				23															1928	597	1	17	12	
		16	7	7							7											1918	539	4	18	14	
		17	17	17							17											1926	537	4	17	12	
		18	22	22							22											1921	537	1	17	12	
		19	19				19															1922	538	4	18	12	

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
TOTAL 3.4-1				746	0	779	874	115	159	329	1637	578	5490	0	270	373	2	2	85	85	85						
3.4-2	53	11	1												1	1							990		18		
		14	22												22							1880	515	2	17	6	
		15	4												4							1938	535	5	18	4	
		16	9												9							1978	533	5	17	2	
	57	1	40							40												1937	329	4	18	14	70
		2	10							10												1937	329	4	17	14	70
		3	10							10												1937	329	4	18	12	70
		4	52							52												1937	329	5	17	12	70
		5	31							31												1937	329	5	11	12	70
		6	25							25												1930	449	1	18	14	70
		9	20				20															1900	538	1	17	15	60
		11	1													1							990		11		
		22	7					7														1890	517	1	11	8	30
		27	1													1							990		11		
		31	20			20					20											1880	539	1	18	14	40
		35	2												2	2						1910	515	3	11	4	
		36	22												22	22						1910	548	4	17	10	
		40	4							4												1960	326	5	11	7	70
		41	2							2												1960	326	5	11	7	70
		45	13							13												1960	446	5	11	8	70
		55	4												4	4						1985	323	5	17	1	
		56	7												7	7						1960	519	3	17	11	
		57	11						11						11							1940	538	3	17	6	
		58	6						6						6							1955	519	1	17	8	
		59	32												32	32							990		5		
		60	20												20	20						1960	518	3	17	5	
	58	1	23										23									1953	518	1	17	5	
		2	35										35									1940	538	5	18	6	
		3	26										26									1960	536	5	18	6	
		4	37							37			37									1950	329	5	18	9	70
		5	26							26			26									1950	329	5	17	9	70
		6	34										34									1950	328	5	18	6	
		8	17										17									1895	518	2	17	8	
		9	11										11									1937	518	1	17	8	
		10	15										15									1952	538	1	18	7	
		11	1													1							990		17		
		12	30										30									1968	323	5	17	2	
		13	2										2										980		21		
		14	20										20									1968	328	5	17	7	
		15	8										8									1966	325	5	11	8	
		16	39										30									1966	325	5	18	5	
		17	34										19									1928	539	1	18	10	
		18	1													1							990		15		
		19	11										11									1966	898	6	5	7	
		22	24										24									1923	538	1	18	5	
		23	17										17									1968	328	5	18	5	
		24	32										32									1969	325	5	17	7	
		25	32										32									1844	518	6	17	6	
		27	11							11			11									1968	329	5	15	9	70
		30	27	25							25	25										1921	539	1	15	12	20
		31	13								13											1980	533	5	17		30
		34	21				21															1924	539	4	17	11	60
		35	24				24															1923	539	1	17	13	60
		36	1													1							990		11		
		37	26				5															1936	539	4	18	14	60
		41	16				16															1940	539	1	17	14	60
		42	6										6									1844	539	1	18	6	
	59	9	7				7															1916	538	1	18	14	60
		11	10	9							9											1916	539	4	18	12	70
		16	48				48															1949	538	1	11	14	70
		19	7	7							7											1920	549	3	17	14	60
		20	12	12							12	12										1920	539	1	11	14	70

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		22	17								17											1930	548	2	18	12	50
		24	11													11							990		3		
		26	13				13															1938	538	1	17	12	60
		28	22				6															1926	519	3	17	13	60
		31	12				12															1932	519	1	11	12	70
	78	2	8												8	8						1941	515	5	17	7	
		3	10												10	10						1935	518	2	11	16	
		4	11												11	11						1913	518	5	11	16	
		5	59												59	59							990		14		
		6	17												17	17						1893	538	5	17	7	
		7	7												7	7						1950	725	2	5	6	
		8	41												41	41						1910	518	3	18	14	
		9	7												7	7							990		14		
		10	10												10	10						1937	518	5	17	8	
		11	28												28	28						1920	539	5	18	10	
		12	24												24	24						1923	518	3	17	12	
		15	4												4	4						1951	328	5	11	9	
		16	19				19															1942	548	5	17	9	50
		18	16							16												1947	326	5	18	6	80
		19	20							20												1946	329	5	17	9	80
		20	25			25					25											1928	549	4	18	9	40
		22	1													1							990		11		
	79	1	48							48												1941	329	5	17	9	80
		2	32							32												1950	329	5	18	9	80
		3	60							60												1946	329	5	17	9	80
		16	21							21												1944	329	5	18	9	80
		17	11							11												1947	329	5	17	9	80
		19	21				5															1944	538	5	18	11	50
		20	41				41															1941	549	5	17	12	50
		21	1													1							990		11		
		23	27				27															1946	549	7	18	12	50
		26	17	17							17	17										1948	538	1	18	12	20
		36	1													1							990		11		
		39	25			25					25											1945	539	5	18		
		40	1													1							990		11		
	82	11	24						24													1940	539	1	18	10	70
		12	1													1							990		11		
		16	23						23													1938	539	1	18	10	70
		18	2													2							980				
		20	16				16															1939	539	1	18	10	50
		21	12				12															1939	539	1	11	10	50
		22	9				9															1939	539	1	17	10	50
		23	38							38												1945	329	5	18	9	80
		27	1													1							990		11		
		43	13						13													1938	549	3	17	9	70
	83	1	7							7												1971	326	5	17	5	80
		2	11	11							11	11										1930	538	1	17	12	20
		3	20							20												1971	326	5	17	5	80
		5	21							21												1970	326	5	11	5	80
		7	31							31												1970	326	5	17	5	80
		13	12				12															1938	538	1	18	10	50
		14	10				10															1939	538	1	11	10	50
		15	19				19															1938	538	1	17	10	50
		23	1													1							990		11		
		24	26				20			6	20											1945	328	5	11	10	70
		25	28							28												1945	328	5	18	10	70
		26	6				6															1941	329	5	18	9	70
		27	10				10															1941	329	5	17	9	70
		28	26				20			6	20											1941	329	5	11	9	70
		29	1													1							990		11		
		30	19							19												1970	326	5	17	5	80
		33	14				14															1945	328	5	18	9	70
		37	18							18												1972	326	5	11	5	80

