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Department of
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Environmental Assessment

Lower Broad Analysis Area

Sumter National Forest
Enoree Ranger District

Fairfield, Union, Chester and Newberry Counties
South Carolina

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Lead Agency:	**USDA Forest Service**
Responsible Official:	**Elizabeth LeMaster, District Ranger**
Contact Person:	**John Richardson, Silviculturist** **20 Work Center Road** **Whitmire, South Carolina 29178**
Telephone:	**(803) 276-4810**
FAX:	**(803) 276-9303**

Chapter 1 - Purpose and Need for Action

1.1 Introduction

The Enoree Ranger District of the Sumter National Forest is proposing commercial thinning and regeneration harvesting in the Lower Broad Analysis Area. The project would create early successional habitat, favor preferred tree species, reduce potential for insect and disease damage and produce high quality, valuable sawtimber. In addition, some Forest Service system roads would be decommissioned (no longer needed for management), and one Forest Service road would be relocated to reduce adverse resource impacts.

1.2 Project Area Description

The Enoree Ranger District is located in north central South Carolina in the Piedmont between the Appalachian Mountains and the Coastal Plain. This area has gentle to steep rolling hills and a mild climate.

The Lower Broad Analysis Area (LBAA) is located in the southeast portion of the Enoree Ranger District south and east of Carlisle, South Carolina. The Broad River flows south through the LBAA. The LBAA totals approximately 53,713 acres over 19 compartments. The majority of the LBAA is privately owned; only 15,614 acres are National Forest system land. Private land inholdings are interspersed among national forest system lands (NFS).

1.3 Purpose And Need

The project proposal is consistent with the 2004 *Revised Land and Resource Management Plan Sumter National Forest* (Forest Plan). The Forest Plan was used to guide development of the proposed action.

A. Early-successional habitat

Currently less than one percent of NFS in the Lower Broad Analysis Area are in early-successional habitat. Early succession is defined as the biotic community that develops immediately following the removal of most, or all, of the forest canopy. This habitat is limited not only in this area but also across the Sumter National Forest. Early successional forest habitat adds to the biological diversity in the area. This habitat is highly productive for wildlife due to the diversity of food sources, insect populations, nesting, forage, escape cover, and soft mast. Regeneration harvests would establish early successional habitat in the High Quality Forest Products (10.B.) management prescription. A desired condition of the 10.B. management prescription is to have from 10-17 percent of forested land in early-successional forest conditions. The proposal would increase the amount of early successional habitat to about nine percent in the analysis area.

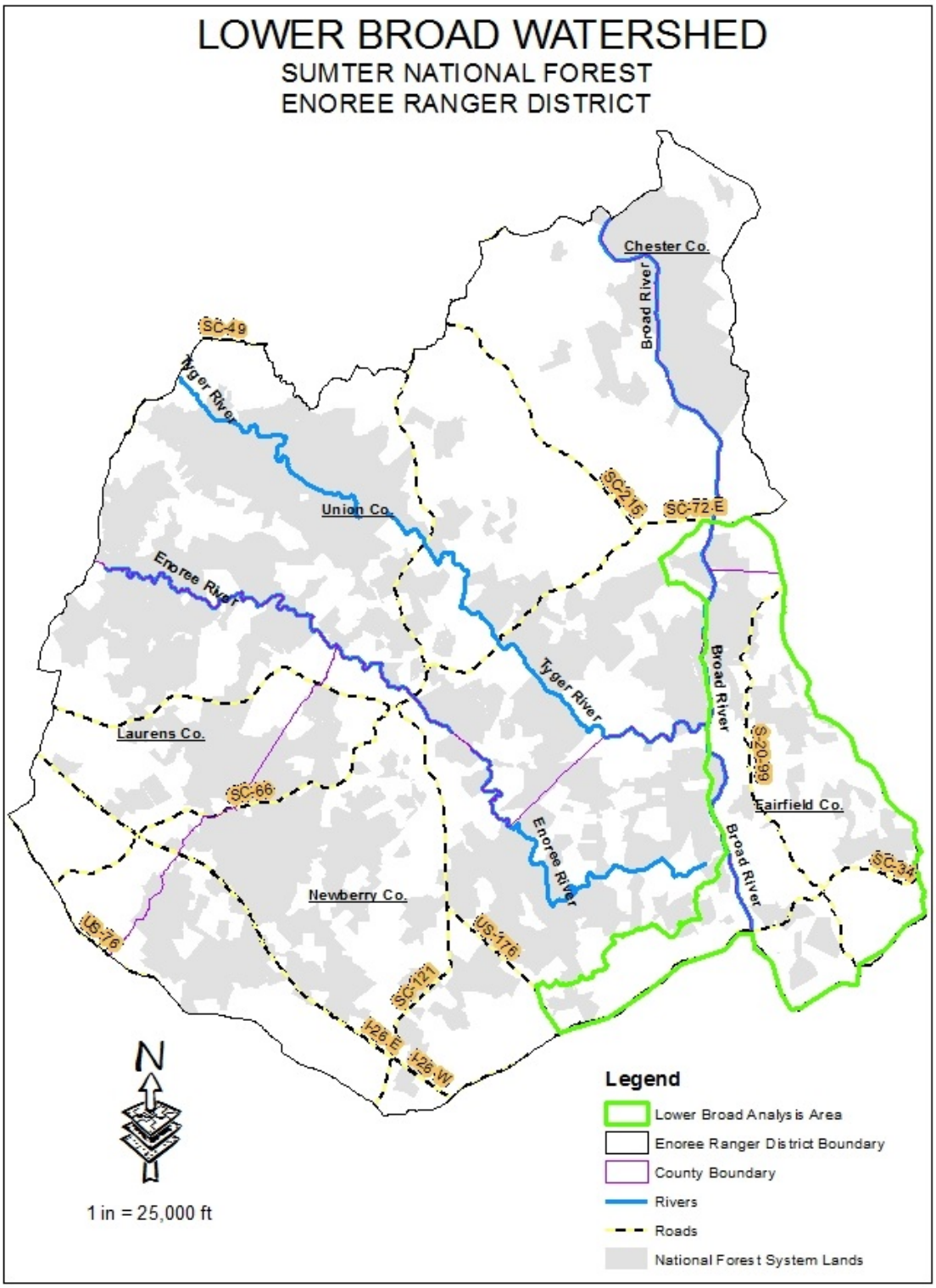


Figure 1.3-1. Lower Broad Analysis Area on the Enoree Ranger District

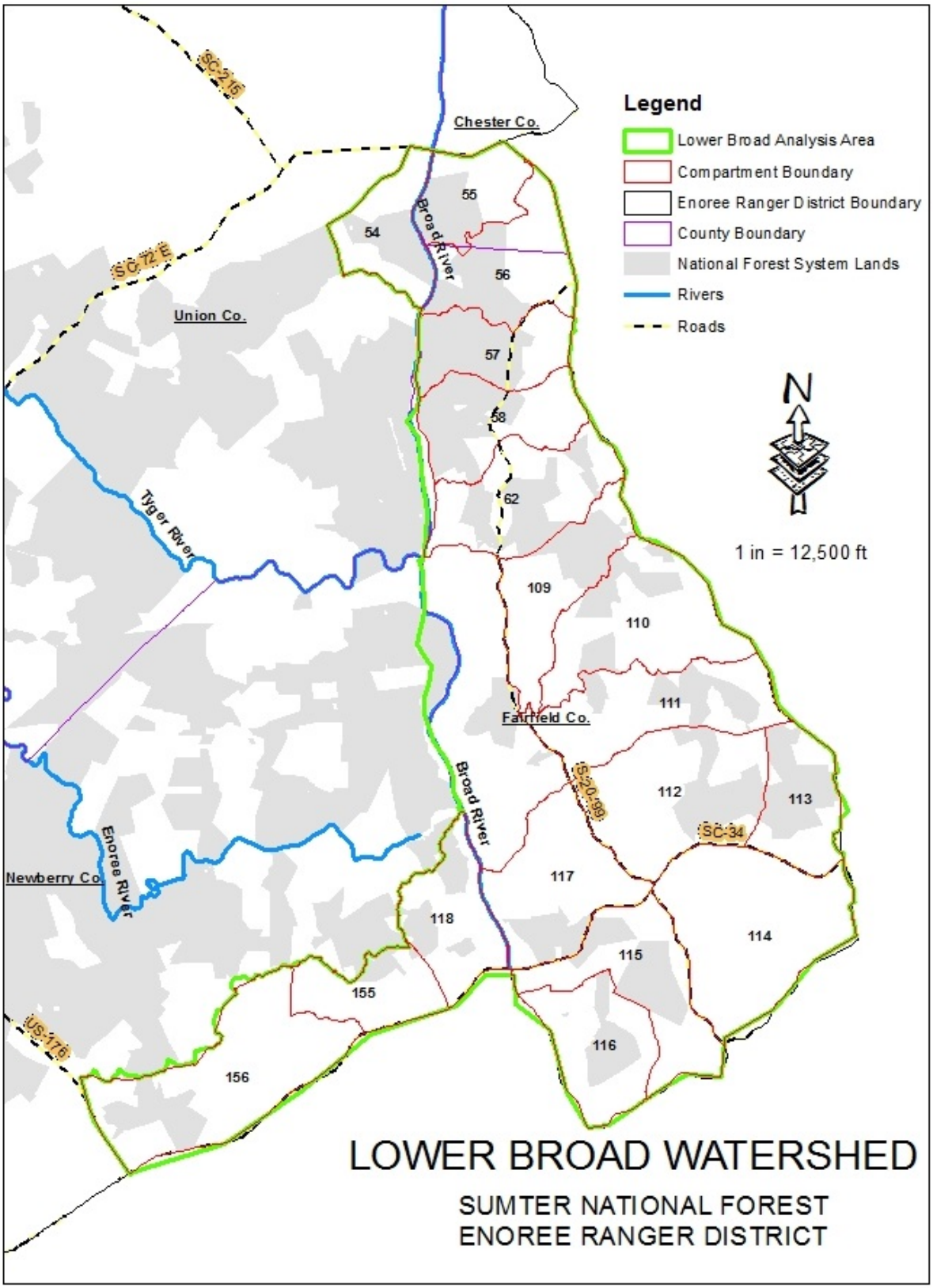


Figure 1.3-2. Lower Broad Analysis Area and Surrounding Area

B. Favor preferred tree species

The desired condition for management prescription 10.B., in addition to loblolly pine, favors hard and soft mast producers, such as oak, hickory, pine, dogwood, black gum, grapes, etc. to provide a range of habitat conditions for wildlife. In regeneration harvest areas, site preparation and follow-up release would discriminate against less desired species, such as sweetgum, red maple, winged elm, and yellow-poplar. In, addition, healthy shortleaf pine would be retained.

C. Reduce potential for insect and disease damage

Many of the pine stands are at risk of Southern pine beetle outbreaks. Currently, in the analysis area, there are almost 7,000 acres of loblolly pine stands with high basal areas (above 100 square feet per acre). Forest Plan desired conditions for loblolly pine stands are moderate basal areas (less than 100 square feet per acre). Thinning would reduce basal areas between 60 to 80 square feet per acre. Regeneration would replace older pine forest with vigorous young pine and hardwood stands.

D. Produce high quality, valuable sawtimber

The Forest Plan states “timber stand improvement and regeneration harvest methods that best provide for the growth and harvest of high quality, valuable sawtimber that is most in demand in the marketplace are applied” in 10.B. management prescription areas. The Forest Plan also states “opportunities are also provided for other high value forest products”. Clearcutting regeneration harvests would promote high quality forest products through higher quality stocking (2nd generation improved seedlings vs. natural unimproved seedlings), would allow for optimal spacing (correct spacing is important to produce high quality sawtimber) and would eliminate the risk of damage to residual stands (seedtree removal often results in substantial seedling damage).

E. Decommission Roads/Relocate Road

Some Forest Service system roads in the analysis area would be decommissioned to reduce long term resource impacts and to reduce maintenance costs. Two system roads would be relocated to reduce resource impacts but would still provide access for resource management.

1.4 Proposed Action Description

The proposed action was reduced by 48 acres from what was scoped. Units within the foreground viewshed of the Broad River were reduced in size to be consistent with Forest Plan management prescription 7.E.1 – Dispersed Recreation Areas (Piedmont Only). Also, the total mileage of temporary roads for the proposed action is estimated at less than one mile.

The proposed action involves first and intermediate commercial thinning on 6,355 acres and regeneration harvest on another 2,354 acres. Shortleaf pine would be restored on some areas where suitable soils and other conditions exist. Site preparation following regeneration harvest

would consist of herbicide, mechanical and prescribed burning. Herbicide would be applied by foliar spray from backpack sprayers and by the hack-n-squirt method that utilizes a hatchet or other cutting tool to make cuts into the cambium where herbicide is sprayed or injected. Mechanical site preparation would consist of a shearer and roller-drum chopper. Loblolly pine trees would be planted on most clearcut with reserve areas but shortleaf pine would also be planted in specific stands. Herbicide would be used to release crop trees from competing vegetation once they are established. Precommercial thinning using manual methods would take place in regeneration areas to reduce stand stocking to normal levels. Prescribed burning would be completed under and existing Decision Notice, *Prescribed Burning on the Enoree Ranger District*, signed February 4, 2008.

Some system roads would be decommissioned and one road would be relocated.

1.5 Forest Plan Direction and Consistency

This proposed action provides an opportunity to work toward the forest management goals and objectives as described in the 2004 *Revised Land and Resource Management, Sumter National Forest* (Forest Plan) described in Chapter 2. Management prescriptions are described in Chapter 3.

Management Prescription 7.E.1 Dispersed Recreation Areas.

The Desired Condition states:

> These areas include the foreground viewshed of the Enoree, Tyger and Broad Rivers. Mature forest and older stands in various stages of climax canopy development and decline dominant habitat conditions provided by this prescription. Tree harvest may be used to control insect infestation or disease, to remove salvage timber, to maintain moderate stand densities, to create small canopy gaps or to create openings for canebrakes.

Management Prescription 10.B High Quality Product Forest products.

The Desired Condition states:

> Grow and sell saw log size timber (pine and hardwood) in a sustained manner on upland sites. As markets allow, pine stands are maintained at moderate densities (less than 100 square feet of basal area per acre) to reduce susceptibility to southern pine beetle attack and to encourage development of larger diameter trees. A mix of forest successional stages characterizes these areas with an emphasis on early-successional forests. Mid-and late-successional forests are common, but 10 to 17 percent of the landscape of the forested land is in early-successional conditions. Twenty percent of the forest is in middle-to late-successional forest conditions and within this 20 percent at least 10 percent is in late successional or old growth conditions. Relative equal areas exist in each 10-year age class.

