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Environmental Assessment

Demumbers Creek Area

Land Between The Lakes National Recreation Area
Lyon County, Kentucky

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Table of Contents

Summary ..... **iv**
I. Introduction **1**
Background and Location 1
Summary of Modified Proposed Actions 5
Decision Framework 5
Public Involvement 5
Issues and Concerns 6
II. Alternatives **7**
Alternative 1 – No Action 7
Alternative 2 – Proposed Action 7
Alternative 3 – Modified Proposed Action and Preferred Alternative 11
Design Criteria Common to All Alternatives 13
Comparison of Alternatives 14
Alternative not analyzed in detail 15
III. Environmental Consequences **15**
Vegetation Management 19
Wildlife 42
Proposed, Endangered, and Threatened (PET) Species 42
Regional Forester Sensitive Species 47
Management Indicator Species 48
Species of Viability Concern 52
Soils 57
Water 60
Air Quality 69
Climate Change/Carbon Sequestration 74
Health Effects and Herbicides 79
Recreation and Environmental Education 83
Dispersed Recreation 83
Scenery 86
Environmental Education 89
Cultural Resources 90
Socioeconomic Resources 101
IV. Environmental Justice **104**
V. Consultation and Coordination **105**
VI. Appendices **107**
Appendix 1: Herbicides 107
Appendix 2: Cultural Resources – Section 106 Compliance Conditions 109
VII. References **113**

List of Maps

Map 1. Demumbers Creek project area and vicinity. v

Map 2. Map of the proposed actions under Alternative 2. 10

Map 3 Map of proposed actions under the preferred alternative-Alternative 3 12

Map 4. Transportation in the Demumbers Creek project area 22

Map 5. Land capability classes and areas of each LCC 58

Map 6. Map of streams within the project area 61

List of Figures

Figure 1. Photos demonstrating existing condition of forest in the Demumbers Creek project area. 2

Figure 2. Condition of FSR 303 (a) and FSR 304 (b). Note potholes, ponding, and deep rutting down the roads. 21

Figure 3. Forest structure type acreage if Alternatives 2 or 3 are implemented in the Demumbers Creek project area. Over time (10-15 years) regenerating forest would move toward young forest structure 29

Figure 4. Photos of areas to receive canebrake restoration, including existing canebrakes. 41

Figure 5. Stream type classifications, from Rosgen 1994 62

Figure 6. Analysis area for air assessment. 70

Figure 7. Prescribed fire emissions compared to measured fine particulate concentrations at two monitors located within 25 miles of Land Between the Lakes Recreation Area. (Two green and two red lines represent results from different monitors.) 71

Figure 8. Previous surveys and identified sites within the current project APE 92

Figure 9. Historic features and cemeteries that will be flagged and protected during prescribed burns. 94

Figure 10. Sites recorded within and adjacent to Demumbers Creek timber treatment units 96

SUMMARY

The Land Between The Lakes National Recreation Area (LBL) proposes an integrated forest vegetation management project in the Demumbers Creek area. The project area is located adjacent to Demumbers Bay at the north end of LBL in Lyon County, KY (Map 1). Core Area bounds the project along the northeastern edge; a small portion of Core Area is within the project boundary.

This integrated forest vegetation management project is proposed to increase the diversity and distribution of the structural and age class characteristics of multiple stands throughout the project area. Stand uniformity is expressed in terms of canopy development, tree density, age, and height, thereby limiting forest characteristics that optimize the availability of food and shelter for a diversity of wildlife. Native oaks and hickories are unable to expand and increase crown development under existing conditions, thus minimizing the amount of mast they produce. The proposed actions encourage resilient forest conditions, unique recreational opportunities, and diversifying wildlife habitat development through silvicultural treatments, designed to increase plant vigor, richness, and abundance.

The proposed forest vegetation management actions will develop a diverse set of forest habitats, including mature oak woodlands, mature open oak forests, regenerating oak-hickory and shortleaf pine forests; these in turn would support a wide variety of wildlife in the project area.

Environmental education programs accompany the proposed integrated forest vegetation management project. Opportunities would be created to educate interested members of the public about forest vegetation management and its importance, including visual representation of the process and the results. The project area is adjacent to a large forested area where little to no active forest management is proposed. This juxtaposition of forest conditions and wildlife habitat provide a setting for comparison and discussion on the wide variance of forest management options and the associated outcomes of the forest management spectrum on public lands.

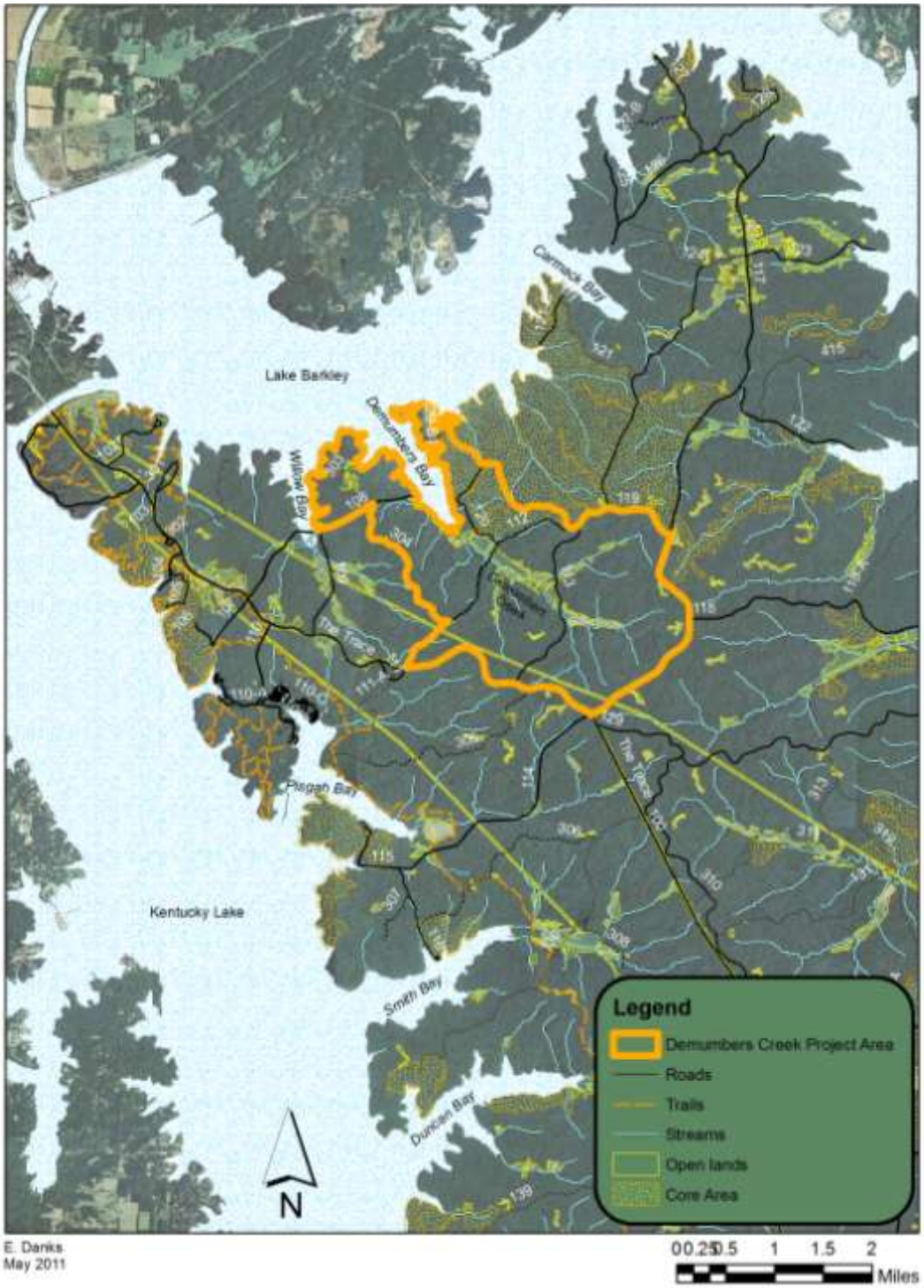
The Forest Service has evaluated the following alternatives:

- *No Action Alternative:* Forest management would continue as it currently occurs, which includes limited management of existing open lands in the project area and no prescribed fire or tree thinning activities. No environmental education opportunities would be created. This alternative represents baseline conditions already typical in surrounding areas of LBL.

- *Alternative 2 - Proposed Action Alternative:* Tree thinning activities, prescribed fire, and herbicides would be used to create diverse forest conditions in the Demumbers Creek area. Prescribed fire and herbicides would be used to control non-native invasive species. An environmental education program about forest vegetation management would be developed using existing roadways.

- *Alternative 3-Modified Proposed Actions – Preferred Alternative:* Public comments and internal scoping led to development of this alternative. This alternative includes the proposed actions, plus addition of a wildlife stand improvement thinning around open lands and a reduction in the prescribed fire area. After evaluation of the effects of all three alternatives, this was chosen as the preferred alternative.

Map 1. Demumbers Creek project area and vicinity.



I. INTRODUCTION

Background and Location

The Land Between The Lakes (LBL) National Recreation Area is proposing an integrated forest management project in the area adjacent to Demumbers Bay in the northern end of the recreation area (Map 1). The project consists of vegetation management, through prescribed fire, thinning activities, integrated pest management strategies (including herbicide use) to reduce non-native invasive plant species (NNIS) populations, biomass collection, native canebrake restoration, and environmental education. The Demumbers Creek project area has been affected by multiple storm events. This series of events along with previous land uses or activities has contributed to and shaped the current condition of the project area. Some of these conditions include damage to the dominant and co-dominant trees (primarily oaks and hickories) that compose the highest forest canopy levels, improved growing conditions for the mostly shade tolerant tree species that occupy the lower canopy levels which in turn inhibit conditions favorable to the long term survival of shade intolerant plant regeneration (i.e. oaks, grasses, and forbs), and created the accumulation of hazardous fuels in the forest (Figure 1). When these conditions are combined with inciting stress factors (e.g. damage from storm events or insect outbreaks) the likelihood of forest decline complexes (e.g. red oak decline) increases.

The project area is approximately 3,700 acres, and is typical of the mature closed canopy upland oak forested landscape at LBL. On average most stands in the project area range in age from 60 to 90 years old, there are several open lands (crop fields and old fields) primarily located adjacent to Demumbers Creek. There are also several small overstocked and stagnant (having a low live crown to tree height ratio) stands of planted pines (Virginia, loblolly, and white pine). The perennial creek, Demumbers Creek, runs through the project area and drains into Demumbers Bay. It is fed by 16 intermittent tributaries. The project area makes up approximately 2% of the land base of LBL.

The Demumbers Creek area has been known to support federally endangered and Regional Forester Sensitive (RFS) species. The endangered gray bat (*Myotis grisescens*) has been documented in the area, and potential habitat exists for Price's potato bean (*Apios priceana*) and Indiana bat (*Myotis sodalis*). Bald eagles have nested in the project area in the past. Several species of viability concern (SVC) are likely to inhabit the area, including pygmy rattlesnake and scarlet kingsnake. Crème false wild indigo (*Baptisia bracteata*), a plant SVC, has been documented in the project area.

a. b.

c.

Figure 1. Photos demonstrating existing condition of forest in the Demumbers Creek project area.

Purpose and Need for Action

The purpose and need for forest management in the Demumbers Creek area derives from the 2004 Land and Resource Management Plan of LBL (Area Plan)(USDA Forest Service 2004).

1) The Area Plan calls for creation of a variety of forest conditions within general forest areas, which would support diverse wildlife species; therefore, the desired conditions for the Demumbers Creek area include a wide range of wildlife habitat and multiple forest age

classes, structures, and types. In creating these different forest attributes there would be a gradual transition and a more even distribution of one habitat type to another throughout the project area.

2) The Demumbers Creek project area consists of a forest with a dense mid-story dominated by shade tolerant tree species. Currently, this mid-story of shade tolerant cohorts is positioned to be dominant as the next generation of forest; at the expense of the mature oak overstory that has endured a majority of the crown damage (30% of the forest) through its lifetime. This transition represents the need to improve and increase the conditions suitable for the continued dominance of shade intolerant plant species (oaks, hickories, herbaceous plants) found in the project area. Variations to the successional patterns and habitat conditions of the forested project area contribute directly to an increase in low species, structural, and age class diversity. High tree density causes undue competition for resources such as light, water, and space. These conditions make the forest more vulnerable to stress by decreasing tree vigor and thereby less resilient to recovery after catastrophic weather events such as the series of recent storms that have affected the area (hurricane-force winds, a tornado, and a major ice storm). In addition, these conditions correspond to a decline in habitat diversity for wildlife.

3) Creation of varied forest types would provide a valuable opportunity for dispersed recreation and environmental education through a self-guided interpretive program with a focus on forest management practices.

First, the project would improve wildlife habitat diversity, as prescribed in the Area Plan. The high density of existing stands prevents adequate light levels from reaching the forest floor, thereby inhibiting herbaceous plant growth (such as native grasses and wildflowers) important to many wildlife species. The area has been affected by anthropogenic fire exclusion – LBL is part of a region with a higher fire regime condition class (i.e., a higher frequency, intensity, and larger spatial extent of fire) than what has characterized it during the last 60 years, due to human exclusion of fire.

Specifically, the project supports land allocation prescriptions for General Forests (Area Plan p. 27), and the following goals and objectives:

Goal 1: Prioritize projects to provide the greatest recreation, environmental education, and resource stewardship benefits.

Objective 1a: Eighty percent of all special projects will have identified and demonstrated benefits to recreation, environmental education, and resource stewardship.

Goal 3: Utilize a variety of methods and opportunities to provide an environmental education message to every visitor.

Objective 3a: Insure that 80 percent of LBL communications, programs, and activities have an interwoven environmental education message.

Goal 4: Manage natural and physical resources, and authorized Forest Service activities, to reduce erosion or deterioration of riparian areas and watershed conditions.

Goal 5: Use a collaborative approach to maintain and restore: 1) a diversity of plant and animal communities that support viability of associated plants, fish, and wildlife; and, 2) sustainable levels of habitat and wildlife populations to support public demand for wildlife-related recreation.

Objective 5a: In mature oak forests, provide open forest structure on approximately 19,000 acres by the end of the first decade with a long-term objective of 31,000 acres.

Objective 5b: In mature oak forests, provide woodland structure on approximately 6,000 acres by the end of the first decade with a long-term objective of 30,000 acres.

Objective 5c: Provide a sustained supply of regenerating forest habitats totaling approximately 5,400 acres at any point in time. Regenerating forest will be treated predominantly within oak forest although other forest types and natural disturbances will be included.

Objective 5e: In mature forests on moist sites, provide canopy gaps on a minimum of 1,600 acres by the end of the first decade with a long-term objective of a minimum of 9,000 acres.

Objective 5f: Create and maintain at least 250 acres of shortleaf pine forest by developing desired mature open forest and woodland structural conditions over the first decade with a long-term objective of 450 total acres of shortleaf pine forest.

Objective 5g: Restore 50 acres of canebrake over the first 10 years of Area Plan implementation, with a long-term objective of 240 total acres of canebrake.

Objective 5i: Maintain approximately 10,600 acres in open lands – cultivated and grassland cover types to – support game species, early successional species, and watchable wildlife.

Objective 5j: Restore and maintain fire regimes and fire return intervals in fire dependent communities by prescribed burning an average of approximately 10,000 acres per year by the end of the first decade, with a long-term objective of 21,000 acres per year on average. Some acres will incur repeat fire application during the planning period.

Goal 7: Enhance dispersed recreational and environmental education opportunities throughout LBL.

The second purpose and need for this project is to reduce the vulnerability of the forest to catastrophic occurrences by promoting conditions that ensure the persistence, occurrence, and diversity of the many oak and hickory species native to LBL. Current high density, low diversity forest stand conditions and the presence of only one or two age classes lower the resiliency of the forest through discouraging a diversity of forest conditions that are more suited for oak and hickory species persistence as a dominant feature of the landscape. Like herbaceous plants, oak regeneration is inhibited because adequate light levels are not reaching the forest floor. In addition to the closed canopy conditions, parts of the project area most affected by recent storms have heavy fuel loading that further shades the forest floor, and large numbers of storm-weakened trees which increase the likelihood that fungus, insects, and disease would occur. Furthermore, competition from NNIS throughout the project area limits and displaces native species diversity even more. Without action, a new age class of oaks and hickories would begin to decline in number and occurrence, which limits overall tree species diversity. Low native plant species diversity does not support a diversity of wildlife desired in forests on LBL.

The third purpose for this project is to improve forest conditions so that recreation and environmental education opportunities would also be improved. Areas along Lake Barkley and Demumbers Bay are heavily used for dispersed recreation; storm damage in these areas has made conditions less safe for the high volume of users to traverse the forest. Additionally, dispersed recreation opportunities in the project area do not meet their potential. Dense forest stands and large amounts of fallen woody debris on the forest floor decrease access and visibility into the forest interior for hunting, hiking, backcountry camping, wildlife viewing, and scenic driving opportunities.

Finally, the project supports potential and existing partnerships developed to utilize biomass from LBL for fuel.

A need connected with the proposed actions is road maintenance. Several miles of roads in the project area are in need of repair. Maintenance of these roads is necessary to support forest management actions, environmental education, and dispersed recreation, to reduce soil erosion, and to prevent degradation of water quality.

Summary of Modified Proposed Actions

The Forest Service is proposing the following actions in the project area. For a more complete description of the proposed actions, see the descriptions under each alternative in Section II: Alternatives, or visit the Demumbers Creek Project Detailed Proposal on LBL's webpage at www.lbl.org/LRMPProjects.html.

- Develop various upland oak and shortleaf pine forest structures (mature oak woodland, mature open canopy oak forest, regenerating oak and shortleaf pine forest, and wildlife stand improvements) by thinning trees using mechanical and non-mechanical means including herbicide use.
- Use prescribed fire as a means to improve the fire regime condition class by decreasing fuel loading, assist in the development and maintenance of the various upland oak, shortleaf pine, and canebrake forest structures created, and as a component of an integrated pest management strategy for reducing non-native invasive species populations in the project area.
- Use selective herbicides to assist in development of various upland oak and shortleaf pine forests structures, and as a component of an integrated pest management strategy for reducing non-native invasive species populations in the project area.
- Restore native canebrakes in some existing open lands close to Demumbers Creek.
- Develop a self-guided interpretive program with a focus on forest management.
- Integrate the utilization of woody biomass harvested in conjunction with the proposed mechanical thinning treatment areas.
- Improve conditions to portions of Forest Service Roads within the project area
- Restrict access to two Forest Service Roads in the project area and add roads for access to open lands, cemetery, and campsite.

Decision Framework

The Responsible Official, the Area Supervisor, will decide whether or not to proceed with the modified proposed actions or an alternative.

Public Involvement

The proposal for the Demumbers Creek project area was first posted on the Schedule of Proposed Actions (SOPA) on April 1, 2010. There were two phases of public involvement: scoping, and notice and comment. A scoping letter was submitted to the public on May 10, 2010: the letter was posted on LBL's webpage (www.lbl.org) and mailed or emailed to 200 persons who have expressed an interest in projects posted to the SOPA for LBL, those interested in receiving more

information about the 2009 ice storm at LBL, and others who contacted Forest Service staff directly for more information about the Demumbers Creek project. A list of persons contacted and a copy of the scoping letter are kept in the project record. A legal notice was published in the Paducah Sun on May 11, 2010, and an article about the project was published in the same paper on May 19, 2010. On June 14, 2010, Forest Service staff met with the LBL Sportsmen's Club in Grand Rivers, Kentucky at their monthly meeting to talk about the project. Forest Service staff also attended the monthly meeting of Between the Rivers, Inc. in Eddyville, Kentucky on August 10, 2010.

During this initial public scoping process 11 people or organizations commented on the scoping letter via email, standard mail, or telephone, which led to 55 separate comments. LBL staff evaluated each comment individually, and was led by the comments to develop a third alternative. LBL staff also took relevant comments under consideration during environmental analysis of the alternatives. A summary of the comments can be found in the Scoping Summary and Issue Analysis document at http://www.lbl.org/LRMPProjects.html.

After the scoping period, a notice and comment letter and detailed proposal were developed. On September 21, 2010 the letter was mailed or emailed to all parties mentioned above, as well as several new persons who expressed interest during scoping. A legal notice was published in the Paducah Sun on September 22, 2010. Both the letter and the detailed proposal were available on LBL's webpage by September 30, 2010. An amendment to the detailed proposal (a single-sentence addition) was emailed on September 23, 2010.

During the legal notice and comment period, six people or organizations emailed comments to LBL staff. One email was an automated notice that the commenter was out of the office. Two emails were identical. No issues were presented that were different from those identified during scoping.

Issues and Concerns

During the scoping and notice and comment phases, no issues (as defined in the Forest Service Handbook 1909.15, Chapter-Zero Code) were identified. Several comments brought up relevant concerns identifying consequences which could be directly or indirectly caused by implementing the proposed actions. These comments were discussed by the interdisciplinary team and incorporated into the analysis and the alternatives. A third alternative was developed in response to scoping comments, and after analysis the interdisciplinary team decided that this is the preferred alternative.

The majority of comments identified non-relevant issues and concerns. Non-relevant comments were defined as those: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. A list of all comments, issues and concerns, and reasons regarding their categorization as relevant or non-relevant, may be found in the Demumbers Creek Project Scoping Summary and Issue Analysis, and the Demumbers Creek Project Notice and Comment Summary and Response, available on LBL's webpage at www.lbl.org. In addition, that document lists indicators that were identified to measure whether relevant concerns could be remedied by implementing different alternatives or design criteria.

II. ALTERNATIVES

Alternative 1 – No Action

Under the No Action alternative, current management plans would continue to guide management of the project area. No prescribed burning, herbicide use, or commercial thinning would be implemented to accomplish project goals. Open lands in the project area would continue to be managed as prescribed in the 2007 Open Lands Revised Environmental Assessment, which includes use of herbicides, mowing, planting agricultural crops, and disking. Road maintenance within the project area would be minimal, and road quality may deteriorate over time. The No Action Alternative does not meet the need for the action, but provides a baseline for comparison to the action alternative.

Alternative 2 – Proposed Action

This alternative includes the original actions proposed by the Forest Service during public and internal scoping for the Demumbers Creek area.

- Using the methods described below (Table 2.1), develop the following forest types: mature oak woodland (20-40% canopy cover), mature open oak forest (40-90% canopy cover), oak and shortleaf pine regenerating forest (forest dominated by less than 10-year old trees). (Map 2).

Table 2.1. Proposed silvicultural treatments and acreage planned for treatment within the project area.

Forest Type and Structure	Estimated Acreage	Proposed Timber Thinning Objectives	Proposed Prescribed Fire
Oak woodland	800	Intermediate treatment (thinning from below) to thin existing canopy and create canopy gaps, as delineated in Table 3.1.3	• Pre-harvest rough fuel reduction burn • Post-harvest burn targeting small diameter woody growth (<3" dbh), intended to improve site characteristics for floral diversity and abundance • Burns at intervals required to create and maintain herbaceous plant development
Open mature oak forest	700	Intermediate treatment (thinning from below) to thin existing canopy, creating a transition between woodlands and closed-canopy forest, as delineated in Table 3.1.3	• Pre-harvest rough fuel reduction burn • Post-harvest burn targeting small diameter woody growth (<3" dbh), intended to improve site characteristics for floral diversity and abundance • Burns at intervals required to create and maintain herbaceous plant development
Regenerating shortleaf pine forest	90	Regeneration treatment that removes existing planted pine trees and plants native shortleaf pine seedlings.	• Pre-harvest rough fuel reduction burn • Post-harvest site preparation burn • Burns as appropriate for shortleaf pine retention to limit mortality, by discouraging competition from NNIS and other encroaching competing vegetation
Regenerating oak forest	225	Two methods of regeneration treatments (uniform and group shelterwood with reserves strategies) to create a new oak age class, as delineated in Table 3.1.2.	• Pre-harvest rough fuel reduction burn • Post-harvest site preparation burn • Burns as needed (expected every 5-10 years) to promote vigorous oak regeneration/sprouting, and reduce competing vegetation

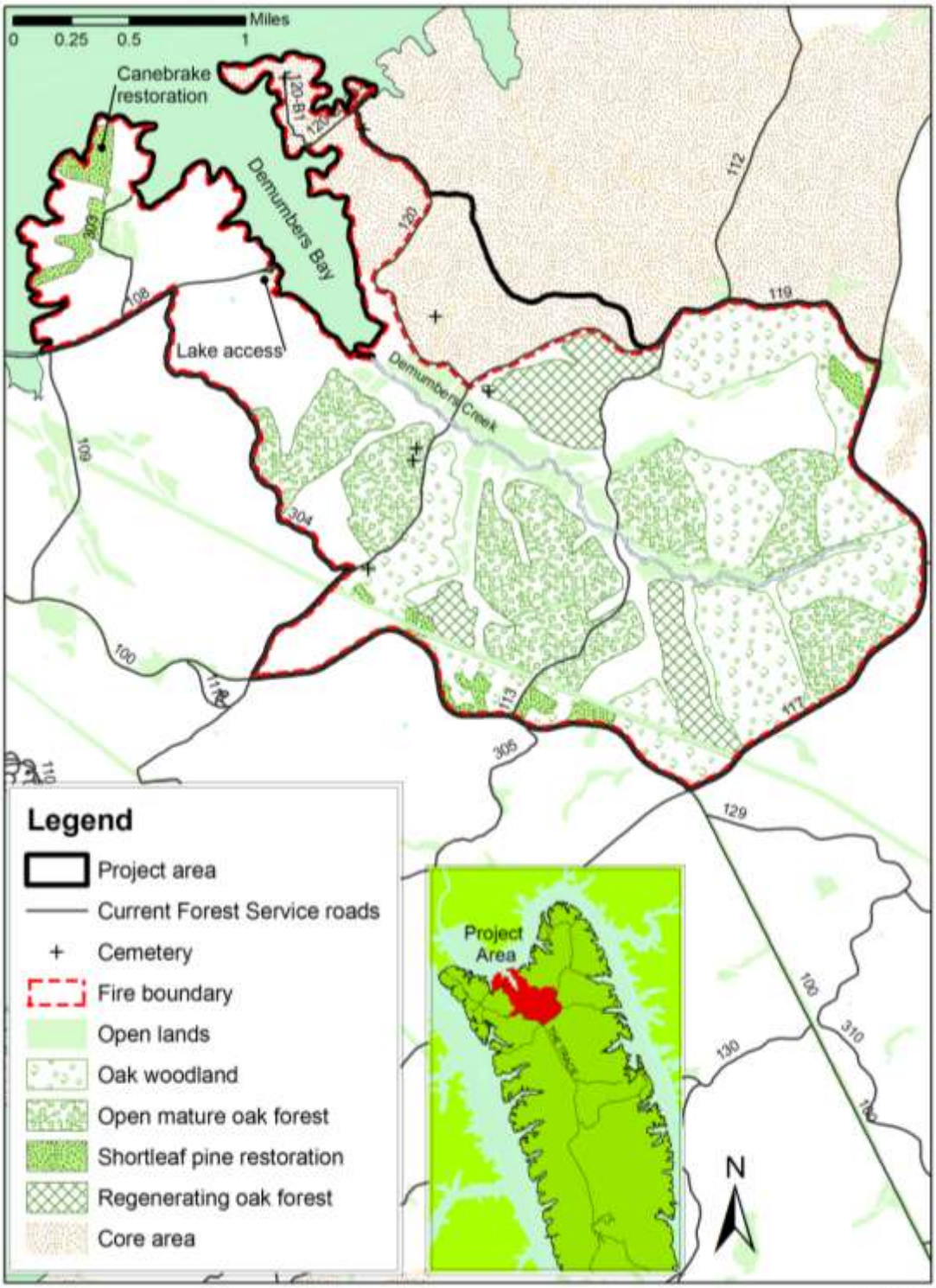
Table 2.1. Proposed silvicultural treatments and acreage planned for treatment within the project area.

Forest Type and Structure	Estimated Acreage	Proposed Timber Thinning Objectives	Proposed Prescribed Fire
Project's Core Area	205 of 455	No timber harvest proposed	• Burns at intervals required to create and maintain herbaceous plant development and decrease NNIS competition
Remaining General Forest	1,220	No timber harvest proposed	• Periodic rough fuel reduction burns, as needed. Portions of area would also be burned in conjunction with other proposed treatment needs
Total Area	3,700		

- Prescribed burning of approximately 3,450 acres to increase visibility and access to the forest interior. These 3,450 acres include areas to receive timber harvest treatments, open lands, and general forest areas (Map 3). See Table 3.1.4 for the proposed schedule and objectives of prescribed burning. Prescribed burns and timber harvests would be conducted in accordance with the Area Plan and the Terms and Conditions outlined in the US Fish and Wildlife Service's Biological Opinion for the Land Between The Lakes National Recreation Area's Wildlife and Forest Vegetation Management Program of January 22, 2010. Prescribed burns would not occur over the entire proposed burn area each time and not likely as an entire block; they would be planned in conjunction with desired conditions. Fires may be ignited aerially by helicopter or from the ground by hand crews, or a combination of both methods.
- Use of an integrated approach to control NNIS where needed along roadsides and in timber treatment areas, including coordination of herbicide treatments and prescribed fire. Herbicides proposed to be used are triclopyr, imazapyr, and glyphosate. Herbicide treatment would be limited to 600 acres/year. Within those 600 acres, herbicides could be applied more than once per year, as long as at least one half-life (46-67 days, depending on the herbicide) passes between applications. The proposed use of herbicides on 600 acres/year does not include the open lands acreage within the project area. Herbicide treatments would continue to occur on the 208 acres of open lands as described in the 2007 Revised Environmental Assessment for the Continued Maintenance of Open Lands (OLREA).
- Restore approximately 10 acres of native canebrakes (*Arundinaria gigantea*) in damaged pine stands along Willow Bay. (Map 3).
- Develop a self-guided interpretive program with a focus on forest management, utilizing existing roads.
- Utilize a portion of the woody biomass generated from the proposed thinning treatment areas. Biomass operations would be conducted in collaboration with the proposed thinning operations thereby limiting the number of entries, and collecting biomass only once, during the course of mechanical treatments.
- Improve conditions to portions of Forest Service Roads 108, 112, 113, 119, 303 and 304 to support or enhance current infrastructure and decrease resource degradation concerns. Improvements would include maintenance such as adding gravel, grading, and cleaning ditches. Culverts would be replaced after appropriate surveys are completed.

- Restrict access to Forest Service Roads 303 and 304 to Forest Service staff, contractors, and partners
- No new permanent roads would be constructed. There would be a need for temporary roads. Utilization of existing legal and historic roads would be used where possible, and an estimated 4.5 miles of temporary roads would be created to access the stands where timber treatments are planned. Using a quarter mile skidding distance would reduce the overall requirements of temporary roads. When finished with the temporary roads, they would be obliterated. This involves seeding, mulching, and installing earth berms.

Map 2. Map of the proposed actions under Alternative 2.



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May 2011

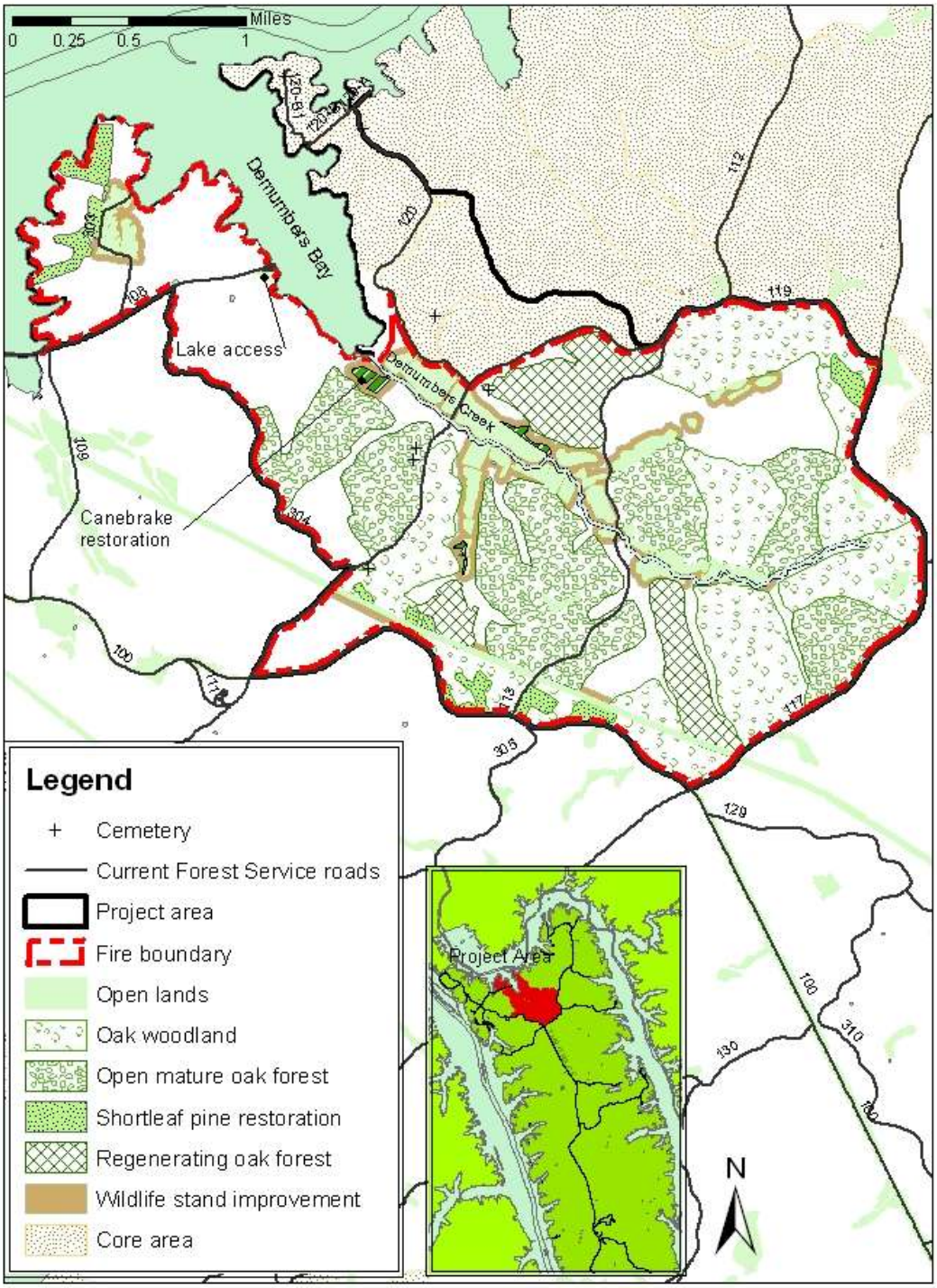
Alternative 3 – Modified Proposed Action and Preferred Alternative

As a result of public involvement and internal scoping, the proposed action was modified to exclude prescribed fire from the project's core area and to add a wildlife stand improvement thinning around open lands. After analysis, the interdisciplinary team decided to recommend this alternative to the responsible official, rather than the original actions proposed during scoping.