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		43	3							3												1962	326	5	11	6	80
		44	13							13												1971	326	5	17	5	80
		46	3							3												1963	326	5	11	5	80
		49	11							11												1970	326	5	17	5	80
	85	7	17	15							15	15										1921	539	1	11	11	20
		8	9	9							9	9										1927	538	1	17	11	20
		9	24			24					24				24							1934	539	1	18	10	40
		10	7			7					7				7							1931	535	1	17	6	40
		11	21												21							1997	593	9	18		
		12	15												15							1934	538	4	17	8	
		13	14			14					14				14							1925	549	1	18	13	40
		14	31			31					31				31							1911	549	1	18	7	40
		15	15			15					15				15							1894	549	1	18	8	40
		16	10			10					10				10							1914	548	1	18	8	40
		17	18												18							1889	545	5	17	7	
		18	44							44					44							1981	326	5	17	1	90
		19	22												22							1923	545	5	18	7	
		20	10												10							1918	549	5	17	12	
		21	9												9							1996	593	5	17	1	
		22	18												18							1996	533	5	18	1	
		23	3							3					3							1969	326	5	14	5	80
		24	40												40							1981	323	5	17	1	
		25	4			4					4				4							1914	549	5	14	7	40
		26	21				21								21							1873	549	5	17	9	50
		27	15												15							1901	549	5	17	7	
		28	15												15							1898	518	5	17	5	
		29	15												15							1890	547	2	5	11	
		30	7												7							1909	538	5	17	6	
		31	10												10							1994	513	5	17	0	
		32	10												10							1994	593	5	17	0	
		33	17												17							1911	548	5	17	8	
		34	16												16							1993	593	5	17	1	
		35	41			41					41				41							1915	548	5	18	6	40
		36	1												1	1							990		11		
		37	17												17							1934	538	5	18	5	
		38	27												27							1948	538	5	18	7	
		39	13												13							1943	548	5	18	4	
		40	13												13							1934	538	5	18	9	
		41	8												8							1994	593	5	18	0	
		42	4												4	4							980		5		
		43	36												36							1921	539	3	17	8	
		44	10												10							1944	548	5	17	7	
		45	6												6							1924	538	5	17	8	
		46	37												37							1923	538	5	17	6	
		47	15			15					15				15							1935	538	5	17	8	40
		48	63												63							1935	538	5	17	7	
		49	51												51							1885	535	5	18	5	
		50	22												22							1903	538	5	18	6	
		51	8												8							1993	593	5	18	1	
		52	21												21							1993	593	5	17	1	
		53	1												1	1							990		11		
		54	25				25								25							1880	549	4	17	10	50
		55	28												28							1875	549	5	17	6	
		56	37												37							1907	538	5	18	8	
		57	18												18							1884	549	5	5	11	
		58	3												3							1870	549	5	18	12	
		61	6												6							1925	549	5	18	10	
		62	1												1	1							990		17		
		63	5												5				5			1931	539	4	18	9	
		64	38												38	38			38	38	38		990		19		
		65	66												66	66			66	66	66		990		5		
		66	32												32	32			32	32	32		980		17		
		67	31												31	31			31	31	31		980		18		
		68	36												36	36			36	36	36		980		17		
		70	1												1	1							990		17		
		71	1												1	1							990		18		

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
	86	2	30				30															1942	539	7	18	9	50
		10	16				16															1873	549	4	18	12	50
		17	21				21															1916	538	4	18	9	50
		18	7				7															1920	538	3	17	9	50
		19	5													5							990		5		
		27	18				18															1948	538	5	18	9	50
		31	1													1							990		18		
	87	1	15			15					15											1919	539	3	18	11	
		4	12			12					12											1931	538	2	17	9	
		6	15							15					15							1948	329	5	17	8	40
		9	1													1							990		11		
		10	21												21							1981	533	5	17	1	
		11	15				15								15							1930	539	3	18	8	50
		12	27				27															1905	548	4	18	12	50
		13	12												12	12						1945	538	9	17	4	
		15	13				13								13							1939	538	5	18	9	50
		16	14												14							1889	538	5	17	6	
		17	13												13							1853	538	5	14	6	
		18	12				12								12							1918	538	3	18	12	50
		19	27												27	27						1934	535	5	17	7	
		20	13						13						13							1926	535	5	17	9	70
		21	27												27							1902	518	3	17	7	
		27	11													11							980		5		
		31	21				21															1924	539	2	18	10	50
	88	1	5												5	5						1930	519	5	18	10	
		2	9												9	9							990		5		
		3	4												4	4	4	4					990		5		
		4	6												6	6	6	6					990		5		
		5	28												28	28						1931	518	5	17	7	
		6	2												2	2							990		17		
		7	13												13	13						1892	519	4	18	11	
		8	22												22	22							990		18		
		9	17												17	17							990		5		
		10	10												10	10							990		5		
		11	3												3	3							990		18		
		12	4												4	4							990		17		
		13	34												34	34						1935	518	5	17	8	
		14	7												7	7							990		11		
		15	19												19							1953	533	3	17	4	
		16	19			19					19				19							1914	519	4	18	11	40
		17	39												39	39						1945	328	5	17	8	
		18	31												31	31						1939	328	5	18	8	
		19	18							18												1946	329	5	17	9	80
		26	24							24												1949	329	5	18	9	80
		27	11							11												1936	329	5	17	10	80
		28	1												1	1	1	1					990		5		
		29	3												3	3							990		5		
		30	4												4	4							990		5		
TOTAL 3.4-2				105	0	277	638	7	90	808	452	89	466	0	1981	851	11	11	208	203	203						
3.4-3	89	1	19													19							990		5		
		2	17			17					17											1945	538	3	18	9	40
		4	19							19												1931	449	3	18	11	70
	90	8	30			30					30											1933	539	5	18	9	40
		10	17						17													1955	599	1	18	11	40
		13	26			26					26											1932	578	7	17	9	50
		15	35			35					35											1923	538	5	18	9	40
		16	17				17				17											1930	539	5	17	9	50
		17	16				16															1945	449	7	17	9	50
		19	1													1							990		11		
		24	3														3	3					990		5		