Management Prescription 9.A.3 Watershed Restoration Areas.

The desired condition states:

> Upland forest canopies are maintained at moderate to low densities to encourage a dense understory of shrubs, warm season grasses, and other herbaceous species. Over time there is an increased oak/hickory component. Permanent openings are retained and occupy 1 to 2 percent of the area. An intermediate mix of forest successional stages characterizes these areas. Mid- and late-successional forests are common, but 4 to 10 percent of the forested land is in early-successional forest conditions. Fifty percent of the forest is in middle to late successional forest conditions and within this 50 percent, at least 10 percent is in late successional or old growth conditions. Pine stands are maintained at moderate to low densities (less than 100 square feet/acre basal area) to reduce susceptibility to southern pine beetle attack and promote understory development. A flow of wood products is provided to local economies. The emphasis of this prescription would create two distinct combinations of habitat conditions interlaced across the landscape.

Management Prescription 11, Riparian Corridors (embedded within other management prescriptions).

The Desired Condition states:

> The physical integrity of aquatic systems, stream banks and substrate, including shorelines and other components of habitat is intact and stable. The natural range of in-stream flows is maintained to support channel function, aquatic biota and wildlife habitat, floodplain function, and aesthetic values… Silvicultural treatments including timber and vegetation removal may occur to restore and/or enhance riparian resources such as soil, water, wildlife and natural communities. Prescribed fire can be used within the corridor to create or maintain the composition and vitality of fire-dependent vegetative communities (e.g., canebrakes). Low intensity fire may occur when streams are used as natural firebreaks in association with landscape-level burning.

1.6 Decision to be Made

The Responsible Official (Enoree District Ranger) will make a decision based on a review of the EA. The Responsible Official will decide:

1. Whether to proceed with the proposed action, alternative 3 or the “No Action” alternative.

2. Whether the decision that is selected will have a significant impact on the quality of the human environment or not. If the determination is made that the impact is not significant, then a “Finding of No Significant Impact” (FONSI) would be prepared. Significant impacts on the quality of the human environment would require the preparation of an Environmental Impact Statement [NEPA, 1501.4 (c) and (e)].

The decision of the Responsible Official will be documented in a Decision Notice (FSH, 1909.15, 43.2).

1.7 Public Involvement

The scoping period began March 19, 2015 with a scoping letter mailed based on the district mailing list. The project is also listed in the Planning, Appeals and Litigation System at **Web Link:**http://www.fs.fed.us/nepa/nepa_project_exp.php?project=44865
Two comment letters were received.

1.8 Key Issues

Comments received during scoping wee reviewed and the following key issues were identified. Comments received in response to scoping were reviewed by the interdisciplinary team (IDT) and are listed below as key issues. Key issues were used to develop another action alternative. Public comments are contained in the project record.

1. Issue: An alternative to regeneration by the clearcut method needs to be developed.

   Response: Alternative 3 will be analyzed in detail and includes replacing clearcut with reserves silvicultural method with regeneration harvest by the seedtree method (using loblolly pine seedtrees) except in stands that would be regenerated to shortleaf pine. Leaving loblolly pine seedtrees in these stands would hinder the establishment of shortleaf pine. Stands that contain healthy shortleaf pine in combination with suitable soils for its growth and development are in short-supply across the district. Retaining and regenerating is a high priority and is consistent with Goal 16 (Forest Plan page 2-13).

2. Issue: New system and temporary roads should not be built to access timber stands for commercial harvest as this will have additional adverse resource effects and result in increased long term maintenance costs.

   Response: Alternative 3 will include the use of only existing system roads for timber harvest purposes. Temporary roads would not be built to access proposed harvest units.

Chapter 2 - Alternatives

This chapter includes a description of the no action, proposed action, alternative 3, connected actions, alternatives considered but not developed, design criteria and an alternative comparison table.

Acreage information is derived from the Geographic Information System (GIS) database and varies slightly from the acreage presented in scoping, though no substantive changes were made.

Actual timber volumes, treatment acreages and road mileages would likely vary from the estimates made during planning due to sampling methods and actual site conditions. Basal areas that are given are a target range and would vary due to on-the-ground differences. Location and mileage of the temporary roads would vary slightly with the type of logging equipment and differing site conditions.

All stands proposed for treatment are loblolly and shortleaf pine forest type. A listing of compartment and strands treated along with maps for the action alternatives can be found in the appendix of this EA.

2.1 Alternative 1 – No Action

Under this alternative, none of the proposed management activities included in the proposed action would be implemented. Already approved management activities will continue to be implemented in the area.

The no-action alternative provides a baseline for estimating the effects of the action alternatives as well as an alternative that is considered in detailed effects analysis.

2.2 Alternative 2 – Proposed Action

The proposed action was reduced by 48 acres from what was scoped. Units within the foreground viewshed of the Broad River were reduced in size to be consistent with Forest Plan management prescription 7.E.1 – Dispersed Recreation Areas (Piedmont Only). Also, the total mileage of temporary roads for the proposed action is estimated at less than one mile.

The proposed actions would involve thinning and regeneration harvests in the Lower Broad Analysis Area (LBAA). Proposed silviculture prescriptions are listed in Table 2.2-1.

Commercial Thinning

Commercial thinning is proposed on 6,355 acres of loblolly pine stands. First thinnings are proposed in younger poletimber stands (less than 30 years old). Intermediate thinnings are proposed in older stands (30+ years old). The desired basal area would average from 60 to 80 square feet of basal area per acre for both first and intermediate thinnings.

Regeneration Clearcut with Reserves

Regeneration clearcut with reserves is proposed on 2,083 acres of loblolly pine stands. Healthy shortleaf pine and desirable hard mast species (oaks, hickories, etc.) that are eight inches or greater in diameter would be retained. Regeneration clearcut with reserves is subject to Forest Plan design standards applicable to even-age or two-aged regeneration management (*e.g.*, limitation of available suitable acres, size of area cut, and age of stands).

An herbicide site preparation treatment would be used prior to planting of loblolly pine seedlings to control sprouting and to release desirable oaks, hickories and loblolly/shortleaf pine trees.

Planting of 600 – 650 trees per acre of loblolly pine seedlings would take place during the dormant season (December-March). Approximately 3-5 years after planting loblolly pine, an herbicide release treatment may be prescribed if there is competition from undesirable tree species.

Shortleaf Pine Restoration - Regeneration Clearcut with Reserves

Field evaluations of three stands using the Campbell and Copeland (1954) risk rating for little leaf disease, indicate that suitable soil conditions exist for the restoration of shortleaf pine. All or portions of stand 12 (29 acres) in compartment 156 and stands 2 and 8 (13 and 20 acres, respectively) in compartment 55 would be targeted for shortleaf restoration totaling 62 acres. Healthy shortleaf pine and desirable hard mast species (oaks, hickories, etc.) that are eight inches or greater in diameter would be retained. Regeneration clearcut with reserves is subject to Forest Plan design standards applicable to even-age or two-aged regeneration management (*e.g.*, limitation of available suitable acres, size of area cut, and age of stands).

A herbicide site preparation treatment would be used prior to planting of shortleaf pine seedlings to control sprouting and to release desirable oaks, hickories, and shortleaf pine trees.

Planting of 600 – 650 trees per acre of shortleaf pine seedlings would take place during the dormant season (December-March). Approximately 3-5 years after planting shortleaf pine, a herbicide release treatment may be prescribed if there is competition from undesirable tree species. If after 5 years, shortleaf pine cannot be restored for ecological or management reasons, the area would be considered for regeneration to loblolly pine as described above under regeneration clearcut with reserves.

Shelterwood with Reserves

Shelterwood with reserves is proposed on 208 acres of loblolly pine stands. Shelterwood harvests would leave approximately 30 square feet per acre of basal area of trees to provide a seed source for natural regeneration, shade to favor shortleaf pine and oak over loblolly pine, and woody fuel to carry a fire in these stand. Merchantable pine and certain hardwood species would be harvested to achieve the basal area objective. Desirable hard mast species (oaks, hickories) and shortleaf pine that are eight inches or greater DBH would be retained. Herbicide site preparation treatments would be used to control undesirable woody sprouting and to release desirable oaks,

hickories, and shortleaf pine trees. The overstory loblolly pine trees would be removed when the stands are stocked.

An herbicide release treatment would be prescribed after final removal of the loblolly overstory approximately 3-5 years after initial harvest.

A manual pre-commercial thinning would be completed after the loblolly pine trees have been removed. Herbicide treatments and pre-commercial thinning are described below.

Table 2.2-1 - List of timber management activity acres in the Lower Broad Analysis Area – Proposed Action

Treatment	Acres
Clearcut with Reserves	2,083
First Thin	2,092
Intermediate Thin	4,264
Shelterwood	208
Shortleaf Pine Restoration	62
Total	**8,710**

Site Preparation

Site preparation is scheduled after the initial regeneration harvest and before tree planting. Site preparation would occur only in the stands identified for regeneration harvest (clearcut with reserves, shortleaf pine restoration and shelterwood with reserves) and the purpose of site preparation is to reduce competition from less desired species, such as generation, sweetgum, red maple, winged elm, and yellow-poplar. In the shelterwood stands only chemical site preparation would be used to encourage both natural loblolly and hard mast regeneration. In clearcut stands site preparation would utilize herbicides (chemical site preparation) during the growing season (June through September) to control less desired species. Site preparation in clearcut stands differ from shelterwood stands in the desire to eliminate natural loblolly pine regeneration. The control of loblolly pine regeneration would utilize chemical site preparation followed by burning (March-June). Prescribed burning is covered under an existing Decision Notice (2/4/2008). Natural loblolly pine regeneration is difficult to control, and utilizing chemical, burning, and mechanical methods may be needed. The clear-cut areas would be planted to either loblolly or shortleaf pine once woody vegetation has been controlled through chemical, burning and or manual treatments.

Chemical Site Preparation

Chemical site preparation consists of the use of herbicides containing the active ingredients: Imazapyr (such as Arsenal AC or equivalent) and Triclopyr (Garlon 3A or Garlon 4 or equivalents). The herbicides would be applied to control sprouting of tree species, such as sweetgum and maple. The objective of the herbicide treatment is to promote the growth of selected species by limiting competition from non-preferred species. Preferred species, including shortleaf pine, oak, and hickory, would be selectively released from competition from undesirable species such as sweetgum,

naturally regenerating loblolly pine, yellow-poplar, red maple, sourwood, winged elm, blackgum, and other undesirable species. Herbicide treatments would occur between July and October.

Herbicides would be applied using foliar spray and hack-n-squirt methods (see Table 2.2-2 for methods and herbicide concentrations).

Foliar spray herbicides would be applied using a backpack sprayer to spray the foliage of targeted plants. A mixture containing 0.5 ounce of Arsenal AC (active ingredient Imazapyr), 0.5 ounce of Milestone (active ingredient aminopyralid), 5 ounces Accord XRT II (active ingredient Glyphosate), 2 ounces of Bullseye spray pattern indicator (water soluble dye), and 1-2 ounces of Cidekick adjuvant (limonene) per gallon of water would be used. Herbicides would be applied to targeted vegetation by speckling the leaf surface during the period of July through October of the second or third growing season. The anticipated application rate is 10 gallons of mix, 5 ounces of Arsenal AC (0.16 pound of Imazapyr) and 5 ounces of aminopyralid per acre.

In hack-n-squirt applications, a hatchet is used to cut into the tree surface of larger (greater than 6 feet tall) targeted vegetation and Imazapyr (Arsenal AC or equivalent) and triclopyr (Garlon 3A) herbicide are sprayed/injected into the cut area. A cutting tool, such as a hatchet, machete, or sandvik, would make the cuts. A mixture of 50 percent Garlon 3A and 50 percent water, plus 6 ounces of Arsenal AC per gallon of water would be used. All treated areas would be monitored for further follow-up treatments after the initial treatment. All downed vegetation would be left on-site to decompose.

Commercial herbicides/ adjuvant/dyes referenced in this document (Garlon 3A, Arsenal AC, Cidekick, and Bullseye) represent those formulations that are commonly used for the proposed forestry treatments. However, other equivalent formulations may be used for implementation of the proposed treatments. Equivalent formulations would include any other brand name herbicides that have an equivalent proportion of the specified active ingredient.

Table 2.2-2 - Herbicide Application Summary

Method	Herbicide (Active Ingredient)				Additives (Non-Active)	
	Arsenal AC (Imazapyr)	Garlon 3A (Triclopyr)	Milestone (Aminopyralid)	Accord XRT II (Glyphosate)	Bullseye (Indicator)	Cidekick (Adjuvant)
	Estimated Application Rate (LBWs active ingredient/acre)				Proposed Maximum Application Rate (oz./acre)	
Foliar Spray	0.16		0.066	1.6	2	2
Hack-n-squirt	0.02	0.18				
Frequency: Herbicides may be applied once or twice depending on need. First time for chemical site preparation as listed in the attached table for the regeneration areas and the second time for chemical release during the 3rd, 4th, or 5th growing season after the initial clearcut in the regeneration areas**.**						

Mechanical Site Preparation

Mechanical site preparation would consists of a one-time pass with a shear and roller drum chopper used to control unwanted natural loblolly pine regeneration in clearcut stands and shortleaf restorations sites. A bulldozer with a shearer attached to the blade and a roller drum chopper attached to the rear pass over the regeneration area and chop up un-merchantable materials left on site. Hand tool site preparation (chainsaw or brush saws) may also be used in conjunction with the mechanical site preparation treatments.

Tree Planting (proposed only for Regeneration Clearcut with Reserves)

It is anticipated that not enough trees would be left to restock the stand, so planting loblolly pine seedlings would be needed except for compartment 156 stand 12 and Compartment 55 Stands 2 and 8 which would be planted to shortleaf pine. Planting would be implemented immediately after site preparation. Tree seedlings for both loblolly and shortleaf pine would be planted on 7ft x10ft spacing.

Chemical Release (Proposed only for regeneration sites)

Herbicide would be used to release crop trees from competing vegetation. Under management prescriptions, an average of 500 seedlings of pine, oaks, and hickories per acre is the desired stocking level. Stands would be treated for release approximately 3-5 years after initial regeneration harvest and when the survival and stocking checks indicate more than one hundred stems per acre of sweetgum, maple, and yellow-poplar. The herbicides and the applications used would be similar to the chemical site preparation treatments described above.