This alternative is the same as Alternative 2 with four exceptions:

- Perform wildlife stand improvement (WSI) treatment to soften the edges between open lands and adjacent forest, which is believed to reduce the "edge effect" that is detrimental to many wildlife species. The forest along opens lands (180 acres) would be thinned using herbicides (Map 3) to reduce NNIS and saplings less than 10 feet in height in forests up to 150 feet from the edges of open lands, leaving trees best suited for wildlife, such as dogwood, pawpaw, black gum, deciduous holly, persimmon, wild plum, American beech, and oak and hickory species.
- Prescribed fire would occur in 3,245 acres, excluding all 455 acres of the project's Core Area (Table 2.2 and Map 3).
- Restore canebrake areas on approximately 10 acres of several open lands where the existing conditions are favorable to canebrake restoration (Map 3).
- Add approximately 4.2 miles of existing but unauthorized roads to the National Forest System roads and the INFRA database, as described in the Demumbers Creek Project Transportation Analysis appendix. Obliterate up to 30 miles of unauthorized roads, as needed, for resource protection.

Map 3. Map of proposed actions under the preferred alternative – Alternative 3.



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Design Criteria Common to All Alternatives

In response to interagency and public comments on the proposal, design criteria were developed to ease some of the potential impacts the various alternatives may cause. The design criteria apply to all the action alternatives. In addition, applicable laws and regulations, Area Plan Standards, and Terms and Conditions of the 2010 US Fish and Wildlife Service's Biological Opinion for Wildfire and Forest Vegetation Management Program (FWS 2009-B-0084, with exceptions noted in the Demumbers Creek Biological Assessment and consulted on with the US Fish and Wildlife Service) would be followed.

- Within the 100-foot Visual Quality Zone (VQZ) along Woodlands Trace and other Maintenance Level 4 and 5 roads, timber-marking paint would be applied in a way that is not highly visible from the road.
- Slash treatment zones would be applied to reduce the height and amount of woody debris generated by the proposed actions within a minimum of 300 feet from the edge of the scenic byway (Woodlands Trace)(USDA Forest Service 2008).
- Biodegradable signage would mark any sale boundary that can be seen along Woodlands Trace.
- If any unanticipated Threatened or Endangered species are located in the project area during project implementation or monitoring, work would be suspended and a biologist would be consulted to determine a course of action.
- Herbicide treatment would be limited to 600 acres/year. Within those 600 acres, herbicides could be applied more than once per year, as long as at least one half-life (46-67 days, depending on the herbicide) passes between applications. The proposed use of herbicides on 600 acres/year does not include the open lands acreage within the project area. Herbicide treatments would continue to occur on the 208 acres of open lands as described in the 2007 Revised Environmental Assessment for the Continued Maintenance of Open Lands (OLREA).
- Follow Section 106 Compliance Conditions in Appendix 2 for prescribed burn, timber treatment, and canebrake restoration undertakings.

Monitoring

Timber sale contracts include multiple monitoring standards related to residual stocking rates, road condition upon termination of the contract, condition of the standing forest structure and forest floor upon completion, and others. Standard 39 in the Area Plan guides the timber stocking levels that must be met; if these levels do not occur within 5 years of implementation of the mechanical timber harvest, then remedial efforts would be taken, including planting native trees to improve stocking rates. Regeneration surveys would be conducted three and five years after harvest, to determine if appropriate regeneration is occurring. New canebrakes would be monitored one year and three years after planting to ensure adequate growth and proliferation of planted cane.

Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. Information in Table 2.2 is focused on activities and effects where different results can be distinguished quantitatively or qualitatively among alternatives.

Table 2.2. Comparison of proposed actions in each alternative.

	Alternative 1 – No Action	**Alternative 2 – Proposed Action**	**Alternative 3 – Modified Proposed Action**
Environmental Education Project	None planned.	A self-guided driving tour would be developed to compare the wide spectrum of forest management objectives and strategies used at LBL.	Same as Alternative 2.
Prescribed Burning	Prescribed burning would not occur.	Burning would be accomplished multiple times on about 3,450 acres made up of 3,245 acres of general forest (including open lands) and 205 acres of the project's Core Area. Burning would occur more frequently upon initiation of the project (burns every 1-3 years), and then less frequently thereafter, in order to maintain or improve development of desired conditions.	Same as Alternative 2, on all but approximately 205 acres of the Alternative 2 burn area. Fire would be excluded from the 205 acres of the project's Core Areas. The total acres proposed for prescribed fire treatment is roughly 3,245.
Mechanical Thinning	No thinning would occur.	Hardwood and pine basal area would be reduced on 1,825 acres within the project area. Oak woodland, open canopy oak forest, and regenerating oak and shortleaf pine forest structures would be developed.	Same as Alternative 2.
Non-mechanical Thinning	No thinning would occur.	No non-mechanical thinning would occur.	Non-mechanical thinning (herbicide use, or wildlife stand improvement [WSI]) would occur in forests up to 150 feet from the edge of open lands, if no other thinning were already occurring in those areas. Targeted plant species include NNIS and tree saplings less than 10 feet in height.
Shortleaf Pine Planting	No planting would occur.	Shortleaf pine would be planted on up to 90 acres.	Shortleaf pine would be planted on up to 100 acres.
Road Management	Current minimal road maintenance would occur. No roads would be reconstructed or decommisioned, and no existing legal roads would	About 9.5 miles of road improvements would occur, and 2.5 miles of road would have access limited. In addition, 4.5 miles of temporary road would be	Same as Alternative 2 plus the addition of approximately 4.2 miles of unauthorized roads to the National Forest System and INFRA, for access to open

Table 2.2. Comparison of proposed actions in each alternative.

	Alternative 1 – No Action	**Alternative 2 – Proposed Action**	**Alternative 3 – Modified Proposed Action**
	have access limited.	created; these would be obliterated after timber harvest.	lands, cemetery, and dispersed campsite.
Herbicide Use	Herbicides would still be used in open lands and along some road rights-of-way, as prescribed in the Open Lands REA. There would be no control of non-native invasive species (NNIS) in forested areas.	Herbicides would be used in open lands and forested areas to control NNIS and to limit vegetative competition in shortleaf pine regeneration areas. Glyphosate, imazapyr, and triclopyr would be the three herbicides used. Up to 600 acres per year would be treated; treatment would generally include spot application where needed to control NNIS, rather than broad application over an entire area.	Same as Alternative 2. In addition, herbicides would be used in non-mechanical thinning areas (WSI) around open lands, which include riparian areas. Herbicides approved for aquatic application would be used in riparian areas if necessary.
Biomass Collection	No biomass would be collected.	Harvesting of some woody biomass would be generated by the proposed 1,825 acres of mechanical thinning operations.	Same as Alternative 2.

Alternative not analyzed in detail

One suggestion that was presented by a commenter was to remove more of the canopy within 10-15 years after new oak regeneration is established within the proposed oak regeneration areas. They suggested upon this second entry that the basal area should be left no higher than 20 ft^2/acre. This is sometimes referred to as a “release cut” in a three step shelterwood thinning operation. This harvesting system is generally accepted as an excellent way to increase growing spacing and maintain high light levels needed to support the growth of the next generation of oak cohorts. In practicing this system of regeneration the primary objective is to optimize the number of trees per acre regenerating. This is a very important concept when managing primarily for timber and fiber production. However, the regeneration methods proposed for this project have been modified from the conventional three step shelterwood system in an attempt to balance between the objectives of a sustained supply of forest products but also provide a continual supply of hard mast for wildlife consumption, and diversity for the various recreational activities here at LBL. The purpose and need of the proposed oak regeneration thinning is to provide a regenerating oak forest structure and age class, but not necessarily at the highest stocking levels that the site can support.

III. ENVIRONMENTAL CONSEQUENCES

This section evaluates the biological, physical, cultural, social, and economic environments of the affected project area and the potential changes to those environments due to implementation of the alternatives. In some cases, the evaluation given is a summary of a more detailed specialist report that is available upon request from the Demumbers Creek project record. This section also presents the scientific and analytical basis for comparison of alternatives presented

in the table above. Table 3.0 below summarizes the evaluation; a more detailed description of the evaluation and effects is given below.

Table 3.0. Comparison of effects of each alternative on each resource.

	Alternative 1 – No Action	**Alternative 2 – Proposed Action**	**Alternative 3 – Modified Proposed Action**
Vegetation – trees/timber	A shift from oak-hickory forests to maple-elm-blackgum forests would gradually occur (over decades). Wildlife habitat diversity would decrease. The future conditions of the LRMP would not be met in the project area.	A mix of oaks, hickories, and shortleaf pine would occur, and a mix of forest structural conditions, including regenerating oak and shortleaf pine forest, oak woodland, and open oak forest would be developed. This would lead to an increase in wildlife habitat diversity. See Figure 3 for projected forest structure changes.	Similar to Alternative 2, with a less abrupt transition between open lands and forests in the areas treated with WSI.
Vegetation – herbaceous	Herbaceous ground cover would decrease as the forest canopy became more closed. Plant diversity would decrease because there would be fewer seral stages represented.	Herbaceous ground cover would increase once the canopy was opened up by timber treatments and prescribed fire. Habitat for multiple seral stages would be created, leading to increased plant diversity.	Similar to Alternative 2. The total area of increased herbaceous ground cover and opportunities for increased diversity would be greater by about 180 acres (WSI) than with Alternatives 1 or 2.
Wildlife– PET	There would not likely be any adverse effects to any threatened or endangered species. There would be no opportunity to improve potential habitat for all three species considered.	Small likelihood of adverse effects during implementation, but potential habitat would improve for all three species considered.	Similar to Alternative 2. Potential habitat improvements for two species (Indiana bat and Price's potato bean) would be improved.
Wildlife– RFS	Overall, no beneficial or adverse effects would occur for most species; two species would benefit.	May impact individuals but not likely to cause a trend to federal listing or a loss of viability for most species; two species would benefit.	Same as Alternative 2.
Wildlife– MIS	Some species would benefit from no actions and others would not. See Table 3.2.7	Some species would benefit and some would not. See Table 3.2.7	Similar to Alternative 2. See Table 3.2.7
Wildlife– SVC	No direct effects; adverse indirect effects through habitat loss.	Implementation may impact individuals but is not likely to cause a trend to federal listing or a loss of viability for any SVC. Habitat quality and quantity would remain stable or improve for these species.	Same as Alternative 2.

Table 3.0. Comparison of effects of each alternative on each resource.

	Alternative 1 – No Action	**Alternative 2 – Proposed Action**	**Alternative 3 – Modified Proposed Action**
Soils and Water	There would be no change to soil and water resources. Management of open lands would still occur, leading to improvements in water quality. Active downcutting of Demumbers Creek channel would continue. Poor road quality would continue to contribute to erosion and sedimentation of streams.	Soil moisture and temperature would increase temporarily in treated areas (for <10 years). Increased soil nutrients would be immediately available, but some would also be quickly leached from soil. The effects on increased nutrients would last <5 years. Localized soil compaction may occur and localized soil productivity may be reduced; however, these effects would be reduced by adherence to KY BMPs. Road improvements would decrease erosion and sedimentation. There is a potential for herbicide runoff into soils and surface waters, but this is mitigated by herbicide selection and application methods.	Same as Alternative 2, except potential for herbicide runoff into streams is greater in the SWI treatment areas. See Design Criteria in Area Plan for reductions to this potential impact.
Air Quality	There would generally be no effects; however, smoke from unplanned wildfires may have adverse effects on nearby human populations.	Smoke from prescribed fires may cause increases in air emissions for <1 day, as long as good smoke management practices are followed as planned. Emissions would be less than potential wildfire emissions. Cumulatively, emissions from the proposed actions are negligible when added to existing emissions, and are dwarfed by emissions from nearby coal-fired power plant.	Same as Alternative 2. Reduction in burn area would not have a noticeable impact on air quality compared to that of Alternative 2.
Climate change/ carbon sequestration	The existing forest is likely currently sequestering carbon at maximum levels, but carbon storage would decrease with time. The project area scale has imperceptible effects on global climate change.	After implementation of the proposed actions, carbon sequestration would be similar to current levels on all but 325 acres of regenerating forest, which would have lower rates of carbon sequestration. Improved resiliency of forests would allow them to be more adaptable to climate changes. The project area scale has imperceptible effects on global climate change.	Same as Alternative 2, with slightly increased carbon-storage capacity in the WSI areas.

Table 3.0. Comparison of effects of each alternative on each resource.

	Alternative 1 – No Action	**Alternative 2 – Proposed Action**	**Alternative 3 – Modified Proposed Action**
Recreation / Environmental Education	Visitor access to the project area would remain limited. Visitors complain that it is difficult to enjoy the project area now because of large amounts of woody debris from recent storm damage. This limits recreation opportunities, with no cumulative change to recreation on LBL.	Short-term (<5 years) adverse impacts (aesthetics, access) would occur, directing visitors to other parts of LBL. Long term, aesthetics, hunting access, wildlife viewing, and dispersed recreation opportunities would improve once the forest understory is opened up. An environmental education opportunity unique at LBL would be created.	Short-term and cumulative impacts would be similar to Alternative 2. The opportunity to improve a dispersed recreation site would be lost with fire exclusion from the project's Core Areas. Visibility into the forest would improve in WSI areas, increasing wildlife viewing opportunities. Changes to canebrake restoration area would improve diversity of visuals and opportunities for wildlife viewing.
Cultural resources	Neglect and vegetation growth have had the most damaging impact on the prehistoric and historic sites and the no action alternative will be more of the same. Existing sites would be subject to damage by wildfires. Fewer surveys would be conducted, foregoing an opportunity to learn more about cultural resources in the area.	Ground-disturbing activities would have no effect, positive or negative, on any significant historic properties. But prescribed burns would help decrease vegetation, thus increasing visibility at sites within the project area so they could be recorded and baseline data collected. Improvement in vegetation conditions would also mean easier access so that field interpretive programs would be possible.	Similar to Alternative 2. WSI treatment would be an additional low-impact way to remove concealing vegetation from cultural resource sites, further improving conditions for recording and collecting baseline data in those areas.
Socioeconomic resources	There would be no change in revenue for LBL and no change in the local economy. Forest product value would decrease over time, and decreased value of experience to recreation users would also result.	The value of timber products would offset the costs of implementing proposed actions and create a benefit to the local economy. Changes described under recreation and environmental education provide a social benefit.	Similar to Alternative 2.

Vegetation Management

This section of the Environmental Assessment includes effects of silvicultural treatments (timber harvest, non-mechanical timber treatments), herbicide use, biomass collection, prescribed fire, shortleaf pine restoration, and canebrake restoration on the affected environment. A related action that will be considered in this section is road improvement and maintenance, and the construction of temporary roads. This section is a summary of the more detailed vegetation management specialist report, available in the project record.

Affected Environment

Background

The LBL is delineated into Land Allocation Prescription Areas (LAP) in the Area Plan. The forested acres in the project are 455 acres in Core Area LAP and 3,062 in General Forest LAP. The remaining 208 acres are also classified as General Forest; however, they exist in an open land condition. The 455 acres of Core Area in this project area account for 1% of the total Core Area designated throughout LBL.

Overall, the Demumbers Creek project area is approximately 94% forested (3,492 acres) and 6% in various forms of open lands (Map 1). The forest communities are predominately upland oak communities (88% of project area). There are also sweet gum-yellow poplar stands (5%) and planted pine stands (1%) in the project area. Most of the planted pine stands are occupied by loblolly pine; however, some locations have Virginia and eastern white pine planted among or adjacent to the loblolly pine.

Past management activities included timber harvest and prescribed fire. The last known timber harvest activities in the project area were conducted by the Tennessee Valley Authority (TVA) in 1985 (see the Vegetation Management Specialist Report in the project record) and the Forest Service in 2005 (a 67-acre salvage sale after a tornado).

A prescribed fire was conducted in the Willow Bay area (378 acres) by Forest Service staff in 2007. The objective of this prescribed burn was to improve native warm season grass establishment within the open lands inside the burn area, and increase early successional habitat condition within the forested sections of the burn block.

The incidence and extent of wildland fires in the project area has been relatively low. Based on wildland fire data collected during the past 20 years, there were 5 fires that consumed a total of 684 acres inside or within a ½ mile radius of the project boundary. Four out of the five fires recorded took place after 2005 (492 acres). Wildfire points of origins are typically adjacent to roads or trails at LBL. Over the past 20 years, most fires occurring at LBL have been attributed to human causes, although nationally arson is only attributed to 25% of all wildland fires.

There are no existing system trails within the project area. The condition of the road system within the project area varies considerably. Several miles of FS roads 303 and 304 in the project area are in poor surface and drainage conditions (Figure 2). There are several sections within these two roads that are impassible or present unsafe driving conditions caused by vehicle use during times of excessive soil moisture. These conditions have contributed to users going around these areas, and creating alternative paths which contribute to other resource degradation

concerns. For example, the end point of FS road 303 is an open land. However, the road has been extended illegally and now reaches a portion of the western shoreline of Demumbers Bay. This unmanaged and user created road segment has ruts and areas where vegetation is constantly being removed which impacts many resources. These two roads are important for administrative purposes related to open lands, wildlife, and forest management, but they do not access any cemeteries or facilities at LBL. As part of the proposed action these roads would be repaired and gated to allow for the continued administrative use and the walk-in turkey hunt program. The total road repair mileage for these two roads is approximately 3.0 miles.

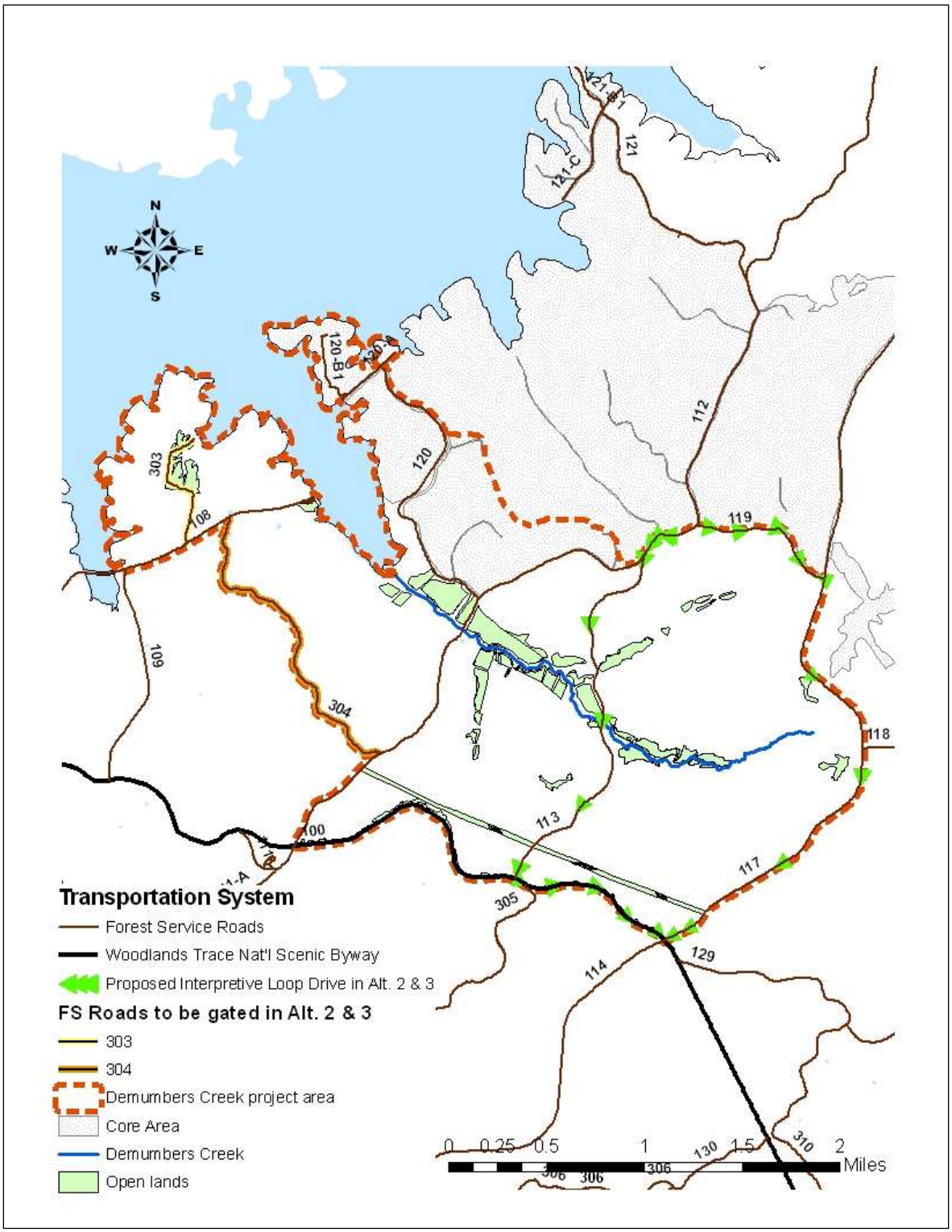
The other roads within the project area are in better surface condition. The sections of FS roads 100, 108, 117, and 120 that fall within the project area are maintained to a level suitable for low-clearance vehicles and are not anticipated to need any maintenance related to the proposed action of this project. FS roads 112, 113, and 119 are also maintained to the same user level but have been identified in the Demumbers Creek Project Travel Analysis (USDA Forest Service 2011) as needing maintenance activities on approximately 6.0 miles of road. Road maintenance in this situation is defined as road grading, ditch cleaning, spot surfacing of gravel, and repairing of potholes. Culverts would be replaced after appropriate surveys are completed. This type of maintenance would be conducted during the life cycle of the proposed timber sale activities.

An area-wide Draft Roads Analysis Report was completed for LBL in July 2003(USDA Forest Service 2003). Some issues identified in this report that impact the Demumbers Creek area include ensuring cemetery access; supporting management activities such as timber harvest, prescribed fire, and field access; ensuring access for future research needs; and reducing risk of erosion from roads and sedimentation of watersheds. Other issues may apply as well. The Demumbers Creek Project Travel Analysis report (USDA Forest Service 2011) identified road access and maintenance issues related to the proposed actions, and resource conservation as it applies to roads in the project area. If the preferred alternative is implemented, roads would be used to: access timber harvest areas and extract timber; access areas to be treated with herbicides, planted with shortleaf pine, receive canebrake restoration, and monitor all vegetation management activities; serve as control lines during prescribed fire operations; and support environmental education and dispersed recreation programs. If the proposed actions were not implemented, roads would still be necessary to access the project area for maintenance, security, recreation, and cemetery access. A map of roads in the project area is below (Map 4).

a. b.

Figure 2. Condition of FSR 303 (a) and FSR 304 (b). Note potholes, ponding, and deep rutting down the roads.

Map 4. Transportation in the Demumbers Creek project area.



Existing Forest Composition and Structure

During the fall of 2009 the project area was inventoried using the Forest Service's Common Stand Exam (CSE) program. The CSE results are available from the project record upon request. From this inventory data, twelve forest types were identified. Ten of the twelve are upland oak forest types. The remaining two forest types are sweet gum-yellow poplar and loblolly pine. The various tree species found in the project area fall under a wide spectrum of shade tolerance. For example, there are species ranging from very shade tolerant (maples), to intermediate shade tolerance (oaks and hickories), to highly shade intolerant (pine species) (Chester 2002).

Structure type and age class distribution are important components that are usually tied together in the description of a forest or individual stand. Using the inventory data collected in 2009 and historical information about the prior TVA timber harvesting cycle, Forest Service staff determined that 2,616 acres, or 69% of the project area, are mature forest. Within this area, the forest structure is predominantly a two-tiered closed canopy, which inhibits oak, hickory, and pine regeneration (Franklin, Fralish et al. 2002). This current stand structure leads to light levels at the forest floor that are not sufficient to provide for the long-term growth and development of shade intolerant tree species. The remaining 877 forested acres in the project area are middle-aged forest, defined as having a dominant age class between 30 to 60 years old. Although there are young trees and seedlings throughout the project area, there are no stands that qualify as regenerating or young forest conditions. More importantly, the small vacancies created have allowed establishment of new plants beneath the old stand, which are often shade-tolerant tree species (Smith, Larson et al.).

The various planted pine stands (100 acres) are characterized by different canopy conditions than most of the project area. These small plantations (each less than 50 acres) were established 40 to 50 years ago. Seedlings were planted in dense rows (at least 800 trees per acre), which for the first 20 years of growth provided great cover for wildlife. These stands were never thinned, however, which has resulted in the current condition of an extended stem exclusion stage. Stem exclusion is a term used to describe a stand of trees where the above- and below- ground growing space is densely occupied by trees' roots and crowns growing together, forming a closed canopy (Smith, Larson et al.). Under this condition very little other plant growth is gained except for shade-tolerant species development. The planted pines have continued to grow vertically due to no available space horizontally, leading to a high number of trees/acre and very little canopy complexity (see CSE report). The high tree density has led to a lack of diameter growth to support long term survival during strong weather disturbances. Characteristics such as these do not support resiliency or longevity with respect to individual tree or stand development. Most of the pine trees have a very low live crown ratio (26% on average); when this ratio decreases to 30% or less, there is a general reduction in vigor (Smith, Larson et al. 1997). The reduction in vigor is a substantial concern for the longevity of these stands.

Xeric and dry site types dominate the project area, covering 2,222 acres (60% of the project area). Canopy composition on these sites is dominated by a mixture of post, white, scarlet and chestnut oak. The mid-story and understory associates include species such as elm, sweet gum, sassafras, black gum, and dogwood.

The dry-mesic site type is the second most abundant (1,378 acres, or 37% of the project area). Canopy composition along this site type is more of a mixture of white oak, southern red oak,

northern red oak, black oak, and various hickory species. The mid-story and understory associates include ash, red maple, sugar maple, black cherry, and yellow poplar.

The remaining 3% of the project area is made up of mesic and riparian site types. These two site types total only 100 acres, and 33% of these acres (33 acres) exist in open land conditions. The small percentage of forest found on these site types is primarily composed of yellow poplar, sweet gum, white oak and various red oak family species. Other tree species associated with these sites include sycamore, river birch, and hackberry.

The forest has been substantially affected by a series of major storms since 2005. A tornado, strong winds from a remnant hurricane and a 100-year ice storm have severely damaged portions of the forest canopy in the area, leaving an augmented level of woody debris on the forest floor as trees and limbs have fallen during and in the years after these events. It is estimated that at least 40% of the project area stands have endured significant crown damaged (i.e., 50% or more of a stands' dominant and co-dominant tree species had a majority (33% or more) of the crown broken, or removed) (USDA Forest Service - Land Between The Lakes NRA 2009). The woody debris left by these storms impedes movement for people and wildlife; yet it does provide an extensive source of biomass for insects, fungi, pathogens, and wildlife on the forest floor. One of the primary forest management concerns related to the project area is the current condition which does not support the long term creation and survival of shade intolerant oak species and herbaceous plants found in the forest understory. This is because most of the stands in the project area contain a well-developed mid-story of shade tolerant hardwoods which are positioned to advance into various openings created through the combination of an aging oak over-story and the multiple weather events mentioned above. Through the process of canopy closure in the denser shade tolerant tier of the canopy light levels become insufficient in the long term support of oak, hickory, shortleaf pine, or shade intolerant herbaceous plant growth on the forest floor. The shade tolerant hardwood mid-story has a strong competitive advantage in becoming the dominant forest type and future generation of forest within the project area. By displacing oaks and hickories from the dominant canopy position the forest floor composition also changes and creates another competitive advantage for the next generation of shade tolerant hardwood species.

Several relevant issues related to vegetation management were raised during scoping. Many of these were adequately addressed in the August 2010 Demumbers Creek Scoping Summary and Issue Analysis. Those that warranted further analysis are:

1) One commenter was concerned that prescribed fire is not the most suitable method of reducing woody growth and thinning the forest in the project area. Alternatives 2 and 3 below analyze integrative methods of reducing forest density, including prescribed fire, timber harvests, cut-and-leave thinning, and use of herbicides.
2) Several timber treatment alternatives are presented by one commenter to encourage oak and hickory regeneration in the project area. The effects of these alternatives are discussed below.
3) Two commenters expressed doubts about the proposal to remove coarse woody debris for biomass energy use. Details about the methods of removal of biomass and their effects are analyzed under Alternative 2 below.
4) A commenter expressed concern that herbaceous understory diversity would continue to decline with the proposed timber treatments, and timber harvests would encourage

undesirable species to outcompete native plants. Effects to herbaceous vegetation are analyzed under each alternative below.

5) One commenter was concerned that preemptive and salvage logging in the project area may do more harm than leaving the forest as it has been left after the storms have hit it, and cited a specific scientific paper (Foster and Orwig 2006). The proposed action alternatives (Alternatives 2 and 3) are contrasted with a No Action alternative (Alternative 1) to help determine the preferred course of action.

Existing Herbaceous Layer Structure and Composition

Open lands make up 208 acres of the project area (Map 1). Nearly half of these (91 acres) are currently agricultural crop fields. The rest (117 acres) are hayfields (cool season grasses), old fields managed by occasional mowing, utility corridor rights-of-way, or planted in spring or fall with wildlife plantings.

The forest floor is made up of a combination of sprouting shade-tolerant tree species, grasses, and both native and non-native herbaceous forbs. There are also oak and hickory seedlings and saplings within the stands found in the project area. However, in most stands within the project area (as indicated in 2009 CSE data/ Vegetation Management Specialist Report) the amount of shade-tolerant seedlings and saplings are equal to or greater than the total number of oaks and hickories of the same size class. The herbaceous layer in forested areas was surveyed during July-September 2010, with a focus on species of viability concern (SVC), Regional Forester Sensitive (RFS) species, threatened and endangered plants, and non-native invasive species. Survey data can be found in the project record. One SVC was found to be present in the project area: *Baptisia bracteata*. Effects to this species are evaluated below under the Wildlife section. No RFS or threatened and endangered species were found. The relatively dense mid-story prevents many herbaceous plants from thriving; therefore, the forest floor has a lower density of vegetation than its potential.

There are several non-native invasive species (NNIS) found in the project area (Table 3.1.1). Six of these species (Japanese honeysuckle, Japanese stiltgrass, tall fescue, Johnson grass, autumn olive, and privet) are considered by the Forest Service and the Kentucky Exotic Pest Plant Council to be highly invasive, enough to be a severe threat to native species and ecological communities, and easily spread into native communities.

Table 3.1.1. Non-native invasive species identified during vegetations surveys July - September 2010

Common Name	Scientific Name	LBL-Wide NNIS Strategy Priority*
Tree of heaven	*Ailanthus altissima*	2
Queen Anne's lace (Wild carrot)	*Daucus carota*	4
Autumn olive	*Elaeagnus umbellata*	2
Japanese clover	*Kummerowia striata (Syn. Lespedeza striata)*	3
Bicolor lespedeza (Shrub lespedeza)	*Lespedeza bicolor*	1
Sericea lespedeza (Chinese lespedeza)	*Lespedeza cuneata*	2

Table 3.1.1. Non-native invasive species identified during vegetations surveys July - September 2010

Common Name	Scientific Name	LBL-Wide NNIS Strategy Priority*
Privet	*Ligustrum sp.*	2
Japanese honeysuckle	*Lonicera japonica*	4
Japanese stiltgrass, Nepalese browntop	*Microstegium vimineum*	4
Mulberry	*Morus sp.*	4
Princess tree (Chinese empress-tree)	*Paulownia tomentosa*	3
Loblolly pine	*Pinus taeda*	2
Multiflora rose	*Rosa multiflora*	3
Tall fescue	*Schedonorus phoenix (Syn. Lolium arundinaceum, Festuca elatior* var. *arundinacea)*	4
Meadow fescue	*Schedonorus pratensis*	4
Sicklepod or Java bean	*Senna obtusifolia*	Revised Open Lands EA NNIS**
Japanese bristlegrass (Giant foxtail)	*Setaria faberi*	4
Johnsongrass	*Sorghum halepense*	2
Cocklebur	*Xanthium sp.*	Revised Open Lands EA NNIS**

*LBL NNIS priority ranking template: 0 = Not yet known on unit-eradicate new occurrences immediately; 1 = Eradicate where ever found; 2 = Control source populations and eradicate outliers; 3 = Prevent invasion of last areas not invaded-eradicate in high priority areas; 4 = Status on unit "naturalized", uncertain or not presently known, control/eradication site specific.
**Revised Open Lands EA Appendix 6.1.1 Table-A3: special use permit holder identified invasive plant species in agriculture managed fields.

Effects

Alternative 1 – No Action

There would be no timber harvesting, prescribed fire, non-mechanical thinning, canebrake restoration, biomass collection, shortleaf pine regeneration, or herbicide use to manage vegetation within the forested portions of the project area. Open lands in the project area would continue to be managed as prescribed in the 2007 Continued Maintenance of Open Lands Revised Environmental Assessment (OLREA), which includes use of herbicides, mowing, agricultural crop planting, and disking. Road maintenance within the project area would be minimal due to lack of funding or revenue, and road quality would continue to deteriorate over time. Prescribed burning could continue under separate NEPA decisions.

Direct and Indirect Effects

The age structure of the forest cover on LBL continues to steadily advance toward a more mature and late successional forest ([TVA] Tennessee Valley Authority 1999; Chester and Fralish 2002). Without the implementation of silvicultural treatments, this trend would continue, and the majority of the project area would continue to mature and shift from being dominated by shade intolerant tree species such as oaks and hickories to more shade tolerant, mesophytes tree species such as maples, elms, black gum, and beeches (Bormann and Likens 1979; Franklin, Fralish et al. 2002). A study from LBL estimated that 40-50 percent of the area would eventually support forest dominated by mesophytes (in this case, primarily shade-tolerant tree species)(Franklin, Robertson et al. 1993; Franklin 2002), leading to a decline in oak species diversity. The desired condition stated in the Area Plan for maintaining oak and hickory forest would not be met, as oak decline similar to what is currently occurring in the red oak family would eventually impact the white oak family tree species as well. More mature and late successional forest dominated by mesophytes would mean a loss in the diversity of oak species present. Data collected in the project area support the overall trend in LBL's Area Plan that most species within the red/black oak family are damaged or are showing signs of reaching physiological maturity and impending old age (Area Plan FEIS pg. 106) (USDA Forest Service 2004).

Many of the mature stands that have an overstory canopy (the taller and older trees) dominated by oak species also have large amounts of canopy damage from various stresses such as old age, insect and disease occurrences, and various weather events. This combination of biotic and abiotic stresses has also contributed to increased fuel loadings. All these conditions could increase the potential for wildfires, insect and disease outbreaks, and mortality in the overstory. The overstory has endured these stresses over its lifetime and acted as a buffer to many of the crowns of shade-tolerant mid-story trees. In this situation the mesophytes (various elms, black gum, and maple species) that occupy the mid-story are now positioned to recruit and advance into a more dominant canopy position – the overstory. The mid-story would then reach an extended "stem exclusion" period of stand development, favoring new shade tolerant tree species; this form of stand development doesn't necessarily favor superior wildlife habitat, old-growth candidacy, or improved quality of the forest structure (Oliver and Larson 1996; Franklin, Fralish et al. 2002). While the ecological processes of a forest would still occur even if no management is done (Foster and Orwig 2006), the goals and objectives of LBL's Area Plan would not be achieved in the project area. Overall the project area would not have a diversity of age and structure classes associated with various forms of upland oak forest development. Planted pine stands would continue to increase in mortality which would create canopy openings where shade intolerant tree species would shortly occupy.