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		26	12													11							970		5		
		30	38						8													1938	539	5	18	5	50
		31	9						2													1941	539	5	17	11	50
		32	8						1													1930	539	3	18	10	50
		33	23						2													1951	539	5	17	10	50
		35	35	34							34											1936	539	1	18	11	20
		36	1													1							990		18		
		37	18						5													1928	539	1	17	10	50
	91	1	44						44													1935	549	4	18	9	50
		3	15							6												1962	329	3	18	5	50
		5	1													1							990		11		
		14	14			14					14											1903	549	1	18	9	40
		15	7			7					7											1921	549	5	17	7	40
		16	15							15												1961	329	5	18	8	80
		18	18				5				5											1940	329	5	18	9	50
		21	1													1							990		18		
		22	14				14				14											1928	549	3	17	9	50
		23	52													52			52	52	52		990		5		
		24	11	11							11											1923	539	1	18	5	50
		29	22			22					22											1932	538	1	11	7	50
		30	10			10					10											1918	539	1	11	7	50
		31	1													1							990		11		
		33	1													1							990		5		
	92	8	6			6					6											1931	538	1	11	12	40
		10	11			11					11											1870	549	4	18	14	40
		12	8			8					8											1880	549	4	18	16	40
	99	1	28				28															1934	539	1	17	11	50
		5	21																			1934	538	2	18	9	50
		8	3							3												1960	328	5	15	7	80
		13	21						21													1927	538	1	17	12	80
		14	12						12													1921	539	1	18	12	80
		15	29						29													1935	539	1	17	12	80
		25	46						46													1927	539	1	18	12	80
		26	25						25													1933	549	4	18	12	80
		29	23						23													1923	539	1	18	16	70
		32	19						19													1931	538	3	18	12	80
		33	25						25													1933	449	5	17	12	80
		38	15						15													1933	538	1	17	14	80
		39	12						12													1924	539	1	18	14	70
	100	1	16				16				16											1934	329	4	11	9	50
		6	11							11												1960	326	5	5	7	80
		12	6							6												1960	329	5	18	10	80
		14	46				46				46											1933	449	4	11	9	50
		21	10		10						10											1934	539	1	17	10	20
		22	16		16						16											1936	539	1	11	10	20
		24	1													1							990		15		
		29	1													1							990		11		
		35	20				20															1929	549	1	17	9	50
		36	11				11															1926	538	1	11	9	50
		46	19				19															1936	538	1	17	12	50
		47	16				16															1929	539	1	11	12	50
		48	33			33					33											1923	539	1	18	10	40
	118	1	7						7													1937	329	4	17	9	70
		2	1													1							990		11		
		5	15												15							1923	538	1	17	7	
		6	19												19							1989	533	5	18	3	
		7	21												21							1989	533	5	17	3	
		8	19												19							1945	538	3	17	7	
		9	7												7	7							990		17		
		10	20												20	20							990		5		
		11	7												7	7							990		5		
		12	11												11	11							990		7		

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				HARVEST ACTIVITIES							REGENERATION ACTIVITES		FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	PLANT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																											
		13	4												4							1954	539	1	7	8	
		14	12												12							1923	899	3	5	7	
		15	6												6	6							990		7		
		16	3												3	3							980		7		
		17	5												5	5							990		5		
		18	18												18							1934	539	1	17	8	
		19	17	17							17				17							1930	538	1	18	10	20
		20	10												10							1919	539	4	18	4	
		22	18	18							18											1919	538	1	18	11	20
		23	26				26															1920	328	3	15	10	50
		24	1													1							990		15		
		39	12				12															1923	328	1	17	12	50
		41	17																			1930	328	1	17	9	50
TOTAL 3.4-3				80	26	219	234	0	313	60	423	0	0	0	194	151	3	3	52	52	52						
TOTAL 3.4				**931**	**26**	**1275**	**1746**	**122**	**562**	**1197**	**2512**	**667**	**5956**	**0**	**2445**	**1375**	**16**	**16**	**345**	**340**	**340**						

Note:**FH**= FINAL HARVEST;**ST**= SEED TREE;**SW**= SHELTERWOOD;**UAM**= UNEVENAGED;**OSR**= OVERSTORY REMOVAL;**SAN**= SANITATION

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
3.4-1	19	2	1												1							990		17		
		4	8				8														1926	538	4	17	10	50
		6	6							6											1960	326	5	14	8	80
		13	13							13											1963	326	5	18	6	80
		15	13							13											1965	328	5	17	10	80
		16	12							12											1963	326	5	18	8	80
		17	17							17											1961	326	5	17	8	80
	20	2	7							7											1964	329	5	18	10	80
		3	66							66											1959	448	3	14	10	80
		7	15			15					15										1924	598	3	18	12	40
		10	1												1							990		14		
	21	1	8							8		8									1961	326	5	14	8	80
		2	8							8		8									1966	326	5	14	8	80
		3	16	13							13	16									1916	537	1	17	12	20
		4	21	21							21	21									1911	539	1	18	14	20
		5	39									39									1912	538	4	18	12	20
		6	21			12					12	21									1961	327	5	14	10	30
		7	20									20									1960	447	3	17	10	
		8	26									26									1961	328	5	18	10	
		9	13									13									1911	599	3	18	12	
		10	1									1			1							980		5		
		11	28			28					28	28									1921	598	3	18	12	40
		12	22									22									1922	539	1	17	11	
		13	34									34									1963	449	5	17	12	
		14	26									26									1962	447	5	14	10	
		15	17									17									1962	447	5	18	10	
		16	1									1			1							990		14		
		17	24									24									1917	597	4	18	14	
		18	16									16									1900	598	4	18	12	
		19	24			24					24	24									1926	597	3	14	14	30
		20	2									2									1972	596	5	14	5	
		21	2									2									1967	326	5	14	8	
		22	11									11									1922	537	1	17	10	
		23	21			21					21	21									1923	548	4	18	12	40
		24	15									15									1973	446	5	17	8	
		25	10									10									1916	538	5	18	13	
		26	16									16									1996	530	9	18	0	
		27	15			7					7	15									1961	447	3	18	10	30
		28	4									4									1922	597	3	5	13	
		29	7									7									1916	549	4	17	12	
	22	1	1									1			1							990		5		
		2	7									7									1928	539	7	17	12	
		3	33									33									1963	446	5	17	8	
		4	15									15									1919	538	1	17	10	
		5	23									23									1987	511	5	17	1	
		6	22							22		22									1981	323	5	17	1	80
		7	26									26									1926	538	4	18	14	
		12	1									1			1							990		14		
		13	12			12					12	12									1919	539	1	17	14	40
		14	3									3									1967	326	5	14	8	
		15	23			23					23	23									1926	539	4	18	16	40
		16	26							26											1981	322	5	14	3	80
		17	16			16					16	16									1928	539	1	17	12	40
		18	15			15					15	15									1922	538	4	18	14	30
		19	20			20					20	20									1923	539	1	17	14	40
		20	17				17														1923	539	4	18	14	60
		23	1												1							990		14		
		25	14					14													1916	597	4	17	14	
		29	25				25				25										1936	598	4	18	10	
		30	19				19				19										1923	539	7	17	12	
		31	16				16														1922	539	1	14	12	
		32	27							27											1964	329	5	14	10	
	23	1	26									26									1919	539	1	17	12	