Pre-commercial Thinning (Proposed only for regeneration sites)

Pre-commercial thinning consists of felling and/or deadening pre-merchantable trees to reduce tree stocking in overstocked stands (overstocked is defined as 700 stems per acre or greater). The objective of pre-commercial thinning is to accelerate diameter increment on remaining steams, maintain stand density range, and to improve the vigor and quality of remaining trees. Pre-commercial thinning would take place in shelterwood stands after seed tree removal (3-5 years after initial harvest). In clearcut with reserves, pre-commercial thinning may be used to control unwanted natural loblolly pine regeneration when stocking is over 700 stems per acre. Pre-commercial thinning would be accomplished using hand tools such as chainsaws, brush saws, and other manual tools to reduce stocking levels to 500 stems per acre. Healthy shortleaf pine, oaks and hickories would be favored for release over loblolly pine.

Road Decommissioning and Road Relocation

Approximately four miles of Forest Service system roads would be decommissioned and includes roads 406B (compartment 55 map), 411A (compartment 108 map), 412F and 412G (compartment 112 map), E110-2 (compartment 110 map), E116-2(compartment 116 map), E156-2 (compartment 156 map), E-54-1 and E54-2 (compartment 54 map). The same road numbers (E-54-1 and E54-2) would be used to establish new roads to provide long term access (see the next paragraph). Decommissioning work may include but is not limited to removing culverts, restoring normal drainage function, removing road ditching, blocking the road from further access, out-sloping to improve drainage and water-barring and reseeding with native and desired non-native vegetation.

Forest Service system roads E54-1 and E54-2 (totaling 0.63 miles) would be constructed in new more sustainable locations to continue to provide access to a privately owned cemetery and to provide access for the maintenance of two wildlife openings, respectively. The intent is to reduce long term adverse resource impacts from the existing roads while still providing access to these areas.

Connected Actions

The following connected actions are associated with project activities.

Road Work

Approximately 1.6 miles of system roads would be needed to provide access for present and future timber management as well as for other resource management activities.

System road reconstruction/reconditioning and maintenance work (estimated at about 43.4 miles) would also be needed to support timber removal and other management activities. Reconstruction/reconditioning work would consist of, but not be limited to, gravelling road surfaces, replacing culverts, ditch cleaning, removing brush and trees along road rights-of-way, installing or replacing gates and correcting road safety hazards.

Maintenance would consist of spot gravel, road grading, cleaning culverts, light brushing and mowing. Specific information on roads is contained in the project file.
Temporary roads would be needed for access (less than 1 mile). Temporary roads would be closed after use, water-barred as needed and revegetated to reduce soil erosion.

Erosion Control

Log decks, skid trails and temporary roads at risk for erosion would be vegetated or covered with logging slash to act as a mulch to reduce soil erosion. As a general rule, this disturbed area averages three percent of the harvested area. If planting is utilized for erosion control, native and desired non-native vegetation would be used. Native vegetation may include a mix consisting of fall panicum, little bluestem, deer tongue grass, purple top, side oats grama, bird's foot trefoil, black-eyed Susan, partridge pea, showy tickseed, false sunflower and Illinois bundleflower (spring mix). Native vegetation for fall planting may include a mix of Virginia wild rye, gray goldenrod and hairy mountain mint. Desirable non-native vegetation may include a mix consisting of bahia grass, brown top millet, kobe lespedeza, and common Bermuda (spring mix) or a mix consisting of perennial rye grass, clover, wheat, and kobe lespedeza (fall mix).

Rights-of-way acquisition

Four rights-of-way (approximately 1.3 miles) would be acquired to improve/establish access to national forest system lands for resource management. These rights-of-way are located in compartment 62 stand 1, compartment 108 stand 4, compartment 109 stand 19 and compartment 110 stand 2. The roads would be constructed to provide sustainable access.

Skidding, Decking and Hauling of Logs

Logs would be skidded with heavy equipment to landings where they would be stacked for later removal by logging trucks. Existing and new skid trails would be used during skidding operations.

2.3 Alternative 3

Alternative 3 addresses the two issues identified in Chapter 1 of this EA.

Issue 1

This alternative would use the seedtree method of regeneration in place of clearcut with reserves with the exception of the areas proposed for shortleaf pine regeneration.

Issue 2

Timber harvest would occur from existing system roads.

Commercial Thinning

Commercial thinning is proposed on 5,881 acres of loblolly pine stands. First thinnings are proposed in younger poletimber stands (less than 30 years old). Intermediate thinnings are proposed in older stands (30+ years old). The desired basal area would average from 60 to 80 square feet of basal area per acre for both first and intermediate thinnings.

Regeneration - Seedtrees with Reserves

Regeneration seedtrees with reserves is proposed on 1,973 acres of loblolly pine stands. Merchantable pine and hardwood would be harvested to leave an average of 10 square feet per acre of residual basal area. Healthy shortleaf and desirable hard mast species (oaks, hickories, etc.) that are eight inches or greater in diameter would be retained for wildlife habitat as well as tree diversity. For most stands, the desired stocking levels are 450 seedlings per acre of pine and hard mast trees. The seed trees would be removed when the new stands are stocked, usually within 3-5 years.

Shortleaf Pine Restoration - Regeneration Clearcut with Reserves

Silvicultural treatments would be the same as the proposed action but only 42 acres would be harvested.

Shelterwood with Reserves

Silvicultural treatments would be the same as the proposed action.

Table 2.3-1 - List of timber management activity acres in the Lower Broad Analysis Area – Alternative 3

Treatment	Acres
Clearcut with Reserves	1,973
First Thin	2,092
Intermediate Thin	3,790
Shelterwood	208
Shortleaf Pine Restoration	42
Total	**8,105**

Site Preparation

Site preparation is scheduled after the initial regeneration harvest and before tree planting (shortleaf restoration stands). Site preparation would occur only in the stands identified for regeneration harvest (seedtree with reserves, shortleaf pine restoration and shelterwood with reserves) and the purpose of site preparation is to reduce competition from less desired species, such as generation, sweetgum, red maple, winged elm, and yellow-poplar. In the shelterwood stands only chemical site preparation would be used to encourage both natural loblolly and hard mast regeneration. In seedtree stands site preparation would utilize herbicides (chemical site preparation) during the growing season (June through September) to control less desired species.

Site preparation in the shortleaf restoration stands differ from seedtree and shelterwood stands in the desire to eliminate natural loblolly pine regeneration. The control of loblolly pine regeneration would utilize chemical site preparation followed by burning (March-June). Natural loblolly pine regeneration is difficult to control, and utilizing chemical, burning, and mechanical methods may be needed. Once the loblolly pine seedlings have been controlled (through chemical, burning and or manual treatments), the shortleaf restoration areas would be planted to shortleaf pine.

Chemical Site Preparation

The herbicides and application methods would be the same as the proposed action.

Mechanical Site Preparation

Mechanical site preparation would be used to control unwanted natural loblolly pine regeneration in shortleaf restoration sites. The equipment and methods would be the same as those described in the proposed action.

Chemical Release (Proposed only for regeneration sites)

This treatment would be the same as the proposed action.

Tree Planting (proposed only for shortleaf pine restoration stands)

Shortleaf pine would be planted in compartment 156 stand 12 and compartment 55 stands 2 and 8. Planting would be implemented immediately after site preparation. Shortleaf pine tree seedlings would be planted on 7ft x10ft spacing.

Chemical Release (proposed only for regeneration sites)

This treatment would be the same as the proposed action.

Pre-commercial Thinning (Proposed only for regeneration sites)

This treatment would be the same as the proposed action.

Road Decommissioning and Road Relocation

Road decommissioning and road relocation would be the same as the proposed action

Connected Actions

The following connected actions are associated with project activities.

Road Work

New system road construction (approximately 0.1 mile) would be needed to provide sustainable access to a privately own cemetery. The current road is causing resource damage.

No temporary roads would be built under this alternative.

System road reconstruction/reconditioning and maintenance (estimated at about 43.0 miles) would also be needed to support timber removal. Reconstruction/reconditioning work would consist of, but not be limited to, gravelling road surfaces, replacing culverts, ditch cleaning, removing brush and trees along road rights-of-way, installing or replacing gates and correcting road safety hazards. Maintenance would consist of spot gravel, road grading, cleaning culverts, light brushing and mowing. Specific information on roads is contained in the project file.

Erosion Control

Log decks, skid trails and temporary roads at risk for erosion would be vegetated or covered with logging slash to act as a mulch to reduce soil erosion. As a general rule, this disturbed area averages three percent of the harvested area. If planting is utilized for erosion control, native and desired non-native vegetation would be used. Native vegetation may include a mix consisting of fall panicum, little bluestem, deer tongue grass, purple top, side oats grama, bird's foot trefoil, black-eyed Susan, partridge pea, showy tickseed, false sunflower and Illinois bundleflower (spring mix). Native vegetation for fall planting may include a mix of Virginia wild rye, gray goldenrod and hairy mountain mint. Non-native vegetation may include a mix consisting of bahia grass, brown top millet, kobe lespedeza, and common Bermuda (spring mix) or a mix consisting of perennial rye grass, clover, wheat, and kobe lespedeza (fall mix).

Rights-of-way acquisition

To address issue 2, there would be no rights-of-way acquisition under this alternative.

Skidding, Decking and Hauling of Logs

Logs would be skidded with heavy equipment to landings where they would be stacked for later removal by logging trucks. Existing and new skid trails would be used during skidding operations.

2.4 Alternatives Considered but Not Developed

Several actions were considered by the ID team during the planning process, but were eliminated from further analysis. These actions are listed below with a short rationale for their exclusion.

Non-commercial treatments – The use of "cut and leave" non-commercial methods (whereby trees are harvested, chopped up, and left on site) were discussed as a replacement for thinning and regeneration harvests.

This alternative was not considered in detail because the slash and downed trees would increase hazardous fuel loading on the site, and thereby increase the risk of catastrophic fire occurrence in the area. Additionally, under this method of vegetation management, no revenues are generated to offset treatment costs.

Prescribed fire to develop desired stand conditions – This alternative would use prescribed fire to thin stands and to regenerate areas. This type of prescribed burning would require the use of high intensity fires that would kill standing trees and created canopy gaps for regeneration and reduce live basal areas.

This alternative was not considered further because these high intensity fires would be uncontrollable and could also impact firefighter safety, private property and cause significant resource impacts.

2.5 Design Criteria

Forest-wide standards found in the Forest Plan would be followed during implementation of this project. In addition, *South Carolina Best Management Practices for Forestry* (2003) and *National Best Management Practices for Water Quality Management on National Forest System Lands* (2012), collectively referred to in this document as BMPs, and *Soil and Water Conservation Practices Guide for R8* (2002) would also be followed.

The following design criteria are common to **both action alternatives**.

1. Identified heritage sites would be avoided during site disturbing activities associated with logging and follow-up treatments.

2. Skid trails would be located in a manner as to minimize concentration of water flow.

3. Gully crossings would be avoided and water from roads would not be directed into gullies.

4. Log decks would be ripped, disked, seeded, limed, fertilized and mulched at the time each harvest area is closed. Seed mixtures would include native grasses and legumes or other desired non-native species.

5. Trees would not be harvested within gullies or on steep slopes adjacent to gullies unless needed to promote stabilization or recovery efforts.

6. Streams would be identified on sale area maps and protective measures would be specified in the timber sale contract.

7. Desirable oaks and hickories would be retained within treatment stands.

8. Hardwood inclusions, to be protected within and adjacent to harvest units, would be identified on-the-ground and on the sale area map of the timber sale contract.

9. Skid trails that cross ephemeral streams would be recontoured to the natural terrain as much as possible to avoid discharging sediment directly into stream channels. These areas would be seeded, limed, fertilized and mulched after the area is recontoured to the natural terrain.

10. Erosion control devices such as diversions and temporary rock sediment dams would be installed prior to road construction, reconstruction and maintenance activities where needed to deter soil runoff into streams. Erosion control devices would be maintained in working order throughout project activities until plant growth is established and stable enough to control runoff and erosion. Road ditch lines would not be routed toward stream crossings, but instead into vegetative buffers.

11. No logging operations would occur in or around the perimeter of Rocky Branch Seasonal Camp, during fall and April hunting seasons. Coordinate with other project work to reduce the direct impacts to recreational users. There would be no hauling of timber through the seasonal campground.

12. Flowering and other visually attractive trees and understory shrubs would be favored when leaving vegetation during timber marking.

13. If temporary roads, skid trails and landings are necessary, they would be located outside the immediate foreground viewshed of roads, trails, Broad River corridor or other recreation facilities, when possible. If these features must be located in the immediate foreground view shed of roads, trails or other recreation facilities, disturbed soil would be re-vegetated with native species or covered with woody material as soon as possible following the completion of logging activities.

14. Protection zones shall be delineated and maintained around all bald eagle nests and communal roost sites, until they are determined to be no longer suitable through coordination with the US Fish and Wildlife Service. The protection zone shall extend a minimum of 1,500 feet from the nest or roost. Activities that modify the forest canopy within this zone are prohibited. All management activities not associated with bald eagle management and monitoring are prohibited within this zone during the periods of use (nesting season is October 1 to June 15; roost use periods are determined through site-specific monitoring). Where controlled by the Forest Service, public access routes into or through this zone would be closed during the seasons of use, unless they are major arterial roads. (Forest Plan Standard FW-28)

The following design criteria are pertinent to the **Proposed Action** only.

15. Drainage dips and lead-outs would be incorporated into construction of temporary roads.

16. Temporary roads would be closed, ripped, disked, rolling-dips installed if needed, limed, fertilized, mulched and seeded with native and desirable non-native vegetation.

2.6 Monitoring

Activities and effects would be monitored to ensure compliance with Forest Plan standards. Forest Service personnel would administer integrated resource and timber sale contracts. This ensures resource protection and adherence to contract clauses.

Effectiveness of mitigation measures and a determination that Forest Plan and project objectives are being met would be done periodically on a forest-wide rather than on an individual basis. However, spot checks of effectiveness of design criteria and compliance with BMPs may occur on this project.

Other monitoring that would be done on the district would include annual air quality monitoring, impacts and spread of NNIS, annual bird monitoring surveys including MIS species, aquatic monitoring, and BMP compliance checks.

2.7 Comparison of Alternatives

This section compares aspects of the alternatives to one another. Analysis of the effects can be found in the next section, Environmental Consequences.

Table 2.7-1 Comparison of the Alternatives

Indicator	Alternative 1	Alternative 2	Alternative 3
First Thinning (acres)	0	2,092	2,092
Intermediate Thinning (acres)	0	4,264	3,790
Regeneration - clearcut with reserves (acres)	0	2,083	0
Regeneration - shelterwood	0	208	208
Regeneration – seedtree with reserves (acres)	0	0	1,973
Shortleaf Restoration (acres)	0	62	42
System road decommissioning (miles)	0	4	4
System road construction (miles)	0	1.63	0.1*
System road reconstruction/maintenance/reconditioning (miles)	0	43.4	43.0
Temporary road construction (miles)	0	<1	0
Rights-of-way acquisition (miles)	0	1.30	0

***New sustainable system road construction is necessary to provide access to an existing cemetery on private land.**

Chapter 3 – Affected Environment and Environmental Consequences

3.1 Physical Environment

3.1.1 Water (Including Riparian Areas, Wetlands and Floodplains)

Affected Environment

Area/Weather

The Enoree Ranger District is within the piedmont (Gulf Atlantic Rolling Plain physiographic province) of South Carolina. Historically, the piedmont region of South Carolina supported mixed forests that were dominated by mature hardwoods, loblolly pine and short leaf pine. Disturbances in this dynamic system included fire (both wild and man caused), insects, diseases, storms, droughts and floods. Past farming practices in the Piedmont Region resulted in severe gullying and loss of topsoil.