Non-native invasive species (NNIS) would continue to displace native species, which would otherwise provide forage for native species of insects and other animals. The potential plant species diversity of the area would not be realized.

Cumulative Effects

Multiple biotic and abiotic stresses continue to interact with existing oak and hickory stands in the region including the project area, furthering the decline of these species. Areas across LBL, including the project area, with less active management can expect the shade-tolerant mid-story and understory to advance and expand, causing long term declines in the establishment of future oak regeneration. The result of this process has both ecological and economic importance

(Loftis 1990; Foster and Orwig 2006). Oak-hickory forests are vital for a diversity of wildlife, providing large numbers of acorns and buds as a major food source, especially in winter when other food sources are scarce. In terms of forest products, the wood from oaks and hickories has a high value. With the eventual loss of oak-hickory forests, there would ultimately be an effect on the supply and demand for these products in the region (Close 1996; Franklin, Fralish et al. 2002). Closed-canopy, mesophytic forest characteristics could potentially decrease the biodiversity of LBL by reducing the number of oak species and number of herbs that depend on higher light levels than found under maple-beech forest (Franklin, Fralish et al. 2002). Finally, there would be no "on-the-ground" opportunities to educate the public about oak-hickory and shortleaf pine forest management in the region (Loewenstein and Davidson 2002).

Alternative 2

Direct and Indirect Effects

Effects of Harvests through Timber Sale

The proposed actions are designed to promote a mix of oaks, hickories, and shortleaf pine. The amount of shade and tree densities found under the current conditions impedes these intermediate and shade intolerant tree species from developing and retaining a vigorously growing new cohort. The proposed timber harvests would also create a diversity of stands with multiple age and structural conditions (Figure 3), meeting the desired conditions described in the Area Plan. Removing damaged trees in the overstory would limit the likelihood of insect or disease outbreak and improve overall forest health.

Mechanical thinning would focus on retention of white oak, post oak, southern red oak, hickory species, chestnut oak, black oak, and scarlet oak, in that order as determined by on-the-ground conditions (Map 2). Retention priority would be 1) healthy trees, and 2) mature trees. To the extent possible, flowering trees and both hard and soft mast producers would be favored for retention, in order to improve scenic quality and wildlife habitat, along scenic roads adjacent to areas proposed for thinning activities. These trees include species such as dogwood, pawpaw, eastern red bud, deciduous holly, persimmon, wild plum, and oak and hickory species. Cedar trees would also be favored for retention along the Woodlands Trace Scenic Byway as a desired conifer species that adds to the primarily hardwood forest composition.

The existing road system and historic roadbeds would be used to access this area for treatments, to the extent possible. Improvements and maintenance of the road surface and/or drainage would be made as required to complete the thinning treatments. Approximately 9.5 miles of roads would be reconditioned. In addition, approximately 4.5 miles of temporary road would be constructed for access to timber harvesting activities. These temporary roads would be decommissioned and rehabilitated after timber thinning operations finish. A direct effect of the proposed thinning activities is that timber sale contracts include required road maintanance provisions in order to maintain or improve the road condition. Some of the maintenance activities usually performed through a timber sale contract include road grading, ditch cleaning, culvert replacement, spot surfacing of gravel, and repairing of potholes. Additional discussion of roads can be found in the Demumbers Creek Project Travel Analysis (USDA Forest Service 2011)and in the Soils and Water section below.

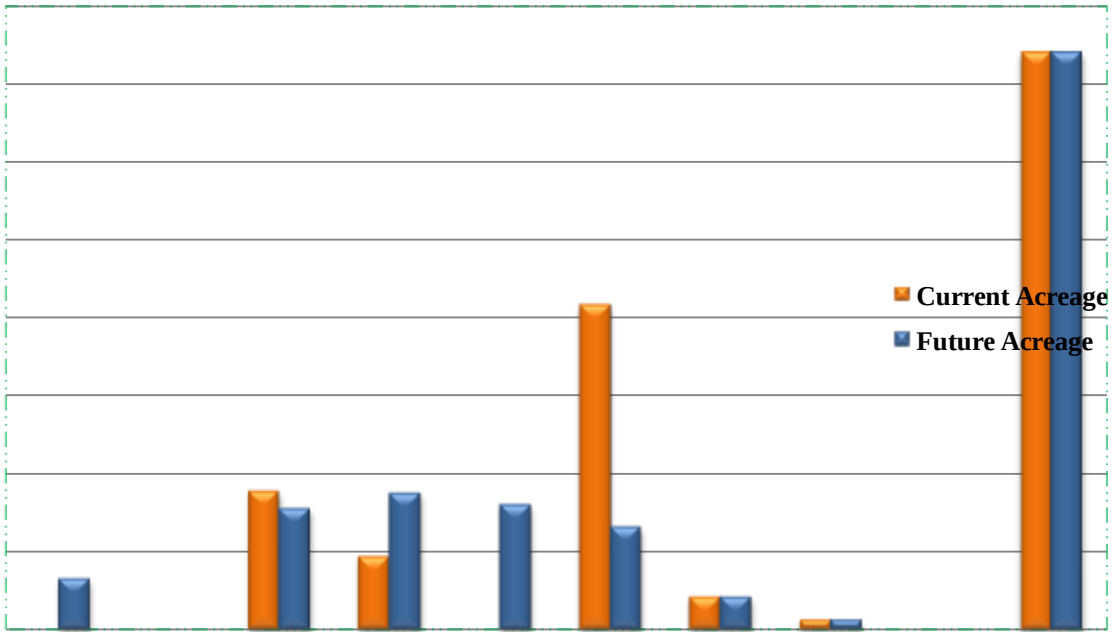


Figure 3. Forest structure type acreage if Alternatives 2 or 3 are implemented in the Demumbers Creek project area. Over time (10-15 years) regenerating forest would move toward young forest structure.

Regenerating oak-hickory forests

The objective of this action is to provide regenerating oak-hickory forest habitat predominately on xeric and dry site types through the use of two different silvicultural methods: 1) modified group shelterwood with reserves treatments (140 acres), and 2) modified uniform shelterwood with reserves treatments (85 acres; Table 3.1.2, Figure 3). These two proposed regeneration methods would develop site conditions suitable to sustain and promote the vigorous growth of existing oak and hickory advance regeneration. The use of the term "modified" in the shelter wood term simply means that instead of multiple thinning entries these sites are currently proposed to have only a single entry or thinning at this time. Future harvest would be planned and appropriate at a much later time (approximately 20 years or more). In deferring future shelterwood entries the residual mature trees constitute the "reserves" in this system. The reserve trees provide a continual supply of hard mast for wildlife consumption, and diversity for the various recreational activities here at LBL. The proposed regeneration thinning activities are designed to increase the site conditions favoring long-term survival of existing oak and hickory advance regeneration, and to create a diverse composition of regenerating oaks and hickories primarily on xeric and dry site types, with two distinct oak-hickory age and structure classes established.

Before the regeneration thinning activities occurred the combination of a prescribed burn to reduce the litter layer, and stem injection herbicide applications to decrease mid- and understory shade tolerant tree densities, would be performed. This set of treatments would provide the initial effect of an immediate and temporary (5 years) increase in forest floor light levels. This combination of treatments has two effects. First it reduces the number of competing hardwood advance regeneration seedlings and saplings (primarily shade-tolerant species such as maple and elm) found in the mid-story and understory. This is important since once the overstory canopy is

thinned these species are left unchecked and will also thrive and compete against the advanced oak regeneration in gaining the newly acquired sunlight and canopy space resources. Secondly the use of fire also increases light levels temporarily but more importantly fire stimulates the vigorous resprouting of oaks from existing root sources. The new oak cohorts would now exhibit characteristics like vigorous resprouting and good apical dominance, two signs that these trees are well positioned for long term survival and health once the majority of the overstory canopy is removed through the regeneration thinning.

Once the regeneration thinning operations are complete, the treated stands would be dominated by a large number of small trees (at least 150 tree/acre) most of which would be oak and hickory species with a few large oak and hickory trees (roughly 30 trees/acre) scattered throughout the stands. The canopy closure provided by the remaining overstory older trees would be less than 60%.

It would be impractical and unnecessary to attempt to remove all shade tolerant hardwood competition, and this is not the desired condition or intent of this project. Instead, the expected effect is to have a greater number of shade intolerant oaks and hickories as part of a new cohort of regenerating tree species.

Table 3.1.2. Site type distribution (in acres) among the proposed oak-hickory regeneration harvests.

Site Types	**Proposed Modified Group Shelterwood Site Types**	**Proposed Modified Uniform Shelterwood Site Types**	**Total Acres**
Xeric	0	4	**4**
Dry	132	62	**194**
Dry-Mesic	8	19	**27**
Total Acres	**140**	**85**	**225**

Modified Group Shelterwood Method with Reserves – The modified group shelterwood with reserve harvest would reduce the canopy cover in a more heterogeneous pattern compared to the modified uniform shelterwood with reserve harvest. This strategy of regeneration is designed to create various openings (groups) in the forest canopy where oak-hickory regeneration already occurs and can then capitalize on the newly available resources (sunlight, water, growing space, nutrients). Groups would vary in size from about ¾ to 1 acre, and would represent approximately one third of the total acreage (effectively, 48 acres out of the total 140 acres). The amount of direct sunlight reaching the forest floor and other various levels of the canopy would fluctuate throughout the stands. Groups would be irregularly shaped and trace the contours of the land in order to mimic natural disturbances while increasing the diversity of light levels surrounding the openings. Areas between the groups would be thinned from below to approximately half the current tree density, leaving oaks with the healthiest crowns for an average of 45 ft^2/acre basal area in these sections of the stands. This basal area is averaged with the basal area of the group openings (effectively zero ft^2/acre) to leave a total stand basal area of approximately 30-35 ft^2/acre. Group openings would be placed a minimum of 100 feet from the maintained right of way (ROW) on Level 3, 4, and 5 roads.

When combined with prescribed fire and use of herbicides to reduce the litter layer, decrease mid- and understory vegetation densities, increase light levels reaching the forest floor, reduce competing hardwood advanced regeneration, and allow for the vigorous resprouting of oaks from existing root sources, a young oak-hickory forest would be developed from the regenerating forest over the course of approximately ten years. Afterwards, this young forest

would continue to mature and the regenerating forest condition would be only temporary. On average, the composition within the modified group shelterwood areas would change from about 60% shade tolerant hardwood species in the regenerating mid- and understory to roughly 20%.

Modified Uniform Shelterwood with Reserves Method – This thinning strategy would leave a very open mid-story and understory with a more evenly distributed canopy of oaks and hickories. Trees with the best formed crowns are considered the best mast producers and would remain first priority in designating reserve trees. Approximately half the basal area of the selected forest stands would be removed, leaving an average of 40 ft^2/acre basal area. The total basal area of the reserve trees would consist of approximately 20 ft^2/acre of basal area coming from the white oak family species; and the remaining portion of the basal area derived from a combination of the healthiest available red oak or hickory family species.

This proposed method of regeneration harvesting would occur instead of creating group openings in stands because of these characteristics: 1) the combination of shallow, rocky soil conditions on western or southern slope aspects make some sites susceptible to windthrow when larger openings (1-2 acres) are created, and 2) crown characteristics and past storm damage to individual trees in these stands were fairly evenly distributed throughout, as opposed to areas treated through the modified group shelterwood method where more clustered storm damage was observed.

On average, the composition within the uniform shelterwood areas would change from about 25% shade tolerant hardwood species in the understory to less than 10% shade-tolerant hardwoods.

Regenerating Shortleaf Pine Forests

The regeneration strategy for shortleaf pine is quite different from the oak-hickory regeneration explained above. Shortleaf pine is a rare species at LBL, being found in only a few areas in the forest. There are no shortleaf pines growing on the sites proposed for regeneration. It is a shade-intolerant species and does not survive or grow well in the presence of competing vegetation (1980). Based on these factors, shelterwood methods are not a desirable regeneration strategy. Instead, a stand replacement with reserves harvest would be used to establish shortleaf pine on 90 acres. The various pine species existing (Virginia, loblolly, and eastern white pine) would all be removed, as well as some damaged and shade tolerant hardwood species. Healthy oaks and hickories would remain to some extent. The maximum number of healthy mature oaks and hickories to be retained is limited to leaving no more than 20 ft^2/acre basal area. These reserve trees would most likely be scattered in small pockets wherever former planted pine trees did not survive. This low density canopy would ensure plenty of growing space and high light levels needed for shortleaf pine seedling survival.

Shortleaf pine seedlings would be planted after the thinning operations have been conducted. The shortleaf pine seedlings would be planted at a lower density than existing pines were planted: roughly an 8’ x 8’ spacing interval, or 681 trees per acre (at least 200 trees per acre less than the previous plantings). The desired condition is the same as in the oak regeneration proposed action: create a regenerating two-aged forest structure, except with shortleaf pine instead of oak in the younger age class.

Oak Woodlands and Open Oak Forests

The proposed action also includes 1,500 acres of intermediate thinning, or thinning from below, which means removing trees mostly from the lower crown classes (understory and mid-story) to favor the upper crown classes (overstory). Approximately half of the existing basal area of the forest would be removed. This type of intermediate thinning is designed to create approximately 800 acres of mature oak woodland and 700 acres of open mature oak forest conditions predominately along xeric and dry site types (Table 3.1.3, Figure 2). Trees 6.0" in diameter at breast height (dbh) and larger would be removed by mechanically harvesting. Flora and fauna communities that require high light levels reaching the forest floor would be enhanced through a combination of these harvests and periodic prescribed burning. Overall, the canopy structure within the stands proposed for intermediate thinning would change to a forest with a much lower density of the smaller diameter trees that occupy the middle and lower canopy layers. The higher overstory canopy layers would also be reduced, but not nearly to the same extent.

The proposed intermediate thinning operations described share some common traits with the proposed uniform shelterwood with reserves method. Both cutting operations are designed to create an open middle and lower canopy with larger dominant trees from the highest canopy levels having more space between them to grow and produce various degrees of shade and sunlight mixtures. Trees selected first for removal are prioritized by those species that are not oak or hickory, and then removing oaks and hickories that are either showing signs of stress or in order to meet the desired basal area for that specific stand. The major difference between the two cutting methods is that after the intermediate thinning is completed, prescribed burning would continue in these areas at a higher return interval than the shelterwood areas, in order to maintain the desired condition (an open mid-story, high light levels reaching the forest floor, and an understory dominated by a diverse herbaceous cover). As a result of the intermediate thinning, the mid-story canopy layer would be reduced by roughly 70%, creating a very open forest condition. This results in 40% to 90% of the forest floor receiving direct sunlight, which increases the dominance of herbaceous growth in the forest understory. The project area as a whole is still dominated by mature oak forest. The majority of the proposed thinning activities (1,500 acres) are intended to create a greater diversity of mature forest conditions. The 225 acres of regenerating oak and 90 acres of regenerating shortleaf pine are the only areas that are changing from the mature structure type classification. The 315 acres of proposed regeneration thinning account for less than 10% of the project area.

Table 3.1.3. Site type distribution (in acres) among the two proposed intermediate thinning treatments.

Site Types	**Proposed Mature Oak Woodland Site Types**	**Proposed Open Mature Oak Forest Site Types**	**Total Acres**
Xeric	8	2	**10**
Dry	761	548	**1,309**
Dry-Mesic	31	150	**181**
Total Acres	**800**	**700**	**1,500**

Mature Oak Woodland Thinning – Mature oak woodland conditions are defined as a very open forest with canopy tree age averaging greater than 60 years old and an understory dominated by grasses and forbs (wildflowers and legumes). The amount of canopy cover within 800 acres in the project area would fluctuate between 10% and 60% due to attributes such as tree species composition and height, slope, aspect, site type (xeric, dry, dry-mesic), mid-story development, past disturbance cycles, tree density, successional stage, and tree age class distribution. For example, the canopy closure designated in the Area Plan for woodland conditions ranges from less than 10% on xeric ridge and upper-slope sites, to 60% canopy

closure along dry and dry-mesic mid- to lower-slope sites. On average, the stands thinned to meet the mature oak woodland conditions would have a density (basal area) of 30-45 ft^2/acre. This condition would be maintained over time by periodic prescribed burning.

Open Mature Oak Forest Thinning – The establishment of open mature oak forests would increase forest structural diversity on 700 acres in the project area. Open mature oak cover types are described as transitional, encompassing a wide range of fluctuating canopy conditions between the two ends of the mature forest spectrum; the homogeneous closed canopy mature oak cover type and the heterogeneous mature oak woodland cover type. The Area Plan describes this cover type as having 20%-40% canopy closure and providing spacing between trees that is wide enough to allow light to various levels of the canopy and forest floor (Area Plan pg 28 and 91). This condition promotes vigorous crowns with reduced susceptibility to insect and disease, and stimulates ground vegetation, including regeneration of oak seedlings. The basal area distribution would vary from 20 - 80 ft^2/acre at any given place within the stands treated for this condition, with an average density of 50 -60 ft^2/acre. This condition would also be maintained by periodic prescribed burning.

Herbaceous response to timber harvests

The herbaceous understory in all of the proposed thinning areas is expected to increase with growth. The length of time in which the understory will be dominated by herbaceous plant life versus small trees and shrubs will vary by thinning objective. There would be an increased density of herbaceous vegetation, as well as an increased diversity of species as a full array of shade-tolerant, intermediate, and intolerant species of herbs and shrubs would have the opportunity to thrive (Bormann and Likens 1979). During the first year or two, there may be a single dense layer of plant growth on the forest floor, as a variety of species take advantage of increased light, water, and nutrient levels (Bormann and Likens 1979). This response would vary depending on how much the canopy was opened up; for example, open canopy forests may not receive as much of a response as oak woodlands on xeric ridges. Regenerating forests would see a large herbaceous response for the first ten years after the thinning occurred. The first several years, several strata would develop, and it would be possible to see a more well-defined mid-story, understory, and herb layer (Bormann and Likens 1979). During this time, the new canopy of regenerating trees would begin to enclose the open spaces left between trees, and gradually reduce light levels reaching the forest floor. The new oak or shortleaf pine canopy would begin to shade out the herbaceous layer after ten years of growth, therefore the amount of herbaceous species found after ten years would start to decrease.

In contrast, the mature oak woodlands and mature open oak forest areas are maintained by more frequent prescribe fire and would continue to have openings between trees due the low density mid-story in place for many years. There would be a component of shade intolerant tree species remaining in the herbaceous layer as these species are well adapted to frequent low intensity ground fires and vigorously sprout back after a fire. The amount of trees sprouting after the fire will vary considerably based on the mosaic pattern of a prescribe burn. In general the xeric and dry site types where oak woodland and open mature oak forest treatments take place (88% of these two treatments acreage) will contain the longest herbaceous response surpassing the ten years of herbaceous response anticipated within the regenerating forests treatments.

Herbicide Use

The herbicides triclopyr, imazapyr, and glyphosate would also be used to treat NNIS in the project area, including those listed in Table 3.1.1. This is part of an integrated pest management strategy that is described in the Vegetation Management Specialist Report. The direct effect of herbicide use on vegetation structure and composition would primarily include a reduction in non-native invasive species (NNIS), loblolly pine, and shade tolerant hardwood species located in the forest mid- and under-stories. The use of herbicides on a maximum of 600 acres per year is proposed to control NNIS, as well as shade tolerant hardwoods and early successional plant species that have a competitive advantage and would inhibit the establishment and survival of shortleaf pines, oaks, or hickories within the proposed regenerating forest treatments. Areas where herbicide use would be focused include roadsides, open lands edges, and timber thinning locations, with retreatment as needed to maintain desired conditions and reduce NNIS numbers (see Appendix 1 for a description of proposed herbicide application methods). Within Core Areas and along the outer edge of roads that form the perimeter of the project area, herbicides would only be applied along the road right-of-way where NNIS populations were located. Herbicides would promote shortleaf pine regeneration establishment because the soil on these sites were highly disturbed by previous land use and NNIS population are well established and abundant. In these areas suppressing NNIS growth is vital to ensure newly planted shortleaf pines are not overtopped quickly. Herbicide use would suppress NNIS growth in the project area, thereby allowing native plants opportunities to establish and flourish. Because herbicides kill the root system (not only the top part of the plant like prescribed fire does), the targeted NNIS and shade tolerant saplings that make up the understory and mid-story would be reduced for a much longer period of time (10-15 years).

Herbicides would not be broadcast sprayed over large areas, but there would be temporary periods (<1 growing season in each area) where patches of brown vegetation would be visible in the project area; this would be most noticeable in the shortleaf pine regeneration area, along roadsides and the edges of open lands, or other areas where NNIS occurrence is extensive. As a result of NNIS reduction, areas treated with herbicides would have a larger structural and species diversity of native herbaceous vegetation.

Biomass Collection

The focus of biomass collection is greater utilization of woody materials generated during the proposed timber sales, with the intention of increasing opportunities to advance shade intolerant plant species richness, rather than maximizing biomass volume yields. The selective harvesting of biomass within the project area would produce effects to forest structure and composition similar to timber thinning. Specific details about what portions or types of trees to be harvested are in the Vegetation Management Specialist Report, available upon request in the project record. The majority of biomass collected would come from trees 6-10 inches in dbh often harvested for pulpwood, thereby representing an effect similar to the proposed timber harvests.

There would be a reduction of the number of small diameter trees in the mid-story and lower canopy levels, creating an open mid-story condition. This supports the desired structural condition of mature oak woodlands and open mature oak forests. The removal of trees from these lower canopy levels for use as biomass energy would have a direct effect on stand composition; removal efforts would be focused on shade-tolerant hardwoods, and retaining oak species. The amount of biomass generated from this potential source is primarily limited to the

trees that exist and are cut in the proposed timber harvest areas. The collection of biomass would occur during the thinning operations. The estimated volume of chipped biomass to be removed from the project area is 3,000 CCF, which is approximately half of the pulpwood estimated to be removed from the project area.

With a decrease in tree density in the lower canopy levels an indirect effect to forest structure and composition would be the increase in additional resources (sunlight, water, nutrients, and space) available to herbaceous and oak development on the forest floor. Higher resource levels to the forest floor stimulate more herbaceous growth and diversity along with creating conditions more favorable to the woodland and open mature forest structure classes. In regeneration treatment areas, herbaceous development would have a short term increase in growth and diversity, as well. In these areas, however, increases in herbaceous growth would slow or decrease over time (10 years) as oak, hickory, or shortleaf pine regeneration also released by the thinning and biomass operations begins to dominate the site. At this point in time the canopy would begin to close again, decreasing the level of available resources on the forest floor.

The proposed actions would not remove any of the existing substantial amounts of woody debris from the forest floor, but would remove only debris generated by timber harvest. In addition, the most nutrient-rich portions of stems, the fine woody material 3 inches in diameter or less, would be left on site to replenish soil nutrient levels. The forest floor in the project area currently has a larger than average amount of woody debris as a result of recent storm activity; this debris would not be collected during biomass operations. The existing debris would serve as wildlife habitat, and would continue to replenish soil carbon and nutrient levels.

Canebrake Restoration

The planting of native cane (*Arundinaria gigantea*) to create a canebrake restoration area totaling approximately 10 acres would occur within a stand that would be cleared of loblolly pine along Lake Barkley (Map 2). In this area, rather than planting shortleaf pine as proposed for the other pine regeneration areas, native cane rhizomes would be planted. Native cane rhizomes to be used would be harvested from the project area and other areas on LBL to ensure that local genotypes with the best chance to thrive are planted. They would be harvested using a backhoe, hand and shovel, or both. Areas where cane is harvested would then be allowed to naturally regenerate cane from remaining stocks. Native cane rhizome culms would be planted with the use of a tree planter and tractor or hand planted with a tree dibble. These newly created canebrakes would receive occasional prescribed burning similar to general forest areas.

Prescribed Fire

Under Alternative 2, prescribed fire would be repeatedly utilized on approximately 3,450 acres (Map 2) for the purpose of wildlife habitat improvement, fine fuel reduction, site preparation of shortleaf pine/oak regeneration, creation and maintenance of oak woodland and other various oak forest community structure types, and improvement of visitor safety. Prescribed burns would occur in the General Forest (3,245 acres [includes open lands]) and part of the Core prescription areas (~205 acres of areas designated for minimal management). Burns would predominantly occur during the dormant season, and occasionally be conducted during the growing season. Roads, utility rights-of-way (ROW), creeks, riparian areas and the shoreline would be used as control lines. Prescribed burns would be ignited from the ground by firefighters and aerially by helicopter. Although the proposed action calls for prescribed fire

repeatedly on approximately 3,450 acres within the project area, this does not mean that fire would burn every time over the entire project area. The project area has several features such as roads, open lands, and utility ROW which would facilitate the division of the area into smaller sections, thereby allowing creation of differing fire return intervals and exclusion periods.

The proposed actions are designed to promote a wide range of structural and successional forest conditions. To accomplish this objective, prescribed fires would be used at various times of the year and at different intensities and frequencies.

Dormant Season – Dormant season burns are conducted from mid-September through March. Prescribed fire during this time of year typically results in killing the above-ground portion of woody plants with stems less than 3.0" in dbh, and often a new sprout is produced from the established root system of these plants. Most hardwood tree species have the ability to re-sprout in this fashion, especially oaks and hickories. Shortleaf pine in the early development stages also has the ability to re-sprout after the above-ground portion of the plant has been killed by fire. In general the older a tree gets the less likely it is to resprout whether the above ground portion of the tree is removed by fire, cutting, or other disturbances like strong winds. Dormant season prescribed burns would result in a rough reduction in litter layer fuels, site preparation in proposed regeneration areas, killing the above-ground portion of shade tolerant and NNIS vegetation, and promoting the vigorous re-sprouting of oaks, hickories, and native herbaceous flora from existing root sources.

Growing Season – Growing season burns take place from April through mid-September. Woody vegetation has a different response from burning during this time of year because more of the plant's energy resources are available above ground, and often when the above-ground portion is killed, there are fewer energy reserves in the root system available to facilitate re-sprouting. Growing season burns are an important component to developing and maintaining the herbaceous understory associated with oak woodland and open mature oak forest conditions. Burning during this time period would primarily focus on increasing the floral diversity and abundance within oak woodland and open mature oak forest treatment areas. A low intensity, short duration, growing season prescribed burn conducted to reduce above-ground growth of woody vines (i.e., muscadine grape and green briar) would assist oak, hickory, and shortleaf pine regeneration. This type of fire assists in preventing young tree growth suppression which occurs when young trees are overtopped by fast-growing early successional species. Table 3.1.4 below illustrates the season, objectives, and expected vegetation and fuel effect associated with prescribe fire use, before and after the proposed thinning operations would commence.

Table 3.1.4. Alternative 2 proposed prescribed burns. Note that this is the anticipated burn schedule; however, the frequency, intensity, and extent of prescribed burning would be tailored to accomplish desired conditions and could vary from that listed here.

Prescribed Burn	Season	Objective(s)	Expected Vegetation and Fuel Effects
Prescribed Burns Conducted Before Thinning Operations Start			
#1	Dormant Season	Reduction in fine fuel levels on roughly 3,450 acres within the project area.	• Above ground mortality of at least 50% of woody stems less than 1" in dbh. • Slight reduction in litter layer depth.

Table 3.1.4. Alternative 2 proposed prescribed burns. Note that this is the anticipated burn schedule; however, the frequency, intensity, and extent of prescribed burning would be tailored to accomplish desired conditions and could vary from that listed here.

Prescribed Burn	Season	Objective(s)	Expected Vegetation and Fuel Effects
Prescribed Burns Conducted During or After Thinning Operations Cease			
#2	Dormant Season	Site preparation burn for shortleaf pine regeneration; conducted after overstory of planted pines has been cut	• Above ground mortality of 50% of hardwood stems less than 3" in dbh. • 50% rough reduction in slash material. • 90% mortality of loblolly pine seedlings germinating from the soil seed bank. • Above ground mortality of NNIS.
#3	Dormant Season	Site preparation burn to improve advanced oak-hickory regeneration already in place if a majority of the regeneration has been damaged or lacks apical dominance.	• Increase vigor of oak advanced regeneration. • 50% rough reduction in slash material. • Increase above ground mortality in shade tolerant hardwood stump sprouting/regeneration.
#4	Growing Season	Improve site characteristics for floral diversity and abundance within oak woodland and open mature oak forest treatment areas.	• Above ground mortality of 50% of remaining woody stems less than or equal to 3" dbh. • Promote established native herbaceous plant development and growth. • Provide site conditions favorable to the expansion of native herbaceous plant development. • 50% rough reduction in slash material.
#5 +	Combination of either dormant or growing season burns	Maintain and improve understory herbaceous plant development and characteristics associated with oak woodland and open mature oak forest conditions. Conducted periodically as needed to maintain those conditions.	• Maintain conditions that allow for an understory dominated by herbaceous flora. • Above-ground mortality of at least 50% of woody stems less than or equal to 3" dbh.
Burns Conducted in Open Lands in Conjunction with Larger Forested Burn Blocks			

Table 3.1.4. Alternative 2 proposed prescribed burns. Note that this is the anticipated burn schedule; however, the frequency, intensity, and extent of prescribed burning would be tailored to accomplish desired conditions and could vary from that listed here.

Prescribed Burn	Season	Objective(s)	Expected Vegetation and Fuel Effects
With larger forested burn blocks	Dormant or growing season burns	Maintain early successional habitat. Improve native herbaceous conditions. Reduce woody encroachment along open lands.	• Promote established native herbaceous plant development and growth. • Reduce woody stems by 90%. • Above ground mortality of NNIS

Reintroducing fire at varying intensities, frequencies, and seasonal distribution in different places within the project area is designed to increase site conditions favoring the dominance of oak, hickory, and shortleaf regeneration. The prescribed burns are estimated to result in 5-10% mortality of stems between 4.0”-6.0” in dbh. Shrubs (less than 4 ft in height) and small seedlings (less than 2 ft in height) over time would be reduced by up to 97% in the woodland and open mature structure types, and trees between 2.0”-4.0” in dbh would be reduced by up to 38% (Bowles, Jacobs et al. 2007). Fire would be more severe on micro-sites with more fine fuel buildup and topography that allows fire to burn uphill, especially on south slopes. Prescribed fire has been shown to have a positive effect on seedling establishment by reducing leaf litter. Fire can also alter stand structure (mostly in the shrub and mid-story layer), further resulting in an increase in light reaching the forest floor. Prolific sprouting of top-killed vegetation after a fire, however, may consume the newly created growing space. Therefore, the overall effect of prescribed fire would be to achieve a more balanced distribution in the establishment of shade intolerant species (oak, hickory, shortleaf pine, herbaceous species) with a short term increase (less than 5 years) in sunlight reaching the forest floor, as new plants and sprouts continue to grow and capitalize on the space and light readily available.

This leads into one of the underlying principles in proposing the integrated use of prescribed fire, herbicide, and thinning of the forest canopy. In order to sustain the effects acquired through prescribed burning (higher understory light levels, shade intolerant plant establishment and the space to freely grow) while being responsive to the longer amount of time needed to recruit and maintain shade intolerant plant species communities and structure types, another disturbance which affects the upper levels of the canopy (such as the proposed thinning) would also have to occur. Prescribed fire used after the proposed thinning would then have the effect of maintaining forest structural conditions established through this integrated forest management process.

Cumulative Effects

This cumulative effects analysis reviewed multiple spatial levels within the entire 37,152 acres of the Lower Cumberland River Watershed (LCRW). Forest Service land within the LCRW is 11,053 acres; and the Demumbers project area is 3,700 acres. The temporal scales used in this analysis considered multiple points in time; including the present (2011), five years from now (2016), and 10 years from now (2021).

There are no other thinning projects scheduled at LBL within the LCRW. The only change to forest structure and composition that is completely dependent on the Demumbers Creek project

and specifically the proposed thinning operations is the development of a new regenerating oak and shortleaf pine forest structure type.

There are 4,452 acres in two prescribe burning projects (Crossroads and Little Chicago) proposed at LBL that would fall within the LCRW. Together with the Demumbers Creek project (3,500 acres) there is potential to treat up to 7,952 acres with prescribe fire in the LCRW over time, though not at the same times. This is 72% of the land that the USFS manages within the LCRW and 21% of the total watershed.

The total effect to forest structure and composition within the LBL portion of the LCRW is that there would be a more balanced and diverse number of various mature oak forest structure types over the next 10 years. The Demumbers Creek project would account for approximately 70 % (in acres) of newly created oak woodland structure type. The other effect to forest structure found within the LBL portion of the LCRW over the next 10 years would be the shift from the current condition of, mature closed canopy forest being the most abundant structure type found (50% in acres), to the future condition of open mature canopy forest being the most abundant structure type found (31% in acres).

The spatial extent of this analysis continues past the boundaries of LBL and reviewed the LCRW as a whole. USFS ownership of the LCRW accounts for 30% of the total acres, but of that amount almost half (45%) of all forested acres in the watershed are on LBL. The open lands within the LBL account for only 18% of all open lands in the LCRW, while roads/developed areas combine for only 13% of that cover type throughout the watershed. The proposed actions of this project and the other projects analyzed here do not change the cover types that are currently associated with the LBL portion of the LCRW. It is assumed the cover types in the LCRW outside Forest Service control will change very little, given past trends. The land cover types in these 26,099 acres are made up of approximately 35% as Lake Barkley, 5% roads and development, and 60% either open lands or forests. The fact that the Forest Service projects are designed to maintain a diverse, vigorously growing, forest with increased resiliency provides some assurance that the LCRW has some resistance to cover type conversion.

Additional details about cumulative effects are in the project record.

Alternative 3 – **Preferred Alternative**

Direct and Indirect Effects

Effects of Timber Treatments

The effects of all harvests through timber sale would be the same as for Alternative 2 – no changes to timber sale harvests are proposed with this Alternative. Other changes to the forest would occur due to the proposed wildlife stand improvement thinning (Map 3).

Wildlife stand improvements (WSI)

The proposed wildlife stand improvement (WSI) thinning would begin to create a feathered effect, or ecotone, up to 150 feet along open lands to create a more subtle transition between open land and forest, approximately 180 acres (Map 3). This ecotone is intended to provide a greater diversity of vegetative conditions and minimize the “edge effect” thought to be

detrimental to interior forest species. The WSI would affect wildlife habitat and dispersed recreation opportunities; see those sections in this document for details about anticipated effects to those resources. The WSI would not occur in the project's Core Areas. No biomass collection would occur in WSI areas because no mechanical treatment is being done in these areas.