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		2	2									2			2							990		21		
		3	2									2			2							990		21		
		4	20									20									1942	538	1	17	10	
		5	21									21									1916	538	1	17	13	
		6	30									30									1929	539	3	17	18	
		7	25				25					25									1929	538	4	17	12	60
		8	8									8									1939	539	3	18	14	
		9	40									40									1922	537	1	17	16	
		10	28									28									1939	598	7	18	12	
		11	30									30									1920	539	4	17	14	
		12	27									27									1926	518	3	17	12	
		13	40			15					15	40									1936	539	3	17	12	
		14	20			10					10	20									1924	539	1	18	14	
		15	37				37					37									1929	599	7	17	12	
		16	20									20									1993	533	5	18	0	
		17	8									8									1915	519	3	14	12	
		18	8			8					8	8									1922	549	7	17	12	
		19	38									38									1932	537	3	17	12	
		20	31									31									1929	539	4	18	13	
		21	40									40									1933	517	3	17	10	
		22	2									2			2							980		14		
		23	2									2			2							980		14		
		24	1									1									1959	424	3	18	6	
		25	6									6			6							980		3		
		26	5									5			5							980		7		
		27	24									24			24			24	24	24		990		14		
		28	20									20									1927	517	3	17	12	
		29	25									25									1926	539	4	18	16	
		30	20									20									1931	539	1	17	14	
		31	23									23									1929	539	4	14	14	
		32	30									30									1996	533	5	17	1	
		33	32									32									1929	599	4	18	14	
		34	12									12									1927	597	3	5	10	
		35	29									29									1919	539	1	17	12	
		36	22									22									1922	539	1	17	12	
		37	12									12									1927	539	4	18	11	
		38	1									1			1						1991	990		14	0	
	33	1	42				20					42									1921	539	1	17	14	
		2	33									33									1923	539	1	17	14	
		3	20				20					20									1920	539	1	14	14	
		4	26									26									1993	533	5	18	0	
		5	40									40									1919	539	3	17	14	
		6	23									23									1989	533	5	18	2	
		7	44			44					44	44									1917	539	4	14	14	
		8	1									1			1							990		14	0	
		9	15									15									1928	599	4	17	12	
		10	31									31									1993	593	5	18	0	
		11	21									21									1921	599	4	18	14	
		12	34									34									1916	599	4	18	14	
		13	34									34									1992	533	5	18	0	
		14	22									22									1925	539	1	17	14	
		15	33									33									1996	533	5	14	1	
		16	27									27									1923	599	4	17	12	
		17	13									13									1938	797	3	3	10	
		18	22									22									1915	549	4	18	11	
		19	7									7			7							990		3	0	
		20	24									24									1923	599	4	18	14	
		21	38									38									1911	539	4	18	14	
		22	33				33					33									1929	539	1	17	12	
		23	31									31									1932	539	1	14	12	
		24	2									2			2							990		14	0	
		25	2									2									1921	599	3	17	16	
	34	1	61									61			61			61	61	61		990		7	0	
		2	10									10			10							990		7	0	
		3	40									40									1919	797	3	3	14	

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		4	8									8									1927	599	4	18	16	
		5	28									28									1945	599	5	5	16	
		6	39									39									1942	539	5	18	16	
		7	24									24									1951	539	5	17	14	
		8	15									15									1927	539	1	18	16	
		9	40									40									1996	533	5	17	1	
		10	15			15					15	15									1916	539	4	18	14	
		11	14			14					14	14									1930	538	1	17	12	
		12	34			34					34	34									1922	599	4	18	14	
		13	36									36									1928	539	4	18	14	
		14	26									26									1921	539	4	18	16	
		15	44									44									1919	598	4	17	12	
		16	29									29									1994	533	5	18	0	
		17	37									37									1930	538	3	17	12	
		18	42									42									1922	538	1	17	12	
		19	20									20									1921	538	1	18	16	
		20	15									15									1924	538	1	17	14	
		21	30									30									1924	538	4	18	16	
		22	25									25									1922	537	3	18	14	
		23	34	34							34	34									1923	539	1	17	14	
		24	1									1			1							990		11	0	
		25	32					32			32	32									1921	539	4	18	16	
		26	39									39									1917	539	1	17	12	
		27	14									14									1924	539	1	18	18	
		28	19									19									1994	533	5	18	0	
		29	25									25									1931	538	4	17	14	
		30	16							16		16									1975	326	5	17	8	80
		31	41									41									1938	539	5	18	14	
		32	29	29							29	29									1928	539	1	17	14	
		33	28									28									1932	539	1	17	14	
		34	26									26									1931	599	6	5	14	
		35	22									22									1905	539	6	18	16	
		36	26									26									1930	599	6	17	16	
		37	25									25									1939	599	5	17	14	
		38	35	35							35	35									1931	519	3	18	12	
		39	22							22		22									1975	326	5	17	6	80
		40	16									16									1931	598	4	17	14	
		41	19							19		19									1974	323	5	14	3	80
		42	23									23									1923	538	3	18	14	
		43	5									5			5							980		17	2	
		44	2									2			2							990		14	0	
		45	1									1			1						1991	990		7	0	
		46	5																		1920	538	1	17	10	
	35	4	12				12														1916	598	4	11	12	50
		5	16							16											1963	328	5	17	10	
		9	21					21													1928	538	3	18	12	
		14	18				18														1919	597	4	18	10	
		16	19							19											1965	325	5	17	8	
		17	12								12										1920	597	3	17	12	
		18	12							12											1965	446	5	11	8	
		19	8								8										1963	537	3	11	12	
		20	13	13							13										1913	548	4	18	12	
		28	12	12							12										1920	598	3	17	12	
		29	16						16												1923	517	7	17	12	
		37	12	12							12										1931	537	3	17	14	
		41	22											22	22							980		5		
	36	3	21			21					21										1938	538	3	18	14	30
		4	25					25													1923	538	4	18	12	
		6	12					12													1946	537	5	17	12	
		7	6					6													1925	537	3	18	12	
		8	23						23												1937	538	5	18	12	
		9	12						12												1926	537	1	17	10	
		11	1												1							990		18		
		17	5					5													1931	537	3	17	12	
		18	9						9												1919	537	1	14	12	