With sound management practices, effects of harvests are usually minimal, but piedmont soils can be erodible if good practices are not followed.

Storms and storm sequences in the southeastern United States can be severe. From 5 to 8 inches or more rain can be generated from a severe tropical storm event. It is likely that the area would be exposed to one or more of these during any treatment or recovery period. In addition, thunderstorms and frontal events are more frequent across the landscape, though typically not as severe.

Generally, precipitation averages 45 inches per year for the piedmont of the Sumter National Forest. Water yield averages about 13-15 inches, so about 30-32 inches is typically utilized by plants in transpiration, or evaporates. The highest potential for precipitation and associated runoff and flooding occurs in the winter and early spring when groundwater levels are higher and soils are moister. Winter rains are usually widespread and prolonged while much of the summer rains are localized thunderstorms of short duration.

Stream flow behavior is described as “flashy” in headwater streams, meaning that the channels and their contributing stream networks are capable of rapidly delivering a high volume of water in response to sustained heavy precipitation events. Many of the channels are entrenched into the landscape due to gully development or resultant deposition and degradation due to recovery, down-cutting and entrenching. The headwaters do not typically have a floodplain where flood flows are partially detained and/or retained. The extensive networks of gully channels develop to be efficient for the delivery of flow and sediment. Partially because of this delivery efficiency of surface flow, base flow (or ground water contribution to surface flow) can be a minimal component of stream flow. As the watershed recovers, soils are able to absorb and maintain base flow. Recovery of area gullies are in part due to better riparian management, conversion of agriculture back to forest, better watershed management and attention to BMP’s. The current pine dominated forest uses more water than hardwood and grasslands, so this along with the

gullies contribute to why many of the small channels are typically devoid of surface flow during the hot summer months (July through September).

Several of the proposed units contain streams or channels of various types that will be protected with the riparian corridor guidance for perennial and intermittent streams or plan guidance for scoured ephemeral channels. Any ephemeral channel with active erosion, gullies or scouring will be managed as a scoured ephemeral. The corridor guidance includes direction to implement BMPs, in addition to other guidance. Many stands border the Broad River its tributaries. Stands with various types of gully erosion are relatively abundant, and most of these gullies are healed and not active. Care will be taken to avoid funneling surface drainage from roads and skidding operations into these channel areas or gullies. Opportunities to avoid stabilize or restore active erosion and sediment sources will be identified and evaluated. This assessment did not evaluate, but does not preclude measures to improve soils, water quality, channel stability, aquatic habitat and other desired results identified as goals and objectives in the forest plan. These items were not evaluated at this time, but will be considered as opportunities for funding emerge with KV, stewardship or appropriated dollars.

Watershed

The project area is in the Piedmont Ecoregion in the hydrologic boundaries of the Lower Broad basin, HUC 03050106; with subwatersheds of Lower Sandy River, Coxs Creek-Broad River, Beaver Creek-Broad River, Hellers Creek and Rocky Creek-Broad River. Small portions of the proposed activities are outside of the listed subwatersheds, and contained within the Outlet Enoree River or West Fork Little River hydrologic units. The remarks that apply to the conditions and effects for the Lower Broad watershed, also apply to these areas. Of these five watersheds, about 16 percent of the 132,406 acres is managed by the Forest Service with the majority of private land being forested (Table 3.1.1-3). Elevations of the PRA range from ~257 to 690 above mean sea level. Many small perennial, intermittent and ephemeral streams exist throughout the PRA.

Of the nearly 542 miles of streams within the entire analysis area, hydrologic unit codes (HUCs), there are a total of 190 stream miles within or immediately adjacent to treatments within the project proposal. Perennial and intermittent streams have buffers consistent with the Revised Land and Resource Management Plan, Sumter National Forest (Forest Plan) riparian corridor direction and South Carolina Best Management Practices for Forestry (BMPs). Additional buffers are used along scoured ephemeral channels consistent with the Forest Plan direction and BMPs.

All streams within the project area watersheds are classified “freshwaters” (FW). Most of these freshwaters are suitable for primary and secondary recreation, as source of drinking water, fishing, survival and propagation of a balanced indigenous community as well as industrial and agricultural uses.

Riparian Areas

The riparian areas, lakes, wetlands, perennial and intermittent drainages, and most bottomland hardwood forest managed by the US Forest Service are included in Management Prescription 11 – Riparian Corridors of the Revised Land and Resource Management Plan for Sumter National Forest (2004). Riparian corridor includes floodplain, wetlands, springs, seeps, perennial and intermittent streams. Plan standards FW-1 and FW-2 indicate that BMPs including Streamside Management Zones (SMZs) would be employed for forest management activities (USDA 2004). When properly implemented, BMPs have been effective at protecting water quality and associated resources (Adams and Hook, 1993; Adams, 1994, 1998; and Jones, 2000). The riparian corridor prescription in the forest plan maximizes protection of the streams and creeks and is not specifically mapped as other management areas. The riparian corridor prescription is imbedded into mapped management prescriptions to ensure good water quality and aquatic and riparian habitat throughout the forest. The management prescription that is most protective, state BMP or Riparian Corridor, will be applied to ensure resources are conserved and protected as needed.

Water Quality

As shown in Table 3.1.1-1, the dominant land use/land cover of the area including national forest and private land in these watersheds is forested, followed by grassland. Forested land is characterized by a mix of deciduous and evergreen trees, including forested wetlands. Barren land is characterized by a non-vegetated condition of land, both natural (rock, non-vegetated flats) and human induced (clearcut forest) (SCDHEC, 2003).

Table 3.1.1-1. Land Use/Land Cover in the Lower Broad Project Watersheds

Watershed	Land Cover Type/Land Cover Usage							
	Forested	Grassland	Barren	Herbaceous Wetland	Urban	Water	Alt. 2*	Alt. 3*
Lower Sandy River	83.2%	14.1%	1.1%	0.0%	0.1%	0.1%	3.5%	3.5%
Coxs Creek-Broad River	83.5%	9.3%	1.3%	0.0%	0.6%	2.6%	8.8%	8.1%
Beaver Creek-Broad River	81.5%	14.5%	1.8%	0.0%	0.1%	0.1%	8.8%	7.1%
Hellers Creek	71.5%	24.0%	0.5%	0.0%	0.3%	1.0%	2.0%	2.0%
Rocky Creek-Broad River	79.2%	9.4%	1.0%	0.0%	0.4%	7.1%	8.3%	8.3%
Percent of project area	58.3%	10.2%	0.8%	0.0%	0.2%	2.0%	4.9%	4.5%

Source: SCDNR, 2001. *Clearcut, shelterwood and thinning are part of the overall Forested area, this calculation is treatment acres/Total watershed acres as a percentage. Background data was omitted from table.

Federal and State laws regulate the quality of surface waters in South Carolina, including the Federal Clean Water Act (CWA) South Carolina Pollution Control Act (48-1-10, et seq., S.C. Code of Laws, 1976). South Carolina water quality standards provide for the protection and maintenance of the existing and classified uses of the waters of the State. Waters in South Carolina are classified for a variety of designated uses, which include: aquatic life, recreation, drinking water and agriculture. A watershed quality assessment of the Broad River Basin was

prepared in 2007 by the South Carolina Department of Health and Environmental Control (SCDHEC) and presents a general assessment of the water quality conditions and water pollution control programs in South Carolina. During 2010 there were 7 water quality monitoring sites within the analysis aquatic life and recreational uses vary in supported levels. Inadequate support is due to upstream historic and present private land use. In 2012, four streams were listed on the 303(d) list for excess total phosphorous or low macroinvertebrate; no additional or updated reports were located.

Wetlands are seldom found along most of the lower order streams because soils are well to moderately-drained. Wetlands found in the Sumter Forest are typically associated with higher order streams and are found in areas throughout the RPA. Digital National Wetland Inventory (NWI) maps from the United States Fish and Wildlife Service are available for the entire RPA. See Table 3.1.1-2 for mapped wetlands are found in or near units. When wetlands are found they are to be treated as a lake and the measurement would start at the ordinary high water mark and go around the perimeter.

There are no surveys available that address springs or recharge areas within the boundaries of any of the proposed treatment units. The riparian corridors are measured in on-the-ground surface feet perpendicular from the edge of the channel, bank, or highest point of noticeable scour and extend out from each side of the stream. To simplify implementation in the field during layout of the units, the following definitions would apply for riparian corridor widths:

Corridor widths for perennial streams and lakes would be 100 feet, 125 feet and 150 feet corresponding to the following slope breaks 0-30%, 31-45% and 46% plus, respectively.

Corridor widths for intermittent streams would be 50 feet, 75 feet and 100 feet corresponding to the following slope breaks 0-30%, 31-45% and 46% plus, respectively.

Channeled ephemeral streams that have a defined channel of flow where surface water converges with enough energy to remove soil, organic matter and leaf litter.

The Forest Plan also addresses standards for scoured ephemeral stream channels with a 25 foot low impact zone with infrequent crossings.

Floodplains and wetlands are protected by Executive Orders 11988 and 11990. In addition, they are included in the riparian corridor prescription for the Forest Plan including adherence to BMPs. Since they are included in riparian buffers and consist mostly of hardwoods, effects from either of the alternatives is not expected.

Roads

Roads managed by private landowners or entities, Forest Service, state, county and other federal agencies are the most prominent feature on the landscape. On private land, roads are mostly native surface and are designed for periodic to permanent use in such activities as logging, farming, ranching, recreation and access to home sites. State, county and U.S. roads are mostly paved, whereas roads managed by the Forest Service are mostly graveled with some native and

paved surfaces depending on the distance from streams and maintenance level designation. Roads can affect water quality and aquatic habitats by causing chronic soil erosion, resulting in sedimentation into streams.

The vegetation management activities proposed for the RPA can have a variety of effects on water resources. Most of the effects are temporary to short term. These effects are generally described below.

Scope of Analysis

Unless otherwise stated, the scope of analysis for direct and indirect effects to Water Resources are National Forest System lands in the Lower Broad Watershed. Cumulative effects includes private lands within the watershed. The cumulative effects analysis will consider activities that have occurred in the past five years since sediment delivered to the stream should work its way through the system within this timeframe. Cumulative effects will also consider future activities in the next 10 years since this timeframe roughly coincides with USFS out-year planning.

Soil loss and sediment yields were calculated using the Revised Universal Soil Loss Equation (Wischmeier and Smith, 1978, Dissmeyer and Foster, 1984) for use in forest conditions and past DBRU analysis by physiographic area (McLaughlin et al 1981, Goddard 1982, Hansen, et. al. 1994). Soil loss is the amount of soil movement. Only a portion of soil movement leaves the site as erosion and even less is delivered to streams. The amount of soil loss that is delivered to streams varies by drainage size, slope and other circumstances (Roehl, 1982). A sediment delivery ratio of 0.34 was used to calculate the percentage of soil loss that reaches headwater perennial streams, and this sediment delivery ratio (SDR) value is based on the size of typical 3rd and 4th order perennial channels (i.e., perennial streams). A sediment delivery ratio is less for larger streams as there is typically more opportunity for storage of sediments within the channel or on the floodplain (Roehl, 1982). The length of time for site recovery was adjusted from past timber sale activities that typically had less intensive BMPs and a greater duration of impact (Dissmeyer and Stump, 1978). Their recovery time was reduced one year from the Dissmeyer and Stump estimates because the treatment areas are actively stabilized today as compared to more passive approaches in the late 1970s. The surface erosion based sediment values do not include channel, gully, landslide and other forms of erosion and sediment. Although these may sometimes be substantial, we had no easy way to incorporate these items into our estimates or to determine how these might change with activity. Sediment yield calculations can be found in the process records. Estimates were made at the analysis area scale and to address the highest intensity of activity within a 6th level HUC and also for both thinning and regeneration practices within individual DBRUs. The high intensity areas within the project proposal provide the upper bounds of expected effects within these hydrologic scales. Assumptions were made to address sediment effects at these various scales, and the values generated are not accurate, but useful to compare alternatives and give an estimate of project related effects.

Temporary effects from forest management activities last for only a limited time (2-3 years) since project design criteria including erosion control measures lead to rapid revegetation of disturbed areas. Each alternative summarizes sediment delivery to streams and the project file

contains detailed erosion and sediment calculations by alternative. Comparison among the alternatives can be made over a decade include tons of sediment, percent increase over background levels, and average sediment concentration in parts per million (ppm).

Direct and Indirect Effects of Alternative 1

Impacts on water resources under alternative 1 would be limited to the effects of periodic prescribed burning under already existing project decisions, routine road maintenance, invasive species control, southern pine beetle control efforts, management activities on private lands and climate change. Some road maintenance issues that would be repaired or improved with the action alternatives would not be fixed. No other impacts are anticipated under this alternative.

Cumulative Effects of Alternative 1

Existing levels of erosion-based sediment were approximated from land use activities and delivered to small streams (methods summarized by Hansen et. al, 1994, Roehl, 1962). Estimates of erosion and sediment from these practices have been made by using the land use estimates and average erosion coefficients for these practices (Hansen et. al., 1994). The summary of erosion and sediment calculations are in the project record. Over 80% of the sediment was linked to private sources. These types of erosion include channel, gully and other forms of erosion that are difficult to predict. Normal geological and legacy erosion and sedimentation would continue related to current conditions. The mean concentration of forest activities were estimated at 4.1 ppm, while the mean concentration of non-USFS activities were estimated at 138 ppm, with a composite concentration connected to these 5 subwatersheds of 142 ppm.

No substantial impacts to riparian areas, perennial, intermittent or ephemeral streams would occur under this alternative since BMPs apply to private land forestry practices as well. Soil loss and sediment yields would be associated with existing roads and ongoing land management activities. Some of the barren lands were adjacent to the lake and to some extent a part of lake level management that periodically floods areas with vegetation mortality, and sediment accumulations. Other pollutants to streams or water bodies may occur associated with activities in the subwatersheds including oil or petroleum based leaks along motorized areas including roads, parking lots; herbicide and pesticide uses associated with undesired plants, insects, disease; litter and garbage dumping or recycling; pets and farm animals; septic tanks, waste treatment facilities, etc. Portions of some watersheds include areas flooded by Thurmond Lake as managed by the Corps of Engineers. Erosion and sediment associated with wind, waves, boat wakes, etc. occur around the lake shore and other potential sources of sediment or other pollutants were not assessed as part of this analysis. On private land, sediment and water quality (including fecal) impacts are primarily associated with communities, roads and timber harvesting.