The stands proposed for treatments are currently high density, closed canopy stands. The overstory would remain the same after treatment, because only trees in the understory and lower levels of the mid-story would be removed; therefore, the overstory would remain a partially closed canopy. Trees less than 10 feet high would be targeted with the proposed herbicides. Within one growing season after treatment, killed trees would be visible throughout the WSI treatment area; these trees could be seen from the edges of open lands. During the same growing season as the treatment, brown and wilted vegetation would be visible. This is a temporary effect, lasting only part of the first growing season. Reserve trees would be a combination of the healthiest soft and hard mast producers, such as dogwood, pawpaw, eastern red bud, black gum, deciduous holly, persimmon, wild plum, American beech, black cherry, and oak and hickory species, in order to favor wildlife and improve aesthetics.

Herbicides would be used to prevent the spread of NNIS in the ecotones, and to allow native plants time to establish with minimal competition. Overall, no more than 600 acres per year within the forested project area would be treated with herbicides under this alternative, the same as proposed under Alternative 2.

Project-wide Herbicide Use

The total number of acres to be treated annually in the forested project area (maximum 600 acres) would be the same with this alternative as Alternative 2. The areas where herbicide application are focused would shift slightly, because herbicides are proposed to be used in the WSI areas (approx. 180 acres) to reduce NNIS and thin the forest next to open lands, creating a transition between the open land and the forest (a soft, "feathered" edge). Many of these WSI areas occur closer to streams than treatment areas proposed in Alternative 2. Adherence to Area Plan standards regarding riparian corridors (generally, herbicide use is limited within 30 feet on either side of streams) would minimize adverse impacts of herbicides on stream habitat and water quality. If necessary to treat NNIS or develop the WSI, formulations of the proposed herbicides approved for aquatic use (e.g., glyphosate and imazapyr) would be used within the riparian buffer zone, in adherence to Area Plan standards.

Biomass Collection

Effects of biomass collection for this alternative would be the same as Alternative 2; biomass would be primarily collected from the timber harvest areas, and these areas are not proposed to change with this alternative compared to Alternative 2.

Canebrake Restoration

Alternative 3 proposes to restore native canebrakes on up to 10 acres of open lands currently planted in wildlife plantings and old fields. Canebrake restoration would occur within existing open lands in areas draining into Demumbers Bay (Map 3). As in Alternative 2, native cane would be transplanted from other areas within the project area, particularly from areas adjacent to the open lands to receive canebrakes. The areas where cane is harvested would be allowed to regenerate cane from remaining stocks. Direct effects include replacement of existing cool

season grasses and wildlife plantings (generally milo and clover) with native cane. Some of these fields have been allowed to regenerate naturally in recent years, and are currently a mixture of native and non-native cool season grasses, forbs, and tree saplings. Prescribed fire would reduce the number of saplings and other vegetation, preparing the site for canebrake restoration. In addition, selective mowing of undesirable vegetation in the open lands (as approved in the 2007 OLREA) would reduce vegetative competition to native cane before and during restoration. Native cane rhizome culms would be planted using a tree planter and tractor or by hand. Cane would then be allowed to spread naturally through the field. Other vegetation would continue to be reduced through periodic prescribed fire.

Figure 4. Photos of areas to receive canebrake restoration, including existing canebrakes.

a. Existing canebrake along edge of open lands; example of where cane may be harvested
b. Existing canebrake growing within forest along edge of open lands.
c. Existing canebrake along edge of open land to be planted with cane in Alternative 3.
d. Open land to be planted with cane in Alternative 3.

Prescribed Burns

Both dormant season and growing season burning would be the same as with Alternative 2, with one important exception: burning would not occur in this project's Core Area. Forest conditions in this project's Core Area would continue to be the same as those described under Alternative 1 (No Action). An existing field access road would be used as a control line to exclude fire from the project's Core Area. Under this alternative the effect of prescribe burning would be the same

or only slightly reduced since the total acreage proposed for prescribe burning is 3,245 versus the 3,450 acres under Alternative 2.

Cumulative Effects

Cumulative effects for this alternative would be the same as Alternative 2.

Wildlife

Effects to wildlife were analyzed in several specialist reports, available in the project record. Below is a summary of the findings of those reports.

Proposed, Endangered, and Threatened (PET) Species

Four federally-listed threatened or endangered species were considered in a Biological Assessment (BA) for this project (Table 3.2.1), which was submitted to and evaluated by the US Fish and Wildlife Service Kentucky Field Office (KFO). The BA lists the rationale for selection of the potentially affected species; three species were selected as potentially occurring in the project area.

Table 3.2.1. Federally-listed species considered in the Biological Assessment for the Demumbers Creek project.

Common Name	Scientific Name	Potentially in Project Area	Listing
Interior least tern	*Sterna antillarum athalassos*	No	Federally endangered
Gray bat	*Myotis grisescens*	Yes (foraging habitat)	Federally endangered
Indiana bat	*Myotis sodalis*	Yes (foraging & roosting habitat)	Federally endangered
Price's potato bean	*Apios priceana*	Yes (potential habitat)	Federally threatened

Affected Environment

Surveys are conducted for each of the threatened or endangered species that may occur on LBL, with the exception of interior least tern. This bird is likely only to occur on sandbars on Kentucky Lake and Lake Barkley, with a very small potential of occurrence on lakeshores on LBL. The majority of habitat for this bird is outside of the jurisdiction of LBL.

Area-wide surveys for bats are conducted every five years, and project-specific surveys are done as needed. The most recent survey was completed in 2010. Of the two endangered bat species that may occur on LBL, only gray bats have been found. This species has not been found on LBL since 2003, but its numbers appear to be stable in the surrounding region. Gray bats have been captured in the Demumbers Creek project area in the past.

Annual surveys for Price's potato bean are conducted at the five known population locations on LBL. Additionally, before implementation of any project, surveys are conducted for potential habitat locations within the project area. Potential habitat areas within the Demumbers Creek area were surveyed in summer 2010, and no Price's potato bean plants were found. Descriptions of all surveys are included in the Biological Assessment.

A detailed description of the habitat requirements for the threatened and endangered species that may occupy LBL is given in the BA. Below is a brief summary.

Both species of endangered bats require mature forests with large trees. They both require shaded riparian corridors or other shaded open water conditions for foraging during at least part of their life cycle. Indiana bats use trees with flaking bark, such as white oaks or hickories, for roosting habitat in summer. They require large diameter trees exposed to direct sunlight during at least part of the day. Gray bats roost exclusively in caves or cave-like habitats, and are unlikely to occupy LBL during the day in any time of year. Neither species is likely to occupy LBL during the dormant season, from November to March.

Price's potato beans on LBL have generally been associated with limestone outcrops in dry or dry-mesic site conditions. They require sunlit conditions and would not thrive in shade.

In 2010, formal consultation of the effects of wildland fire use and vegetation management actions on LBL was completed with the US Fish and Wildlife Service Kentucky Field Office. The outcome was an LBL-wide Biological Opinion for Wildland Fire Use and Vegetation Management (FWS 2009-B-0084), whose Terms and Conditions limit the amount of prescribed fire and vegetation management that can occur on LBL. The Demumbers Creek project would not exceed the limits on fire or vegetation management; however, use of herbicides, collection of biomass, and road maintenance are outside the scope of that document and were evaluated separately.

Effects

Alternative 1 – No Action

Direct and Indirect Effects

A determination of effects has been made in the Demumbers Creek Biological Assessment, and is summarized here (Table 3.2.2).

Gray bat (*Myotis grisescens*)

Alternative 1 would not likely adversely affect this species, because suitable foraging habitats such as stream corridors, ponds and open water would still persist as forest types shift away from oak-hickory toward beech-maple dominated forests. Quality foraging habitat for this species would continue to be protected within the project boundaries and throughout LBL by adhesion to the Area Plan Standards for soil, water and air resources. Open lands management would continue to occur, as prescribed in an earlier decision.

Indiana bat (*Myotis sodalis*)

Alternative 1 would not likely have adverse effects to this species. This alternative would have no effects on this species directly. Habitat quality for this species would decline, as trees with flaking bark are gradually replaced by thin-barked tree species (e.g., maples, beeches, and elms) that would be less usable for roosting by Indiana bats. Prey species would also decline in the resulting closed-canopy forest.

Price's potato bean (*Apios priceana*)

Alternative 1 would not harm any individual plants if the species occurs in the project area, because no management actions would occur. However, extensive field surveys indicate that this species does not presently occur in the area. This alternative would limit already limited habitat in the project area, as forests succeed to closed-canopy structure. No new habitat would be created, and there would be little opportunity for potential new populations to establish.

Cumulative Effects

Ongoing Forest Service management actions likely to occur in the region surrounding the project area are described in the Vegetation Management section above. Approximately 25% of LBL is undergoing or proposed to undergo some sort of vegetation or recreation management within the next several years. Many species of plants and wildlife, including those discussed in detail below, may find refuge in the remaining 75% of LBL during implementation of active management. In addition, the majority of active management would not occur at once, allowing wildlife even more opportunity to escape from the project area(s) during project implementation, if needed.

Gray bat (*Myotis grisescens*) / Indiana bat (*Myotis sodalis*)

Alternative 1 is not likely to cause adverse cumulative effects to gray and Indiana bats, beyond those discussed in the OLREA. Roosting and foraging habitat would still be available inside and outside the project area for both species. The annual extent of prescribed fire and vegetative management on LBL would be limited by the Terms and Conditions of the 2010 BO, which would limit the potential for individual bats to be affected by the proposed actions in concert with other management activities on LBL.

Price's potato bean (*Apios priceana*)

Alternative 1 would have no cumulative effects to Price's potato bean. No populations of this species would be affected if no action is taken in the project area and the recovery of this species would not be enhanced.

Alternative 2

Direct and Indirect Effects

A determination of effects has been made in the Demumbers Creek Biological Assessment, and is summarized here (Table 3.2.2).

Gray bat (*Myotis grisescens*)

Alternative 2, the proposed alternative, would not likely adversely affect this species. A nearly discountable potential for adverse impacts exists during implementation of the proposed actions; however, this species is not likely to occupy the project area during implementation. There may be short-term (<1 year) losses in habitat quality. Overall, the proposed actions would improve foraging conditions for this species in the project area.

Indiana bat (*Myotis sodalis*)

Alternative 2, the proposed actions, has the potential to harm Indiana bats during implementation; however, this potential is small because Indiana bats have not yet been captured on LBL. Habitat would be improved as mature oaks and hickories are encouraged and openings in the forest canopy are created. These changes to habitat would support a larger prey base for Indiana bats and provide improved roosting habitat. There may be short-term (<1 year) losses in habitat quality, but these would be offset by habitat improvements overall.

Price's potato bean (*Apios priceana*)

Alternative 2 may cause adverse effects to this species during implementation, if the species occurs in the project area; however, extensive field surveys indicate that this species does not presently occur in the area. This alternative would improve habitat conditions, even within the first year of implementation. Risk management measures would be taken to avoid adverse effects of herbicide use and other management actions.

Cumulative Effects

Gray bat (*Myotis grisescens*) / Indiana bat (*Myotis sodalis*)

Alternative 2 is not likely to have cumulative adverse effects on gray bats. Continued low intensity burning and thinning in adjacent areas, in concert with the proposed action, would benefit this species cumulatively by further increasing and improving forage habitat. Treatment of nearby caves as smoke management areas and adherence to Area Plan standards and design criteria would minimize adverse effects from prescribed fires, herbicide treatments, and timber harvests proposed to occur in the northern end of LBL. Control of NNIS in the project area and surrounding open lands would encourage native plant species, which would increase native insect populations.

The 2010 Biological Opinion (BO) issued by the US FWS for wildland fire use and vegetation management on LBL (FWS 2009-B-0084) allows up to 27,000 acres of take of Indiana bat due to prescribed fire, and up to 2,200 acres of take due to timber removal. These acreages are limited according to the Terms and Conditions set in the BO. Alternative 2, when combined with other management actions planned or proposed on LBL, would not exceed those acreages. Continued low intensity burning and thinning in adjacent areas would improve habitat for this species cumulatively by further increasing and improving forage opportunities. New snags would be created throughout LBL by prescribed burning, and forest management would encourage white oaks and hickories with flaking bark to mature and be exposed to more sunlight, creating ideal roosting conditions for this species. The combination of these activities on Forest Service lands is expected to have beneficial cumulative effects which would outweigh any potential adverse effects to individuals that may be exposed to smoke, fire, or timber harvest operations.

No private, state, or local agency will be conducting actions at these project sites without consultation with the Forest Service and compliance with the Area Plan Standards; therefore, the Forest Service would take into account the effects of future actions by these agencies on the bats in concert with the proposed action.

Price's potato bean (*Apios priceana*)

Alternative 2, combined with other management efforts described above, would likely improve conditions for this species by creating and improving habitat. This project would increase the likelihood that this species would occur in the project area in the future. Through the adherence to Area Plan standards, this species is at low risk from direct exposure to herbicides and the operation of machinery. No known populations of this species would be affected by implementation of the proposed actions; potential effects to other populations are considered and mitigated upon decision to implement other actions on LBL.

Alternative 3 –**Preferred Alternative**

Direct and Indirect Effects

Gray bat (*Myotis grisescens*)

Alternative 3, the modification to the proposed alternative, would have similar effects as Alternative 2. Creation of ecotones around open lands would further improve habitat conditions for this species.

Indiana bat (*Myotis sodalis*)

Alternative 3 would have similar impacts to Indiana bats as Alternative 2, except that habitat surrounding open lands would be improved by the proposed creation of ecotones.

Price's potato bean (*Apios priceana*)

Alternative 3 would have the same habitat benefits and potential for adverse effects as Alternative 2. Creation of ecotones would create even larger areas of improved habitat for this species than those proposed in Alternative 2.

Cumulative Effects

Gray bat (*Myotis grisescens*) / Indiana bat (*Myotis sodalis*)

The analysis of the Biological Assessment for the Demumbers Creek project concluded that Alternative 3 would have the same cumulative effects as Alternative 2 on these species.

Price's potato bean (*Apios priceana*)

The analysis of the Biological Assessment for the Demumbers Creek project concluded that Alternative 3 would have the same cumulative effects as Alternative 2 on these species.

Table 3.2.2. Determination of Effects

Species	Alternative 1	Alternative 2	Alternative 3
Gray bat	"Not likely to adversely affect"	"Not likely to adversely affect"	"Not likely to adversely affect"
Indiana bat	"Not likely to adversely affect"	"Likely to adversely affect"	"Likely to adversely affect"
Price's potato bean	"Not likely to adversely affect"	"Not likely to adversely affect"	"Not likely to adversely affect"

Regional Forester Sensitive Species

Ten Regional Forester Sensitive species were evaluated in a Biological Evaluation (BE) for this project. Of these, eight species were deemed to be potentially affected by the project (Table 3.2.3). The summary of direct, indirect, and cumulative effects determinations made in the BE for these eight species is listed below (Table 3.2.4). No Sensitive plants were found in the project area during vegetative surveys. Neither of the Sensitive bat species have ever been captured or detected on LBL. Bald eagles have nested in the project area in the past, and are reasonably likely to nest there in the future, but are not known to nest there currently.

Table 3.2.3. Regional Forester Sensitive species considered in the Biological Evaluation for the Demumbers Creek project.

Common Name	Scientific Name	Potentially in Project Area*
Bald eagle	*Haliaeetus leucocephalus*	Yes (nested there in past)
Southeastern myotis bat	*Myotis austroriparius*	Yes (foraging habitat)
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	Yes (potential roosting habitat)
Spreading yellow false foxglove	*Aureolaria patula*	Yes
Appalachian bugbane	*Cimicifuga rubifolia*	Yes
Butternut	*Juglans cinerea*	Yes
Fraser's yellow loosestrife	*Lysimachia fraseri*	No
Ocean-blue phacelia	*Phacelia ranunculacea*	Yes
Barbed rattlesnake-root	*Prenanthes barbata*	Yes
Sweet-scented or Indian plantain	*Synosma (Hasteola) sauveolens*	No
*If the species habitat did not occur in the project area, then it was not evaluated further in the Biological Evaluation and is not discussed below.		

Effects

Alternatives 1, 2, and 3

Direct, Indirect, and Cumulative Effects

Three species are expected to benefit from the proposed actions in both Alternatives 2 and 3: spreading yellow false foxglove, barbed rattlesnake root, and butternut. These species would benefit from disturbance and early successional conditions created. Appalachian bugbane and ocean-blue phacelia, two interior forest, mesic species, would benefit most if no action were taken in the project area. Conditions suitable to these species would continue to exist in the project area even if the proposed actions were implemented, however.

Table 3.3.4 summarizes the effects analysis of the Demumbers Creek Biological Evaluation.

Table 3.2.4. Species evaluated in the Biological Evaluation and summary of determinations of direct, indirect, and cumulative effects.

Species evaluated	Alternative 1	Alternative 2	Alternative 3 Preferred Alternative
Rafinesque's big-eared bat	No effect	May impact individuals but not likely to cause a trend to federal listing or a loss of viability	May impact individuals but not likely to cause a trend to federal listing or a loss of viability
Southeastern myotis	No effect	May impact individuals but not likely to cause a trend to federal listing or a loss of viability	May impact individuals but not likely to cause a trend to federal listing or a loss of viability
Bald eagle	No effect	May impact individuals but not likely to cause a trend to federal listing or a loss of viability	May impact individuals but not likely to cause a trend to federal listing or a loss of viability
Spreading yellow false foxglove	No effect	Beneficial impact	Beneficial impact
Appalachian bugbane	Beneficial impact	May impact individuals but not likely to cause a trend to federal listing or a loss of viability	May impact individuals but not likely to cause a trend to federal listing or a loss of viability
Barbed rattlesnake root	No effect	Beneficial impact	Beneficial impact
Butternut	No effect	Beneficial impact	Beneficial impact
Ocean-blue phacelia	Beneficial impact	May impact individuals but not likely to cause a trend to federal listing or a loss of viability	May impact individuals but not likely to cause a trend to federal listing or a loss of viability

Management Indicator Species

Affected Environment

Management indicator species were selected in LBL's Area Plan as indicators of effects on specific habitats that are within the project area. Effects of the proposed actions on the following species (Table 3.2.5) were considered in a separate management indicator species evaluation. A summary of results of that evaluation is presented in the 'Effects' section below.

Table 3.2.5. Management Indicator Species at the Land Between The Lakes NRA.

Common name	Scientific name	Indicator of:
Pileated woodpecker	*Dryocopus pileaus*	Snags within forests
Eastern bluebird	*Sialia sialis*	Snags within open areas
Acadian flycatcher	*Empidonax virescens*	Mature forest within riparian areas

Table 3.2.5. Management Indicator Species at the Land Between The Lakes NRA.

Common name	Scientific name	Indicator of:
Prairie warbler	*Dendroica discolor*	Oak woodlands
Great-crested flycatcher	*Myiarchus crinitus*	Mature open oak forest
Wood thrush	*Hylocichla mustelina*	Mesophytic and riparian forests with complex canopy structure and mature forest interior
Yellow-breasted chat	*Icteria virens*	All forest type regeneration
Eastern bluebird	*Sialia sialis*	Demand non-game species (wildlife viewing)
Eastern wild turkey	*Meleagris gallopavo*	Demand game species (hunting)
White-tailed deer	*Odocoileus virginianus*	Demand game species (hunting)

The management indicator species at LBL represent a varied group in terms of existing population conditions. Some species are increasing and others are declining throughout their range; regional data about bird population trends are summarized in Table 3.2.6. Two of the declining species (Acadian flycatcher and wood thrush) require mature forest interior habitats, while the other two (prairie warbler and yellow-breasted chat) use more early successional habitats on LBL; therefore, no single management action would provide improved habitat conditions for all MIS species considered. In order to improve populations of a broader diversity of wildlife, it is more appropriate to manage for a variety of habitat conditions.

Table 3.2.6. Population trends for birds in the southeast region, reported by the North American Breeding Bird Survey, 1966-2003.

Species	Trend	Percent change/year
Pileated woodpecker	Increasing	>1.5
Eastern bluebird	Increasing	>1.5
Acadian flycatcher	Decreasing	-1.5 to -0.25
Prairie warbler	Decreasing	< -1.5
Great-crested flycatcher	Increasing	>0.25 to 1.5
Wood thrush	Decreasing	-1.5 to -0.25
Yellow-breasted chat	Decreasing	< -1.5
Eastern wild turkey	Increasing	>1.5

Effects

Alternatives 1, 2, and 3

Direct and Indirect Effects

Since the management indicator species were selected to represent a variety of habitats that may occur on LBL, effects of the no action and proposed action alternatives on each species will vary from having no effect, negative effects, and beneficial effects. A summary is presented in Table 3.2.7 below.

Table 3.2.7. Summary of direct and indirect effects on each management indicator species evaluated.

	Alternative 1 – No Action	**Alternative 2**	**Alternative 3 – Preferred Alternative**
Pileated woodpecker	This species would benefit from limited management in the project area. Snags and senescing trees would persist and likely increase, increasing the habitat quality for this species. After many years, replacement of oaks and hickories by shade-tolerant species would result in a decline of habitat quality for this species.	Habitat quality would decline in timber treatment areas and improve in areas treated by prescribed fire only. Individuals may be adversely affected during nesting season.	Effects would be similar to Alternative 2. Habitat quality would decline in an additional 180 acres where WSI treatments occur.
Eastern bluebird	Existing habitat for this species is minimal in the project area, found only near the edges of existing open lands; this condition would remain unchanged by no action.	Suitable habitat would increase by creation of forest openings, open forest conditions, and regenerating forest adjacent to mature forest. Individuals may be adversely affected during nesting season.	This alternative would benefit this species even more than Alternative 2 by opening the forest canopy adjacent to open lands, providing improved cover conditions adjacent to food sources.
Acadian flycatcher	This species requires mature, closed canopy, riparian forests. There is a small area of habitat within the project area. No action would allow habitat to improve within this small area, but would not create additional acreage of habitat. Cumulatively, Core Areas across LBL would continue to provide habitat for this species where they intersect with riparian areas.	No direct or indirect impact is likely, as minimal management would occur in the portions of the riparian corridor likely to be used by this and associated species. Cumulative effects would be similar to Alternative 1.	The WSI treatments would cause a decline in habitat suitability in the riparian area, by decreasing the amount of forest interior in riparian corridors available to this and associated species. Cumulatively, this action is relatively small compared to the area of suitable habitat protected within Core Areas on LBL.
Prairie warbler	Habitat quality for this species is declining in the project area, and would continue to decline if no management occurs. Shrubby areas within or adjacent to open lands would be diminished.	Creation of oak woodlands would improve habitat conditions for this species. Individuals may be adversely affected during nesting season during years when management actions are occurring.	Nesting habitat along the edges of open lands would be improved for this and associated species, resulting in an overall improvement of conditions.
Great-crested flycatcher	This species depends on open oak forests. No management of the project area would lead to habitat quality decline as forests continue to have closed canopy. No direct adverse effects are expected. Cumulatively, total habitat area for this species would continue to be low on LBL, as most forested areas are closed-canopy.	Timber thinning treatments and prescribed fire would improve habitat quality for this species by opening up the canopy and and the understory. Individuals may be adversely affected by management actions that occur during nesting season.	Dual effects are expected on this species. Opening the forest canopy would improve habitat quality in a greater area than Alternative 2; however, these actions may leave this species more vulnerable to nest parasitism and predation adjacent to open lands.

Table 3.2.7. Summary of direct and indirect effects on each management indicator species evaluated.

	Alternative 1 – No Action	**Alternative 2**	**Alternative 3 – Preferred Alternative**
Wood thrush	Populations of this species are unlikely to change. A small amount of suitable habitat exists in the project area, and habitat would not be augmented or degraded.	In some areas, habitat would be degraded for this species (with open canopy conditions); in other areas, habitat would be improved (by augmenting the shrub and understory layers), resulting in no net effect. Individuals may be harmed by management actions that occur during nesting season.	The WSI treatments would adversely affect small areas of habitat for this species by changing late-successional forested areas to mid-successional forest in riparian zones, thereby reducing habitat. Individuals may be harmed by management actions that occur during nesting season.
Yellow-breasted chat	Suitable habitat does not occur in the project area, except for marginal areas at the edge of open lands, and would not be created by this alternative.	Regeneration harvest areas and open land edges thinned by prescribed fires would offer suitable habitat conditions for this and associated species. Individuals may be harmed by management actions that occur during nesting season.	Suitable habitat area would increase. This and associated species would benefit from thinned forests adjacent to open lands. Individuals may be harmed by management actions that occur during nesting season.
Eastern wild turkey	Suitable habitat would be lost over time, as existing patches of shrubby undergrowth and complex canopy structure are lost as a result of increased canopy closure. In addition, an important food source (hard mast in the form of acorns and hickory nuts) would decline as maples, elms, and other shade-tolerant trees succeed existing oaks and hickories. No direct adverse effects are expected.	There would be a benefit to this and associated species as complex canopy structure and open forest, woodlands, and forest openings are created. Improved oak and hickory vigor, leading to higher mast production, would also benefit this species. Individuals may be harmed by management actions that occur during nesting season.	The juxtaposition of open lands with more complex forest conditions adjacent to them would provide even more benefits than Alternative 2. Individuals may still be harmed by management actions that occur during nesting season.
White-tailed deer	Habitat area would decrease over time as mature, closed canopy forests develop. In addition, an important food source (hard mast in the form of acorns and hickory nuts) would be lost as maples, elms, and other shade-tolerant trees succeed existing oaks and hickories. No direct adverse effects are expected.	Minimal direct impacts are expected to affect deer. Indirectly, deer would benefit because habitat would improve as tree vigor improves, leading to increased mast production. Herbaceous plant growth stimulated by increased light to the forest floor would also benefit this and associated species.	Habitat adjacent to open lands would be improved; this presents an increased indirect benefit over Alternative 2, as food and cover habitat would be created closer in proximity. All other benefits of Alternative 2 would be realized.

Cumulative Effects

In determining cumulative effects, actions considered included management prescriptions in the Area Plan FEIS.

Cumulatively, the proposed actions would **benefit** six of the nine species evaluated:

- eastern bluebirds
- prairie warblers
- great-crested flycatchers
- yellow-breasted chats
- eastern wild turkeys
- white-tailed deer

Prairie warblers and yellow-breasted chats are two species that are declining in this region, so these species would benefit most from the proposed management in the project area.

The proposed actions would have a **neutral** effect (no benefits and no adverse effects) on Acadian flycatchers and wood thrushes. These species currently have only small areas of potential habitat within the project area.

Finally, habitat for pileated woodpeckers would be most likely to receive an adverse effect as a result of the proposed actions, when combined with other actions at LBL that may create woodland and open canopy forests. Woodland and open canopy forest structures are prescribed in the Area Plan for 66,400 acres across LBL, or about half of the 123,000 acres prescribed to be mature forests that would provide suitable habitat for pileated woodpeckers. Since these woodpeckers are increasing regionally, the proposed actions combined with other actions on LBL do not present a major concern to the viability of this or associated species.

Species of Viability Concern

Species of viability concern considered in this document are: amphibians, scarlet king snake, pygmy rattlesnake, and crème false wild indigo. Individual species were selected from those considered in the Area Plan FEIS as locally rare; they were selected because they have been documented to occur within or near the project area. Monarch butterflies are included in this section not because of their rarity, but because their populations have declined and it has become more important to consider the potential to encourage this species through vegetation management actions. Amphibians were selected for analysis because of concerns about the effects of herbicides and biomass collection on their populations.

Affected Environment

Amphibians

A pesticide risk assessment for impacts to amphibians was conducted on LBL in 2007 for two of the most commonly used pesticides: glyphosate and triclopyr. Its results are summarized here; a copy of the report is in the project record. Amphibians are vulnerable to herbicides applied to their habitat because of the permeability of their skin, and because they have several different life stages, each of which may be impacted differently by herbicides. Several different studies on the effects of herbicides on amphibians indicate that amphibians may be most vulnerable during egg or early developmental stages (ENSR International 2005); none of these studies evaluated the chemicals proposed for this project. Generally, fish are more sensitive to herbicides than amphibians, so any herbicide that has little to no toxicity to fish will have even less toxicity to amphibians. Several studies are cited (Tatum 2004).

Herbicides containing glyphosate and triclopyr have been found to be toxic to amphibian larvae. Glyphosate-containing herbicides are generally most toxic in formulations not approved for

aquatic use; the surfactant in these formulations is actually the most toxic ingredient to aquatic organisms, rather than glyphosate itself. When applied alone, glyphosate is relatively nontoxic to amphibians and other aquatic life.

No studies have been conducted on the effects of imazapyr on amphibians. Imazapyr has a very low potential to have adverse effects on aquatic animals under normal use, and is likely to only impact the most sensitive species of fish under the worst case scenario of an accidental spill into a body of water. It does not bioaccumulate in animal tissues, including fish (Durkin and Follansbee 2003).

Coarse woody debris is an important habitat feature for many species of amphibians. It is used as protective cover, and it harbors insects that amphibians eat. It provides critical aquatic habitat for breeding, providing protective stream structure and ponding as well as increased biomass of aquatic invertebrates (Evans 2011). The levels of woody debris on the forest floor in the project area are currently much higher than most places on LBL, due to recent storm damage to the overstory. These levels will continue to rise in the short term (over the next 3-5 years) especially in riparian areas, as broken and hanging limbs fall from treetops during high wind events.

Scarlet king snake (*Lampropeltis triangulum elapsoides*)

The scarlet king snake is associated with Upland Forest and Downed Wood communities in the Area Plan FEIS. It is a red, black, and white striped snake which ranges from Virginia to western Kentucky and Tennessee, and south to South Carolina and Mississippi. It is considered possibly extirpated from all Kentucky counties except Trigg and Lyon, and there are no current natural history records for it in Tennessee, indicating that it may be extirpated from there as well (NatureServe 2011). Surveys for reptiles are generally not conducted on LBL, and it is not known if this species occurs in the project area; however, recent reports by the Kentucky State Nature Preserves Commission indicate that it has been documented near the project area. The primary threats to this species are clearcutting, herbicides, and direct killing by people who mistake it for the venomous coral snake. It prefers pine woods and wet meadows (NatureServe 2011). It has the potential to occur in the project area in the pine plantations and open lands. Despite its bright coloration, it is rarely seen because of its secretive behavior; therefore, little is known about this species (NatureServe 2011).

Pygmy rattlesnake (*Sistrurus miliarius*)

Pygmy rattlesnake is associated with Riparian Forest Opening, Wet Grassland, Lakeshore, and Pond and Marsh communities in the Area Plan FEIS. This small snake (up to 20” long) is grey-brown with black blotches and a brown stripe along the back. It occurs from Florida to Kentucky, and west to central Oklahoma. LBL is at the northern edge of its range. It is considered imperiled in Kentucky and Tennessee, where it likely was never common due to limited habitat area (NatureServe 2011). It is not known if this species occurs in the project area, but habitat does exist. The primary threats to pygmy rattlesnakes are not well known, but habitat loss and degradation are believed to have a role in this species’ decline. This species uses wet savannas and pastures, primarily keeping to bottomlands and within the vicinity of lakes and marshes. It is an opportunistic eater, feeding on small mammals, other reptiles, nestlings, and various terrestrial invertebrates (NatureServe 2011). In the project area, it may inhabit many of the open lands and their edges; however, crop fields would not likely support this species.

Crème false wild indigo (*Baptisia bracteata*)

Crème false wild indigo is associated with Xeric and Dry Open Forest and Xeric and Dry Grassland and Woodland communities in the Area Plan FEIS. This is a herbaceous species that occurs from Minnesota to Texas, and from Kentucky west to Kansas, with a few occurrences east of Kentucky). Its global status is G4 (Apparently Secure) (NatureServe 2011), but in Kentucky and Tennessee it is considered a species of special concern. It is known from Lyon and Trigg Counties in Kentucky, but is thought to be extirpated from Stewart County, Tennessee (USDA Natural Resources Conservation Service 2011). This plant was found commonly in the Demumbers Creek project area during 2010 vegetation surveys.

Baptisia bracteata is a cool-season legume in the pea family native to the tallgrass prairie, flowering from April into June. It is not adapted to drought stress. It is known to grow on annually-burned sites (Fay and Knapp 1996). This species performs well on moderately disturbed sites, but cannot survive where soil erosion occurs (Smith 1940).

Monarch butterfly (*Danaeus plexippus*)

Monarchs are migrating butterflies that migrate from as far as Canada to Mexico. Their migration represents a unique ecological phenomenon; in order to preserve this phenomenon, there is a need to protect and enhance the migration routes of this species. Monarchs migrate up to 2,175 miles south in September and north in March. Their migration is likely stimulated by temperatures and day length (Malcolm 1987).

Monarch butterflies feed at nectar sources in late summer and fall in order to store high lipid concentrations for their fall migration. They store the majority of the needed lipids in Texas and northern Mexico, but also accumulate a large amount during the course of their migration through the central United States. They are not species-specific in their nectar selection, but rather select from dozens of flower types in any open habitat (Brower, Fink et al. 2006). Monarchs have been known to use over 30 species of milkweed for reproduction, but are most commonly known to use common milkweed (*Asclepias syriaca*). In Kentucky, honeyvine milkweed (*Cynanchum laeve*) is more common, and may be equally preferred by monarchs (Yeargan and Allard 2005).

There was no major variation in inter-annual monarch butterfly migration numbers from 1997 to 2004 in two eastern US census areas; however, 2004 had the lowest number of butterflies counted during that time period (Gibbs, Walton et al. 2006). Since then, several phenomena (both natural and human-caused) have resulted in major declines in monarch populations (Brower, Taylor et al. 2011). Counts of monarch butterflies have been conducted at LBL since 2002. The number counted fluctuates greatly each year; there have been as few as 4 and as many as 209 counted, with no clear downward or upward trend (B. Gilley, naturalist, Land Between The Lakes Association, pers. comm.).

Management actions that maintain or encourage open space would benefit monarchs. This species can be negatively affected by the use of more nonselective herbicides, such as glyphosate, which kill many of the nectar-producing plants they need (Dr. L. Brower, Sweet Briar College, personal communication); however, in cases where non-native invasive species (NNIS) are outcompeting native wildflowers, selective use of herbicides can benefit this species

by minimizing the presence of NNIS so native plants can thrive (C. Taylor, University of Kansas, personal communication).

Effects – Species of Viability Concern

Alternative 1 – No Action

Direct, Indirect, and Cumulative Effects

Amphibians – There would be minimal adverse effects to amphibians under the no action alternative. Open lands in the project area would continue to be managed, with effects as described in the OLREA. Herbicides would continue to be used in open lands. This does not present a large risk to amphibians, because open lands make up a very small portion of the project area (6%), are generally less suitable habitats for the majority of amphibian species, and riparian corridors are provided.

There is currently a much larger than average amount of woody debris on the forest floor, which provides excellent habitat conditions for amphibians. The amount of woody debris is so high that movement through the forest is impeded for humans and other wildlife (LBL field staff, personal communication), offering protection from predation for amphibians and reptiles.

Scarlet king snake (*Lampropeltis triangulum elapsoides*) – No individuals would be harmed under this alternative. This species may already occupy pine stands in the project area; however, most of these are on upland areas less suitable for this species. Most open lands in riparian zones are generally not suitable habitat for this species because they are currently crop fields and do not provide the habitat structure needed for cover, except on the margins. Overall, this alternative would fail to create habitat conditions for this species. Open lands would continue to be maintained throughout LBL, and many of the non-crop open lands which occur in riparian areas would continue to provide habitat for this species.