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
	37	6	48							48											1962	326	5	17	8	80
		8	12											12	12						1926	597	3	17	14	
		9	30			30					30			30							1912	598	4	18	14	
		10	3	3							3			3							1919	597	4	11	10	
		11	33	33							33			33							1949	538	5	17	12	
		12	11											11	11						1935	538	3	14	12	
		13	18											18	18						1978	446	5	17	6	
		15	9											9	9						1978	324	5	17	6	
		16	45											45	45						1918	537	4	18	16	
		17	48											48	48						1923	538	5	17	14	
		18	32				32														1929	538	1	17	14	60
		20	13							13											1960	326	5	14	8	80
		21	17											17	17							990		5		
		25	22	22							22										1918	597	4	17	12	20
		31	14											14	14						1939	516	5	14	10	
		33	27			27					27										1927	538	3	18	14	40
		37	8											8	8						1935	518	3	14	12	
		41	1												1							990		14		
		42	1												1							990		14		
		43	1												1							990		14		
		46	25			25					25										1920	538	1	12	17	40
	38	1	5							5		5									1973	446	5	14	8	80
		2	33									33									1917	539	3	18	14	20
		3	16	14							14	16									1911	539	3	18	14	20
		4	15						3			15									1919	539	3	18	14	60
		5	29							29		29									1961	326	5	14	8	80
		6	32									32									1994	533	5	18	1	
		7	31									31									1930	539	3	18	14	
		8	26			26					26	26									1910	519	3	14	12	40
		9	36									36									1922	539	4	18	14	
		10	32									32									1994	533	5	17	0	
		11	4									4										990		3		
		12	29									29									1917	599	4	5	12	
		13	27									27									1926	599	3	17	14	
		14	13									13									1994	533	5	18	0	
		15	22									22									1994	593	5	17	0	
		16	32									32									1926	549	3	5	14	
		17	7									7									1933	539	5	17	10	
		18	9									9									1944	539	3	18	12	
		19	30									30									1937	539	3	17	14	
		20	20									20									1924	599	3	18	14	
		21	22	20							20	22									1925	539	3	18	12	20
		22	50									50									1943	539	3	18	10	
		23	16									16									1950	539	5	18	12	
		24	35									35									1948	539	3	17	10	
		25	34									34									1948	539	3	17	12	
		26	18						18			18									1944	539	3	17	12	60
		27	10							10		10									1974	326	5	18	8	80
		28	37			37					37	37									1932	539	3	18	12	
		29	30									30									1991	533	5	18	0	
		30	16									16									1926	539	3	18	14	
		31	40									40									1992	533	5	18	0	
		32	40			40					40	40									1942	539	3	14	12	40
		33	26									26									1942	539	3	18	14	
		34	27									27									1945	539	3	17	12	
		35	16									16									1916	539	4	18	14	
		36	21									21									1922	539	3	17	14	
		37	30									30									1930	539	3	18	16	
		38	38			38					38	38									1916	539	3	18	14	40
		39	25									25									1993	533	5	17	0	
		40	30									30									1927	539	4	18	14	
		41	18			18					18	18									1912	539	1	17	14	40
		42	16									16									1969	539	3	18	10	
		43	18						3			18									1937	539	3	17	14	60

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
	39	6	27				27														1911	539	3	17	14	50
		7	25				25														1911	539	3	18	12	50
		9	36			36					36										1911	539	3	18	14	40
		10	40	38							38										1911	539	3	14	12	20
		15	17				17														1935	539	4	18	14	70
		16	24				24														1938	539	3	17	12	60
		17	12				12														1938	539	3	14	12	70
	40	5	27	27							27										1936	599	3	14	12	
		6	1												1							990				
		12	43			43					43										1937	539	6	14	16	
		21	38				38														1904	539	1	14	14	
		26	28				28														1921	539	3	17	12	
		27	31				31														1938	549	5	17	12	
		30	10	10							10										1942	539	1	14	14	
	41	2	8				8														1966	599	3	11	12	50
		3	10				10														1938	599	3	17	14	50
		6	11				11														1955	539	3	11	14	50
	49	1	4									4									1941	537	7	11	15	
		2	6									6									1948	597	3	17	14	
		3	5									5									1921	538	1	18	14	
		4	19									19									1941	598	5	18	14	
		5	8									8									1932	597	3	6	12	
		6	25									25									1996	530	5	17	0	
		7	10									10									1949	539	5	17	12	
		9	12				12														1938	538	1	17	12	50
		10	10				10														1961	537	3	11	12	50
		11	4												4							980		11	2	
		13	42				42														1936	538	3	14	12	50
		18	5												5							980		7	2	
		19	2												2	2	2					990		5		
		26	2												2							990		17		
		27	9				9														1935	537	4	11	10	50
		28	31				31														1922	539	1	17	12	50
		29	34																		1934	539	4	18	12	
		30	9									9									1931	538	4	18	12	
		31	16								16	16									1939	544	2	17	8	
		32	23									23									1932	539	4	18	16	
		33	33									33									1934	537	3	18	12	
		34	29									29									1948	537	5	11	10	
		35	24									24									1919	538	1	17	12	
		36	22									22									1932	597	7	18	11	
		37	27	25							25	27									1931	599	4	11	12	
		38	42									42									1948	599	5	18	12	
		39	34				34					34									1927	539	1	17	14	
		40	42									42									1929	539	1	17	12	
		41	22				22					22									1956	538	5	11	10	
		42	1									1			1							990		11		
		43	34									15									1950	538	5	14	12	
		44	17																		1924	538	1	17	12	
		45	45																		1953	537	5	18	10	
		46	46																		1947	539	3	17	10	
		47	8																		1945	538	5	18	12	
		48	23	21							21										1926	538	1	17	12	20
		50	16	14							14										1939	539	1	11	12	20
	50	5	2												2							990		14		
		6	14							14											1978	326	5	14	5	80
		7	24			24					24										1916	538	3	18	14	40
		9	19						2												1915	599	7	18	10	60
		10	37				37														1915	599	4	17	12	60
		11	18						3												1929	539	4	18	12	60
		12	17						3												1933	539	5	17	12	70
		13	14							14											1978	326	5	17	5	80
		14	13			13					13										1930	599	7	18	12	40