Direct and Indirect Effects of Alternative 2

Timber Harvest and Connected Actions

The potential for water resource impacts is primarily temporary in duration and minor to moderate on site, with elevated sediment concentrations for two to three years within the RPA sub-watersheds. With the concentration of the regeneration and thinning treatment, increase in sediment would primarily be within Cox Creek watershed. See Table 3.1.1-2 for a comparison of watershed size to treatment area.

Table 3.1.1-2. Proposed Action Treatment Acres and Percent by Project Watersheds

Watershed	Watershed Acres	Treatment Acres	Percent
Lower Sandy River	16,848	585	3.47
Coxs Creek-Broad River	23,625	2,021	8.55
Beaver Creek-Broad River	27,926	2,449	8.77
Hellers Creek	26,112	510	1.95
Rocky Creek-Broad River	37,895	3,131	8.26
Total	**132,406**	**8,704**[1]	**6.6**

Ursic (1986) concluded from data across the south that timber harvesting did not significantly increase sediment levels within any of the South's physiological regions. He observed that any increase in sediment normalized the first year after treatment operations were completed. The development and use of skid trails would likely increase stream sediment during use and for a short term after. Proper implantation of BMPs would help mitigate soil loss from skid trails. Regeneration clearcut with reserves (2,083 acres) and shortleaf pine restoration (62 acres) can degrade stream water quality by increasing sediment and nutrient runoff input to streams. Regeneration would cause some soil displacement and reduce ground cover; however, the sediment production should be minimal due to the extent of the activity and roller drum chopping, which will roughen the surface.

First thinning (2,092) and intermediate thinning (4,264 Acres) as proposed would reduce tree density which would result in increased growth of crowns and understory vegetation. Crown growth and closure would occur in about five to seven years for moderately stocked stands (residual basal area of 60-80 square feet). The recovery period to canopy closure would be somewhat faster for thinned stands with a higher residual basal area. Individual stands are expected to quickly return to pre-harvest water yields since adjacent hardwood stands and hardwood inclusion areas within harvest units would not be thinned. Water yield increases within thinned units are expected to be short term as the residual trees grow larger crowns and roots take advantage of the available water and nutrients.

The shelterwood with reserves treatment (208 acres) would reduce the basal area to ~30 square feet and naturally regenerate the stand. Impacts on water resources from moderate increases in runoff, sediment, and nutrients would be minimal based on forest-wide standards and guidelines

[1] GIS acre analysis differs slightly from acres displayed in the proposed action.

and BMP's implemented during timber harvest operations. Changes in water yields would occur in response to activities that regenerate trees within the watershed or natural processes such as storms or fires that may create canopy openings. Water yields would increase following harvesting gradually returning to normal levels after a period of 5-10 years. Skidder trails/landings and temporary roads decrease water infiltration and can increase surface water flow. This can increase water volume/velocity and soil erosion. The concentrated water, if left uncontrolled can result in stream sedimentation. Other erosion and sediment preventative or reduction measures would include the installation of water diversion practices along roads and skid trails.

Other impacts from harvests include a reduction in normal water infiltration and increased soil and nutrient loss through sheet and rill erosion in the treatment areas. If rill erosions should occur, these impacts are typically temporary. Timber harvest activities have the potential to impair the water quality of streams within the vicinity of harvested areas through vegetation clearing, soil disturbance, and soil compaction from the use of heavy equipment. Vegetation provides water infiltration and uptake, which reduces runoff and subsurface flow to streams. Sediment and nutrient delivery to streams often increases substantially after timber harvest operations and is proportional to the area disturbed and maintained free of vegetation (Gucinski et al., 2001). As the density of the forest stand decreases, intercepted rainfall and transpiration decreases, increasing the amount of surface water runoff and subsurface interflow from the area (Schultz, 1997; USFS, 1985). Increased surface water runoff can increase stream flow and storm flow, which can lead to stream channel scouring, stream bank erosion, increased sedimentation and nutrients, and flooding, all of which can impact aquatic organisms (Fulton and West, 2002; USEPA, 2001; Miller, 1987). Increased flow can also wash away logs and other woody debris in streams, which provide habitat and nutrients for aquatic organisms (USFS, 1989b; Miller, 1987; USEPA, 2001).

The increase in stormflow from harvested watersheds during the growing season is particularly evident because of the lack of water uptake from vegetation, leaving higher ground water tables and/or moisture in the soil. The lack of vegetation can reduce the organic component that helps retain and enhance absorption of water into the soil. Exposed soil may lead to the sealing of macropores with fine particles, soil saturation and subsequently greater volumes of runoff with potential for entering the streams. The development of understory vegetation after harvest and to a lesser extent thinning would reduce the amount of stormflow caused by overstory tree removal.

Surface water runoff and erosion impacts during timber harvests are typically short-term, reducing as vegetation in the affected area reestablishes. Nutrients, including nitrogen and phosphorous can enter water bodies attached to sediment, dissolved in water runoff, or through the air. Nutrient losses from a site and into a waterbody tend to increase proportionately with sediment movement (Schultz, 1997). Increased nutrient runoff to streams can have either adverse effects (Lemly, 2000) or beneficial effects, depending on the level of nutrient runoff, and the current nutrient content of the streams (Tank and Webster, 1998). Many aquatic systems are nutrient poor, and therefore, small increases in nutrients can improve their productivity (USFS, 1989b).

The potential increase in sediment yields to the project area watersheds would be negligible overall but may have temporary effects in the headwater streams; impacts that would diminish substantially further downstream into larger, mid-order streams and into Thurmond Lake. No thinning would occur in wet riparian corridors. If activities are concentrated into a confined area (such as thinning over 25% of a drainage area, entering at 3-5 year intervals would help reduce the effects of water yield change on the landscape and in the streams. No soil disturbance is expected to occur in wetland communities since no timber harvests would occur in these areas. Effects to water resources from potential increases in water, sediment and nutrient yields from seed-tree regeneration would be minimized by design criteria that reduce erosion and sediment (SCFC, 2007). Implementing the BMPs would ensure compliance with the Clean Water Act. Skid trails and log landings would be seeded with native grasses and legumes along with other approved desired seed mixtures following harvest activities to stabilize and rehabilitate exposed soils. If activities are concentrated into a confined area (such as clearcutting over 25% of a drainage area, entering at 3-5 year intervals would help reduce the effects of water yield change on the landscape and in the streams. Surface drainage structures in the form of dips or water bars would be used to limit concentrated flow, erosion and sediment sources.

Leaf and needle fall after activities is rapid, to the extent that bare soil is often covered with litter before vegetation can immerge and grow. Some soil disturbance/exposure, erosion and compaction can affect water resources by increasing water runoff, erosion and sediment to streams. Dissolved inorganic nutrients and sediment in water runoff can impair stream water quality and beneficial uses. Skid trails, log landings, and roads tend to channel surface runoff to streams increasing flow velocities and sedimentation. Mitigation measures such as water bars, dips, or drainage diversions are just one of the BMPs used to minimize these effects. Streamside management zones remain intact, with limited activities that disturb the soils and retain trees or other vegetation as appropriate for the stream type and conditions.

Herbicide treatments in regeneration units include a limited potential for water quality (surface and ground water) contamination from low volume foliar spray from backpack sprayers and from the hack and squirt method. No aerial or broadcast applications of herbicide are being proposed. Foliar application generally involves a greater hazard because herbicides are spread through the air. They can move around by aerial drift, washed off plant leaf surfaces, volatilization, plant uptake, leaching and surface runoff. Drift is the movement of herbicides in air as suspended droplets or dust. Rainfall can cause foliar and stem wash off after application, removing herbicide residue from plant surfaces and transporting them into the soil. Volatilization occurs while herbicides are still exposed to sunlight and air and involves chemical movement in the vapor form through the air.

Plant uptake, removes and absorbs herbicide from foliage and bark surfaces or from the soil and temporarily or permanently depending on the herbicide, removes them from transport. Leaching moves herbicides through litter, soil and out of the plant rooting zone. Surface runoff rapidly transports residues off site either in solution or adsorbed to sediment. Subsurface flow of water removes herbicides in solution from the treatment site in slower ground flow. Processes that break down herbicide chemical structures include photodecomposition, microbial and plant metabolism, thermal degradation and hydrolysis. These processes along with those that transport herbicides, determine the degree to which herbicides persists in the environment.

Imazapyr is a broad spectrum herbicide which controls most grasses, broadleaf weeds and woody species. It is absorbed by both foliage and roots, is translocated through the plant and is accumulated in the growing tissues and root system. Lateral and vertical movement in the soil is limited. Field studies show that movement is restricted primarily to the top three inches of the soil profile. The major route of degradation is photolysis; also broken down by soil microbes. Generally, imazapyr persists in the soil for three months and this depends on the concentration used and soil moisture.

Triclopyr is a selective systemic herbicide used to control woody and herbaceous broadleaf plants. There are two basic formulations of triclopyr (triethyamine salt and butoxyethyl ester).Offsite movement through surface or subsurface runoff is a possibility with triclopyr acid as it is relatively persistent and has only moderate rates of adsorption to soil particles. The salt formulation is water-soluble and with sunlight it may degrade in several hours. The ester is not water-soluble and can take longer to degrade. The ester binds to organic particles in the water column and precipitates to the sediment layer. Bound ester molecules degrade through hydrolysis or photolysis to triclopyr acid which moves back into the water column and continues to degrade.

The potential for surface or ground water contamination from an application of imazapyr or triclopyr is very slight. Foliar hand applications offer very little potential for drift. The hack and squirt method would have a lower potential for contamination since the herbicide is applied directly to the cambium of the treated vegetation via a squirt or spray bottle. The herbicide is then readily taken up by the plant. Herbicide applications would be performed to meet BMP standards and design criteria. The dispersed nature of herbicide application in combination with the low frequency and low application rates would present a low risk of pollution to groundwater. The half-life of imazapyr in water is about 4 days. The half-life of triclopyr in water ranges from 1 to 10 days depending on water conditions.

Aminopyralid targets selected annual, biennial & perennial broadleaf weeds. Used for broadleaved control, there is no advisory on Milestone, (unlike Transline, which should not be used where the water table is high or in sandy soils where movement can occur more readily). The average soil half-life is 35 days and a Aqueous Photolysis degradation half-life of 0.6 days.

Glyphosate- Glyphosate is strongly absorbed to soil particles, which limits its movement into aquatic environments. It is unlikely to enter waters through surface or subsurface runoff, except when the soil itself is washed away by runoff. Most glyphosate found in waters likely results from runoff from vegetation surfaces, spray drift and direct overspray. In water, glyphosate is rapidly dissipated through absorption to suspended and bottom sediments where it persists until degraded by microbes with a half life of 12 days to 10 weeks. Technical glyphosate acid is practically nontoxic to fish and slightly toxic to aquatic invertebrates. The 96 hour LC50 is 120 mg/l in bluegill sunfish and 86 mg/l in rainbow trout. LC50 is defined as the concentration of a chemical, which kills 50% of a sample population in laboratory testing in a specified amount of time. The 48 hour LC50 in Daphnia (important food source for freshwater fish) is 780 mg/l. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms (http://extoxnet.orst.edu).

Streams would be protected from herbicide translocation by limiting herbicide application distances to streams, riparian and aquatic zones. Riparian corridors would reduce the amount of offsite movement of imazapyr in stormflow.

Stream side management zones would absorb any limited movement without noticeable effect on land or aquatic vegetation. Placement of an untreated SMZ parallel to the channel greatly reduces the potential for direct contamination of water resources and these no treatment zones absorbs any movement without noticeable effect on aquatic vegetation.

Road Reconstruction and Maintenance

Road maintenance and brush control can adversely affect water quality through removal of vegetation and litter cover; compaction, exposure and disturbance of soils. Road maintenance benefits nearby water resources by minimizing soil movement, ensuring that drainage culverts are functioning properly and that road banks maintain adequate vegetative cover. Although maintaining roads would contribute to sediment movement because it involves disturbing the soil, mitigation measures would minimize any negative impacts. Long term benefits such as reduction of erosion, sediment and concentrated flow occur when roads get proper and regular maintenance.

There would be 1.63 miles of road construction with the project. System road maintenance (43.4 miles) and temporary road (< one mile) would produce a sediment source through grading and ditching. Adverse water quality impacts from temporary road construction and use for timber harvest activities are typically short-lived, occurring at the highest levels during and for a few years after construction. Temporary roads are closed after harvest and impacts decrease in intensity as the road surface and cut-fill slopes stabilize, and roads revegetate following completion of activities (Fulton and West, 2002; Gucinski et al., 2002). Maintenance of roads and culverts would benefit hydrology and stream water quality by ensuring that drainage culverts function properly and that the road bank maintains an adequate vegetative cover.

The natural variation in water yields and short-term changes in water quality would occur in response to storm, fire, and beetle activity to the same or similar extent as the no-action alternative. In addition, harvesting outlined in these proposals could potentially affect water quality, water quantity, channel morphology and downstream beneficial uses temporarily, in the short run. These effects are minor to miniscule at watershed scales. Short term changes in water and sediment yields would return to normal as sites are re-vegetated.

Sediment

Erosion, sediment and sediment concentration estimates were made on the combination of proposed treatment activities including the opening of closed roads and closing them after use. The amount of estimated erosion over a decade for the proposed action was 8,929 tons, sediment delivered was 3,036 tons, and mean sediment concentration increase of 5.7 ppm. Sediment increases associated with activities would be relatively temporary to short term. As drainage areas increase below activities, the increases would also decline with both dilution and sediment being deposited on floodplains as sediment delivery ratio declines as watersheds get larger.

All analysis area watersheds would have a temporary to short term sediment increase of less than 2 percent. Much of this sediment increase would occur during severe events that occur infrequently, so sediment increases would be difficult to detect in normal day-to-day observations or monitoring. Sediment values reported that reach the perennial streams are going to be substantially reduced before reaching their outlets or Thurmond Lake.

Cumulative Effects of Alternative 2

Other past, present and foreseeable future activities within the project area watersheds mentioned in Alternative 1 that also have a potential to interact cumulatively to affect water resources include herbicide release, SPB suppression and control activities, invasive exotic plant control, system, county, state and special use road maintenance, temporary road construction and maintenance, timber sale activities, prescribed burning, gully restoration/rehabilitation, various types of land uses associated with forestry, agriculture, rural and urban development, golf courses and lake management. Activities contributing to soil erosion and sedimentation are included in the erosion/sediment model located in the project record.