Pygmy rattlesnake (*Sistrurus miliarius*) – Individuals would not likely be harmed under this alternative. Open lands in the project area are mostly crop fields and would not provide suitable cover for this species.

Crème false wild indigo (*Baptisia bracteata*) – Although this species is common in the project area, its populations would begin to dwindle as the forest canopy closes and more mesic species dominate. It would continue to survive in open lands not managed for crops.

Monarch butterfly (*Danaeus plexippus*) – This and other pollinators would continue to find habitat along roadsides and in open lands, but opportunities for habitat creation in the forest would be lost if this alternative is carried out. Fewer flowering species and no milkweeds grow in closed canopy forests, compared to open forests and woodlands.

Alternatives 2 and 3 – Proposed Action and Modifications

Direct, Indirect, and Cumulative Effects

Amphibians – Individuals have the potential to be harmed during implementation of prescribed fire and timber harvest. In many cases, amphibians would occur in cool damp places that are less affected by prescribed fire. Additionally, timber harvest does not occur in stream management zones, which are the areas most likely to be inhabited by these species. Therefore, direct adverse effects would be limited. Proposed herbicide use is not expected to harm these species, because the proposed herbicides would not be applied to riparian areas or water, and

they are not known to be toxic to amphibians. Indirectly, reduction of non-native invasive species, and the subsequent enhanced diversity of native flora, would support larger numbers of native insects which would be used as prey for these species. The proposed actions would remove some of the existing woody debris from the forest floor. However, because of the high levels of woody debris already present, there would be sufficient structural cover for a variety of wildlife species, including amphibians, reptiles, insects, and small mammals, even after biomass removal and especially in the riparian areas. Removal of vegetation in the overstory and midstory would create higher moisture conditions on the forest floor (see Soils and Water analysis in this EA), which, when combined with high levels of woody debris, would support larger populations of amphibians compared with existing conditions.

Scarlet King Snake (*Lampropeltis triangulum elapsoides*) – Of the proposed actions, the primary activities that have the potential to affect this species in the project area are cutting timber in pine stands, use of herbicides, and continued maintenance of open lands. Scarlet king snakes are not likely to occur in pines in the project area because most pines are on upland sites. Pine stands would be planted in shortleaf pine after harvest, and would then continue to provide marginal habitat for this species once the shortleaf pines mature. The herbicides proposed for use have low toxicity to small mammals and insects, prey species for this and other snakes; however, studies have not assessed direct effects of the proposed herbicides on reptiles, including snakes (Durkin 2003; Durkin 2003; Durkin and Follansbee 2003). Overall, the proposed actions (including the modified proposed actions) may impact individuals of this species during implementation, but are unlikely to have long term adverse effects to populations (USDA Forest Service 2007). Most other proposed and continued management on LBL would have no effects on this species, with the exception of continued maintenance of open lands and work proposed in the Devil's Backbone project area. In the Devil's Backbone, at the far southern end of LBL, shortleaf pine regeneration is proposed, which would benefit this species. Open lands maintenance would benefit this species by continuing to maintain open lands near mesic and riparian areas.

Pygmy rattlesnake (*Sistrurus miliarius*) – Effects of herbicide use and continued maintenance of open lands would be similar to those on scarlet king snake discussed above. This species would benefit from maintaining open lands and WSI thinning around open lands; the WSI treatments would increase habitat area for this species, particularly where it overlaps with riparian or mesic zones. Proposed management actions on upland areas would have no impact on this species because it would not occupy those areas.

Crème false wild indigo (*Baptisia bracteata*) – Dormant season management is not likely to adversely affect *B. bracteata*, because it is not actively growing at that time. This species is most likely to be adversely affected by prescribed fires, timber harvests, and use of herbicides that occur from April to June, when it is actively growing and reproducing. Herbicides and trampling from heavy equipment may kill individual plants. The proposed actions, however, would create suitable habitat conditions for this species; habitat is currently limited in the project area and throughout LBL. Overall, adverse impacts would be temporary and not likely to have a large effect on this relatively common species, whereas the lasting impacts of improved habitat conditions would enable this species to enlarge populations throughout the project area. Other management actions on LBL are focused on opening the forest canopy and maintaining open lands, as well; these are all likely to benefit this species.

Monarch butterfly (*Danaeus plexippus*) – The proposed actions would open the forest canopy in up to 1,825 acres, which would benefit monarch butterflies by encouraging the growth of wildflowers. Prescribed fire would maintain 1,500 acres in open woodland and open canopy forests, which would sustain quality habitat conditions. Continued maintenance of open lands, woodlands, and open forest conditions in the project area and throughout LBL would be the best management for this species.

Several management decisions have been made on LBL which support monarch butterflies and other pollinating insects. Seed mixes planted in open lands include wildflowers that produce nectar used by butterflies, such as clover (several species) and partridge pea (E. Raikes, LBL biologist, personal communication). Mowing along roadsides is delayed until October in order to leave time for monarchs to use pollinating plants during their migration. Additionally, many open lands are being converted from old fields with domestic grasses and weeds to native grass and forb plantings, which include wildflowers used by pollinators.

Soils

Affected Environment

The scope of analysis for soil resources will include: soil loss, soil compaction, soil fertility, and herbicide impacts within the assessment area. The assessment area is limited to the area identified under the proposed actions. Maintaining soil productivity is important to assure quality wildlife habitat and forest productivity.

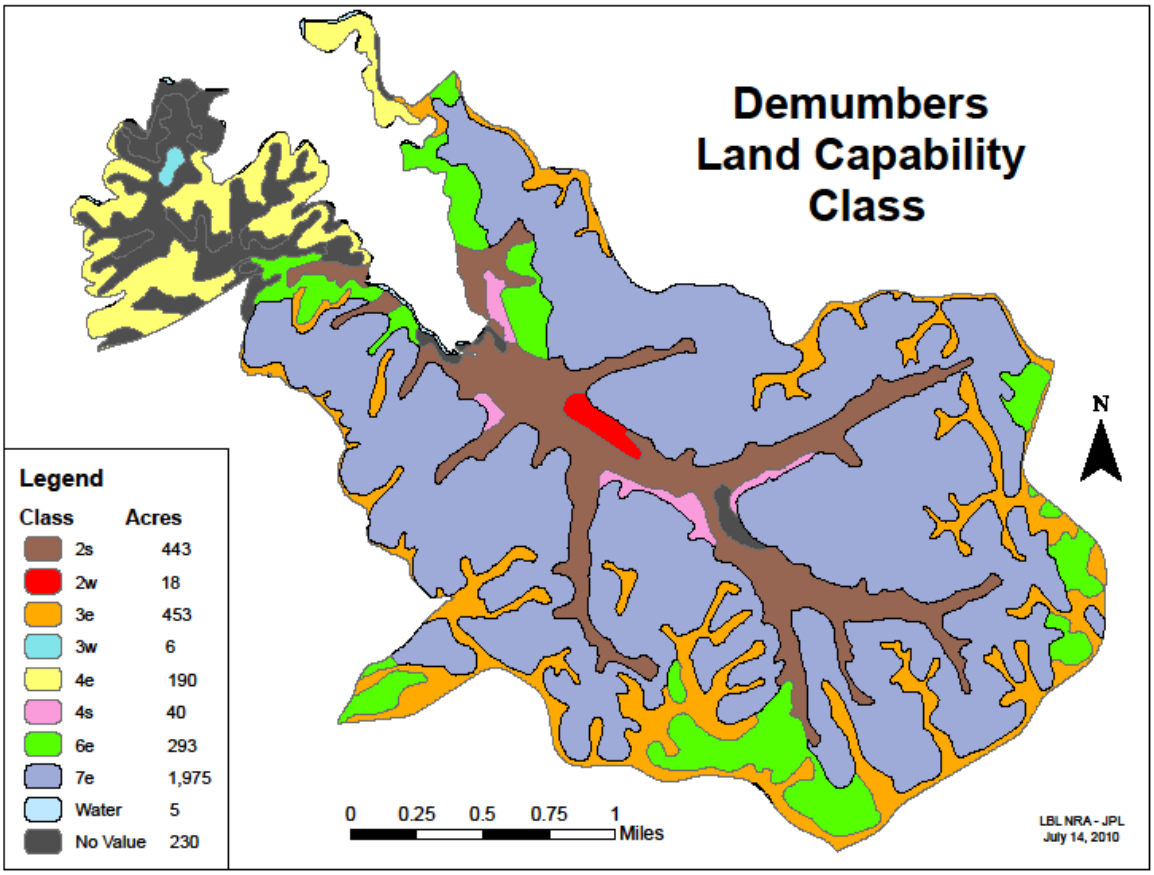
The Demumbers Creek project area has a moderately dissected topography with narrow ridge crests, steep slopes, and narrow bottomlands. Due to the dissected nature of the topography, erosion over a long period of time has had a major impact on processes of soil formation on ridge tops and upland slopes.

The most common upland soil types in the project area are: Brandon, Hammack, Lax, and Nicholson; in the lowlands along drainages, Clifty, Nolin, Saffell, and Newark are most common. Generally, most soils derived from underlying parent material that is typically low in nutrients. Upland soils are mostly forested. Surface erosion is the dominant erosive process. No evidence of wind erosion was found or noted. Surface erosion occurs on native surfaced forest roads, particularly rutted roadbeds. Unarmored stream crossings on lower reaches of Demumbers Creek and unnamed tributaries are another source of surface erosion. Demumbers Creek and unnamed tributary channels have steep gradients in the headwaters, but flatten into low gradient channels within broader valley floors. Bays exist where streams flow into Lake Barkley. Inundation and exposure of mudflats of these bays by Lake Barkley is dependent on lake level regulation by the US Army Corps of Engineers (USACE). The lower reach of Demumbers Creek watershed was manipulated during the first part of the twentieth century to assist past farming practices. This included draining or irrigating fields as necessary to support crop production, but did not involve channelization.

For estimating average (background) soil loss in the project area, soils were grouped into like Land Capability Classes (LCC) and subclasses (USDA-SCS 1961). The LCCs are designated by numbers 1 through 8 which indicate progressively greater limitations and narrower choices for farmland use before resource damage may occur. In the project area, LCCs and subclasses are listed below and shown in Map 5.

- 2s (soils with moderate limitations that restrict the choice of plants or that require moderate conservation practices, and that are shallow, stony, or droughty)
- 2w (same as 2s, except soils are prone to wetness instead of drought)
- 3e (soils prone to erosion and with severe limitations that restrict the choice of plants or that require special conservation practices or both)
- 3w (same as 3e, except soils are restricted by wetness instead of erosion),
- 4e (soils prone to erosion and with very severe limitations that restrict the choice of plants or that require very careful management or both)
- 4s (same as 4e, except soils are shallow, stony, or droughty)
- 6e (soils prone to erosion and with severe limitations that make them generally unsuitable for cropland and that restrict their use mainly to pasture, rangeland, forestland, or permanent wildlife habitat)
- 7e (soils prone to erosion and with very severe limitations that make them unsuitable for cropland and that restrict their use mainly to grazing, forestland, or permanent wildlife habitat)

Map 5. Land capability classes (LCC) and areas of each LCC in the Demumbers Creek area.



The most prevalent LCC is 7e, meaning that soils in the project area are most suited to wildlife habitat, grazing, or forest. In the Demumbers Creek area, average background soil losses have been calculated in forests and open lands, based on the LCC and associated subclass. This is the soil loss expected with no additional vegetation management. In forests, background soil losses

range from 0.02 to 0.38 tons/acre/year, with more soil loss expected in LCC 7e areas (which make up the majority of the project area). In open lands, background soil losses range from 0.17 to 0.52 tons/acre/year, with the majority of background soil lost on agricultural lands.

Threats to Soil Resources

Demumbers Creek is currently suffering from continually shifting water levels and deposition of soil at the lower reaches near the lake. Fluctuating lake levels re-deposit the load and reposition the channels on an annual basis. The lowest reaches of perennial watersheds on LBL are braided and unstable (Area Plan FEIS) (USDA Forest Service 2004). Roads within floodplains and/or riparian areas are influencing channel morphology, limiting channel processes in the project area. The road density in the project area can lead to increased erosion and sedimentation.

A Transportation Analysis (USDA Forest Service 2011)has been developed for the Demumbers Creek project. Roads 304 and 303 (total 2.25 miles) have deep rutting that has resulted because of a lack of gravel in many areas (Figure 2). Road 304 has become so rutted it is causing law enforcement and safety concerns because of motorists being stranded due to the vehicle becoming high centered (the tires will not reach the bottom of ruts). Road 303 does have some areas in good condition; however, other sections have become so eroded motorists have gone outside the legal road and created bypasses. Because of their condition, these roads have limited access to users. Erosion is also caused when the roads are heavily traveled during wet conditions, such as winter or fall seasons. There are approximately 34 miles of unauthorized roads in the project area, and approximately 4 miles of these roads access cemetery and open lands as described in the Demumbers Creek Project Transportation Analysis (USDA Forest Service 2011).

Soil compaction is a concern on roads in the project area. Compaction increases soil bulk density and decreases porosity as a result of the application of forces such as weight and vibration. All soils can compact, some more so than others. Compaction can detrimentally impact both soil productivity and watershed condition by causing increased overland flow during storm events and reduced plant growth due to a combination of factors including reduced amounts of water entering the soil and its reduced availability to plant growth, a restricted root zone, and reduced soil aeration.

Use of herbicides in the project area may have impacts to soils. Three herbicides are proposed: glyphosate, triclopyr, and imazapyr. Glyphosate adsorbs strongly to soils, and lateral or vertical movement within soils is rare (US Environmental Protection Agency 1993; [Extoxnet] Extension Toxicology Network 1994; USDA Forest Service 1997). Because of its strong soil adsorption, it becomes unavailable to plants and root uptake does not occur (USDA Forest Service 1997). Triclopyr does not adsorb strongly to mineral soils, but does adhere to organic material, so movement is generally limited to the top 6” of soil. Imazapyr has the most potential to move, because it does not adsorb to soil or organic material (National Institute of Environmental Health Services 2002; Tatum 2004). It has been found to travel in soils up to 12-20 inches below the surface, but field studies show that actual soil movement is rare (Michael 2004; Tatum 2004). Measures proposed to reduce potential impacts to soil resources are listed in Appendix 1.

Shortleaf pine (*Pinus echinata*) would be planted in the areas where mature planted pines are harvested. Soils in the shortleaf pine regeneration areas are generally prone to erosion and have

moderate or severe limitations in the plants that would occur on them (Maps 2 and 5). Additionally, the planting of native cane (*Arundinaria gigantea*) to create canebrake restoration areas is proposed. The primary soil types of the canebrake restoration areas are Clifty gravelly silt loam, Land Capability Class 2s, and Newark and Nolin silt loam, Land Capability Class 2w (USDA Soil Conservation Service 1981).

Effects

Effects to soil resources are combined with effects to water, and are considered after the water section of this document.

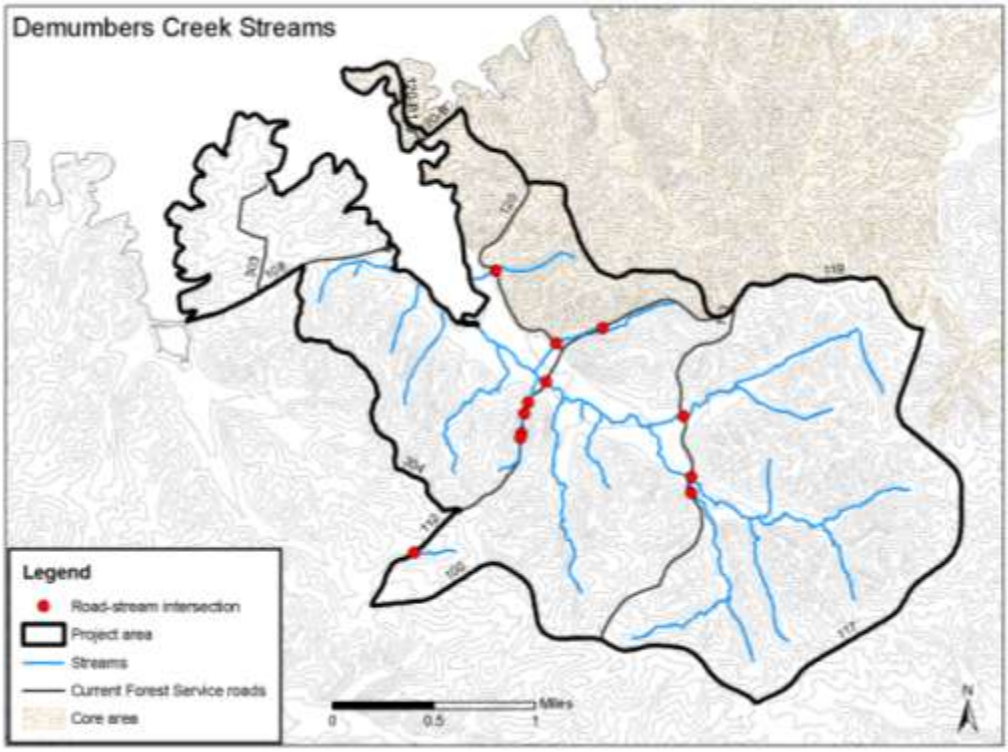
Water

Affected Environment

The Demumbers Creek watershed is a subset of the Lower Cumberland River Watershed, a 6th Level, 12 digit Hydrologic Unit Code (HUC) watershed. Impacts and effects of the proposed action and alternatives are addressed as they relate to water quantity, channel morphology, and water quality (cumulative watershed condition). In assessing cumulative watershed condition, the Area Plan EIS determined the Demumbers Creek watershed to be ranked Excellent, based on past disturbance modeling. This means the probability for adverse effects to aquatic species is low if forest activities maintain or improve aquatic conditions.

The Demumbers Creek project area includes Demumbers Creek and its unnamed tributaries. There are approximately 14.5 miles of streams within the project area (Map 6). The landscape is densely dissected with small ephemeral and intermittent tributaries to Demumbers Creek (Map 6). Little water storage exists within the area (there are few ponds or lakes functioning as catchments/releases). Headwater channel flows are ephemeral, flowing only in response to precipitation. Most reaches of the main channels are intermittent, flowing less than nine months of the year. Residual pools occur in the middle reaches but are not connected by channel flows except following storm events; therefore, aquatic habitat is fragmented. Lower reaches of channels are perennial, flowing most months of the year and sustaining aquatic life. The bottom reaches of the Demumbers Creek is now Demumbers Bay, since inundation by Lake Barkley and high lake levels back up into the lower stream reaches. Historically, it is assumed flows in upper reaches of all streams were ephemeral, similar to today, while middle reaches were sustained by a connected water table with longer duration of flows.

Map 6. Map of streams within the project area.



Channels in the project area are steep in the headwaters, but flatten into low gradients within broad valleys near their terminus. Active transportation of sediments and bedload occurs in the headwaters. These types of incised stream channels, classified under Rosgen classification as "A," "F," and "G" types (Figure 5) (Rosgen 1994), function as sediment transport reaches and are actively down-cutting. An effect of this down-cutting is dewatering of riparian zone vegetation. Middle reaches are recovering toward a more dynamic equilibrium: new type "C" channels are forming in short segments within entrenched gullied sections..

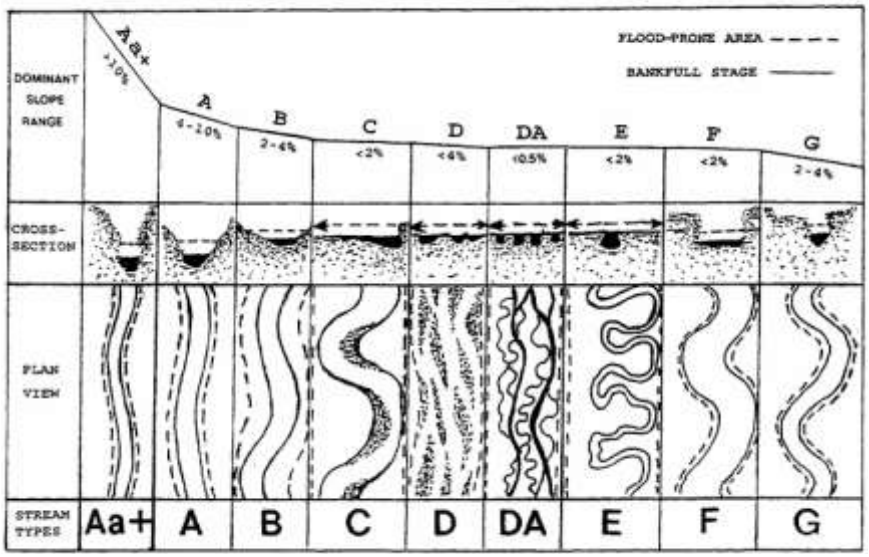


Figure 5. Stream type classifications, from Rosgen 1994.

Demumbers Creek cross sections indicate substrates are small, ranging in the medium to large gravel sizes with fine particles embedded. The lowest reaches of the watershed are braided and unstable both laterally and vertically.

The 2011 Demumbers Creek Project Transportation Analysis found in the project record also considered the Demumbers Creek project area to have a high road density based on road density per watershed area (USDA Forest Service 2011). This indicates that there may be increased potential for siltation from roads into streams in the watershed. The analysis found, however, that the project area has a low risk level from sediment and cumulative effects, this in part, is due to the establishment of permanent vegetation in the riparian corridors. Many more unauthorized roads were accounted for under the 2011 Demumbers Creek Transportation Analysis than appear on project area maps, including historic and unauthorized roads (e.g., unused TVA roads), most of which are un-trafficable due to natural re-vegetation. Unauthorized roads are those not maintained by the Forest Service, and are often user-made. Approximately 4 miles of unauthorized roads are used for open lands access or cemetery access.

Many system and unauthorized roads are located along stream channels or within their valleys. Roads intersect streams at 12 points within the project area (Map 6), extending the stream network during major storm events (roads become streams). Culverts in the project area are undersized; consequently, they are at risk for washout and breaching during major runoff events. Other culverts increase runoff velocity and scour at the outlets, exacerbating channel down-cutting. Photographs of the culverts, taken in 2011, can be found in the project record.

Herbicides proposed for use within the watershed pose limited risk to water quality. Area Plan standards limit ground applications of herbicides near aquatic resources; only herbicides approved for aquatic use are to be ground applied within 30 linear feet (across ground surface) of perennial or intermittent streams or the lake. Measures proposed to reduce the impact of herbicides to water quality are explained in Appendix 1.

As previously discussed, both glyphosate and triclopyr have very limited potential to travel through the soil into the water table. Imazapyr is the most mobile of the three proposed herbicides, but is unlikely to move across 30 feet to a creek. Glyphosate is not readily broken down in water, but is practically nontoxic to aquatic animals and invertebrates (US Environmental Protection Agency 1993). Surfactants in the most common formulations of glyphosate may be more toxic to aquatic life ([Extoxnet] Extension Toxicology Network 1994; USDA Forest Service 1997), and are left out of aquatic formulations ([Extoxnet] Extension Toxicology Network 1994). No formulation of any herbicide would be used within 30 feet of a stream unless it was approved for aquatic use. No herbicide would be applied directly to water. Triclopyr breaks down readily in water (half life is generally less than one day); this limits its toxicity. Also, the commercially-available formulations of triclopyr may be *less* toxic in water than the chemical alone (Ganapathy 1997). Imazapyr has the most potential of the proposed herbicides to move through the soil into water; however, it degrades rapidly in sunlit surface waters and is practically nontoxic to aquatic organisms (National Institute of Environmental Health Services 2002; Tatum 2004).

Other past human-related disturbances noted within the project area include agricultural practices, homestead and community establishments, timber harvesting, and iron furnace industry extraction of timber, iron and other minerals. These disturbances exposed residual soils, increased sediment transport to streams and surface runoff, relocated and channelized original channels, and reduced recruitment of large woody debris into the stream network.

Effects – Soils and Water

Alternative 1 – No Action

If none of the proposed actions are taken, existing sedimentation due to down-cutting of the Demumbers Creek channel would continue to occur. The stream flows of the Demumbers Creek Project area would continue to integrate effects from cultivation of row crops and hay. This alternative would result in no improvement of the watershed, and therefore continued degradation of water quality in the project area.

Direct and Indirect Effects

The Rosgen classification of stream channels in the project area would not change. Active down-cutting of the channels due to Lake Barkley pool levels would continue to occur. Water available for riparian zone vegetation would continue to be lower than historic levels, and lower reaches of watersheds would continue to be laterally and vertically unstable and braided. Undersized culverts would continue to lead to increased risk of channel downcutting, as shown in photographs in the project record, and limit aquatic organism passage.

No road reconstruction would increase long term erosion, sedimentation, and stream habitat damage due to decline of the gravel roads and poor road drainage. The increase in erosion would lead to more culvert failures, further degrading water quality. Excessive rutting of the road surfaces would continue to occur.

A primary source of changes to soil and water quality in the project area is active management of open lands, many of which occur adjacent to the riparian corridors of the project area. Open lands management prescribed in the Revised Environmental Assessment for the Continued Maintenance of Open Lands (OLREA) includes conservation tilling, residue management, and

crop rotation. These practices would continue to provide improvements to water quality within the project area, compared to open lands practices that occurred prior to Forest Service management. Lime, fertilizer, and pesticides approved in the OLREA will continue to affect water quality as described in that document. The OLREA indicated that no direct effects to water would occur from open lands management practices.

Soil losses in the project area are estimated to be 0.02 to 0.38 tons/acre/year, based on LCC.

Cumulative Effects

If the proposed actions are not implemented, open lands management and existing conditions would continue to contribute the same chronic effects to soils and water quality in the project area as described above. Open lands would continue to be managed as described in the OLREA.

Alternative 2

Forest management activities that affect soil and water are timber harvesting, site preparation, timber stand improvement projects, skid trail construction, felling, yarding, skidding, loading, transporting logs, and prescribed fire. Most of these effects are temporary, lasting less than 10 years. Loss of the protective soil cover (litter) from ground disturbance can increase erosion and sedimentation while decreasing soil productivity. Recreational use of roads can affect soil and water quality at stream crossings.

Direct Effects

When vegetation (living biomass) is removed from a site, a portion of potential organic matter and its availability to be recycled into nutrients to the soil is removed, and more sunlight and moisture reach the soil surface. The resultant open canopy condition would reduce evapotranspiration and affect soil temperature, soil moisture, and nutrient cycling. Canopy reduction would increase soil moisture (due to reduced evapotranspiration) and temperature in the topsoil. These conditions would increase soil organic matter decomposition rate and increase available nutrients on the treated area. Other parts of the tree would remain on site to recycle into the soil system over time. Much of this increase in plant available nutrients would be taken up by the stump sprouting of hardwood trees, the root systems of the remaining vegetation on the treated area, and by increasing herbaceous growth. Some nutrients may be leached from the site to reach local streams. The leaching effect is short-term and literature has shown removal of the tree's main stem alone would not reduce long-term soil productivity. These short-term losses are made up by leaf fall, atmospheric additions, and weathering of parent material. Any increased leaching of nutrients from the soil would be very short term (less than 5 years).

Negative effects to soil from prescribed burning are related to the severity and frequency of the burns. Only the upper forest floor litter layer should be consumed during a prescribed fire. This should leave the underlying layer to protect the mineral soil. This organic layer, along with trees and other vegetation, should prevent or minimize any soil movement. Slight, short-term increases in surface erosion will be offset by increased filtration, and over the long term slower infiltration rates will improve soil properties and water quality above current and baseline levels. A study conducted at LBL by Koontz in 2008 found soil nutrients are not negatively affected after prescribed fire.

Planting of shortleaf pine and river cane would have minimal effects on soils. Both would be planted with similar methods: using a tree planter and a tractor, or by hand with shovels. Approximately 4 inches of soil would be disturbed to plant seedlings or rhizomes, and a similar amount of soil would be disturbed to harvest cane rhizomes from areas within the project area where cane is already growing. Localized soil compaction may occur in association with timber harvest, biomass removal, and shortleaf pine planting. The use of large machinery in forestry operations has the potential to compact soils, decreasing productivity. Prescribed burning would not cause soil compaction. In 1989 the Long-Term Soil Productivity (LTSP) study was founded to examine the long-term consequences of soil disturbance on fundamental forest productivity through a network of designed experiments (Powers, Sanchez et al. 2004). The LTSP study examined soil compaction on various sites throughout the United States and Canada and found that even 10 years after extreme soil disturbing activities occurred due to forestry and biomass collection efforts, there were no substantial or universal effects on vegetative productivity (Powers, Scott et al. 2005). Use of Kentucky Best Management Practices (BMPs) would reduce impacts and manage restoration of skid trails and log landings (Stringer and Perkins 2001). Skidding design, sale layout, seasonal restrictions, and suspending operations during times when soil moisture is excessive can be just as important as the physical properties of soil to narrow or reducing the amount of soil compaction to a finite amount during timber harvesting operations.

To minimize compaction, heavy equipment would be limited to July through November in areas with severe compaction hazards. Operations during December through June are allowed with the use of methods or equipment that does not cause excessive soil compaction. These limits do not apply to roads, primary skid trails, or log decks. One additional effort that would be taken to reduce soil compaction is to collect and remove biomass at the same time as timber extraction (Evans, Perschel et al. 2010); this reduces the number of times that heavy equipment must travel over the soil. The Vegetation Management Specialist Report (available in the project record) outlines additional measures to protect soil resources that would be taken when collecting biomass.

Soil stoniness, depth to water table, ponding, flooding, slope, and texture of the surface layer affect trafficability and erodibility. If skid and log trails are designed, implemented, and retired according to BMPs, only short-term impacts to soil resources are expected. Limiting access to 2.25 miles of roads in the project area would reduce motorized use and help further reduce erosion and sedimentation, and improve watershed health. Soil losses in the project area are estimated to be 0.02 to 0.38 tons/acre/year, based on LCCs.

Reconstruction of 9.5 miles of roads and construction of temporary roads to access timber areas would cause soil erosion and the potential for sedimentation during construction activities (during timber removal operations, up to four years). Temporary roads would continue to increase sedimentation into nearby streams until the roads have been reconditioned to their original state. Use of Kentucky BMPs, such as properly locating roads in relationship to streams and ponds, properly draining roads, and maintenance of 30-foot streamside management zones, etc., would minimize their impact (Stringer and Perkins 2001).

Road reconstruction and unauthorized road obliteration are intended to reduce long-term erosion, sedimentation, and stream habitat damage by reducing the current decline of gravel roads and improving road drainage; therefore, temporary increases in soil disturbance would be offset by long-term improvements over current conditions.

Extraction of woody biomass from the site has the potential to affect soil and water conditions. Dead biomass (woody debris) is important in stream structure and function; it ponds water, aerates streams, and stores sediments. It also slows downcutting of stream channels, thereby reducing sedimentation of bodies of water downstream (in this case, Demumbers Bay and Lake Barkley). Woody debris on the forest floor prevents erosion by slowing the rate water moves across the ground surface (Evans 2011). Biomass removal could reduce these functions in a forest. In the project area, however, there is a much higher than typical amount of woody debris already on the forest floor as a result of recent storm damage to the forest; therefore, the net change in erosion resulting from a lack in woody debris is minimal.

Herbicides may affect soil productivity and water quality directly through spray drift during application. In some instances, especially just after treatments, there may be some movement of chemicals with water or soil particles. For all treatments, water in or near the project area would be protected through the use of risk management measures and BMPs. Risk management measures common to all alternatives follow both Forest Plan direction and Kentucky BMPs. These include:

- no herbicide is ground applied within 30 ft of bodies of water
- use of a formulation of herbicides approved for aquatic use within riparian corridors, when necessary
- no application of herbicides directly to water bodies
- consideration of weather conditions before herbicide application.

Indirect Effects

Currently, the high amount of woody debris on the forest floor left by recent storm damage to the overstory, combined with a dense midstory canopy, prevent herbaceous development on the forest floor. The proposed decrease in canopy cover would increase the amount and duration of sunlight contacting the forest floor, while still providing a continued source of woody debris as remaining trees senesce over time. This increase in sunlight would lead to improved protection against soil erosion by stimulating herbaceous development on the forest floor and providing a continuous source of organic matter. In addition, given the current high level of woody debris on the forest floor, any addition of debris from timber harvest would further reduce sunlight reaching the floor; therefore, removal of biomass under existing conditions would have a beneficial effect to soil organic matter levels and erosion prevention by allowing for herbaceous growth.

Woody debris is an important nutrient source to the soil, although not as important as needles and leaves (Evans 2011). The importance of woody debris in soil nutrient levels in the Southeast is dependent on past land use; in some cases, removing most of the woody debris (e.g., during a clearcut) results in little change to the nutrient load, because nutrient levels have already been depleted by earlier agricultural practices. Leaving fine woody material (FWM) and leaf litter on the forest floor has been shown to maintain soil nutrient levels, even when most of the above-ground woody vegetation has been removed (Evans 2011). For this project, no dead woody material would be removed; only material cut directly from the forest, either in the form of small trees or portions of large trees that are not merchantable for sawtimber or pulpwood would be collected. Leaving FWM on the forest floor would continue to replenish nutrient levels in the soil.

Masters et al. (1993) did not find that timber harvesting is a nutrient depleting practice in the western Ouachita Mountains but rather serves to reallocate the nutrient capital within the system. They found that the soil nutrient status improved following timber harvest in the Ouachita Mountains on soils similar to those within the Demumbers Creek project area (Masters, Engle et al. 1993). Nutrient depletion is generally only a concern where soils are initially poor, whole-tree harvest is used, or rotations are short (on the order of 20-35 years) (Jorgenson and Wells 1986). None of these factors are present for this project.

Light to moderate severity fires accelerate the recycling process by releasing nutrients in the soil, thereby stimulating nutrient uptake by vegetation. Even though prescribed fires release some nitrogen gases, overall nitrogen budgets are not significantly affected. Prescribed fires may also help in reducing rates of soil acidification. Any long-term negative effects to the soil would be related to high severity burns or very short (less than 3-year) frequency of the burns. The proposed prescribed burn parameters would result in retention of enough leaf litter to protect soil from the negative effects.

Herbicides may affect soil productivity and water quality indirectly through vegetation control and subsequent soil erosion and nutrient leaching. Herbicides are proposed to be applied during times when the probability of precipitation is small, and a 30-ft stream buffer would be used in application of herbicides that can negatively affect aquatic environments. Small storms generally do not produce enough runoff in forested environments to move herbicides into water bodies. Storms of medium intensity and of long duration generally produce the highest detectable concentrations of herbicides in streams. Storms with large rainfalls usually produce low herbicide concentrations in streams because the active ingredient is diluted by the amount of rainfall received and the distance traveled to reach the stream. There is also some risk of herbicides seeping into groundwater through vertical seepage. When applied at the lowest effective rates, herbicides should not seep into groundwater at concentrations exceeding the EPA's strictest drinking water standards. Risk to groundwater would be minimized through the risk management measures, including the application of herbicides at the lowest effective rate.