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		17	1												1							990		14		
		20	30				30														1922	599	1	14	17	60
		21	27						3												1920	579	4	18	14	60
		22	28	22							22										1926	539	4	17	14	20
		23	2												2							980		17	2	
		24	1												1							980		17	2	
		27	25			25					25										1927	599	4	18	14	40
		28	1												1							970		5	2	
	51	1	19									19									1936	599	4	18	14	
		2	15									15									1942	548	5	17	14	
		3	14				7					14									1926	539	4	18	14	50
		4	29				29					29									1935	598	3	17	14	50
		5	13									13									1939	538	5	18	14	
		6	14									14									1930	598	3	17	10	
		7	17									17									1936	539	5	18	12	
		8	26									26									1928	538	1	17	10	
		9	22	20							20	22									1949	539	5	15	11	20
		10	25									25									1936	598	3	3	12	
		11	4									4			4							980		18	2	
		12	14									14									1951	539	7	18	10	
		13	9				9					9									1936	537	3	15	16	50
		14	14									14									1923	598	3	17	12	
		15	25			25					25	25									1952	598	5	18	12	40
		16	29									29									1953	598	5	17	12	
		17	17									17									1936	799	3	5	10	
		18	10									10									1965	327	5	5	10	
		19	35									35									1967	446	5	18	8	
		20	12									12									1948	596	5	18	10	
		21	25									25									1942	599	5	18	10	
		22	19									19									1969	326	5	17	8	80
		23	6							6		6									1961	329	5	15	10	80
		24	22									22									1962	326	5	18	6	80
		25	36									36									1973	446	3	17	8	80
		26	38									38									1962	326	5	17	8	80
		27	31									31									1946	518	3	18	12	
		28	18									18									1943	518	3	18	10	
		29	21									21									1936	518	3	17	0	
		30	26									26									1946	549	5	18	12	
		31	31									31									1937	538	5	17	12	
		32	45									45									1928	539	4	17	12	
		33	33									33									1941	539	5	17	12	
		34	27									12									1930	539	1	15	14	
		36	12									12									1984	322	5	17	0	
		40	26	26							26	15									1941	598	3	15	12	
		41	34				34																			
		43	17									17									1946	598	5	18	12	
		44	20									20									1983	323	5	17	0	
		48	15									15									1983	322	5	18	0	
		54	10									10									1940	597	3	17	12	
		55	21				21					12									1920	598	3	15	11	
	52	2	33			33					33										1921	597	3	14	10	
		5	11							11											1962	329	5	14	10	80
		10	22						22												1944	537	5	18	14	
		11	26						26												1940	538	5	18	12	
		12	16						16												1941	538	5	18	12	
		15	23				23														1928	597	1	17	12	
		17	17	17							17										1926	537	4	17	12	
		18	22	22							22										1921	537	1	17	12	
		19	19				19														1922	538	4	18	12	
TOTAL 3.4-1				503	0	779	874	115	159	329	1394	5490	0	270	373	2	2	85	85	85						
3.4-2	53	11	1											1	1							990		18		
		14	22											22							1880	515	2	17	6	
		15	4											4							1938	535	5	18	4	

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		16	9											9							1978	533	5	17	2	
	57	1	40							40											1937	329	4	18	14	70
		2	10							10											1937	329	4	17	14	70
		3	10							10											1937	329	4	18	12	70
		4	52							52											1937	329	5	17	12	70
		5	31							31											1937	329	5	11	12	70
		6	25							25											1930	449	1	18	14	70
		9	20				20														1900	538	1	17	15	60
		11	1												1							990		11		
		22	7					7													1890	517	1	11	8	30
		27	1												1							990		11		
		31	20			20					20										1880	539	1	18	14	40
		35	2											2	2						1910	515	3	11	4	
		36	22											22	22						1910	548	4	17	10	
		40	4							4											1960	326	5	11	7	70
		41	2							2											1960	326	5	11	7	70
		45	13							13											1960	446	5	11	8	70
		55	4											4	4						1985	323	5	17	1	
		56	7											7	7						1960	519	3	17	11	
		57	11						11					11							1940	538	3	17	6	
		58	6						6					6							1955	519	1	17	8	
		59	32											32	32							990		5		
		60	20											20	20						1960	518	3	17	5	
	58	1	23									23									1953	518	1	17	5	
		2	35									35									1940	538	5	18	6	
		3	26									26									1960	536	5	18	6	
		4	37							37		37									1950	329	5	18	9	70
		5	26							26		26									1950	329	5	17	9	70
		6	34									34									1950	328	5	18	6	
		8	17									17									1895	518	2	17	8	
		9	11									11									1937	518	1	17	8	
		10	15									15									1952	538	1	18	7	
		11	1												1							990		17		
		12	30									30									1968	323	5	17	2	
		13	2									2										980		21		
		14	20									20									1968	328	5	17	7	
		15	8									8									1966	325	5	11	8	
		16	39									30									1966	325	5	18	5	
		17	34									19									1928	539	1	18	10	
		18	1												1							990		15		
		19	11									11									1966	898	6	5	7	
		22	24									24									1923	538	1	18	5	
		23	17									17									1968	328	5	18	5	
		24	32									32									1969	325	5	17	7	
		25	32									32									1844	518	6	17	6	
		27	11							11		11									1968	329	5	15	9	70
		30	27	25							25										1921	539	1	15	12	20
		31	13								13										1980	533	5	17		30
		34	21				21														1924	539	4	17	11	60
		35	24				24														1923	539	1	17	13	60
		36	1												1							990		11		
		37	26				5														1936	539	4	18	14	60
		41	16				16														1940	539	1	17	14	60
		42	6									6									1844	539	1	18	6	
	59	9	7				7														1916	538	1	18	14	60
		11	10	9							9										1916	539	4	18	12	70
		16	48				48														1949	538	1	11	14	70
		19	7	7							7										1920	549	3	17	14	60
		20	12	12							12										1920	539	1	11	14	70
		22	17								17										1930	548	2	18	12	50
		24	11												11							990		3		
		26	13				13														1938	538	1	17	12	60
		28	22				6														1926	519	3	17	13	60
		31	12				12														1932	519	1	11	12	70