Timber harvest would also be conducted as part of SPB suppression, and control. SPB control efforts occurring before the timber sale could result in the harvest of trees that would ordinarily be harvested during the RPA timber sale. SPB control efforts occurring after the timber sale could result in the loss of potential seed-trees in regeneration areas or openings created in overstocked stands where intermediate and first thinning are proposed. Temporary road construction to access SPB outbreaks and routine road maintenance would result in more soil disturbance and the potential for increased erosion and sediment yields.

Prescribed burning following re-vegetation by understory species would increase potential runoff and higher water yields. A low intensity burn would minimize this. Generally, during low intensity surface burns, woody vegetation recovers quickly along with warm season grasses. Prescribed burning would not be conducted in the regeneration areas in the short term.

Some past and current projects within the affected project area watersheds involve the use of herbicides for selective release and non-native invasive plant control. Herbicide would be applied by on-the-ground, foliar and cut surface application methods. These methods would reduce the potential for drift or accidental contamination of non-target areas. Herbicides used would degrade in the environment after application, leaving a limited window for cumulative adverse effects from other herbicide use projects.

Soil loss is the amount of soil movement off site. Only a small portion is typically transported into streams for each of the activities. The length of time for site recovery was adjusted from normal timber sale activities that typically have a greater duration (Dissmeyer and Stump, 1978). The recovery time should be less than indicated because BMPs and Forest Plan standards and guidelines would be followed. The erosive effect of water is reduced by quickly re-establishing vegetation on highly impacted areas such as skid trails and log landings.

Cumulative increases in sediment concentrations for the five sub-watersheds affected by project activities range from 0.34 to 1.63 ppm over the decade from implementing the proposed action.

At the sub-watershed scale, this change is negligible. The concentrations indicated are those associated with small perennial streams, and do not take into account the reduction in sediment delivery from about 34% to 13-17% expected as drainage size increases from 3rd to 4th order drainages (typically hundreds of acres in size) to sub-watershed scale (sixth level HUCs or 6th-7th order drainages that are 10,000 acres or more in size).

Activities on Private Lands

The majority of the RPA watersheds, including interspersed private lands, consist of closed canopy evergreen forest/woodland. Timber harvest activities on private lands are expected to contribute to both short-term and long-term adverse impacts to water resources in the RPA watersheds and would interact cumulatively with the proposed vegetation management activities. Overall, these adverse impacts are not expected to be substantial since the majority of the watershed is forested, providing protective buffers along streams and wetlands. The implementation of BMP is relatively well accepted as a standard practice on private land and aids in the protection of water quality. Loggers are often trained in BMP implementation. The potential for timber harvesting under Alternative 2 to cumulatively contribute to adverse impacts on water resources would be minimal over the short-term.

Direct and Indirect Effects of Alternative 3

Alternative 3 would have effects similar to alternative 2 with the following changes: 474 acres less of intermediate thinning and 20 acres less of shortleaf restoration due to lack of road access. Stands proposed for regeneration by clearcut would instead be treated using the seedtree method. There would be an additional reduction of 110 acres due to limited road access to seedtree stands. Road construction would decrease to 0.1 mile and road maintenance by ~0.4 miles. New ROW access would not be needed under this alternative.

The potential for water resource impacts would remain almost the same as alternative 2 with slight decreases in sediment in all project watersheds. See Table 3.1.1-3 for a comparison of watershed size to treatment area.

Table 3.1.1-3. Alternative 3 Treatment Acres and Percent by Project Watersheds

Watershed	Watershed Acres	Treatment Acres	Percent
Lower Sandy River	16,848	585	3.47
Coxs Creek-Broad River	23,625	1,875	7.94
Beaver Creek-Broad River	27,926	1,990	7.13
Hellers Creek	26,112	510	1.95
Rocky Creek-Broad River	37,895	3,131	8.26
Total	**132,406**	**8,096**[2]	**6.1**

[2] GIS acre analysis differs slightly from acres displayed in alternative 3.

Sediment

Erosion, sediment and sediment concentration estimates were made on the combination of proposed treatment activities including the opening of closed roads and closing them after use. The amount of estimated erosion over a decade for alternative 3 was 7,786 tons; sediment delivered was 2,647 tons, and mean sediment concentration increase of 4.9 ppm. Sediment increases associated with activities would be relatively temporary to short term. As drainage areas increase below activities, the increases would also decline with both dilution and sediment being deposited on floodplains as sediment delivery ratio declines as watersheds get larger.

All analysis area watersheds would have a temporary to short term sediment increase of less than 2 percent. Much of this sediment increase would occur during severe events that occur infrequently, so sediment increases would be difficult to detect in normal day-to-day observations or monitoring. Sediment values reported that reach the perennial streams are going to be substantially reduced before reaching their outlets or Thurmond Lake.

Cumulative Effects of Alternative 3

Cumulative increases in sediment concentrations for the five sub-watersheds affected by project activities range from 0.34 to 1.30 ppm over the decade from implementing alternative 3. The other effects described for alternative 3 would be the same as alternative 2.

3.1.2 Soils

Introduction

This section covers the soil resources of the Lower Broad River Vegetation Management Project, which proposes to improve forest health, vegetation diversity and wildlife habitat diversity. The treatments proposed to achieve the purpose and need involve the implementation of five (5) silvicultural prescriptions; first thinning, intermediate thinning, regeneration clearcut with reserves, shortleaf pine restoration, and shelterwood with reserves. Ground-based vegetation treatments, i.e. timber harvest, will be the method used, creating the potential for impacts to the soils of the project area. Treatments will also create opportunities to restore, enhance and protect forest ecosystem components in the project area. Herbicide application for vegetation management is proposed in the seedtree and woodland treatments.

Natural disturbance agents such as wildfires, insects and diseases have the potential to impact soil productivity, as do the treatments of this project. The purpose of this soils section is to provide detailed information and analysis regarding soil resources to support the environmental analysis and decisions for the project. This report provides a brief description of the soils of the project, assumptions and methodologies used in the analysis, and discloses the potential effects of the proposed action and alternatives on soil productivity, health, and soil quality. The primary concerns are the impacts of soil erosion and compaction.

This section identifies the applicable laws and regulations that provide direction for the protection of the soil resource, explains the analysis methods and scale used to determine the

potential effects of each alternative, describes the existing condition of soils in the Lower Broad River analysis area and discloses environmental consequences of each alternative.

Regulatory Framework

The regulatory framework providing direction and guidance for protection of a soil's inherent capacity and productivity comes from the principle sources below:

- Forest Service Manual - Section 2500 (WO Amendment 2500-90-2)
- Multiple-Use Sustained-Yield Act of 1960
- National Forest Management Act of 1976
- Forest Service Handbook - FSH 2509.18-2003-1, Region 8 Soil Quality Standards
- Land and Resource Management Plan, Sumter National Forest, 2004
- South Carolina's Best Management Practices for Forestry (BMPs), 1994
- Forest Service - Region 8 Soil and Water Conservation Practices (SWCPs) Handbook, 2003

The Sumter Forest Plan goal for soil productivity is "Maintain or restore soil productivity and quality (USDA Forest Service, 2004). There are four Forest Plan standards related to soil productivity are listed on page 2-4 of the Forest Plan. In summary the standards identify the use of best management practices during projects to avoid impacts to soils, and minimize the extent of detrimental soil disturbance to less than 15 percent of vegetation management treatment areas.

Analysis Methods

Scope of analysis

The geographic boundary used for assessing direct and indirect effects to soils is the treatment areas where ground disturbing actions such as tree harvest, temporary road construction, site preparation, and road maintenance are proposed. The analysis area for soils encompasses all land within an individual treatment or activity area. In general, soils outside the boundaries of the activity areas are not expected to be directly, indirectly, or cumulatively affected by the actions of this proposal. This boundary was chosen because it can be used to determine effects to soil quality from the proposed actions. For instance, the direct effects from a log landing would be the acreage used for the landing because it is the area of soil directly impacted by the activity.

The following activities could potentially affect soil quality and productivity through soil disturbances that can alter existing soil conditions (machines causing impacts are listed):

- Harvesting commercial dimension trees – feller-buncher machines
- Moving felled trees from stump to processing and loading areas – skidders
- Processing logs in loading areas – skidders, loaders, bulldozers, transport trucks
- Construction, maintenance, and closure of log landings, skid roads and temporary roads – bulldozers, dump trucks
- Maintaining or constructing permanent Forest Service system roads – bulldozers, graders, dump trucks

These activities have the potential to cause detrimental soil disturbance that can directly impact soil productivity through compaction, rutting, erosion, displacement and loss of ground cover. The temporal scale for project analysis is dependent on the specific issue being addressed with no one scale being appropriate in all issues. Generally, detrimental disturbance effects on soils are not permanent and depend primarily on soil texture, parent material, aspect, and moisture. For this project, field assessments detected soil disturbance related to past timber harvest up to 30 years in the past and the effects of the proposed management activities can be estimated to be evident about 5-10 years into the future.

The temporal (time) boundary used to assess effects would vary by the activity. Short-term effects from: (1) increases in soil moisture from harvesting may last a year or two until new vegetative growth occurs; or (2) disturbance or mixing of the soil organic horizon may disrupt decomposition processes for a few weeks or months. Long-term effects of five to over 50 plus years may result if the highly productive upper layer of soil is compacted or removed. For example, soil displacement or compaction could result from skid trail development and use. This may remove the organic matter and available nutrients in the upper layer of the skid trails and affect water infiltration. This effect may persist from the time use of the skid trails begins until three to five years following the completion of timber harvest activities, and soils are ripped and revegetated; or, if compacted soils on the skid trails are not ripped after use, impacts to soil productivity on the skid trails may persist for 30 to 40 years.

The most productive portion of a soil occurs near the surface at the contact between the forest litter and the mineral soil. This is also the part of the soil that is easiest to disturb during management activities. Therefore, the analysis of activities was limited to this most productive portion of the soil. Evaluation of deeper soil layers and underlying parent material was used only to determine how they influence the productivity of upper soil layers.

Field visits by Forest Service personnel, Geographic Information System data, records of past activities, and information from the soil surveys for the Sumter National Forest were sources used to evaluate the impacts of proposed activities. The description of anticipated impacts to the soil resource was based on the sensitivity of the soils in the project area and the amount of soil the proposed activities are likely to disturb.

The Southern Region Soil Quality Standards (R8 Supplement 2509.18-2003-1) were designed to be applied at the project level of activities. For harvest operations, the activity areas are identified as the stands to be treated and any associated temporary roads and log landings. For these activities, the intent of this analysis was not to assess the existing site conditions and effects to the soil productivity across the entire “project area”. Rather, the scope of this analysis was narrowed to assess the existing site conditions and effects to soil productivity within the immediate vicinity of the proposed management activities.

The Southern Region Forest Service Soil Management Handbook (USDA-FS-R8-2509.18, 2003) describes a standard of measure for soil quality based on area extent of disturbance to soils by an activity. This direction (excerpt below from soil quality standard 4) states that soil impairment does not occur when the following are within limits:

a. At least 85 percent of an activity area is left in a condition of acceptable potential soil productivity following land management activities.
b. Compaction in an activity area should not significantly impair soil productivity.

To see if this threshold would be exceeded by proposed Lower Broad River Project activities, acres of soil impacted by soil disturbing activities (skid trails, log landings, and temporary road construction) were estimated using the best available information, and compared to the total acres of the activity areas (harvest units and road corridors).

Affected Environment

The Lower Broad River Project is located in the Lower Broad River Analysis Area (LBAA) in the southeast portion of the Enoree Ranger District, south and east of Carlisle, South Carolina. The project area encompasses 53,713 acres within 19 management compartments. National Forest lands occur on 15,614 acres, or about 29% of the analysis area.

The proposed action for the Project identifies treatment units on a total of 8,710 acres, primarily thinning of stands regenerated to loblolly pine 30 to 40 years ago (6,355 acres). Regeneration treatments are proposed on 2,292 acres for loblolly, and 62 acres for restoration of shortleaf pine. Proposed treatments will occur on forest lands that vary in elevation, aspect, slope, soils, disturbance history and resilience to disturbance.

The project area is located within the boundaries of the Sumter National Forest, Enoree Ranger District in portions of Chester, Fairfield, Newberry and Union Counties, South Carolina. These lands are typical of the Piedmont ecological section of the southern United States, having a past history of intensive agriculture that often created conditions causing accelerated erosion and the loss of original topsoil. Some reports and studies identified the loss of several inches to several feet of the productive topsoil layer, moving off-site and becoming deposited into nearby streams. Trimble (1974) estimated an average loss of 7.5 inches of topsoil in the Piedmont, some areas losing as much as 16 inches. These abandoned, eroded, worn-out farm lands were acquired by the Federal government in the 1930s. The Soil Conservation Service was charged with restoration of these lands through conservation practices and reestablishment of vegetation communities. Pines were well adapted to the acidic, low fertility conditions of the eroded, clayey soils, which were dominant and exposed on these new public lands.

Native or natural soils of the Piedmont prior to the extensive agriculture were described as having a surface topsoil layer of loamy texture underlain by the clayey subsoil. Accelerated erosion exposed the red clay subsoils that are highly erodible if not protected by a ground cover. The “red clay” common on much of the southern Piedmont landscape owes its bright color to the presence of iron oxides that result from the intense weathering of feldspar-rich igneous and metamorphic rocks.

Ecologically this project area is situated in the Southern Appalachian Piedmont Ecological Section (231A), identified in the Forest Service National Hierarchical Framework of Ecological Units (Cleland et. al. 1993). The Piedmont Section is a lower level of the Subtropical Division (230), marked by high humidity (especially in summer) and the absence of cold winters.

Southern Appalachian Piedmont Ecological Section (231A): irregular plains with smaller areas of high hills and tablelands, elevation range from 330 to 1300 feet; average annual precipitation from 50 to 60 inches; soils are udults, with some areas severely eroded as a result of past intensive agricultural practices. Soils have a thermic temperature regime and a udic soil moisture regime. Dominant soil series on uplands in the Section include Cecil, Davidson, Madison, and Pacolet. Subsoils are typically fine or clayey textured, increasing the potential for erosion or compaction. Many areas are severely eroded as a result of past intensive agricultural practices, especially for cotton production (USDA Forest Service, 1994)

Four soil survey areas cover the project area; Chester and Fairfield Counties, Newberry County and Union County. These surveys were published cooperatively by the USDA Natural Resources Conservation Service and the USDA Forest Service. Soil survey information for National Forest lands is available in both a Forest GIS data-base and the NRCS Web Soil Survey website by survey area (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). Survey information includes soil series descriptions, soil maps, interpretations for various management uses, and related soil use information.