Due to the limited acreage and dispersed extent of the areas (including site preparation areas), and the short half-lives of the chemicals proposed for use (Table 3.3.1), the indirect effects should be temporary and minor if BMPs are followed. Prompt re-vegetation would provide effective erosion and sediment control.

Cumulative Effects

These treatments would add very little to the ongoing effects to soil and water resources from other past, ongoing, or future actions. The historically large amount of woody debris on the forest floor in the entire northern end of LBL would continue to provide soil nutrients, structure to streambeds, and erosion control. Potential soil compaction resulting from timber harvest on 1,825 acres over 3 or 4 years represents a small fraction of the surrounding land area (~1% altogether), even when combined with the proposed timber salvage harvests in the north end of LBL (at Hurricane and Grace Creeks). Improvement of roads in the project area would reduce erosion in the area but would not make a substantial difference in road-caused erosion across LBL. The three pesticides proposed for use all have relatively short half-lives and thus would not persist on-site between treatments (Table 3.3.1).

Table 3.3.1. Proposed herbicides, application rates, and their duration in environment.

Herbicide	Soil half-life (days)*	Water half-life (days)*	Application rate (maximum)**
Glyphosate	20-60	3.5-70	3.34 lb/acre
Imazapyr	67	325	1.5 lb/acre
Triclopyr	40-46	0.6-3.6	1.36 lb/acre

* Ranges in half-life are due to varied results in the literature.
**Maximum application rates are based on the maximum used within the Forest Service to conduct the actions proposed for the Demumbers Creek project.

Alternative 3 – **Preferred Alternative**

Direct Effects

The effects of this Alternative would be similar to Alternative 2.

Herbicides are likely to be used in WSI areas (180 acres) more extensively than with Alternative 2, although the total herbicide use in the forested project area would not exceed 600 acres/year. There is a greater concern about herbicide runoff into streams following rain events with this alternative, because many of the WSI treatment areas are located close to streams. Only herbicides approved for aquatic use would be applied in these riparian corridors. As discussed above, herbicides would not be used within 30 feet of a stream unless they are an approved aquatic formulation. This would reduce risk of herbicide runoff into streams. In addition, the three herbicides proposed for use, at the proposed application rates, do not present a major risk to aquatic environments because they either bond tightly to the soil (and therefore do not enter the water column) or they degrade rapidly in water (Durkin 2003; Durkin 2003; Durkin and Follansbee 2003).

Soil compaction in canebrake restoration areas would be similar to or less than past agricultural activities in the same fields. The presence of cane in open lands would begin to reduce soil loss from sheet and rill and scour erosion processes.

Changing approximately 4 miles of unauthorized roads to the national forest system at a ML 1 may increase compaction on these roadbeds. There will be infrequent use of these roads for open lands and cemetery access so the compaction will be minimal. The short length (approximately 0.1 miles) to be added to access a water front campsite will be maintained at a ML 2 and will not affect soil compaction and erosion in the project area because the length of the road is short.

Indirect Effects

The effects for this Alternative would be the same as Alternative 2. Thinning of the forest around open lands (approximately 180 acres) would encourage a greater amount of herbaceous growth in those areas, with the consequences described under Alternative 2 above; overall, this would be balanced with less herbaceous response in Core Areas not prescribed burned under this alternative (205 acres).

Cumulative Effects

Cumulative effects would be the same as Alternative 2.

Air Quality

Affected Environment

Due to the fact that air pollution is transported locally and regionally, and that air quality monitoring is limited on LBL, an area larger than LBL must be used to describe air quality and the effects of emissions from proposed activities. Therefore, the scope of this analysis includes counties within 30 miles of the LBL boundary (Figure 3.4.1).

The Clean Air Act has established thresholds (called standards) to six criteria pollutants set to protect human health and welfare. Of these six, only two are monitored extensively, ozone and fine particulate. Thresholds have been set for the amount of fine particulate and ozone that can be in the air before human health is affected. The state monitors these pollutants and within the analysis area all monitoring results currently meet the standards. Most ozone events occur in mid-spring through late summer when hot temperatures and high-pressure air masses may stagnate over an area, and pollution, including smoke, is not dispersed. Prescribed burning is generally not conducted when weather conditions indicate that there would likely be smoke dispersion issues.

There is one ozone maintenance area in the analysis area: Clarksville/Hopkinsville (Montgomery County, TN and Christian County, KY). This is shown as nonattainment in Figure 3.4.1. There are no actual nonattainment areas within 30 miles of LBL, meaning that all current sources of pollution, including emissions from prescribed fire, are not causing air quality to exceed the thresholds established by the EPA to protect human health and welfare. A proposal to change these thresholds has been put forth by the EPA, which may make the Clarksville/Hopkinsville area a nonattainment area. Therefore, this should be considered a smoke sensitive area during burn and smoke management planning. Other smoke sensitive areas include Tobaccoport Cave in Tennessee (due to the potential presence of two endangered bat species), and the usual schools, hospitals, and highways (including I-24 to the north).

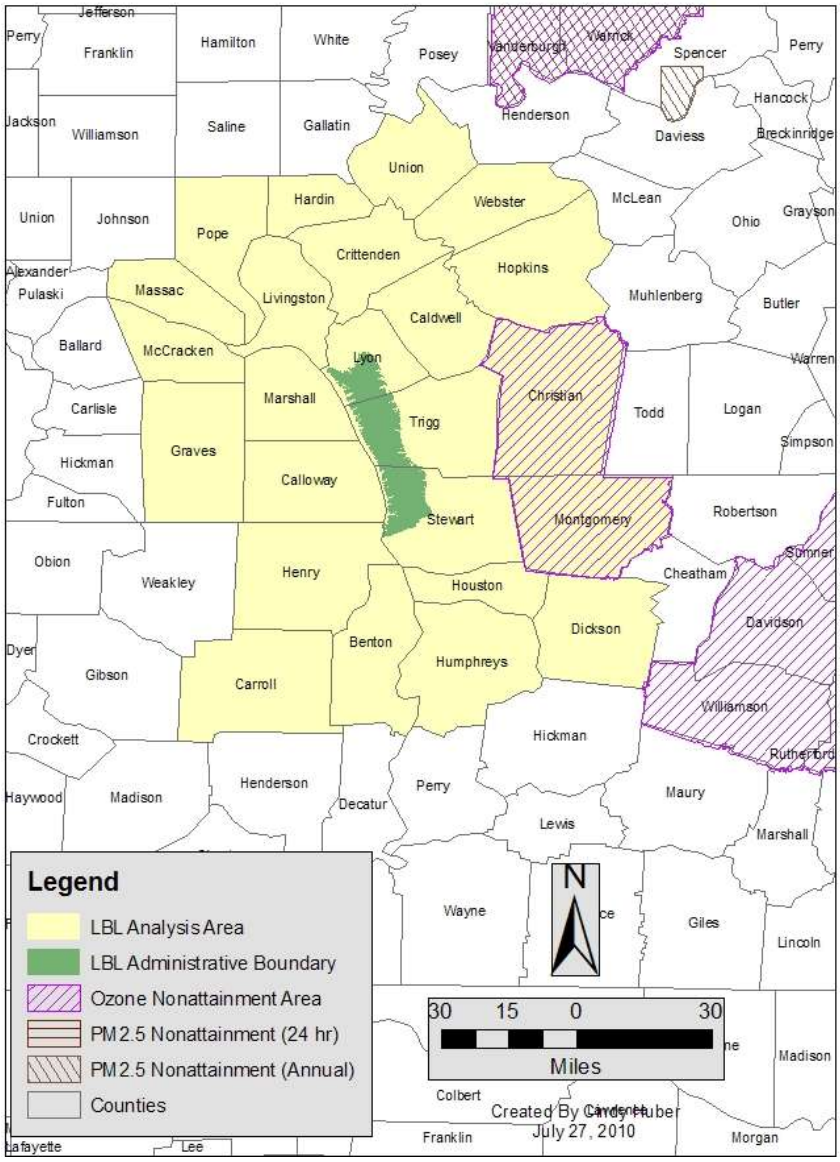


Figure 6. Analysis area for air assessment.

There continue to be no $PM_{2.5}$ nonattainment areas (annual or 24-hour standard) on, adjacent to, or near LBL. With the increasing prescribed fire program, it is important to assess whether there is any indication that levels of local and regional $PM_{2.5}$ levels are mirroring that trend. Figure 3.5 shows the daily and annual fine particulate matter concentrations near LBL from 2005 through 2009 as compared to emissions from prescribed fire conducted on LBL during that same time period. As shown, local and regional $PM_{2.5}$ concentrations do not appear to be correlated with $PM_{2.5}$ emissions from prescribed fires.

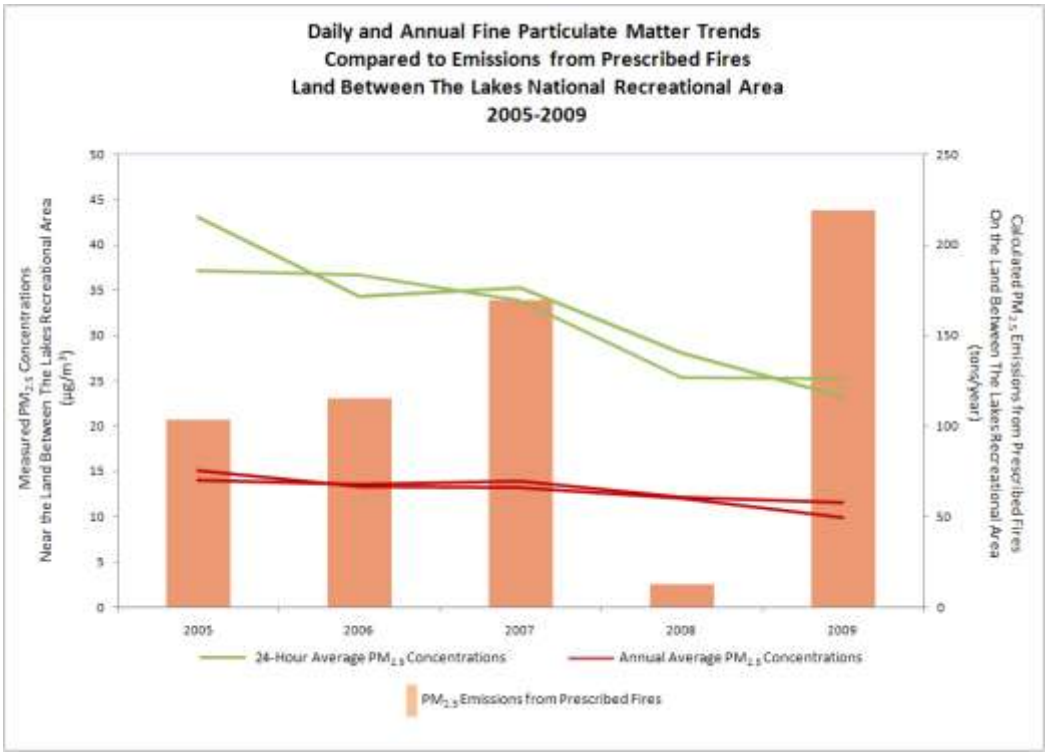


Figure 7. Prescribed fire emissions compared to measured fine particulate concentrations at two monitors located within 25 miles of Land Between the Lakes Recreation Area. (Two green and two red lines represent results from different monitors.)

Prescribed fire emissions make up a small portion of all fine particulates in the analysis area (Table 3.4.1). Within the immediate vicinity of LBL, emissions from agriculture and forestry account for about 4% of the fine particulate and power plant emissions account for 50% (most of which comes from the TVA Cumberland Power Plant in Stewart County). In the larger analysis area, agriculture and forestry emissions account for 10% of fine particulates, with electrical power generation at about 30%. Other sources of fine particulate include fuel combustion for industrial processes, treatment of waste and recycling, and motor vehicles.

Table 3.4.1. Fine particulate emissions (in tons per year) from the VISTAS (Visibility Improvement State and Tribal Association of the Southeast) 2002 inventory* and projected maximum annual emissions increases from the Proposed Action.

Analysis Area	Tons of Fine Particulate	Percent within Analysis Area
All sources in all counties within 50 km (30 miles) of LBL	20,982	
Electrical Generation	6434	31
Forestry and Agriculture	2050	10
Proposed Action	122	<1
All sources in only those counties that intersect LBL	1,586	
Electrical Generation	800	50
Forestry and Agriculture	68	4
Proposed Action	122	8

* Data obtained from the VISTAS emissions inventory using the Emission Tool available at the following website: http://199.128.173.141/emissions/. Site accessed November 25, 2008

Another concern with forest fires is creation of haze. The primary cause of regional haze in the eastern United States is sulfur dioxide emitted from fossil fuel burning, primarily from coal-fired power plants. Recent work by the regional planning organization, VISTAS (Visibility Improvement State and Tribal Association of the Southeast), shows that wildland fire emissions play a very minor role in development of regional haze in the eastern United States, and especially Kentucky (KYDAQ 2008).

Air quality impacts from prescribed burning are generally short-term and smoke disperses within hours. There are times however, when smoke from prescribed fire moves rapidly to the mixing height and then downwind only to come back to earth in the afternoon or evening, putting smoke into a sensitive area. Additionally, air quality is affected when smoke from multiple burns converges and moves downwind. Smoke from one fire may not cause any problems, but smoke from two or more burns combined could be a nuisance, reduce visibility on a highway, or lead to violation of an ambient air quality standard. The project area is close to Fort Campbell which also conducts an annual prescribed burning program of approximately 15,000 acres. The prescribed fire program on LBL coordinates with AIRNow (http://www.airnow.gov/), a website with air quality information compiled by the U.S. EPA, NOAA, NPS, tribal, state, and local agencies. LBL does not implement prescribed burns on days when AIRNow rates the air quality index as Orange (unhealthy for sensitive groups) or worse (i.e., on poor air quality days). In addition, LBL fire staff coordinate with the Kentucky Division for Air Quality.

Effects

Alternative 1 – No Action

Direct and Indirect Effects

There would be no direct effects associated with the No Action alternative. Indirect impacts may occur with the development of unplanned wildfires within the proposed treatment areas if

accumulated fuels remain. With no control over weather conditions especially transport wind speed, wind direction, mixing height, stability class at the time of ignition, or the amount of fuel that may be consumed if the fuel moisture is low; the potential for impact on human populations by unplanned wildfire smoke is high.

Cumulative Effects

There would be no cumulative effects associated with the No Action alternative; however, air quality and standards would continue to be affected by all other sources of air pollution.

Alternatives 2 and 3 – Proposed Actions and Modifications

Because there is no substantial difference in the size of the prescribed burn boundary between Alternatives 2 and 3 (as far as air quality effects), they are considered jointly here.

Direct and Indirect Effects

Prescribed fire emissions (smoke) usually affect air quality for less than 24-hours at a time. The amount of smoke produced and how it is dispersed depend on the size of the burn, the type of fuel and the weather conditions at the time of the burn. In general, smoke from prescribed burning disperses into the atmosphere and combines with other existing pollutants. Most of the emissions are “lifted” high into the atmosphere where they are moved downwind from the fire. The wind moves the smoke/pollutants to areas many miles away where they are added to other gases/pollutants present in the atmosphere. But when many acres are treated over a short time period, the increase in particulates might be enough to cause already dirty air to exceed daily air quality standards, affect human health or reduce visibility; and this can occur some distance downwind. These effects can be minimized or eliminated by controlling the amount of fuel consumed and burning when weather parameters favor good smoke dispersion. This would be especially important if any nearby areas are designated nonattainment.

The remaining smoke is in intermittent contact with the ground and the impact on air quality is reduced by dispersion, surface winds and deposition on plants and the ground. Ground level smoke contains a large amount of particulate matter, especially fine particulates which can cause eye irritation and different kinds of respiratory problems. These same size particles can also reduce visibility at scenic views. Any visibility impairment caused by the proposed prescribed fires is likely to be short term (less than 6 hours), and increase as a person moves closer to the prescribed fire. Again, good smoke management practices can minimize these effects to some extent.

An indirect effect of prescribed burning on air quality would be a reduction in emissions resulting from wildfire. When hazardous fuels are removed through prescribed burning, wildfire occurrence and associated emissions should decrease. Emissions from wildfire generally impact human health and visibility conditions much more than prescribed fire emissions, because the land manager does not have control over weather conditions affecting fire behavior and smoke dispersion.

Cumulative Effects

Cumulative effects could refer to impacts from multiple burns conducted on the same day (short-term), or the impacts of prescribed burning over an entire year (long-term).

Short –Term Effects (24 hours):

Multiple prescribed fires could occur on the same day within the analysis area if burning conditions were favorable, and equipment and staffing were available. At this stage of planning, combinations of burn units that might be treated on the same day are not known and therefore modeling is not an option. Coordination between fire managers operating within the analysis area could help minimize air quality impacts over the course of one or several days.

Long-term Effects (Annual):

One way to assess the cumulative effects of the Proposed Action is to evaluate the change in total annual emissions within the project area and the analysis area. The proposed action targets approximately 3400 acres for prescribed fire treatment with total fine particulate emissions estimated at 122 tons per year. This would roughly double the annual emissions of fine particulate (4% to 8%) from agriculture and forestry sources in the immediate vicinity of the project (Table 3.4.1). Fine particulate from this source sector is still only 11% of the total. Emissions from agriculture and forestry are dwarfed by the emissions from a nearby coal-fired power plant which accounts for roughly 50% of fine particulates near LBL.

When the emissions increase from the proposed action is compared to the larger analysis area, the increase is negligible. Emissions from agriculture and forestry account for about 10% of fine particulate across the analysis area, and the addition of 122 tons per year doesn't change this (Table 3.4.1).

Another way to assess the cumulative impacts of emissions from prescribed fires and all other pollution sources is to compare the monitored fine particulate concentrations with the amount of prescribed fire emissions over time. Figure 3.5 above shows that although prescribed fire emissions from LBL have been increasing, monitored fine particulate has actually decreased. Local and regional $PM_{2.5}$ concentrations do not appear to be correlated with $PM_{2.5}$ emissions from prescribed fires.

Despite the fact that it appears that prescribed fire emissions from LBL are not affecting the regional fine particulate concentrations, LBL would follow smoke management guidelines found in the Forest Service Manual (FSM 5144) in order to avoid creating a nuisance situation, and minimize visibility impacts and impacts to people's health when implementing the prescribed fire program.

Climate Change/Carbon Sequestration

Affected Environment

The US Forest Service has developed a National Roadmap for Responding to Climate Change (USDA Forest Service 2010). This Roadmap outlines ways that US forests may be affected by and themselves can affect climate change. The Roadmap lists the following ecosystem vulnerabilities that may be affected by climate change:

- Climate change impacts on air and water quality.
- Plant community succession dynamics.
- The frequency and intensity of extreme events.
- Landscape patterns in relation to species dispersal.
- The magnitude of temperature and precipitation changes.

- Contextual features, such as topography and physical substrates.
- The ability of systems to adapt.
- Changes in disturbance regimes comprised of insects, pathogens, and wildland fire in key ecosystem processes.

Many of these vulnerabilities apply to forests in LBL and the region of western Kentucky and Tennessee; however, there is not yet enough information available to accurately predict the extent of the impact climate change may have on these systems. Two of the key initiatives that National Forest lands can take are: 1) assess which forests are most vulnerable; and 2) work toward maintaining resilient forest ecosystems (USDA Forest Service 2010).

The Roadmap identifies several climate change risk management measures, including:

- Promote the uptake of atmospheric carbon by forests and the storage of carbon in soils, vegetation, wood products, and landfills.
- Indirectly reduce greenhouse gas emissions (for example, through the use of carbon-neutral bioenergy to offset fossil fuel emissions).
- Directly diminish greenhouse gas emissions (for example, through more prudent consumption in facilities, fleet, and other operations).

Forests in the Demumbers Creek area have been severely damaged by multiple storm events, which has in turn increased the risk of disease to damaged trees. The proposed actions are intended to increase the resiliency of the forest (as explained in the Vegetation Management section above), with the corresponding hypothesis that increased resiliency correlates with an increase in the forest's ability to withstand climate change and sequester carbon. Below is a literature review and discussion of how the proposed actions could affect climate change and carbon sequestration.

Timber harvesting, biomass collection, and burning may change the amount of carbon sequestered in forests. Timber harvests result in lower amounts of carbon left in forests as living biomass is removed, especially when more of the basal area is removed and in clear-cuts[1] (Li, Chen et al. 2007; Depro, Murray et al. 2008; Nunery and Keeton 2010), although carbon may continue to be stored in manufactured wood products (Nunery and Keeton 2010). At the same time, thinning and low-impact harvesting of forest products, as proposed for this environmental assessment, may reduce CO_2 emissions by forests, increasing CO_2 uptake due to enhancement of net primary productivity and net ecosystem productivity (Birdsey, Pregitzer et al. 2006; Boerner, Huang et al. 2008). Forest thinning may result in immediate reductions of forest carbon (Depro, Murray et al. 2008; Nunery and Keeton 2010), but this has been shown to be balanced by increased carbon sequestration in subsequent years (Boerner, Huang et al. 2008).

Carbon dioxide and water vapor generally make up over 90 percent of the total emissions from wildland fire (Hardy, Ottmar et al. 2001), releasing approximately 3,000 pounds of CO_2 per ton of fuel consumed. Since wildfires usually consume more fuel than prescribed fires, they release more carbon dioxide into the atmosphere. Prescribed burning is used to reduce the fuel load and the risk of severe wildfire, thereby limiting the release of CO_2 into the atmosphere.

[1] Note: No clear-cuts are proposed as part of this project for any alternative.

Carbon stored in forests may be severely impacted by forest fires, with resulting exacerbation of global climate change. Intensely and extensively burned forest areas no longer sequester carbon at the same rate as they did pre-fire. Unlike large-scale wildfires, prescribed burns are low-intensity and cover only small areas at a time. This results in differences between wildfires and prescribed fires in their effect on the forest carbon cycle. During a fire, carbon stocks are released into soils through the death of living vegetation, temporarily increasing the overall carbon content of the soil in some cases; in other circumstances resulting in overall soil carbon loss. Studies have shown that prescribed fires and wildfires both can increase *or* decrease carbon content in soils (Johnson and Curtis 2001; Cason, Grebner et al. 2006). Low-intensity controlled burns generally do not result in major long-term losses of soil carbon or coarse woody debris on the forest floor (Johnson and Curtis 2001; Hubbard, Vose et al. 2004; Boerner, Huang et al. 2008), and they result in less soil carbon loss than high-intensity fires (Cason, Grebner et al. 2006). A short-term loss of biomass resulting from a prescribed fire may be offset by the burned area's increased ability to produce herbaceous biomass (McCarty 2002).

According to a regional study, the largest carbon pool in forests is in living trees (Li, Chen et al. 2007). Regular, periodic prescribed burning results in a risk reduction of catastrophic, stand-replacing wildfire occurrence (Fernandes and Botelho 2003). Carbon stocks that had been stored within the trees are released into the atmosphere as a result of wildfires (Hubbard, Vose et al. 2004; Birdsey, Pregitzer et al. 2006); prescribed fires generally do not result in large-scale tree death and therefore do not release carbon to the same extent as a wildfire. In fire-mediated ecosystems, carbon sequestration generally equals or exceeds sequestration in unburned systems (Liechty, Luckow et al. 2005).

Soil carbon levels (both organic and inorganic) can also change with forest thinning, although there is some evidence that timber removal does not change soil carbon levels, as long as the area remains forested (Ponder 2007; Depro, Murray et al. 2008). Two primary changes to soil organic carbon may occur: carbon is released when decaying root systems are consumed and respired by soil microbes; and carbon stored in soil biomass increases with increased forest floor herbaceous vegetation. Changes to soil organic carbon levels resulting from plant turnover may increase energy available to soil microbes, ultimately resulting in decreased inorganic carbon levels deep in the soil. This deep soil carbon is one of the largest carbon pools, and its release and reduction over time may have climatic consequences (Fontaine, Barot et al. 2007).

Using biomass as an energy source is considered carbon-neutral by most climatologists, and can even reduce global greenhouse gas (e.g., carbon dioxide) emissions when compared to using fossil fuels for energy at today's rates of use (Searchinger, Heimlich et al. 2008; Council on Sustainable Biomass Production 2010). Using biomass as an energy source alone would likely not resolve the global climate change problem, even if implemented on a global scale, but when combined with other technologies, burning biomass for fuel may offset a portion of carbon emissions (Hoffert, Caldeira et al. 2002; Berndes, Hoogwijk et al. 2003; Karp and Shield 2008). If use of biomass products increases to a more important portion of the global energy supply (plant products currently supply approximately 13% of the world's energy), there are indicators that the concurrent land-use changes necessary would have detrimental effects on carbon storage and global climate change (Hoffert, Caldeira et al. 2002; Berndes, Hoogwijk et al. 2003; Karp and Shield 2008; Searchinger, Heimlich et al. 2008), thereby negating any benefits of using biomass for energy over fossil fuels. The proposed actions do not require any land-use change; the project area would continue to be forested after biomass is collected. Dead biomass

on the forest floor and in forest stream channels is an important part of the carbon storage capacity of a forest (Evans 2011); however, it is not proposed to remove any dead biomass from the project area during implementation of this project.

Another concern with active forest management such as timber harvest and prescribed burning, is that the resulting forest would be no better at offsetting climate change than an old-growth forest that could result if no management had occurred. Early models of forest carbon use indicate that old-growth forests are carbon-neutral (i.e., CO_2 absorbed equals CO_2 respired) (Odum 1965; Kira and Shidei 1967), and therefore have no net benefit or detriment to climate change via carbon storage. In contrast, more recent research indicates that old-growth forests absorb more carbon than is released by the forest (Zhou, Liu et al. 2006; Luyssaert, Schulze et al. 2008) thereby acting as carbon sinks. Additionally, one study modeled the difference between unmanaged and managed forests, and found that mature (80-100 year old), unmanaged forests store more carbon than forests of any of the modeled harvest scenarios studied (Nunery and Keeton 2010); however, another study found that forests harvested at intermediate levels (diameter limit or single-tree selection) store more carbon than mature (100 year old), un-harvested forests (Davis, Hessl et al. 2009). Earlier assumptions posited by Odum and others may have been too general and not taken into account growth processes that occur as trees age in mixed-age natural forest stands, such as a lower rate of photosynthesis (Carey, Sala et al. 2001).

The question remains, what age of forests store the most carbon: old-growth, mature, or young? Desai et al. (2005) found that, while both mature (70-year-old) and old-growth (>300-year-old) forests are carbon sinks (i.e., they store more carbon than they output), mature forests take up more than twice as much as old-growth. These authors believe this is due primarily to stand age and succession stage differences (Desai, Bolstad et al. 2005). Other studies also demonstrate that forests in the range of 40-106 years old sequester more carbon than either young (~20-year-old) or old-growth (190-450-year-old) forests (Law, Sun et al. 2003; Chen, Paw U et al. 2004). However, one series of studies in New England found opposite results; an old-growth hemlock forest sequestered 50% more carbon than an 80-year-old deciduous forest (Barford, Wofsy et al. 2001; Hadley and Shedlbauer 2002). Given the range of carbon storage capacities in different forest age classes, management activities that maintain a variety of forest ages may increase the ability of forest tracts to sequester carbon (Pacala, Birdsey et al. 2007).

Finally, at a global or national scale, any short-term reduction in carbon stocks and sequestration rates (or increases in greenhouse gases) within a single project area are imperceptibly small, as are the potential long-term benefits. The 3,600-acre project area is miniscule when compared to Kentucky's 26 million acres. Even LBL's 170,000 acres make up only 0.6% of the total area of the state of Kentucky. Furthermore, management actions that improve the resilience of forests to climate-induced disturbances such as catastrophic wildfire could help sustain the current strength of the carbon sequestration ability of U.S. forests (Birdsey, Jenkins et al. 2007). The Environmental Protection Agency has concluded that when forest management activities (including fire emissions) are considered together with storage/sequestration activities (reforestation, etc), at the national level, the cumulative result is a net sequestration of carbon dioxide (USEPA 2008). This assumes that the proposed activity does not change the land use and the area remains forested, as is the case with the Demumbers project.

Effects

Alternative 1 – No Action

Direct, Indirect, and Cumulative Effects

The existing condition of the forest is mature, closed canopy. Mature forests are among the most able to sequester carbon, when compared to old growth and regenerating forests. Allowing the forest to mature into old-growth may lead to a decrease in carbon storage; however, in the scale of LBL, this is likely to be imperceptibly small and is unlikely to lead to changes to the global climate. In addition, according to the Forest Service's National Roadmap for Responding to Climate Change (USDAFS 2010), "storing carbon in overly dense forests increases the risk of losing the carbon through smoke and decomposition of fire-killed trees following large wildfires."

Alternative 2

Direct, Indirect, and Cumulative Effects

The proposed timber harvests should improve forest health by removing damaged, disease-prone trees, thereby reducing competition for limited nutrient and water resources and encouraging residual tree vigor. Maintaining the forest in a mature condition through the creation of oak woodlands and open canopy oak forests (1,500 acres) would ensure that the forest is at a high level of carbon sequestration. Creation of regenerating oak and pine forests would decrease the ability of those areas (325 acres) to sequester carbon, although they would still form a carbon sink. Prescribed fire in the project area would release carbon dioxide (CO_2) and carbon monoxide (CO), contributing to greenhouse gases in the atmosphere; however, improving the resiliency of the forest and decreasing the fuel load would minimize the risk of damage due to severe wildfires (and the release of greater amounts of CO_2 and CO), thereby ensuring that forests in the project area would continue to be active carbon sinks and reduce emission of greenhouse gases into the future. Management of forests across LBL to provide a diversity of age classes and structural types (including in other areas planned for forest management such as Prior Creek, Crossroads, and Devil's Backbone) would ensure that the risk of wildfire and disease is limited, thereby promoting continual carbon sequestration on LBL.

One of the proposed actions is to remove biomass from the forest for use as a fuel source in the surrounding area. As indicated above, the consensus in the scientific literature is that biomass energy use is either carbon neutral or offsets carbon emissions produced by fossil fuels. Some studies have indicated that a large-scale, global change toward using biomass for fuel, thereby replacing much of the dependence on fossil fuels, may have a negative effect on greenhouse gases in the atmosphere; these studies state that in order to produce enough biofuels and continue to support the global food demand, land that is not in agriculture now must be converted to biomass production (Searchinger, Heimlich et al. 2008). Land-use conversion could have many adverse effects, not only to global greenhouse gas emissions, but to biodiversity, soil loss, and water and air quality. For the Demumbers Creek project, no land-use change is proposed. Biomass collection is proposed to occur only during timber harvest operations, and it would occur in an area so heavily storm-damaged that there is an exceptional amount of debris on the forest floor that would remain. Once the biomass is collected, the treatment areas would remain forested, with corresponding carbon sequestration. Overall, as

stated in the No Action Alternative above, the project area is so small as to be globally imperceptible in its impact to climate change.

Alternative 3 – **Preferred Alternative**

Direct, Indirect, and Cumulative Effects

The actions proposed under this alternative would improve the resiliency of the forest by reducing stand density along the edges of open lands; this would eventually increase the ability of the forest to sequester carbon even more than Alternative 2. A larger amount of fuel would be left on the forest floor, which eventually (whether through fire or decomposition) would be emitted into the atmosphere, resulting in a temporary loss of carbon storage. Improvements in forest resiliency and light levels to the forest floor (creating increased vegetation there) should offset most of this carbon loss over the long term. Biomass collection would occur at the same levels and from the same areas as Alternative 2, with the same effects described above. Overall, as stated in the No Action Alternative above, the project area is so small as to be globally imperceptible in its impact to climate change.

Health Effects and Herbicides

Affected Environment

The use of three herbicides are proposed: glyphosate, imazapyr, and triclopyr. Commenters expressed concerns about the use of herbicides and their effects on human health and the environment. Staff at LBL performed a literature review and brief risk analysis of the impacts of the three proposed herbicides to people and wildlife; in addition, staff referred to the extensive Forest Service Risk Analyses for each herbicide (Durkin 2003; Durkin 2003; Durkin and Follansbee 2003). A summary of our findings is presented here; the full analysis and review can be found in the Demumbers Creek project record. Measures proposed to reduce the potential risks posed by herbicides are listed in Appendix 1.

The Environmental Protection Agency and the 2003 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulate the level of risk that herbicides can cause toxicity to non-target organisms (Shepard, Creighton et al. 2004) and determine what level of risk endangers the environment (Michael 2004). The fact that an herbicide is available for use indicates that it has passed EPA risk characterizations when used at or below the recommended label rate, and therefore does not pose unreasonable risks of adverse effects to humans or the environment (Tatum 2004). LBL proposes to use each herbicide at rates well below the allowable label rate (Table 3.6.1).

Table 3.6.1. Proposed herbicide and duration in environment.

Herbicide	Maximum label application rate (a.e. lb/acre/yr)[1]	Proposed application rate (a.e. lb/acre/yr)[2]
Glyphosate	3.75	2.75
Imazapyr	1.25	1.25
Triclopyr	5-8	1.25 (TEA), 0.65(BEE)

[1]Maximum application rates are based on the maximum recommended in the Forest Service risk assessment for the actions proposed for the Demumbers Creek project. This is equal to or less than the maximum label rate imposed by the EPA.

[2]The maximum forested acreage to be treated per year within the project area is 600 acres; this may be a combination of two or three chemicals, or exclusively one chemical in a given year.

The Area Plan requires that herbicides be applied at the lowest effective rate to meet project objectives (Standard 23, p. 77). The allowable Hazard Quotient (HQ) of application must be <1.0; if this is not possible, additional risk assessment measures must be applied. The HQ is a measure of the dose at which adverse health effects are possible. The application rate proposed (Table 3.6.1, Table A-1) ensures that the HQ is at acceptable levels for human and wildlife exposure for all likely methods of use for this project.

FIFRA does not regulate other ingredients included in formulations with the active ingredient. Some of these other ingredients, usually labeled "inert," may not be chemically inert. Surfactants are of particular concern, and may be toxic in some applications. Surfactants are chemicals used to enhance spray spreading, wetting, and retention on leaf surfaces, and enhance penetration of the active ingredient (herbicide) into plant tissues (Shepard, Creighton et al. 2004). Surfactants are typically of low toxicity to terrestrial organisms, but may pose risks to aquatic organisms (Tatum 2004).

Modern herbicides, particularly those used in forestry applications, are designed to target plant functions such as simulating plant hormones or disrupting photosynthesis; for this reason, they have low toxicity to animals (Tatum 2004). Acute toxicity and teratogenicity (causing fetal malformations) are the main concerns when evaluating herbicide effects for silvicultural uses; these are effects that may occur after a single exposure or exposure for a short period of time (Tatum 2004). After conducting an overview of the literature, Shepard et al. conclude, "at recommended rates and normal use scenarios, herbicides used in forest management operations pose little if any acute toxicity hazard to wildlife species, are not mutagenic or oncogenic, and are rapidly eliminated from animal systems once ingested/absorbed" (Shepard, Creighton et al. 2004). Since forest herbicides are not reapplied frequently (compared to agricultural uses, where reapplications occur about twice annually), chronic toxicity, reproductive effects, or carcinogenicity are generally not a concern. None of the herbicides considered (glyphosate, imazapyr, or triclopyr) have any evidence of endocrine disrupting effects (Tatum 2004).