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
	78	2	8											8	8						1941	515	5	17	7	
		3	10											10	10						1935	518	2	11	16	
		4	11											11	11						1913	518	5	11	16	
		5	59											59	59							990		14		
		6	17											17	17						1893	538	5	17	7	
		7	7											7	7						1950	725	2	5	6	
		8	41											41	41						1910	518	3	18	14	
		9	7											7	7							990		14		
		10	10											10	10						1937	518	5	17	8	
		11	28											28	28						1920	539	5	18	10	
		12	24											24	24						1923	518	3	17	12	
		15	4											4	4						1951	328	5	11	9	
		16	19				19														1942	548	5	17	9	50
		18	16							16											1947	326	5	18	6	80
		19	20							20											1946	329	5	17	9	80
		20	25			25					25										1928	549	4	18	9	40
		22	1												1							990		11		
	79	1	48							48											1941	329	5	17	9	80
		2	32							32											1950	329	5	18	9	80
		3	60							60											1946	329	5	17	9	80
		16	21							21											1944	329	5	18	9	80
		17	11							11											1947	329	5	17	9	80
		19	21				5														1944	538	5	18	11	50
		20	41				41														1941	549	5	17	12	50
		21	1												1							990		11		
		23	27				27														1946	549	7	18	12	50
		26	17	17							17										1948	538	1	18	12	20
		36	1												1							990		11		
		39	25			25					25										1945	539	5	18		
		40	1												1							990		11		
	82	11	24						24												1940	539	1	18	10	70
		12	1												1							990		11		
		16	23						23												1938	539	1	18	10	70
		18	2												2							980				
		20	16				16														1939	539	1	18	10	50
		21	12				12														1939	539	1	11	10	50
		22	9				9														1939	539	1	17	10	50
		23	38							38											1945	329	5	18	9	80
		27	1												1							990		11		
		43	13						13												1938	549	3	17	9	70
	83	1	7							7											1971	326	5	17	5	80
		2	11	11							11										1930	538	1	17	12	20
		3	20							20											1971	326	5	17	5	80
		5	21							21											1970	326	5	11	5	80
		7	31							31											1970	326	5	17	5	80
		13	12				12														1938	538	1	18	10	50
		14	10				10														1939	538	1	11	10	50
		15	19				19														1938	538	1	17	10	50
		23	1												1							990		11		
		24	26				20			6	20										1945	328	5	11	10	70
		25	28							28											1945	328	5	18	10	70
		26	6				6														1941	329	5	18	9	70
		27	10				10														1941	329	5	17	9	70
		28	26				20			6	20										1941	329	5	11	9	70
		29	1												1							990		11		
		30	19							19											1970	326	5	17	5	80
		33	14				14														1945	328	5	18	9	70
		37	18							18											1972	326	5	11	5	80
		43	3							3											1962	326	5	11	6	80
		44	13							13											1971	326	5	17	5	80
		46	3							3											1963	326	5	11	5	80
		49	11							11											1970	326	5	17	5	80

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
	85	7	17	15							15										1921	539	1	11	11	20
		8	9	9							9										1927	538	1	17	11	20
		9	24			24					24			24							1934	539	1	18	10	40
		10	7			7					7			7							1931	535	1	17	6	40
		11	21											21							1997	593	9	18		
		12	15											15							1934	538	4	17	8	
		13	14			14					14			14							1925	549	1	18	13	40
		14	31			31					31			31							1911	549	1	18	7	40
		15	15			15					15			15							1894	549	1	18	8	40
		16	10			10					10			10							1914	548	1	18	8	40
		17	18											18							1889	545	5	17	7	
		18	44							44				44							1981	326	5	17	1	90
		19	22											22							1923	545	5	18	7	
		20	10											10							1918	549	5	17	12	
		21	9											9							1996	593	5	17	1	
		22	18											18							1996	533	5	18	1	
		23	3							3				3							1969	326	5	14	5	80
		24	40											40							1981	323	5	17	1	
		25	4			4					4			4							1914	549	5	14	7	40
		26	21				21							21							1873	549	5	17	9	50
		27	15											15							1901	549	5	17	7	
		28	15											15							1898	518	5	17	5	
		29	15											15							1890	547	2	5	11	
		30	7											7							1909	538	5	17	6	
		31	10											10							1994	513	5	17	0	
		32	10											10							1994	593	5	17	0	
		33	17											17							1911	548	5	17	8	
		34	16											16							1993	593	5	17	1	
		35	41			41					41			41							1915	548	5	18	6	40
		36	1											1	1							990		11		
		37	17											17							1934	538	5	18	5	
		38	27											27							1948	538	5	18	7	
		39	13											13							1943	548	5	18	4	
		40	13											13							1934	538	5	18	9	
		41	8											8							1994	593	5	18	0	
		42	4											4	4							980		5		
		43	36											36							1921	539	3	17	8	
		44	10											10							1944	548	5	17	7	
		45	6											6							1924	538	5	17	8	
		46	37											37							1923	538	5	17	6	
		47	15			15					15			15							1935	538	5	17	8	40
		48	63											63							1935	538	5	17	7	
		49	51											51							1885	535	5	18	5	
		50	22											22							1903	538	5	18	6	
		51	8											8							1993	593	5	18	1	
		52	21											21							1993	593	5	17	1	
		53	1											1	1							990		11		
		54	25				25							25							1880	549	4	17	10	50
		55	28											28							1875	549	5	17	6	
		56	37											37							1907	538	5	18	8	
		57	18											18							1884	549	5	5	11	
		58	3											3							1870	549	5	18	12	
		61	6											6							1925	549	5	18	10	
		62	1											1	1							990		17		
		63	5											5				5			1931	539	4	18	9	
		64	38											38	38			38	38	38		990		19		
		65	66											66	66			66	66	66		990		5		
		66	32											32	32			32	32	32		980		17		
		67	31											31	31			31	31	31		980		18		
		68	36											36	36			36	36	36		980		17		
		70	1											1	1							990		17		
		71	1											1	1							990		18		
	86	2	30				30														1942	539	7	18	9	50
		10	16				16														1873	549	4	18	12	50
		17	21				21														1916	538	4	18	9	50
		18	7				7														1920	538	3	17	9	50