During soil survey mapping, soil scientists traverse the landscape to inventory and classify soils into soil mapping units. Key soil properties evaluated during surveys include slope gradient, soil depth to bedrock, soil texture, soil drainage, landform position of occurrence, and other physical properties that could influence soil productivity and management. Landform features that may limit use and management are also noted; e.g. gullies and stony areas. These characteristics are generally measured in the field setting, recorded on data forms, and mapped on an imagery base map. Slope gradients on soil mapping units in the project area are identified as 0 to 2 percent on floodplains; 2 to 6 percent on gently sloping side slopes, 6 to 10 percent or 10 to 15 percent on moderately steep side slopes, and 15 to 40 percent on steep sideslopes. Sixty percent of the proposed action stands are on slopes of 2 to 15 percent.

Historic Soil Erosion Conditions

Some of the lands within the Enoree Ranger District exist today due to the presence of legacy erosion conditions as previously described. During the inventory of soils, soil scientists classified and mapped a soil attribute important to soil productivity, the field evidence of accelerated erosion. Three classes of erosion make up the classification that identifies the loss of the original surface soil layer. Evidence of this erosion can be found in most portions of the Enoree Ranger District through the visual observance of gullies, and examination of soil profiles that lack original surface material, often darker in color due to organic material and biological activity.

For example, soils mapped in the Cataula series in the project area are classified as moderately eroded, determined by the amount of original surface horizon that has been eroded by past land use. The NRCS defines moderately eroded or Class 2 erosion as: “soils that have lost, on the average, 25 to 75 percent of the original A and/or E horizons of the uppermost 20 cm (7.8 inches) if the original A and/or E horizons (surface) were less than 20 cm thick. Throughout most cultivated areas of Class 2 erosion, the surface layer consists of a mixture of the original A horizon and material below. (USDA NRCS Soil Survey Manual, 1993) There are approximately 3,494 acres within the proposed treatment units classified as moderately eroded or eroded.

The soil mapping units in the project area with this classification are denoted in the map unit symbol with a “2” at the end of the symbol, e.g. CdB2 – Cataula sandy clay loam, 6 to 10 percent slopes, eroded. An estimated 1075 acres of this mapping unit occur in the project area. These acres have been harvested in the past and continue to support healthy, young loblolly pine stands, however soils need to be minimally impacted to maintain productivity levels.

No wetland soil mapping units were identified in the project area, although there may be small inclusions of hydric soils located in the riparian mapping units. A hydric soil is defined as a soil that is formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Identification of stream associated landforms, e.g. floodplains and riparian corridors, is an important element of managing the forest landscape. These areas typically have different vegetation communities, ecological processes and soil characteristics that reflect their structure and components. Three soil series, Cartecay, Chewacla and Toccoa, are mapped along nearly level floodplains along perennial stream drainage ways in the project area. These soil series are loamy alluvium, somewhat poorly drained and subject to occasional flooding. A seasonally high water table may occur from January through April with water within the top 12 inches of the soil. Small, isolated areas of hydric soils may occur within the mapping unit. There are an estimated 123 acres of these soils within proposed action stands.

Figure 3.1.2-1. Examples of gullies in the Lower Broad River project area. Both gullies would classify as shallow (less than 2 feet deep, 2-4 feet wide), stable (sidewalls vegetated) and inactive (minimal exposed, bare soil within the gully walls). Both gullies are located near the ridge below a permanent road. Evidence of the stability is the size of trees growing within the gully. (Photo Credit – USDA Forest Service)

Watershed Condition Classification

A watershed assessment was completed on the Sumter National Forest in 2011 as part of the Forest Service Watershed Condition Framework. Assessment was conducted at the scale of 6th level hydrologic units (HUC 12). A core set of national watershed condition indicators was used to classify watershed conditions, including soil condition, part of the terrestrial physical ecosystem process category. Analysis evaluated available GIS and local data to consider how management actions can affect the conditions of watersheds and associated resources. The soil indicator addresses alteration to natural soil condition, including productivity, erosion and chemical contamination (USDA-FS, 2011). Indicators was evaluated using a defined set of attributes whereby each attribute was scored as Good (functioning properly), Fair (Functioning at risk), or Poor (impaired function).

Soil condition in the four 6th level HUCs encompassing the Lower Broad River Project are rated as Impaired Function (class 3). Description of the attribute for soil erosion states; "Evidence of accelerated surface erosion occurs over less than 10 percent of the watershed, or rills and gullies are present but are generally small, disconnected, poorly defined, and not connected into any pattern." There are approximately 3,494 acres within the proposed treatment units classified as moderately eroded or eroded. This erosion classification is described as soils that have lost, on the average, 25 to 75 percent of the original surface horizon. Soil scientists identified conditions during soil survey that identify erosion during past land use periods. With the exception of areas with active erosion, e.g. gullies, most of the stands in Forest Service management have been stabilized and restored to productive soil conditions.

Table 3.1.2-1 – Soil Types by Treatment Acres in the Lower Broad River Project Area[3]

Soil Series Name	First Thinning	Intermediate Thinning	Regeneration Harvest Clearcut w/Reserves	Regeneration Harvest Shelterwood	Shortleaf Restoration	Soil Acres Total
A - Upland Soils- 2 to 15 % slopes – These soils are located on upland positions with slope gradients ranging from 2 to 15%.						
Appling		30.04	16.73		14	60.77
Durham		28.71	6.68			35.39
Enon	62.92	59.53				122.45
Hard Labor		1.48	2.93			4.40
Hiwassee		10.62	12.99	7.34		30.96
Iredell		18.41	12.81			31.22
Madison	0.47	9.94			11	21.41
Santuc	24.26	152.14	101.02			277.42
Wilkes	36.93	172.78	93.08			302.79
Winnsboro	403.54	665.09	499.80	21.61		1590.04
Subtotal	528.12	1148.74	746.04	28.95	25	2476.85

[3] Soil acres based on GIS coverage analysis of digitized soil survey mapping. Acres may not coincide precisely with the projected stand boundaries, thus difference in acres.

B - Upland Soils on Eroded Phases – These soils were mapped & classified with Class 2 erosion, based on field observation and measurements.						
Cataula	270.07	662.18	173.86			1106.11
Cecil	117.18	64.39	111.81		15	308.39
Hiwassee	173.13	278.18	153.19	13.66		618.16
Madison	55.76	199.87	45.96	23.60	8	353.19
Rion	28.0	28.85	12.54			69.39
Winnsboro	22.96	3.70	21.21			47.87
Subtotal	667.10	1237.17	518.57	57.26	23	2503.11
C- Upland Soils on 15% or greater slopes - Soils identified in these mapping units were classified with slope gradients of 15% or greater, based on field observations during mapping.						
Enon	13.83	16.70				30.53
Madison	155.70	605.55	118.21	55.21		929.66
Rion	32.25	32.82	23.73			88.80
Wilkes	542.93	896.84	476.42	61.52		1997.71
Winnsboro	122.39	280.37	206.41		12	621.17
Subtotal	867.10	1832.28	824.77	136.73	12	3667.87
D - Riparian Soils - These soils occur on floodplains and riparian areas of perennial streams.						
Cartecay, Chewacla & Toccoa	33.78	43.34	27.16	10.53		122.81
Total Acres	2096.1	4261.53	2116.54	193.47	60	8775.64
Percent of Total Project	24	49	24	3	<1	

Eighteen soil series were inventoried and classified during soil survey mapping within the project area boundaries. Table 3.1.2-1 displays these soil series by landscape position and a category or level of soil management concern, related primarily to physical soil conditions; e.g. slope gradient, erosion condition, proximity to streams. The listings in the Table can also be considered in an ascending order of challenges to implementing management treatments. These groupings can aid in identifying possible operation constraints or need for additional mitigation measures.

Section A, for example, lists the soils on slopes less than 15% gradient with minimal accelerated erosion. Proposed Action treatments can be implemented with Best Management Practices (BMPs) and Forest Service timber sale contract provisions and expect to maintain soil productivity and minimal detrimental impacts. Section B identifies the soil series (or mapping units within series) that have an existing condition of Class 2 erosion meaning a loss of the original topsoil. Implementation of treatments in these areas requires attention to minimizing soil surface disturbance and overland flow of storm water that could activate gullies. Section C identifies the soils that occur on slopes over 15%, requiring attention to location of access routes and harvest layout to minimize need for road construction or possible erosion from steep slopes.

An analysis of existing GIS map and attribute data was used to derive the information in Table 3.1.2-1, and are approximate based on the boundaries of the proposed stands identified for treatment. Six soil series dominate the upland soil types with acreages measuring over 800 acres each in the project area. These series; Cataula, Cecil, Enon, Hiwassee, Wilkes and Winnsboro are common soil series in the southern United States Piedmont region.

Table 3.1.2-2 displays two key soil properties related to soil productivity and potential impacts, and three interpretations related to the proposed action. The first column is the depth to a layer that might restrict plant growth, typically bedrock. The second column displays the typical texture of the surface (topsoil) layer of the soil series, along with the texture common to the subsoil layer. The third column provide a rating for operation of harvesting equipment; generally skidders and felling machines, based on the use of wheeled or tracked machines. Well suited indicates little to no restrictions to operation, moderately suited indicates soil properties or conditions that may require restrictions for safe and efficient operation. Examples would be pre-operation layout of access routes to minimize impacts that could cause erosion or storm water runoff in unacceptable locations.

The fourth column, soil rutting hazard, rates the risk of formation of deep ruts in the uppermost soil layers by operation of equipment. Typically ruts will form after one to three passes when soil moisture is near field capacity. A rating of moderate indicates ruts are likely with the need for mitigations.

The fifth column, mechanical site preparation, rates the suitability of a soil for the use of surface-altering soil tillage equipment. The proposed action of a one-time pass for shearing and roller drum chopping to control unwanted stems would have similar effects. The poorly suited rating is based on the stickiness of the clay textured soils, or the slope gradients over 15% that can cause challenges in machine operation. These sites would generally have residual tops, branches and non-commercial material across the sites which help minimize soil impacts during site preparation operations.

Table 3.1.2-2. Interpretations for Soil Series in Lower Broad River Project Area

Soil Series	Depth to Restrictive Layer (inches)	Soil Textures Surface Layer/ Subsoil Layer	Harvest Equipment Operability	Soil Rutting Hazard	Mechanical Site Preparation
Appling	40+	sandy loam/clay	well suited	moderate	well suited
Cartecay, Toccoa, Chewacla	70+	Fine sandy loam/sandy loam	well suited	moderate	well suited
Cataula	15 to 40	sandy loam/clay	well suited	moderate	poorly suited
Cecil	60 +	sandy loam/clay	well suited	moderate	poorly suited
Durham	60+	loamy sand/sandy clay loam	well suited	moderate	well suited
Hiwassee	70	sandy loam/clay	well to moderately well suited	moderate to severe	poorly suited
Madison	20-50	sandy loam/clay	moderately suited	severe	severe

Soil Series	Depth to Restrictive Layer (inches)	Soil Textures Surface Layer/ Subsoil Layer	Harvest Equipment Operability	Soil Rutting Hazard	Mechanical Site Preparation
Pacolet	60 +	sandy loam/clay	moderately suited	moderate	severe
Rion	60+	loamy sand/sandy clay loam	moderately suited	moderate	poorly suited
Santuc	60+	sandy loam/clay loam	well suited	moderate	well suited
Wilkes	20-40	sandy loam/sandy clay loam	well to moderately suited	moderate	poorly suited
Winnsboro	40-60	sandy loam/clay	well suited	moderate	poorly suited

Discussion of Soil Disturbance Impacts of Concern

Soil compaction and displacement would primarily be limited to the access routes and high traffic areas within mechanical vegetation treatments such as existing National Forest system roads, temporary roads, skid trails, and log landings. With implementation of applicable BMPs and contract provisions, most adverse effects to soils would be minimized or mitigated.

Risk of soil disturbance and site degradation exists whenever ground-based equipment is used in forest operations. The severity and areal extent of this disturbance can be managed (Miller 2004). Soil disturbance refers to a change in the natural state of a soil caused by an artificially imposed force (Arnup, 1998). Region 8 Soil Management Handbook Soil Quality direction defines soil disturbance as: “any activity that alters the existing physical, chemical and/or biological properties of the soil.” (USDA-FS, 2003)

Four basic steps can be analyzed to determine whether a proposed activity will cause adverse impacts to soil productivity:

- Determine what is the soil disturbance caused by the activity
- Match equipment and best management practices to the site
- Minimize soil disturbance that would alter existing physical, chemical and/or biological properties of the soils
- Ameliorate or rehabilitate soil disturbance where needed

In the application of silvicultural or timber management practices, detrimental soil disturbance is commonly recognized in the form of compaction, erosion, or rutting resulting from the use of ground-based harvesting equipment (Howes, 2006). Soils can be adversely impacted by activities such as building temporary roads and log landings, operating heavy equipment, skidding logs

and piling slash. The amount of detrimental disturbance that occurs depends on soil moisture, slope steepness, complexity of topography, and rock content of the soil, depth of slash, season of harvest, skidding design, and type of equipment used, sale administration and the skill of equipment operators. Combinations of these factors affect the magnitude and extent of disturbance.

Skidding felled trees along skid trails to a log landing, and the log landing/loading operations typically cause most of the soil disturbance within a harvest unit. This disturbance is typically compaction, mixing of soil layers, and rutting by operations during wet periods. Surface erosion within a harvest unit is typically limited because of the quantity of woody material left on the ground surface, which disperses and breaks up overland water flows. Thinning operations leave more residual material than regeneration harvest methods, primarily due to a lower number of trees removed, and the continuing contribution of tree tops, limbs, needles and other material to the forest floor. Proper and timely installation of drainage controls or rehabilitation on areas of soil disturbance have been demonstrated as best management practices (BMPs) that can reduce accelerated erosion. These practices are implemented through Forest Service timber sale contract provisions that specify operational procedures and practices to address ground disturbance and soil protection.

Soil Compaction: Soil compaction is the increase in soil bulk density that results in the rearrangement of soil particles in response to applied external forces, typically related to the use of equipment in forest management operations. Compaction decreases porosity as a result of the application of forces such as weight and vibration caused by the operation of heavy equipment. Compaction can detrimentally impact both soil productivity and watershed conditions 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. It is generally acknowledged that all soils are susceptible to soil compaction or soil porosity, particularly when wet.