In addition to concerns about direct effects to humans and wildlife, commenters have expressed concern about the effect of herbicides on water and air resources, and how those effects may impact human health. In Kentucky, best management practices (BMPs) recommend streamside management zones (SMZs) to be at least 25 feet on each side of perennial and intermittent streams; the Area Plan Standard for herbicide use exceeds this by requiring that no herbicides are applied for at least 30 feet on each side of a stream or from a shoreline. The SMZ may be increased based on slope (10 feet increase for every 5% increase in slope, up to 40%) (Michael 2004). All Area Plan standards would be followed when using herbicides on LBL.

Regarding the effect of herbicides on air quality, the proposed use would have spatially and temporally limited impacts. No aerial applications are proposed. Area Plan standards limit the use of prescribed fire after application of herbicides in order to minimize air pollution. Prescribed fires less than 500°C (which prescribed fires on LBL are (Koontz 2008)) have been shown to volatilize large amounts of some pesticides into the air; however this does not increase risk of adverse human health impacts (Neary, Bush et al. 1993). Glyphosate does not evaporate easily, but when treated vegetation is burned it can transform to a form that converts to phosphoric acid in water (USDA Forest Service 1997).

Glyphosate

Glyphosate is a non-selective herbicide used on both food and non-food crops in the U.S. (US Environmental Protection Agency 1993). It is the most used herbicide in the U.S. (Kiely, Donaldson et al. 2004). Overall, the EPA classifies it as Toxicity Category III (Category I is the highest degree of acute toxicity, Category IV is lowest), meaning that glyphosate is slightly toxic. Negative effects to animals have been found only at the highest doses used in lab tests, doses higher than what would be encountered in the environment. Glyphosate is non-carcinogenic, non-volatile, and rapidly eliminated from the body (US Environmental Protection Agency 1993). It is unlikely to cause reproductive or teratogenic effects, it does not bioaccumulate in mammals, and it has very low levels of bioaccumulation in birds, fish, and aquatic invertebrates ([Extoxnet] Extension Toxicology Network 1994; USDA Forest Service 1997). It is classified as practically non-toxic to fish, mammals, aquatic invertebrates, amphibians, and honeybees (US Environmental Protection Agency 1993; USDA Forest Service 1997; Tatum 2004; Richardson and Bloemer 2007), and is slightly toxic to birds (Tatum 2004).

In the environment, glyphosate strongly adsorbs to soil particles, making it unavailable to wash into streams easily. It does not break down easily in water or by sunlight, but soil microbes readily break it down (US Environmental Protection Agency 1993; [Extoxnet] Extension Toxicology Network 1994; USDA Forest Service 1997; Durkin 2003). No long-term effects to soil animals or microorganisms have been found after 6 months post-application; however, short-term (<30 days) effects have been noted. The greatest impacts to the environment may be adverse effects to non-target plants, since this herbicide is non-selective and can be used to kill broadleaf plants, grasses, deep-rooted perennial weeds, some broadleaf trees and shrubs, and some conifers (US Environmental Protection Agency 1993; [Extoxnet] Extension Toxicology Network 1994; USDA Forest Service 1997). Additionally, some surfactants used with glyphosate may be slightly to moderately toxic to fish, amphibians, and invertebrates, and irritating to skin and eyes of people (USDA Forest Service 1997; Richardson and Bloemer 2007). For this reason, some formulations of glyphosate approved for aquatic use contain no surfactants.

Triclopyr

Triclopyr is a selective herbicide used to target woody and broadleaf plants. It is used primarily in forests, rights-of-way, industrial lands, grasslands, and parklands. It is available in two forms: TEA or BEE. The EPA has placed it in Toxicity Category III, slightly toxic. Like glyphosate, negative effects to mammals only occurred during lab tests at the highest doses. Triclopyr has no reproductive toxicity, is not teratogenic, and is unlikely to be mutagenic or carcinogenic. It is rapidly eliminated from the body, and is unlikely to bioaccumulate in aquatic organisms ([Extoxnet] Extension Toxicology Network 1996), although it may be slightly bioaccumulating in other organisms (Ganapathy 1997). It has been classified as practically nontoxic to birds, fish, and aquatic invertebrates, nontoxic to bees, and slightly toxic to mammals ([Extoxnet] Extension Toxicology Network 1996; Tatum 2004). The BEE formulation is more toxic to fish than the TEA formulation ([Extoxnet] Extension Toxicology Network 1996). Triclopyr has not been extensively tested on amphibians, but generally fish are more sensitive to herbicides than amphibians, so it is unlikely that triclopyr is toxic to amphibians (Durkin 2003; Tatum 2004). Triclopyr has been found to adversely affect tadpoles, but has been shown not to affect amphibian reproduction in one study (Richardson and Bloemer 2007).

In the environment, triclopyr has the potential to move through the soil during storm events that occur after application. It does not bond readily to soil, but is degraded by soil microorganisms ([Extoxnet] Extension Toxicology Network 1996; Ganapathy 1997). Its movement into the water supply is limited, however, because it bonds readily to leaf litter and organic matter in the soil, where it is then degraded (Ganapathy 1997). It may remain on foliage (including that which may be consumed by people) for up to six months, but if consumed, it is rapidly eliminated from the human body (Ganapathy 1997; National Pesticide Information Center 2002).

Imazapyr

Imazapyr is normally used to control woody vegetation. It can be applied year-round; its use is not restricted to actively growing plants. The EPA has classified it under Toxicity Category IV, practically non-toxic (National Institute of Environmental Health Services 2002). Acutely, it is practically non-toxic to mammals, fish, birds, and bees (National Institute of Environmental Health Services 2002; Durkin and Follansbee 2003; Tatum 2004). It has not been tested on amphibians, but is likely to be practically non-toxic because that is how it is classified for fish (Durkin and Follansbee 2003; Tatum 2004). Imazapyr does not bioaccumulate (National Institute of Environmental Health Services 2002; Tatum 2004).

In the environment, imazapyr has the potential to move through soil into groundwater and in soil runoff, but it is not shown to move extensively in field studies (National Institute of Environmental Health Services 2002; Tatum 2004). It does not bind to soil particles or organic matter, but it degrades rapidly in water exposed to sunlight (National Institute of Environmental Health Services 2002; Tatum 2004). One study applied up to 100 times the normal prescription rate of imazapyr to a forested wetland; the result was no adverse effects to taxa richness or total abundance of all taxa (Michael 2004), indicating that imazapyr is relatively benign in the environment.

Effects

Alternative 1 – No Action

Direct, Indirect, and Cumulative Effects

No herbicides would be used in forests in the project area under this alternative, and so effects to human health would be no more than they are currently. Herbicides would continue to be used in open lands in the project area and throughout LBL. Effects associated with this use have been evaluated under the 2007 OLREA.

Alternatives 2 and 3 – Proposed Action and Modifications

Direct, Indirect, and Cumulative Effects

Appendix 1 contains the hazard quotients for the proposed application rates of glyphosate, imazapyr, and triclopyr.

Herbicides are proposed to be used in the same acreage per year under these two alternatives, so they are considered concurrently here. Each herbicide has very limited acute toxicity to humans and all wildlife assessed, including both aquatic and terrestrial organisms. Glyphosate and triclopyr have limited mobility in soils, and are unlikely to move to or contaminate groundwater or surface waters in streams and the adjacent lake. Imazapyr has more soil mobility than the

other two herbicides, but rapidly degrades in water. Air quality impacts would be minimal, because no herbicide would be sprayed aerially, and the ground spraying proposed would result in only short-term and short-distance aerial exposure. Therefore, the primary adverse effects of these herbicides would be to plants, which may then affect the habitat of animals. Herbicides are proposed to control non-native invasive species in the project areas; these species outcompete native plants in many cases. Short-term losses to overall vegetative coverage of portions of the project area would be offset by long-term benefits to native vegetation that would be realized as a result of herbicide use.

If necessary to treat infestations of NNIS, only formulations of glyphosate or imazapyr approved for aquatic use would be used in streamside management zones or sensitive riparian areas, if necessary. Aquatic formulations would only be used in accordance with Area Plan Standard 20.

Herbicides beside those proposed for the Demumbers Creek project would continue to be used in the open lands in the project area and throughout LBL. When herbicide applications within open lands are considered, the total acreage to be treated within the project area would be approximately 800 acres maximum. A detailed analysis of herbicide use in open lands was considered in the 2007 OLREA. Most herbicides, when used at the same time, have additive effects, meaning that the combination of two or more is a sum of the effects of each, rather than synergistic effects (toxicity of the combination is greater than additive); synergistic toxicity is rare (Shepard, Creighton et al. 2004; Tatum 2004). The proposed application rate and method, with no retreatment to occur before the previous treatment has had time to degrade and dissipate in the environment, would minimize the effects to soil, water, and biological resources.

Recreation and Environmental Education

Dispersed Recreation

Affected Environment

Existing conditions inside the proposed action area for recreational opportunities are similar to any other undeveloped areas of LBL. Recreational opportunities within the project area are limited to dispersed recreation since there are no developed recreation facilities or trails within this project area. The dispersed recreation activities that exist within the project area include backcountry camping, fishing, hunting, and scenic and wildlife viewing. Currently, there is no developed interpretive or environmental education program designed for this area.

Other than Road 108, which intersects the lake in two locations, the existing Forest Service roads within the project area provide low levels of wildlife and scenic viewing opportunities due to the enormous amount of vegetative visual barriers and the lack of wildlife habitat for watchable species (e.g., deer, turkeys, eastern bluebird and a diversity of other songbirds). The project area is mainly utilized by hunters and backcountry campers. The whole project area has been heavily impacted by downed trees and woody debris which make this area complicated to access and even more complex to navigate. The Demumbers Creek Roads Analysis concluded that Forest Service Roads 303 and 304 (total 2.25 miles) have deteriorated enough so they are almost inaccessible to most vehicles; other roads in the project area are accessible with either a passenger car or a high clearance vehicle. There is a popular user created dispersed waterfront backcountry campsite with a short unauthorized road off Road 120 on the east side of

Demumbers Bay. There are backcountry campsites on Roads 120-A and 120-B. Vegetation has grown up making it difficult to access 120-A.

Effects

Alternative 1 – No Action

Direct Effects

Roads within this project area are heavily traveled by forest users seeking a variety of dispersed recreation opportunities. If there is no action in the project area, several areas would remain obstructed, unhealthy trees would remain, and dense vegetation would remain along heavily traveled roads. No new recreation opportunities would be created.

Indirect Effects

The no action alternative would result in a continuation of dispersed recreation. Unhealthy trees would die and create safety hazards, as well as visual pockets of dead trees, which would increase along the scenic byway and heavily traveled roads. Non-native invasive species would outcompete the native and desired non-native wildflowers in the project area, including along the scenic corridor. Visitors would have limited access over time due to the dawned material.

Cumulative Effects

The net change for dispersed recreation is likely to be negligible. Visitors would continue to use areas throughout LBL for recreation, even though those visitors may not visit the Demumbers Creek area at as high a rate as now. Non-native invasive species would outcompete the native and desired non-native wildflowers along the scenic corridors. Lack of new recreation opportunities and difficulty accessing the project area may result in loss of interest from forest users resulting in a negative economic impact to local and private industries.

Alternative 2

Direct Effects

In order to meet the purpose and need of this project, proposed actions such as prescribed burning, shortleaf pine regeneration, mature oak woodland thinning, and open mature forest thinning would have a direct impact on visitors during and after implementation.

During the vegetation management treatments, a limited amount of slash, limbs, and logging debris would leave some short term undesired visual impacts along Woodlands Trace and on roads heavily used by backcountry campers and hunters. The duration of these impacts depends on many factors including weather, ground contact of material, size of material, amount of material consumed during prescribed burns, and risk reduction techniques used by the logger. For example, Forest Service timber contracts require that a slash treatment zone is observed within 100 feet of level 4 and 5 roads (such as Woodlands Trace); in these zones, all slash material would lay no higher than two feet above the ground in order to reduce adverse visual impacts. The shortleaf pine regeneration treatment would also create a visual break in the existing contiguous even-aged closed canopy of mixed-hardwood pine forest which would provide visual diversity along the scenic corridor. Traffic in these areas may be slower since equipment associated with these treatments would be using these roads periodically. Safety and hazard issues may arise. Hunting and backcountry camping may be restricted in some areas

while logging activity is present since logging has historically been done during some portions of hunting seasons (generally, March15- Dec 15). Treatments in this alternative would create a wider and longer sight distance for wildlife viewing.

Prescribed burning would remove a portion of downed trees and woody debris from the forest floor and open up access for hunting. Road closures would be implemented during the prescribed burning periods. Traffic in these areas may be slower during the burn periods. Prescribed burning may also leave some undesired visual effects such as scorched and fire-weakened trees. Generally, the more immediate unfavorable impacts are necessary to achieve two major benefits: increased visual variety, and extended viewing length and width into the forest (Wade and Lunsford 1989). Popular backcountry camping sites are located within the 205 acres of project Core Area to be burned. Removal of downed woody debris and invasive species by burning would create a more desirable backcountry camping experience. Prescribed burning may leave some undesired backcountry recreational experiences in these 205 acres for those that prefer passive management in Core Areas.

Indirect Effects

Several portions of LBL would have an increase in users seeking to recreate due to closure, restrictions, and conflict with equipment associated with forest management practices in the project area. The diversity of regenerating forbs, grasses, and mast producing trees would provide food, cover, and wildlife habitat diversity. Thinning and prescribed burning would also create a diversity of wildlife habitats for several species. This increased diversity in food, cover, and shelter would enhance the opportunity of viewers to see a variety of watchable wildlife species. Existing unhealthy pine trees and downed and dead debris would be less of a safety threat to forest users. There would be a variety of recreational opportunities created in the Demumbers area. There may be a gradual increase in dispersed recreation users as a result of this increase in opportunities. The proposed actions would create the environment required for the designation of a 7-mile auto interpretive tour of ecosystem management, as described in the Environmental Education section below.

The driving tour would create a recreational and environmental educational opportunity that does not currently exist on LBL. The increase in drivers following the interpretive route may cause an increase in the traffic volume in this area. Over time, roads may require more maintenance due to higher traffic volumes. Slower driving speeds should also be expected.

Cumulative Effects

The increase in traffic from the 7-mile auto interpretive tour is not expected to be so much that access is restricted or overall traffic volume to LBL is noticeably increased. There would be an increase in native and desired non-native vegetation along the Scenic Byway and heavily traveled roads.

Alternative 3 – **Preferred Alternative**

Direct and Indirect Effects

Effects would be primarily the same as with Alternative 2. Prescribed burning would remove downed trees and woody debris from the forest floor and open up access to hunting. It would also provide a more open and navigable forest for a variety of disperse recreation users such as dispersed campers, swimmers, and fishermen. Refraining from prescribed burning in the

project's Core Area would reduce these opportunities, particularly in a very popular dispersed lake access area used for camping and swimming. Feathered edges and herbicide treatments along the edges of the open lands would create more wildlife viewing opportunities. These treatments would also provide the desired conditions for a variety of hunted wildlife species.

The addition of approximately 0.1 miles road to access a lakefront dispersed campsite provides an additional opportunity for dispersed recreation.

Cumulative Effects

Cumulative effects of Alternative 3 would be similar to those of Alternative 2. Hunting and wildlife viewing would be improved as a result of the wildlife stand improvement surrounding the open lands, since game species and wildlife demand viewing species (such as bluebirds) would be more likely to use those areas after the proposed timber thinning.

Scenery

Affected Environment

Scenery is described as the general appearance of a place, general appearance of a landscape, or features of a landscape.

The scenery along the travel ways of the Demumbers Creek area is natural-appearing. These travel ways are dominated by oak and hickory species with small pockets of pine on both sides of the road. The existing landscape character consists of gently rolling terrain blanketed by an almost continuous canopy of soft-textured, rounded tree forms, creating a natural-appearing landscape character. The tree canopy is broken only by stream courses, drainages, wildlife openings, a utility corridor, small ponds, cemeteries, and scattered patches of coniferous evergreen trees. Scenic integrity has been modified by the most recent ice storm (winter 2009) , resulting in unhealthy trees being left with damaged crowns, broken tops, and large amounts of downed woody debris throughout the understory. Although there is a diversity of deciduous trees and shrub species, they are intermixed to the point that there is a consistency in vegetative scenic effect from aerial and on-the-ground views. Vegetation density in this area prevents most views beyond immediate foreground (from observer to 300 ft). Seasonal variation presents changes in the depth of views from immediate foreground during leaf-on to foreground views (from observer to ½ mile) during the leaf-off season. There are several springs and creeks scattered throughout the project area that provide intriguing sights and sounds that vary depending on the volume of the water, how fast it is moving, and the speed in which the observer is traveling. Cultural features, in the form of cemeteries, exist within the project area. There are four cemeteries scattered through this area that are easily visible from the roadways.

LBL's scenic resources are managed in accordance with the Area Plan Corridor Management Plan, and the guidelines of **Landscape Aesthetics: A Handbook for Scenery Management** (USDA Forest Service 1995). As established in the Area Plan, a Scenic Integrity Objective (SIO) of Moderate or higher would be applied to any new management activities within Visual Quality Zones. Scenery along Woodlands Trace would be managed according to the scenic byway management plan.

Effects

Alternative 1 – No Action

Direct and Indirect Effects

This alternative would have no immediate effect on scenery and visual resources. Over time there is a potential for damaged, unhealthy, and overstocked trees to become more susceptible to insects, diseases, and natural disasters. The dead and dying trees along heavily traveled roads would be acceptable to some forest users and unacceptable to others. The existing unhealthy trees within the project area would continue to present themselves as hazards. There would be no new sightseeing and wildlife viewing opportunities created as a result of this alternative. If there is no action in the project area, downed and dead trees would remain in the understory and dense vegetation would continue to prevent most views from immediate foreground.

The no action alternative may result in a continuation of illegal road use in the project area.

Cumulative Effects

The net change for the scenery and visual management is likely to be negative for most people. As the condition of the trees the along roads continue to decline, so would the visual quality and diversity. The lack of fire and the increased sunlight on the forest floor would lead to a dense forest understory and mid-story. Wildlife viewing along these roads would decrease with the lack of browse. Eventually the end result would be a vegetation tunnel effect along these roads, resulting in a decline to visual quality in the northern part of LBL.

Alternative 2

Direct Effects

In order to meet the objectives of the proposed action, there would be short-term visual impacts. There would be a limited amount of slash, limbs, and logging debris that would leave short term negative visual impacts along some heavily traveled roads. The duration of these short term impacts depends on many factors including weather, size of material, amount of material consumed during prescribed burns, and risk reduction techniques used by the logger.

Any active timber sale units along FSR 108, 117, 119, 112, 113, and Woodlands Trace would have clear and highly visible safety signs that inform visitors of potential timber sale traffic. A Visual Quality Zone (VQZ) of 100 feet would be applied to harvest areas adjacent to these roads, as required by the Area Plan. Within hardwood forests in the VQZ, collection of small diameter biomass (trees under 6” at dbh) is acceptable, but biomass would not be collected from shortleaf regeneration areas within the VQZ so that it may provide a visual buffer. This would give the desired transition between the shortleaf pine regeneration treatment and the adjacent hardwood forest. Trees harvested within the VQZ should focus on increasing aesthetics, reducing road maintenance costs, and reducing safety hazards. Within the VQZ, slash treatment, stump heights, landing locations, temporary road design, and directional felling should consider aesthetics and be delineated by contract during the timber sale process. There may be accumulation of biomass along roads other than Woodlands Trace during implementation of any timber sales in the project area. Design criteria described in Chapter 2 would minimize effects to visual quality within VQZs.

Prescribed fire would also have a direct visual impact on the project area. Prescribed burning may leave some undesired visual effects such as scorched trees and fire weakened trees. Generally, the more immediate unfavorable impacts are necessary to achieve two major benefits - increased visual variety and increased visual quality (Wade and Lunsford 1989).

Indirect Effects

The desired long-term effect would be a natural appearing, aesthetically gratifying, safe, and healthy forest with an abundance of species diversity.

The various vegetation and prescribed fire treatments would create the desired forest health, species diversity, texture, and patterns that were once present, while preserving the existing natural landscape characteristics. Removal of non-native invasive species would increase the diversity of native herbaceous vegetation, leading to a broad array of colors and textures in the forest floor during all seasons rather than the uninteresting monoculture that often occurs with infestations of invasive species. Varied patterns of sunlight and shade would alternate as users drive along the roads in the project area, and visible wildlife species, especially songbirds, would vary in different areas along the drive. Visible differences between managed and unmanaged areas would be apparent on either side of the road (FSR 119 and 120) for years to come, and visitors could begin to imagine what the history of the land is.

Pine species would be different than other areas at the north end of LBL, and shortleaf pine stands would appear more natural than the monoculture of neat rows of spindly pines in existing plantations.

Removal of biomass would not be noticeable from the roads, because it occurs primarily in the forest interior. Users walking through treatment areas would notice that there was less slash and debris on the forest floor than a typical timber treatment, and the effects of timber removal would be less noticeable over time compared to a typical timber harvest.

Cumulative Effects

The net change for the scenery and visual management is likely to be positive. The proposed treatment would result in an open diverse forest with a variety of plants in a lush understory with a healthy over story. Visitors driving the roads would be able to see deep into the woods with greater opportunity for wildlife viewing and scenic diversity, thus adding to the scenic experience in the northern part of LBL.

Alternative 3 – **Preferred Alternative**

Direct Effects

Effects would be similar to Alternative 2 except in the WSI areas (180 acres), core areas (205 acres) and cane restoration areas (10 acres). Alternative 3 would immediately affect visual resources in this area. The wildlife stand improvements along the open lands would result in more wildlife viewing opportunities. Desired condition for several watchable wildlife species (for example, eastern bluebirds, wild turkeys, and deer) would be created or improved. Herbicide treatments along the edges of the open lands may cause some short term visual impact. There would be temporary adverse views as non-native vegetation turns brown as a result of herbicide treatment; however, there would be a flush of native wildflowers and grasses filling those areas that would make edges of open lands more attractive. Canebrake restoration

within existing open lands add to the diversity of native open lands early successional habitat that would be seen from Road 120.

Indirect Effects

Effects would be similar to Alternative 2. Wildlife stand improvement and prescribed fire treatments would enhance the desired species diversity, increase wildlife viewing opportunities, and enhance visual quality along open lands, which are areas more easily accessed by visitors than closed canopy forest. Visitors moving through open lands would be able to see farther into the forest. Over time, native wildflower diversity and abundance would respond to the increased light conditions, prescribed burning, and reduction of non-native invasive species, adding color and texture to the landscape. Songbird diversity and abundance would increase in the WSI zone, attracting birdwatchers and other visitors to the area to hear and see the various birds. The existing natural landscape characteristics would be preserved.

Cumulative Effects

The net change for the scenery and visual management would be similar to Alternative Two. The proposed treatment would result in an open diverse forest with a variety of plants in a lush understory with a healthy over story. Visitors driving the roads would be able to see deep into the woods with greater opportunity for wildlife viewing and scenic diversity in the northern part of LBL.

Environmental Education

Affected Environment

The affected environment for environmental education is similar to what is described under Dispersed Recreation above. There are no environmental education programs in the project area currently.

Effects

Alternative 1 – No Action

Direct and Indirect Effects

Under this alternative, no changes would be made to the environmental education program in the project area. There is currently no environmental education program for the Demumbers Creek area, and no need for a program would exist. There would be no vegetation treatments, and therefore nothing to compare and contrast with existing conditions or Core Areas.

Cumulative Effects

Cumulative effects of each alternative are discussed under the Socioeconomic section below.

Alternative 2

Direct and Indirect Effects

A self-paced interpretive driving loop would be developed under this alternative (Map 4). The loop would guide visitors to see areas where different forms of forest management have occurred, and compare those areas to Core Areas where no forest management has occurred or

is planned. Visitors could see changes to forest structure and plant species composition; they could compare areas with infestations of NNIS to those that have been restored to native plant conditions. Visitors could learn what the difference between an oak woodland, open oak forest, regenerating forest, and closed canopy forest looks like. They could see a rare and declining community: shortleaf pine forest. They could compare newly developed forest and woodland conditions with a forest approaching old growth conditions. School groups could come out for an informal field trip or formal lecture on the different aspects of forest management.

Cumulative Effects

Cumulative effects of each alternative are discussed under the Socioeconomic section below.

Alternative 3 – **Preferred Alternative**

Direct and Indirect Effects

The effects of this alternative would be very similar to those in Alternative 2. The self-paced interpretive driving tour would be the same (Map 4). The primary difference in this alternative is that along the driving loop, visitors would be able to see further into the forest around open lands as a result of the WSI treatments that would occur there. The WSI treatments would encourage more wildlife to inhabit the edges of open lands. Information about these wildlife could be integrated into the driving tour interpretive materials.

Cumulative Effects

Cumulative effects of each alternative are discussed under the Socioeconomic section below.

Cultural Resources

Affected Environment

In 2005, following consultation with the Tennessee and Kentucky State Historic Preservation Offices (SHPO), LBL began to create, and has since been testing and modifying, standardized survey strategies for routine undertakings (projects/activities) and protocols for emergency conditions and situations. Earlier versions of the strategies and protocols (which continue to be modified as a result of lessons learned during implementation) are included in a draft Heritage Programmatic Agreement (PA) which is under review by the public and 16 consulting parties.

The following strategies and protocol were implemented for the current investigation:

- Prescribed Burn Survey Strategy
- Timber and Other-Ground Disturbance Survey Strategy
- Dangerous Conditions Protocol

Two reports for the above Demumbers Creek investigations were submitted to the Kentucky SHPO for review and comment in May 2011.

In addition to the current investigation, five previous surveys have been conducted within the Demumbers Creek area of potential effect (APE) and 40 sites were identified as a result of the previous surveys, although none of them were officially recorded (Table 3.8.1 and Figure 8).

In addition to researching previous professional investigations, maps of the Demumbers Creek project area were shared with a group of former residents who marked locations of sites that were of cultural significance to them. While the site locations they noted were in the LBL heritage database, many of the site names they provided were not.

Table 3.8.1. Previous archaeological investigations conducted within the current project APE.

Author	**Year**	**Title**	**Results** **(within current APE)**
Nance	1972	A Summary of Work and Assessment of Archaeological Resources in the LBL (R-8)	1 prehistoric site
Nance	1973	LBL Archaeological Project: Phase II Archaeological Sites Discovered in 1973 (R-11)	4 prehistoric sites
Merritt	1997	1997 Timber Harvest (R-47)	0 sites
Bennett	2006	Alley Tornado Salvage Sale (R-113)	4 historic sites
Bennett	2011	Demumbers Preburn Survey (R-224)	31 historic sites

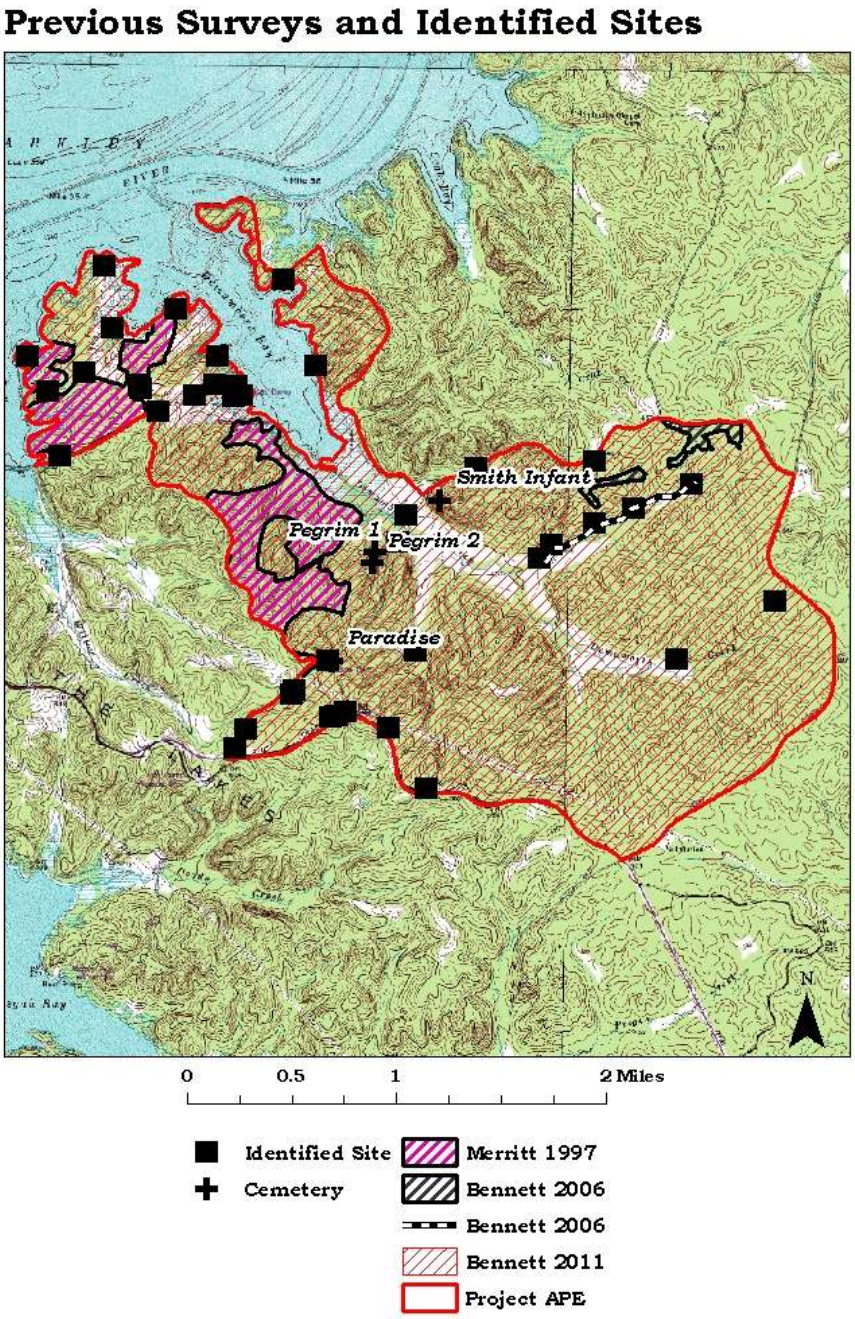


Figure 8. Previous surveys and identified sites within the current project APE.

Prescribed Burn Survey

The preburn portion of the prescribed burn survey was completed prior to the rest of the

investigation and the results were submitted to the Kentucky SHPO for review as a separate report (Bennett 2011). Based on historic maps and records, thirty-nine historic sites were tentatively identified. The 39 sites were examined in the field and preliminarily documented in order to determine whether they contained significant features and/or components that could be damaged by a prescribed burn. Of the 39 sites visited, only 5 features were identified as features to be flagged and protected during prescribed burns. In addition, there are 4 cemeteries within the project APE and that will be flagged and protected during prescribed burns (Table 3.8.2 and Figure 9).

Table 3.8.2. Summary of flagged and protected historic features and cemeteries for prescribed burns within Demumbers Creek APE.

Site #	**Flagged Feature**
LBL-135	Remains of bottom pier of log foundation
LBL-1249	Cedar gate post with metal hinge
LBL-1461	Standing outhouse
LBL-2237	Remains of collapsed double-pen log house
	Remains of log barn
Cemeteries	
Pegrim 1	
Pegrim 2	
Smith Infant	
Paradise	

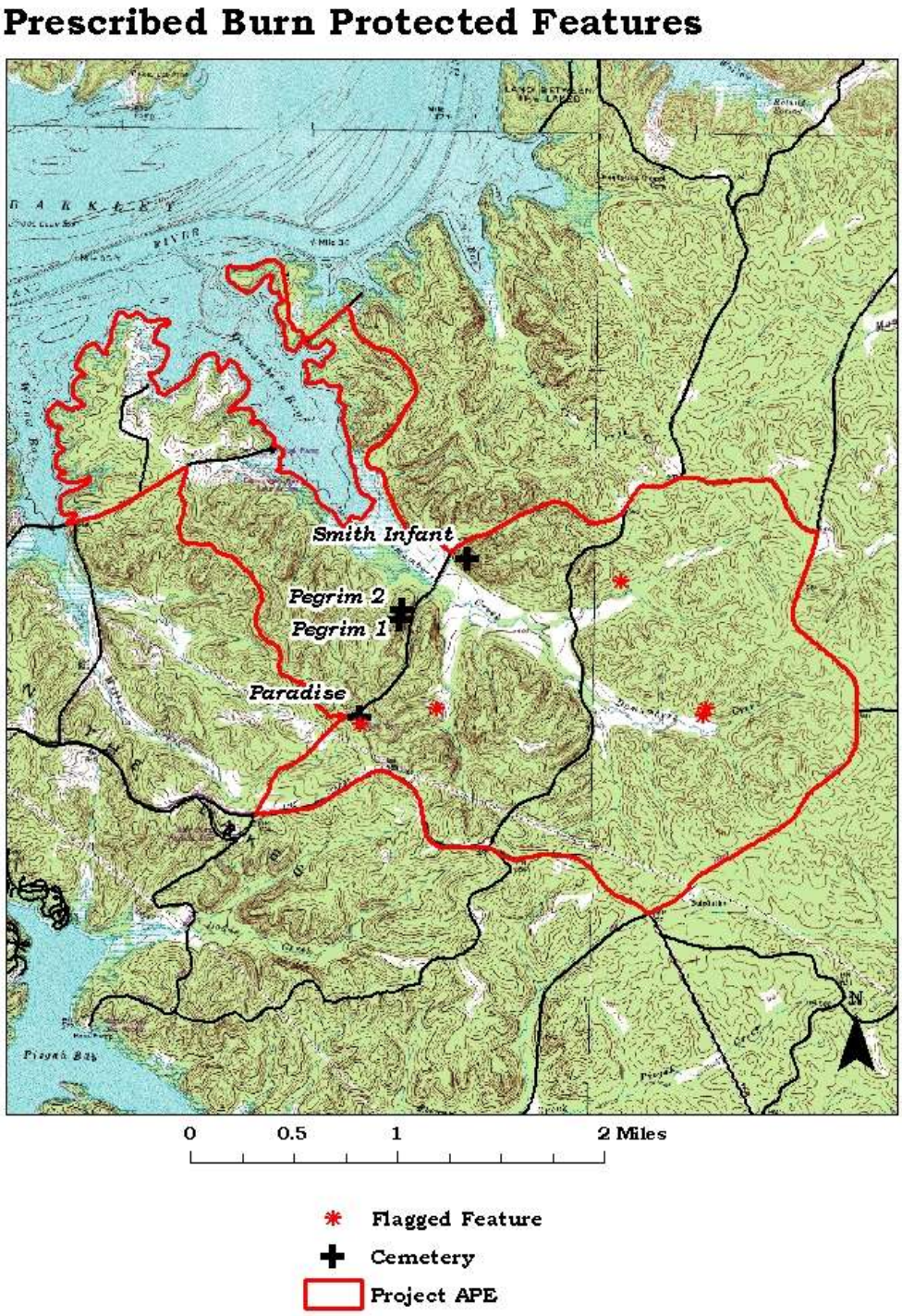


Figure 9. Historic features and cemeteries that will be flagged and protected during prescribed burns.