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		19	5												5							990		5		
		27	18				18														1948	538	5	18	9	50
		31	1												1							990		18		
	87	1	15			15					15										1919	539	3	18	11	
		4	12			12					12										1931	538	2	17	9	
		6	15							15				15							1948	329	5	17	8	40
		9	1												1							990		11		
		10	21											21							1981	533	5	17	1	
		11	15				15							15							1930	539	3	18	8	50
		12	27				27														1905	548	4	18	12	50
		13	12											12	12						1945	538	9	17	4	
		15	13				13							13							1939	538	5	18	9	50
		16	14											14							1889	538	5	17	6	
		17	13											13							1853	538	5	14	6	
		18	12				12							12							1918	538	3	18	12	50
		19	27											27	27						1934	535	5	17	7	
		20	13						13					13							1926	535	5	17	9	70
		21	27											27							1902	518	3	17	7	
		27	11												11							980		5		
		31	21				21														1924	539	2	18	10	50
	88	1	5											5	5						1930	519	5	18	10	
		2	9											9	9							990		5		
		3	4											4	4	4	4					990		5		
		4	6											6	6	6	6					990		5		
		5	28											28	28						1931	518	5	17	7	
		6	2											2	2							990		17		
		7	13											13	13						1892	519	4	18	11	
		8	22											22	22							990		18		
		9	17											17	17							990		5		
		10	10											10	10							990		5		
		11	3											3	3							990		18		
		12	4											4	4							990		17		
		13	34											34	34						1935	518	5	17	8	
		14	7											7	7							990		11		
		15	19											19							1953	533	3	17	4	
		16	19			19					19			19							1914	519	4	18	11	40
		17	39											39	39						1945	328	5	17	8	
		18	31											31	31						1939	328	5	18	8	
		19	18							18											1946	329	5	17	9	80
		26	24							24											1949	329	5	18	9	80
		27	11							11											1936	329	5	17	10	80
		28	1											1	1	1	1					990		5		
		29	3											3	3							990		5		
		30	4											4	4							990		5		
TOTAL 3.4-2				105	0	277	638	7	90	808	452	466	0	1981	851	11	11	208	203	203						
3.4-3	89	1	19												19							990		5		
		2	17			17					17										1945	538	3	18	9	40
		4	19							19											1931	449	3	18	11	70
	90	8	30			30					30										1933	539	5	18	9	40
		10	17						17												1955	599	1	18	11	40
		13	26			26					26										1932	578	7	17	9	50
		15	35			35					35										1923	538	5	18	9	40
		16	17				17				17										1930	539	5	17	9	50
		17	16				16														1945	449	7	17	9	50
		19	1												1							990		11		
		24	3													3	3					990		5		
		26	12												11							970		5		
		30	38						8												1938	539	5	18	5	50
		31	9						2												1941	539	5	17	11	50
		32	8						1												1930	539	3	18	10	50
		33	23						2												1951	539	5	17	10	50

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		36	1												1							990		18		
		37	18						5												1928	539	1	17	10	50
	91	1	44						44												1935	549	4	18	9	50
		3	15							6											1962	329	3	18	5	50
		5	1												1							990		11		
		14	14			14					14										1903	549	1	18	9	40
		15	7			7					7										1921	549	5	17	7	40
		16	15							15											1961	329	5	18	8	80
		18	18				5				5										1940	329	5	18	9	50
		21	1												1							990		18		
		22	14				14				14										1928	549	3	17	9	50
		23	52												52			52	52	52		990		5		
		24	11	11							11										1923	539	1	18	5	50
		29	22			22					22										1932	538	1	11	7	50
		30	10			10					10										1918	539	1	11	7	50
		31	1												1							990		11		
		33	1												1							990		5		
	92	8	6			6					6										1931	538	1	11	12	40
		10	11			11					11										1870	549	4	18	14	40
		12	8			8					8										1880	549	4	18	16	40
	99	1	28				28														1934	539	1	17	11	50
		5	21																		1934	538	2	18	9	50
		8	3							3											1960	328	5	15	7	80
		13	21						21												1927	538	1	17	12	80
		14	12						12												1921	539	1	18	12	80
		15	29						29												1935	539	1	17	12	80
		25	46						46												1927	539	1	18	12	80
		26	25						25												1933	549	4	18	12	80
		29	23						23												1923	539	1	18	16	70
		32	19						19												1931	538	3	18	12	80
		33	25						25												1933	449	5	17	12	80
		38	15						15												1933	538	1	17	14	80
		39	12						12												1924	539	1	18	14	70
	100	1	16				16				16										1934	329	4	11	9	50
		6	11							11											1960	326	5	5	7	80
		12	6							6											1960	329	5	18	10	80
		14	46				46				46										1933	449	4	11	9	50
		21	10		10						10										1934	539	1	17	10	20
		22	16		16						16										1936	539	1	11	10	20
		24	1												1							990		15		
		29	1												1							990		11		
		35	20				20														1929	549	1	17	9	50
		36	11				11														1926	538	1	11	9	50
		46	19				19														1936	538	1	17	12	50
		47	16				16														1929	539	1	11	12	50
		48	33			33					33										1923	539	1	18	10	40
	118	1	7						7												1937	329	4	17	9	70
		2	1												1							990		11		
		5	15											15							1923	538	1	17	7	
		6	19											19							1989	533	5	18	3	
		7	21											21							1989	533	5	17	3	
		8	19											19							1945	538	3	17	7	
		9	7											7	7							990		17		
		10	20											20	20							990		5		
		11	7											7	7							990		5		
		12	11											11	11							990		7		
		13	4											4							1954	539	1	7	8	
		14	12											12							1923	899	3	5	7	
		15	6											6	6							990		7		
		16	3											3	3							980		7		
		17	5											5	5							990		5		
		18	18											18							1934	539	1	17	8	

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				HARVEST ACTIVITIES							REGEN ACTIVITES	FUELS ACTIVITES		WILDLIFE ACTIVITIES		FISHERIES ACTIVITIES		RANGE ACTIVITES			STAND DATA					
	COMP	STAND	ACRES	FH	ST	SW	UAM	OSR	SAN	THIN	NAT	Pburn	Mech	Pburn	Mech	Stock	Rehab	Graze	Mow	Fert/Lime	AGE	TSD	SC	ELT	DBH	RxBA
MGMT AREA																										
		19	17											17							1930	538	1	18	10	20
		20	10											10							1919	539	4	18	4	
		22	18	18							18										1919	538	1	18	11	20
		23	26				26														1920	328	3	15	10	50
		24	1												1							990		15		
		39	12				12														1923	328	1	17	12	50
		41	17																		1930	328	1	17	9	50
TOTAL 3.4-3				29	26	219	234	0	313	60	372	0	0	194	151	3	3	52	52	52						
TOTAL 3.4				**637**	**26**	**1275**	**1746**	**122**	**562**	**1197**	**2218**	**5956**	**0**	**2445**	**1375**	**16**	**16**	**345**	**340**	**340**						

Note:**FH**= FINAL HARVEST;**ST**= SEED TREE;**SW**= SHELTERWOOD;**UAM**= UNEVENAGED;**OSR**= OVERSTORY REMOVAL;**SAN**= SANITATION