Timber and Other Ground-Disturbance Survey

This survey strategy was originally applied to both the proposed timber treatment and canebrake restoration areas since both projects involved ground disturbance in forested environments. Shortly after the survey was initiated, the proposed canebrake restoration areas were moved to

10 acres (5 fields) within the Demumbers open lands and their survey is discussed in its own section below.

After completing tasks 1-6 of the timber strategy, a map of potential shovel test transect lines was created using the heritage GIS model and loaded onto a navigational GPS in order to set pin flags to mark shovel test locations in the field. However, it was soon discovered that the storm events that had created the need for the proposed project activities also created field conditions that made the timber survey strategy extremely hazardous. After consulting with the Kentucky SHPO, a decision was made to abandon the timber survey strategy and implement the Dangerous Conditions protocol developed for situations where field conditions are too hazardous to safely carry out the standard survey strategy. (Protocol is available in the project record.) LBL has implemented and tested the Dangerous Conditions protocol during compliance for two other, unrelated projects; one in the Kentucky portion of LBL (Bennett 2009) and one in the Tennessee portion of LBL (Bennett 2008).

Even though the proposed timber treatment units could not be surveyed, 14 of the 40 known sites within Demumbers Creek that are within or immediately adjacent to proposed timber treatment units and/or access routes were recorded during this investigation (Figure 10).

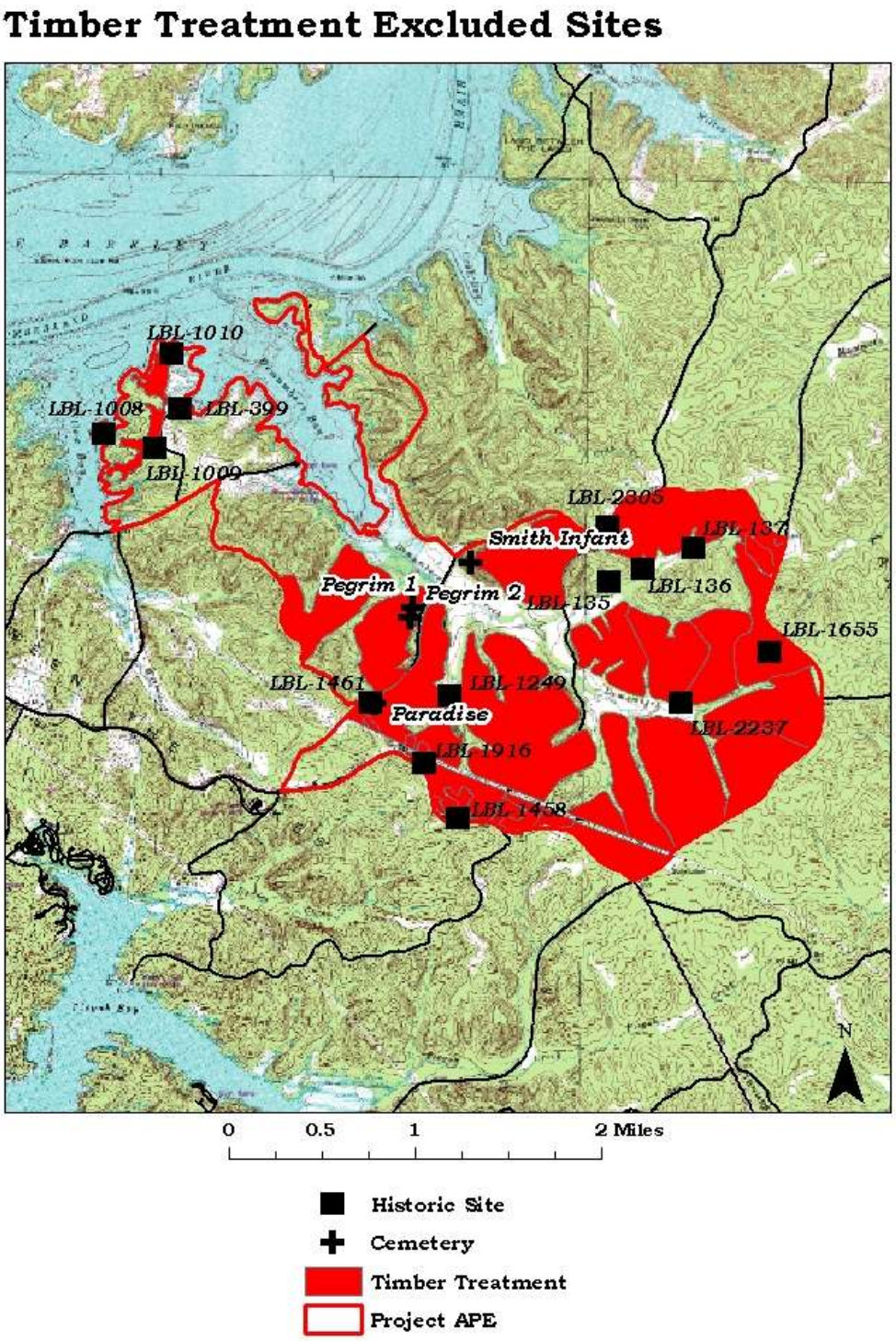


Figure 10. Sites recorded within and adjacent to Demumbers Creek timber treatment units.

Dangerous Conditions Protocol

Since the Demumbers Creek APE encompasses an LBL land type (open lands) that is not forested and so does not present the same dangerous field conditions, we felt that we could

modify the protocol to include survey of this land type even if no project activities would take place in those locations. Adding survey of the open lands was a particularly attractive addition to the protocol because the open lands within the Demumbers Creek APE; a) had never been surveyed, b) are part of a long-term agreement with both SHPOs to be surveyed as a result of an earlier compliance agreement (*Open Lands Heritage Survey Plan* R-137), c) would satisfy the need to survey for the new canebrake restoration undertaking locations, and d) have a high potential for containing significant historic properties. Following consultation with the Kentucky SHPO, LBL heritage staff modified the current dangerous conditions protocol to add a new task which would allow for survey of open lands. (Protocol is available in the project record.)

Demumbers Open Lands Survey

The Demumbers Creek APE contains 35 open land fields totaling 159 acres (Map 2). LBL open lands are one of several land allocation types LBL manages under the requirements of the 2004 Land and Resource Management Plan (LRMP). Open lands at LBL are managed for three desired conditions: to provide for the orderly growth and development of desirable stages of early plant succession, to meet wildlife habitat needs, and to provide opportunities for outdoor recreation and environmental education.

Survey methods were evenly divided between open lands where pedestrian survey (11 fields, 79 acres) was conducted and those that were shovel tested (24 fields, 79 acres). All of the fields that were pedestrian surveyed are cultivated fields and planted in a rotation of corn and soy beans. Shovel testing was conducted on both cultivated open land fields and fields that have a year-round growth of warm and cold season grasses and hayfields.

Only one site was recorded as a result of pedestrian survey (15Ky147/LBL-166). The site is one of the prehistoric sites originally documented by Jack D. Nance in 1972.

No new sites were identified as a result of shovel testing in the Demumbers open lands; artifacts were found but not sites. The prehistoric artifacts found were widely scattered single items except for in the case of 2 of the open lands fields. The positive prehistoric results at these two fields will lead to future testing. Recovery of 14 historic artifacts did not help to identify any new unknown historic sites but they did confirm the presence of nearby sites known from historic maps and/or literature research.

Canebrake Restoration Survey

As a result of interdisciplinary team field analyses, the location for canebrake restoration is proposed to switch from timber treatment areas along the shoreline of Willow Bay (Alternative 2) to approximately 10 acres of open land fields (preferred alternative – Alternative 3). Five fields were chosen as good candidates for canebrake restoration and all but one of the five fields were shovel tested during open lands survey. Two fields were negative for both prehistoric and historic, 2 fields had one prehistoric artifact each (chipped stone flakes), while the only field that was pedestrian surveyed contained both historic and prehistoric artifacts: 2 flakes and 2 whiteware ceramic sherds.

Normally, the presence of the artifact types found during the pedestrian survey would not warrant immediate further testing since LBL open land fields have been subjected to the same sort of ground-disturbance for some time, having been farmed for at least 50 years under federal

agency management and probably much longer by former residents of the area. But in this instance, land use and management would change if canebrake restoration takes place in this field. Add the fact that both historic and prehistoric artifacts were discovered within the field during pedestrian survey and the fact that a historic site was recorded nearby during the investigation, subsurface testing became a necessity. However, only one brick fragment and two small brown glass shards from a modern beer bottle were found during shovel testing.

Effects

Survey of federal lands is required under both Section 106 and Section 110 of the NHPA. In order to identify cultural resources, survey is the first step in heritage resource management. Surveys conducted as part of the Section 106 compliance process also contribute to fulfilling the Section 110 survey requirements and the reality is that Section 106 surveys tend to be a high priority since federal projects cannot proceed until Section 106 compliance is completed. Systematic investigations over the last 6 years as a result of Section 106 compliance have shown that the number one impediment to site identification and baseline documentation and recordation is unchecked vegetation.

Under the National Historic Preservation Act (NHPA), an adverse effect is one which may diminish the integrity of an historic property's (cultural resource/site, historic or prehistoric site, heritage resource) location, design, setting, materials, workmanship, feeling, or associations (36 CFR 800.9[b]). Heritage resources can be adversely affected in three distinct ways. The first is the physical destruction, damage, or alteration of all or part of a resource. The second is isolation of a resource from its setting or alteration of the character of its setting. The third is the introduction of visual, audible, or atmospheric elements that alter the setting or are out of character with it.

There are only three proposed actions in the Demumbers Creek EA that have the potential to affect significant historic properties: prescribed burning and the timber treatments and canebrake restoration, with the latter two being ground-disturbing activities.

In an agreement with the Kentucky and Tennessee SHPOs, all sites are treated as eligible for listing on the National Register of Historic Places and therefore as historic properties until such time as LBL can begin to conduct formal site significance evaluations. The term historic property is a legal term defined as:

> *any prehistoric or historic district, site, building, structure, object or historical/cultural landscape included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. The term includes artifacts, features, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or native Hawaiian organization and that meet the National Register criteria per the definition in 36 CFR 800.16(l).*

For ground-disturbing activities, all historic properties are flagged, protected, and avoided during project implementation and monitored for impacts as necessary during but always after project implementation. This means that ground-disturbing projects will have no effect, positive or negative, on historic properties since they are excluded from project areas and as long as the conditions set out in the compliance report submitted and reviewed by the Kentucky SHPO are carried out (see Appendix 2 for Demumbers Creek project conditions).

This leaves prescribed burning as the only proposed activity that could affect significant historic properties. Interestingly enough, it is also the only routine project activity at LBL that can have

a beneficial effect on historic properties since it offers the opportunity to get vegetation, under control. Prescribed burning can remove vegetation from sites that do not contain any components or feature that would be harmed. Five years have been spent improving the prescribed fire survey strategy in order to effectively protect sites that contain features or components that could be lost. That protection includes removing fuel vegetation prior to the burn. The only time that fire has an adverse effect on sites at LBL is when it is an uncontrolled fire, such as wildfire.

Alternative 1 – No Action

Direct and Indirect Effects

Under the no action alternative, while the preburn survey has been completed there would be no postburn survey since there would be no prescribed burn which means that the sites identified during the preburn would not be recorded and no baseline data would be collected for them. Since dense vegetation will not be removed either as a result of the burn itself or, if there are flagged and protected features, during vegetation clearing as a protection measure prior to the burn, it is more than likely that site recording would be postponed until an affordable alternative is found to remove the dense vegetation. Because the reality is that Section 106 surveys take precedence, the remaining 25 identified new sites found during the pre-burn survey would most likely remain unrecorded and their condition unassessed for some time. In addition, any impacts that may be occurring from any human or natural causes would continue and less would be known about the location, type, number and condition of heritage resources within the project APE. Most importantly, knowledge of past human use and occupation of the landscape would remain unknown.

The objective of preburn survey is to identify those sites and features that contain materials that could be adversely impacted by a moderate prescribed burn and flag and protect them. All parts of LBL, including the project area, are subject to wildfire and, as fuels build up over time, the likelihood that a wildfire would be catastrophic increases. In the event of wildfire, there may not be time or it may not be safe to initiate and carry out protection measures at known site locations. The continued buildup of dense vegetation around site locations increases the likelihood that in the event of a wildfire, there will be an adverse impact to other features at the site as well as the loss of any remaining wooden components.

Cumulative Effects

Unless prescribed burning takes place, the cumulative effects of no action could result in the continued obliteration and degeneration of historic sites within the project area. Neglect and vegetation growth have had the most damaging impact on the prehistoric and historic sites and the no action alternative would be more of the same.

Alternative 2

Direct and Indirect Effects

The survey strategies and protocol developed in consultation with the Tennessee and Kentucky SHPOs and which are currently being reviewed in the draft Programmatic Agreement (PA) and implemented during this investigation ensure that cultural resources that need to be protected from adverse effects are protected.

For ground-disturbing activities, all sites are flagged, protected, and avoided during project implementation and monitored for impacts as necessary during but always after project implementation. This means that ground-disturbing projects would have no effect, positive or negative, on any significant historic properties since they are excluded from the project areas and as long as the conditions set out in the compliance report submitted and reviewed by the Kentucky SHPO are carried out (see Appendix 2 for Demumbers Creek project conditions). Prescribed fire survey strategy requirements ensure that sites and features that could be impacted are found, recorded, and condition documented and those that need to be are protected during the fire. Many of the historic sites and almost all prehistoric sites are hidden by dense vegetation so any efforts to remove or decrease vegetation around sites and features help us better document sites and their condition.

The road improvement activities consisting of grading/graveling existing roadbeds are the same as currently being carried out on roads. The installation of three gates would not impede access to cemeteries since there are no cemeteries located along either of the roads proposed for gating. Cultural resources would still be accessible and the current poor road conditions would be improved.

Cumulative Effects

The cumulative effects of implementing this alternative are that over time and multiple prescribed burns, sites within the project area would become more visible and accessible. This could be recorded and baseline data collected. Continued improvement in vegetation conditions would mean easier access and offer the possibility of leading interpretive programs for the public to site locations to educate them about the prehistory and history of the area.

Alternative 3 – **Preferred Alternative**

Direct and Indirect Effects

The survey strategies and protocol developed in consultation with the Tennessee and Kentucky SHPOs and which are currently being reviewed in the draft PA and implemented during this investigation ensure that cultural resources that need to be protected from adverse effects are protected.

For timber treatment and canebrake restoration activities, all sites are flagged, protected, and avoided during project implementation and monitored for impacts sometimes during and always after project implementation. This means that ground-disturbing projects would have no effect, positive or negative, on any significant historic properties since they are excluded from the project areas and as long as the conditions set out in the compliance report submitted and reviewed by the Kentucky SHPO are carried out (see Appendix 2 for Demumbers Creek project conditions).

Prescribed fire survey strategy requirements ensure that sites and features that could be impacted are found, recorded, and condition documented and those that need to be are protected during the fire. Many of the historic sites and almost all prehistoric sites are hidden by dense vegetation so any efforts to remove or decrease vegetation around sites and features help us better document sites and their condition.

Road improvement activities recommended by the team, consisting of grading/graveling existing roadbeds, are the same as currently being carried out on roads. The installation of three

gates recommended for FS Roads 303 and 304 would not impede access to cemeteries since there are no cemeteries located along either of the roads. Obstructing access past the Lone Grave cemetery to the rest of the unauthorized road would cut down on the amount of damage to the road. Cultural resources would still be accessible and the current poor road conditions would be improved.

The herbicide WSI would have little to no impact on cultural resources and in fact is a low impact way to improve the current dense shrub, grasses, vines, and sapling vegetation conditions at site locations where NNIS vegetation has taken hold and obscured site features.

Cumulative Effects

The cumulative effects of implementing this alternative are the same as Alternative 2 except that the proposed ecotone wildlife stand improvement using herbicides along with multi-year prescribed fire would be beneficial. Herbicide treatment in the WSI would help remove more NNIS vegetation from historic sites around open land fields than prescribed fire alone. LBL's open land fields are often the same fields that were farmed historically and many farms had buildings and structures just inside the tree line around the fields. More often than not, structures are not within the fields since good cropland is not plentiful so none of it would be wasted by placing structures on it. The sites would be more open than they have been for over 50 years due to thinning the edges of forests around open lands with herbicides (WSI) and with the aid of prescribed burns.

Socioeconomic Resources

Affected Environment

The scope of this socioeconomic analysis includes: LBL's potential economic contributions to the local economy in relation to forest products; LBL's revenue generated for each alternative in relation to forest products; and the possible impact to recreation experiences from the proposed actions.

Effects

Alternative 1 – No Action

Direct Effects

If no action is taken in the project area, no change in revenue for LBL would result from the project area (Table 3.9.1). No forest products value would be contributed to the local economy.

Indirect Effects

Crown-damaged timber would depreciate forest product value over time and could further cause forest health issues, which could lead to a decrease in the quality of recreation users' experiences in activities such as hunting, backcountry camping, and wildlife viewing.

Cumulative Effects

The cumulative effects analysis is designed to reveal the context of alternative impacts within the planning area. The assumption made in our analysis of Alternative 1 is that no economic contribution would be made to the surrounding region from the Demumbers Creek project area (Table 3.9.2).

Further, no revenue would be generated from the Demumbers Creek project area for the Forest Service to aid in the cost recovery of LBL's operations.

Table 3.9.1. Estimated amount of revenue the Forest Service would receive from timber for forest products if No Action is implemented

Product	Amount (CCF)[1]	*FS product value ($/CCF)	Approximate FS revenue
Pine saw timber	0	$0	$0
Hardwood saw timber	0	$0	$0
Pine pulpwood	0	$0	$0
Hardwood pulpwood	0	$0	$0
		Total	**$0**

[1]CCF= hundred cubic feet

Table 3.9.2. Estimated amount of revenue generated by a saw mill from timber purchased from the Forest Service if No Action is implemented

Product	Amount (CCF)[1]	Mill product value	Saw Mill revenue
Pine saw timber	0	$0	$0
Hardwood saw timber	0	$0	$0
Pine pulpwood	0	$0	$0
Hardwood pulpwood	0	$0	$0
		Total	**$0**

[1] CCF=hundred cubic feet

Table 3.9.3. Estimated amount of biomass generated if No Action is implemented

Product	CCF	** Product Value	Delivered Value
Wood Chips	0	$0	$0
		Total Value	**$0**

Alternative 2

Direct Effects

Alternative 2 proposes the cutting and removal of standing timber in the project area. Some of this material has value as saw-timber, which can be converted to a variety of building materials. Another portion of the material to be removed is best suited to production of pulp fiber from which paper products may be made or for biomass alternative energy. Therefore, the material to be removed from the designated stands in the project area has value, as shown in Tables 3.9.4, 3.9.5, and 3.9.6. If captured, this value would offset expenses related to implementing other aspects of this project, such as use of herbicides (Table 3.9.7) and prescribed fire. The value of these products is greatly increased by removing them and transporting them to production mills. With the removal of the proposed timber volume, the Forest Service will spark and create a positive economic contribution to the local area.

The Demumbers Creek Transportation Analysis Report (available in the project record) contains the portion of the economic analysis that lists the short-term and long-term maintenance costs and benefits of road maintenance in the project area, for each alternative.

Indirect Effects

Specific user value experiences in activities such as hunting, backcountry camping, and wildlife viewing could increase with proposed management actions. Environmental education opportunities would be developed, which would stimulate more interest in the project area and could bring students in from regional schools. Environmental education is discussed in the Recreation section above.

Prescribed fire is a cost effective tool for reducing fuel load, and thus reducing the severity of burn effects on most resources, including soil and water. The Government Accountability Office, in 2007, estimates wildfire suppression at a national average of $317 per acre; ranging from $88 to 1,132 per acre. Prescribed fire implementation on LBL costs less than $30 per acre. Even at the low end of the wildfire cost estimate, $88 per acre, prescribed fire is more cost effective than fire suppression, and when viewed simply as a preventative measure (i.e. without considering other reasons why prescribed fire may be used) the Forest Service believes prescribed fire is a prudent use of taxpayer dollars.

Cumulative Effects

A substantial economic contribution would be made to the surrounding area within the prescribed area. For example, the proposed use of herbicides, tree planting, and road maintenance are a cost to the Forest Service that is paid into the surrounding community through contracts and retail purchases. Further, the Forest Service would earn revenue generated from the proposed timber sale to aid in the cost recovery of operations.

The proposed self-guided interpretive driving loop would increase visitation to LBL and inform the public about the benefits of forest vegetation management and wildlife habitat improvement. Increased visitation to LBL results in purchases such as gas, food, and lodging in surrounding communities.

Table 3.9.4. Estimated amount of revenue the Forest Service would receive from timber for forest products if Alternative 2 is implemented.

Product	**Amount (CCF)**[1]	***FS product value ($/CCF)**	**Approximate FS revenue**
Pine saw timber	472	$50	$23,600
Hardwood saw timber	5252	$70	$367,640
Pine pulpwood	213	$5	$1,065
Hardwood pulpwood	6547	$5	$32,735
		Total revenue	**$425,040**

[1] CCF=hundred cubic feet

Table 3.9.5. Estimated amount of revenue generated by a saw mill from timber purchased from the Forest Service if Alternative 2 is implemented.

Product	Amount (CCF)[1]	**Mill product value ($/CCF)	Saw mill revenue
Pine saw timber	472	$90	$42,480
Hardwood saw timber	5,252	$134	$703,768
Pine pulpwood	213	$24	$5,112
Hardwood pulpwood	6,547	$24	$157,128
Total amount:	**12,464**	**Total revenue:**	**$908,488**

[1] CCF=hundred cubic feet

Table 3.9.6. Estimated amount of biomass generated and delivered value over the life of the project if the Proposed Action is implemented.

Product	Volume (CCF)	*FS Product Value/CCF	Approx FS Value	Delivered Value/CCF	Delivered Value
Wood Chips	3,000	$8	$24,000	$20	$60,000

Biomass estimates are based on chipped value according to local buyers.

Table 3.9.7. Estimated cost for annual herbicide use contracts.

Maximum number of acres treated/year	600
Cost of glyphosate to treat 600 acres	$3,829
Cost of Imazapyr to treat 600 acres	$1,632
Cost of Triclopyr Acid (Garlon 3A) to treat 600 acres	$3,960
Cost of Triclopyr BEE (Garlon 4) to treat 600 acres	$3,240
Labor cost $/acre	$75
Total cost based on the most expensive herbicide option	**$48,960**

Herbicide cost based on 2011 prices from supplier for open lands management at LBL. Labor cost based on 2011 open lands work orders.

Table 3.9.8. Estimated cost for 100 acres of shortleaf pine reforestation.

Site Preparation	$7,800
Purchase of seedlings	$20,000
Labor cost for planting	$5,000
Total Cost	**$32,800**

Planting cost based on shortleaf pine being planted on 8’ x 8’ spacing which is approximately 681 trees per acre.

Alternative 3 – **Preferred Alternative**

Direct, indirect, and cumulative socioeconomic effects would be the same as Alternative 2.

IV. ENVIRONMENTAL JUSTICE

A specific consideration of equity and fairness in resource decision making is encompassed with concerns of environmental justice and civil rights. Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,” provides “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." Principles for considering environmental justice are outlined in Environmental Justice Guidance under the National Environmental Policy Act (Council on Environmental Quality (CEQ), 1997). The Executive Order also contains emphasis on potential effects of agency actions on subsistence consumption of fish, vegetation, or wildlife. The Executive Order requires agencies work to ensure effective public participation and access to information.

To fulfill these principles, environmental justice was considered throughout the EA process. During the process, no environmental issues were found in connection with the proposal having adverse environmental effects that may affect public health.

Management actions having the greatest potential for impacting human health are those that may influence air and water quality and the effects of herbicides on consumable vegetation. Chapter 3 discloses effects of the project on these resources. There are no disproportionately adverse environmental or health effects to minority and low income populations based on this project.

Subsistence fishing, vegetation, or wildlife programs are nonexistent on LBL.

V. CONSULTATION AND COORDINATION

This project complies with the Terms and Conditions of the 2010 Biological Opinion (FWS #2009-B-0084) issued by the US Fish and Wildlife Service, with exceptions noted in the Demumbers Creek Biological Assessment.

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:

- Kentucky Field Office of the US Fish and Wildlife Service
- Kentucky State Historic Preservation Office
- Kentucky Department of Fish and Wildlife Resources
- Kentucky Division of Water
- Tennessee Wildlife Resources Agency
- Dr. Chip Taylor, University of Kansas
- Dr. Lincoln Brower, Sweet Briar College
- National Resources Conservation Service
- Tribes listed below

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Eastern Shawnee
Eastern Band of Cherokee Indians
Absentee-Shawnee Tribe of Indians in Oklahoma
Choctaw Nation of Oklahoma
Cherokee Nation
Shawnee Tribe
United Keetowah Band of Cherokee

VI. APPENDICES

Appendix 1: Herbicides

Three herbicides are proposed to be used for the Demumbers Creek project: imazapyr, triclopyr, and glyphosate. The Forest Service has developed, in cooperation with Syracuse Environmental Research Associates (SERA), human health and ecological risk assessments for these three chemicals. These risk assessments were developed using an extensive review of the literature about the effects of these herbicides on people and the environment. They include worksheets that use the most updated scientific data available at the time to calculate hazard quotients, among many other statistics. Forest Service staff at LBL used these risk assessments, and also conducted a literature review for more current studies on these chemicals.

The Area Plan requires that a hazard quotient (HQ)<1 be achieved, or additional risk management must be undertaken to reduce unacceptable risks to acceptable levels, or else an alternative method of treatment must be used. For each of the proposed herbicides, application rates were chosen to ensure that the HQ<1, with the exception of human consumption of treated plants and accidental spills in some cases (Table A-1). In the case of human consumption of treated plants, a risk management measure would be adopted from the 2007 Revised Environmental Assessment for the Continued Maintenance of Open Lands (OLREA) on LBL:

> Measure 3: Preclude humans from collecting vegetation for consumption in treated fields where this may potentially occur until the risk subsides.

Measure 3 would be modified to include all treated areas (e.g., forests, fields, roadsides, etc.). In the case of accidental spills, the following risk management measure from the OLREA would be adopted:

> Measure 6: Institute rapid cleanup of any accidental spill potentially affecting water to reduce potential high concentrations in water. Preplanning should be done in such a manner that workers are fully trained in spill response, and have spill kits containing materials necessary to preclude incursion of spilled materials into water. Both the Forest Service and contract applicators have emergency spill plans in place to deal with accidental spills.

These measures were prescribed in the OLREA to reduce impacts from the same chemicals proposed for use in the Demumbers Creek project.

Chemicals in use on LBL have low persistence in the environment, meaning they degrade quickly and have a half-life in the environment of less than 6 months (USDA Forest Service 2007). The chemicals proposed for use in the Demumbers Creek project have a half-life less than three months. None of the chemicals proposed for use have a synergistic effect with each other or with any chemical currently being used on open lands in LBL (USDA Forest Service 2007). The potential effects, therefore, are additive only. The proposed application rate and method, with no retreatment to occur before the previous treatment has had time to degrade and dissipate in the environment, would minimize the effects of treatment to soil, water, and biological resources. Treatments would be coordinated with integrated pest management strategies outlined in the OLREA (p. 276) in order to minimize use of herbicides.

Table A-1. Hazard quotients at the proposed application rate of herbicides to be used in the Demumbers Creek project.

	Glyphosate	Imazapyr	Triclopyr acid (Garlon 3A)	Triclopyr BEE (Garlon 4)
Proposed application rate (max.)	2.75 lb. a.e./ac./yr	1.25 lb. a.e./ac./yr	1.25 lb. a.e./ac./yr	0.65 lb. a.e./ac./yr
Hazard Quotient (central limit at maximum exposure)				
Human (worker)	0.03	0.01	0.6	0.3
Human (general public, max. exposure)	0.9 (accidental spill in water), 0.2 (contam. vegetation)	0.3 (accidental spill in water), 0.08 (contam. vegetation)	4 (contam. vegetation), 0.8 (max. all other categories)	2 (contam. vegetation), 0.9 (max. all other categories)
Small mammal	0.4	0.1	0.3	0.2
Small mammal (insectivorous)	0.4	0.1	0.3	0.2
Large mammal	0.3	0.09	0.6	0.3
Honey bee	0.8	0.2	0.2	0.1
Small bird (insectivorous)	0.2	0.07	0.09	0.06
Large bird	0.1	0.05	0.5	0.3
Fish, sensitive (accidental spill)	19	4	NA	NA
Fish, sensitive (peak EEC)	0.04	0.0009	NA	NA
Fish, tolerant (accidental spill)	11	0.1	0.02*	9*
Fish, tolerant (peak EEC)	0.02	0.00003	0.0006	0.2
Aquatic invertebrate (accidental spill)	2	0.1	0.03	0.3

*For this chemical, fish were not divided into groups of "sensitive" or "tolerant"

Appendix 2: Cultural Resources – Section 106 Compliance Conditions

As a result of consultation with the Kentucky and Tennessee SHPOs in 2006, LBL agreed to treat all identified sites as eligible for listing on the National Register until a cultural overview with appropriate themes to help guide site significance evaluation is developed. This section describes the heritage tasks that LBL will carry out for each undertaking to ensure they will not adversely impact sites. Site protection and discovery clauses are standard in all ground-disturbing FS contracts and will be included for Demumbers contracts as well. In addition, sites will be monitored before and after prescribed burns and as necessary during and following ground-disturbing activities to document any changes in condition and ensure that sites are not impacted.

Prescribed Burn Undertaking

Five historic features and 4 cemeteries will be flagged and protected during prescribed burns (see Table 9). Heritage and fire staffs carry out protection measures for flagged features as a team. Prior to prescribed burns, the LBL Fire Management Officer will call known cemetery contacts to relay cemetery protection measures that will be implemented.

Site #	Flagged Feature
LBL-135	Remains of bottom pier of log foundation
LBL-1249	Cedar gate post with metal hinge
LBL-1461	Standing outhouse
LBL-2237	Remains of collapsed double-pen log house
	Remains of log barn
	Cemeteries
	Pegrim 1
	Pegrim 2
	Smith Infant
	Paradise

Table 9. Summary of flagged and protected historic features and cemeteries for prescribed burns within Demumbers APE.

Since the Demumbers Prescribed Burn is planned as a helicopter burn, the following protection measures will be put in place, as needed and where appropriate, to prevent any impacts from the prescribed burn:

- All fuel vegetation on and surrounding flagged cultural resources will be removed with hand tools including chain saws and leaf blowers.
- The helicopter pilot will be given the gps coordinates of every protected feature large enough to be seen from the air and yellow caution tape will be used to construct a large X across the top of the feature to increase its visibility from the air.
- If heavy vegetation could obscure the pilot's ground visibility, then fire staff will backburn around the protected feature to provide a buffer and a smoke screen that can be seen from the air.
- Fire protection material may be used on single wooden component features such as fence posts, signs, gate posts, etc.

Post-burn:

- Field visit, photograph, and complete prescribed burn condition assessments for all flagged and protected cultural resources and all cemeteries within 60 days of burn or before leaf-out, whichever is sooner, in order to monitor effectiveness of protection measures.
- Should any flagged and protected cultural resource be inadvertently adversely affected, LBL Heritage Program Manager (HPM) will immediately consult with the appropriate State Historic Preservation Office (SHPO).
- If any cemetery is found to have been adversely impacted, the LBL HPM and FMO will immediately contact any known cemetery representatives.
- Within 6 months of the burn or before leaf-out, whichever is sooner, field recording of all newly identified cultural resource sites will be completed as well as any necessary site record updates for previously recorded cultural resource sites.
- Final cultural resource site records will be submitted to the SHPO's within 1 year of the date of the burn.
- A summary for all pre-burn projects performed during the year as well as any completed post burn monitoring will be included in the annual report.

Timber Treatment Undertaking

- After the first prescribed burn of timber treatment unit 30 in the Willow Bay portion of Demumbers, heritage staff will shovel test the portion of the unit that may contain cultural materials related a prehistoric site. This is the general location of Willow Bay 1 (Ly-52/LBL-1938) one of several prehistoric sites identified by Nance during 1973 survey. The area was visited during this investigation but nothing was found which may be due to dense vegetation coupled with the lack of detailed location information. To ensure that if there are remains of Willow Bay 1 within proposed timber unit 30 they are not damaged by treatment, shovel testing will be conducted following the first burn but prior to any ground-disturbing activities. If cultural materials are found, the site will be officially recorded and will flagged, marked in white paint on the ground, and added as an exclusion zone to contract maps.
- Since LBL treats all identified sites as historic properties until such time as a cultural

overview with appropriate themes to help guide site significance evaluation is developed, all known sites within the project APE are treated as historic properties and protected as heritage exclusion zones.

- The LBL Heritage Program Manager will ensure that historic property boundaries within the project APE are clearly flagged and GPS'd and share locations with appropriate staff.
- If a project APE contains heritage exclusion zones, the LBL Project Manager will ensure that the flagged boundary is appropriately, adequately, and clearly marked on the ground and on project maps and explained to contractor personnel and project staff.
- The LBL Project Manager will ensure that heritage staff can provide cultural resource identification training to contract personnel and project staff so that they are aware a) lines and schedule of communication throughout the undertaking; b) of their obligation to report any cultural resource discoveries; c) the reporting process; d) the types of resources that may be discovered; and e) the consequences of violating heritage exclusion zones.
- In addition to training, the LBL Project Manager will ensure that all contracts contain the following two mandatory clauses:
- Exclusion zones (flagged and protected historic properties)
- Demarcated on the ground and on timber sale maps
- Unexpected discoveries (including human remains)
- Immediately cease work in vicinity of find until it is assessed by Heritage Program Manager
- Operator must immediately contact contractor officer representative (COR) who will contact the Heritage Program Manager and the Project Manager
- If an historic property cannot be flagged, avoided and protected, and there may be adverse effects from the undertaking, the procedures outlined in 36 CFR 800.5 and 36 CFR 800.6 will be followed.

During Undertaking:

- The LBL Project Manager will notify LBL Heritage Program Manager when a contractor is working within an area that contains exclusion zones so that heritage staff can monitor as necessary.
- Should any heritage exclusion zone be impacted during the undertaking, the Heritage Program Manager will immediately consult with the appropriate SHPO and any other appropriate consulting parties.

Post-Undertaking:

- The LBL Project Manager will ensure that heritage staff can monitor and assess the condition of exclusion zones within the APE prior to the final close-out of each timber unit or work area.
- All newly discovered prehistoric and historic sites will be recorded and submitted to the appropriate SHPO within 1 year of timber unit close-out.

Canebrake Restoration Undertaking

No conditions are required for this undertaking since the 5 canebrake restoration areas were adequately surveyed and no prehistoric or historic sites were identified within any of the proposed restoration areas.

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