Soil compaction is dependent on soil texture, organic matter, and soil moisture (McKee et al. 1985). Soil compaction causes increased soil density (weight per unit volume) or bulk density. This effect can hamper root penetration and growth, reduces soil aeration, and inhibits soil water movement. The lower the bulk density range, the greater the impacts to tree growth from soil compaction. Sandy textured soils have a higher range bulk density compared to clay textured soils. Presence of organic matter and tree limbs and leaves can reduce soil compaction by providing support to equipment. Soil moisture content has a pronounced effect on soil compaction as it influences soil porosity. Identifying compaction susceptible soils by surface texture, maintaining surface organic matter, and operating equipment under low soil moisture conditions (BMPs) will reduce the effects of soil compaction within the general forest and on skid trails used for thinning and restoration operations. Temporary roads and log landing areas will be compacted to higher levels due to multiple traffic use and passes. Harvest technique can also reduce or increase the potential for soil compaction. Use of standard logging equipment (skidders) can compact the soils with as few as three passes over the same ground. Specialized equipment that reduces or disperses equipment weight, such as low-pressure tires, can assist with limiting soil compaction effects.

Soil compaction during equipment operations is most visible as soil rutting, or the creation of depressions from the vehicle tires, generally during periods of soil saturation or wetness and/or high water table. Formation of ruts occurs when soil strength declines and is not adequate to hold up the weight of the vehicle load. The impact pushes the soil down, and then outwards, destroying natural soil structure, and disturbing the normal flow of water through the soil profile. The photo below illustrates soil rutting caused by skidding during periods of saturated soils. Visible ruts in the photo are 8 to 10 inches deep, 12 to 14 inches wide, and the rut is approximately 200 feet long.

Figure 3.1.2-2. Timber harvest site – skid trail rutting by operations during winter wet period, clayey soils. This impact is classified as detrimental disturbance to soil productivity and would require rehabilitation to restore normal functions to support vegetation growth and water movement. (Photo Credit – USDA Forest Service)

NRCS Web Soil Survey provides soil interpretation for soil mapping units to provide an indicator of potential impacts of various activities and treatments. The majority of soils mapping units within the Lower Broad River Project areas are rated moderate for soil rutting hazard, primarily on the low strength properties. The loam and clay soil textures will readily form ruts when soil moisture content is at or above field capacity – or saturation. This rating is based on standard NRCS/USFS soil rating criteria established in the National Forestry Manual (NRCS, 1998) and National Soil Survey Handbook (NRCS, 1996). Soil properties rated for compaction include soil texture, depth to water table, and percent rock fragments greater than 75mm in size. This condition would occur after several days of rain, soils have not dried out and heavy equipment operates over the soils.

Compaction and rutting can be minimized by locating access routes on well drained terrain, operating equipment during optimum soil conditions (dry) to minimize the occurrence of rutting (BMPs), and by addressing soil rutting conditions when identified during operation periods and implementing timely mitigation measures. Mitigation measures (BMPs) in the Proposed Action Alternative to minimize compaction would be followed in accordance with the Forest Plan, BMPs and timber sale contract provisions. Soil data identifying compaction hazard are included in the project file information for soils.

Use of special equipment (e.g. low psi) and/or operating under seasonally dry soil conditions, usually March through November, will aid in minimizing soil compaction caused by operations of conventional ground-based harvesting equipment within stands (BMPs). Soil compaction and greater exposed mineral soils can be expected on temporary roads, skid trails and log landings. This effect would occur until vegetation becomes reestablished in road prisms, which field observations indicate occurs within two to three years. Using these roads for harvest operations reduces the need for new roads, limiting soil disturbance to existing routes. Application of mitigating measures, ripping and restoring ground cover, will assist in reducing the effects of soil compaction over a three to five year period. Full recovery can take as long as 20 years.

Soil Erosion: Soil erosion is recognized as potentially the most serious form of soil damage. Soil may be permanently lost and soil particles leaving this site may result in sediment in nearby streams which would impact water quality and possibly compromise aquatic habitats. Ground disturbing management practices influence erosion principally because they remove vegetative ground cover and often concentrate and channel runoff water. Research has shown that transportation system and associated impact areas of log decks and primary skid trails are the most common causes of accelerated erosion that occurs in forested watersheds (Gucinski et al., 2000). In addition, erosion rates will tend to remain greater on these areas for several years following their use due to altered soil structure and loss of infiltration.

A soil's susceptibility to erosion varies by soil type and position on the landscape. A slight or moderate erosion hazard indicates that standard erosion control measures such as installing water bars plus seeding and fertilizing roads or skid trails, and not exposing more than 20 to 30 percent of mineral soil in treatment areas, are sufficient to prevent excessive erosion. The proposed stands in the Lower Broad River project with slope gradients of 15 percent or greater have a greater risk of moderate to severe erosion hazard, requiring BMPs during operations to minimize exposed bare soil, and re-establishment of ground cover at the end of operation periods to restore protection to exposed soils.

Soils within the proposed treatment areas have ratings of moderately to well suited for harvest equipment operability, based on NRCS Web Soil Survey ratings. The rating indicates erosion could occur when soils lack ground cover to slow the velocity and concentration of overland water flow. Requiring Best Management Practices including erosion control measures, proper location of access routes, revegetation of bare areas and drainage controls will be recommended for ground disturbing activities to minimize the impact and maintain soil productivity and water quality.

Silvicultural practices such as harvesting trees are known to potentially affect the soil resource primarily through nutrient removal. Harvest in the proposed action alternative will involve removal of the mature saw timber trees, site preparation using roller drum chopping and a removal of residual seed trees three to five years later. Proposed thinning harvest activities will harvest the stem only with tree branches and needles remaining scattered on site. Nutrient removal or restoration where harvesting the stem only, reduces nutrient removal by 50-60% (Pritchett and Fisher, 1979). Nutrient loss from stem removal is believed replaced by soil weathering and natural inputs (Grier et al., 1989, Jorgensen et al, 1971, Wells, 1971, and Pritchett and Fisher, 1979).

Proposed harvest units are expected to meet the regional soil quality guideline of not exceeding 15 percent disturbance because portions of existing trails and roads would be utilized, reducing the need for new ground disturbance. This is feasible and would be implemented through timber sale contract provisions. In addition utilization of existing roadbeds and skid trails would allow for rehabilitation of those areas to be implemented under the timber sale contract.

Temporary roads constructed for access in Alternative 2 to proposed treatment stands and associated skid trails for thinning and restoration treatments are known to affect the soil resource primarily through nutrient removal, soil compaction and soil erosion. Nutrient loss is greatest on temporary roads since the organic layer and surface soil is removed in the process of construction and/or maintenance. Skid trails under a thinning operation usually do not remove organic or soil surface layers leaving nutrients in place. Primary skid trails (those with multiple passes) can be expected to remove organic layers and create soil exposure as high as 50 percent. Secondary skid trails, those with surface soils intact, can be expected to have loss of organic surface and soil exposure as high as 25 percent.

Herbicide Treatment for Site Preparation and Release

Application of herbicide is proposed using imazapyr herbicide in hand applied foliar, and/or hack & squirt, applications in the stands proposed for regeneration of loblolly or shortleaf (2,401 acres) during the first and third year after harvest, primarily to reduce competition of undesirable species prior to planting seedlings, and releasing desired seedlings from competition to be free to grow. Herbicide application direction is described in the proposed action in Chapter 2. This treatment would have minimal effect on soils using a selective hand-applied foliar spray method. This application is targeted to the leaf surface or the stem for maximum effect. No soil disturbance would occur. A hack and squirt application, using a mixture of imazapyr and triclopyr, is also proposed for use on target vegetation greater than six feet tall.

Imazapyr is a foliar and soil active herbicide (absorbed by foliage, stems and roots) used to control trees, shrubs, vine, broadleaf and grass weeds. It degrades in soil, with a half-life of 25 to 180 days. Field studies indicate that imazapyr remains in the top 20 inches of soil and do not indicate any potential for imazapyr to move with surface water. Modeling results indicate imazapyr runoff is highest in clay soils, with peaks after the first rainfall. Triclopyr has an average half-life in soil of about 46 days. Warmer temperatures decrease the time to degrade triclopyr. It is weakly adsorbed to soil, though adsorption varies with organic matter and clay content.

The hack - and - squirt method would be used to treat target vegetation using imazapyr and triclopyr through spray and injection into cuts made into the cambium layer with a manual cutting tool. Triclopyr is potentially mobile in soils since it is generally not bound to soil particles, but in general there is minimal movement through soil. Cut surface treatments are precise allowing little chance of misapplications. Applications are not in proximity of riparian areas or streams.

Effects Analysis

Direct effects of an action are caused by the action and occur on site and affect only the area where they occur. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. In general, direct and indirect effects to soils as a result of the Action Alternative include:

Reduction of the forest canopy would decrease interception (precipitation captured by leaves, branches, and boles) and increases net precipitation reaching the soil surface.

Reductions in interception and transpiration increase soil moisture content, water available for plant uptake, and water yield.
Impervious surfaces (roads and trails) and altered hillslope contours (cutslopes and fillslopes) modify water flow paths, increase overland flow and deliver overland flow directly to stream channels.

Impervious native surfaces increase soil erosion.

Direct and Indirect Effects of Alternative 1 – No Action

No new treatment activities are proposed under this alternative, therefore no direct or indirect effects to soils or watershed conditions are expected as a result of this Alternative.

Under the No Action Alternative, there would be no closure of roads and/or trails that are currently contributing to loss of soil productivity and degradation of water quality. Open system roads would remain at risk of unauthorized use, further contributing to soil erosion or displacement. Ongoing road maintenance of Level 2 and Level 3 roads would continue as in the past.

This alternative would result in no additional acres of ground disturbance from mechanical vegetation treatments, piling of activity-related woody debris, construction and maintenance of permanent or temporary roads, construction and maintenance of trails, and the use of prescribed fire.

Cumulative Effects of Alternative 1 – No Action

Alternative 1 would not implement any new activities that would directly or indirectly disturb soils. Soil erosion may occur as a result of existing conditions or activities; however cumulative effects would be minimal. Activities, on National Forest lands, that are reasonably foreseeable would be implemented under the standards for protecting soils listed in the Revised Land and Resource Management Plan for the Sumter National Forest; therefore, cumulative effects from these actions are minimal.

Activities on adjacent or intermingled private lands in the analysis area may include timber removal, agriculture, prescribed burning, road construction and maintenance, and residential

developments. These activities would be specific to private lands, and no cumulative effects would be expected to the soils on National Forest lands.

Direct and Indirect Effects of Alternative 2 – Proposed Action

Proposed harvest treatments in the project area will have short- and long-term direct effects on forest soils, due to soil disturbance. Impacts, however, can be minimized and mitigated. Soil disturbance effects of concern for the Lower Broad River Project include:

- Compaction and soil rutting
- Erosion and displacement

Past effects from logging are detectable up to 40 or more years. The effect of proposed activities should be relatively short compared to techniques used in the past. If all natural elements and processes remain intact, one can expect soil impacts to be nearly undetectable within 20 to 40 years.

Alternative 2 proposes to conduct silvicultural treatments on approximately 8,758 acres within the project area. Five silvicultural prescriptions are proposed, implementing first time thinning, intermediate thinning, regeneration clearcut with reserves, shelterwood, and shortleaf pine restoration. Operations described under this proposed action include:

1) Mechanical felling of selected commercial value loblolly pine trees. Felling machines will move between trees to access trees to be cut and removed.
2) Skidding to gather felled trees and bring to a central landing area for processing and loading onto trucks. Skidders move around the stand to collect cut trees, and move the collected trees on designated skid trails and/or roads to the landing area. Skidders make repeat trips over skid trails to various parts of the stand.
3) Skidders and loaders operate in the central landing area to process felled trees for loading onto trucks that access the landing area over temporary or permanent roads.
4) Skid trails and roads, log landings and temporary truck access roads are opened (existing routes) or constructed to provide equipment access to remove harvested materials. The same routes are rehabilitated, as needed, to provide drainage, aeration to ameliorate compaction, and addition of appropriate ground cover with vegetation and/or mulch to restore soil protection and function after harvest operations cease.

Ground and soil disturbances in these operations will occur inside the boundaries of the harvest units, with concentrated disturbance on primary skid trails, log landing and loading areas, temporary haul routes for truck traffic to the landing, and on Forest Service system roads. Fire control lines, constructed around areas planted to longleaf pine seedlings, also have the potential to create detrimental disturbance.

Pre-planning and design analysis for the Proposed Action stands has identified stand boundaries, access routes, including new temporary roads, stream crossings, fire control lines for later prescribed burning, and areas of sensitive soils or site conditions that may require specific mitigation during operation periods. Access routes exist in most of the stands from prior entries

for timber harvest operations. These routes will be used in the Proposed Action projects if location and condition meet Forest Plan standards and BMPs. Table 3.1.2-3 displays the categories of ground disturbance related to operations to implement the Proposed Action.

Table 3.1.2-3. Acres of Ground Disturbance - Alternative 2 – Proposed Action

Activity	Number of sites or Miles	Assumptions	Acres of soil Impacted
Log Landings	350 landings (1 landing per 25 acres)	1/3 to ½ acre per landing	175
Temporary Roads	<1 mile	Roadbed and shoulders - 2.0 acres disturbed per mile	~~12~~2
Skid Trails	10-12% of treatment areas	Skid trails not bladed, trees removed from corridor	875-1050
FS System Roads – reconstruction/recondition	43.4 miles	Roadbed and shoulders – 3.0 acres disturbed per mile	130
FS System Roads – new construction (includes ROW acquisition)	2.93 miles	Roadbed and shoulders – 5.6 acres disturbed per mile	16
FS System Roads - decommission	4.05 miles	Roadbed and shoulders – 2.4 acres disturbed per mile	9
Total Acres of Ground Disturbance			1205-1382
Percent of Project Area			14 to 16 %

Pre-planning has identified the need for construction of < one mile of temporary roads to access stands and log landings. These roads would disturb less than two acres disturbed using a 20 foot wide road prism (road bed and sides). Most of these roads have existing routes and templates, requiring minimal ground disturbance to prepare them for use. This condition will minimize the amount of soil disturbance and maintain vegetation cover along the routes to buffer disturbance and resulting erosion. When harvest activities are complete, these routes will be closed to vehicle use and rehabilitated to restore drainage and ground cover. Log landings are needed for any timber harvest sale unit, typically one per unit. These landings are typically from 1/3 to ½ acre in size. Skidding from the cut trees to the log landings is generally within ¼ to ½ mile distance. Skid trails are not bladed, minimizing the disturbance to the soil surface. Trees are removed within the corridor traversed by skidders, maintaining litter and slash on the ground to provide

cover to the soil. Experience has shown that the percentage of harvest areas involved in skid trails to be around 10-12 %. The 875-1050 acres of soil impacted by skid trails would be primarily overland travel by the skidders, with minimal to no blading or excavation of soils. The remaining 175 acres (1-2% of the total project area) disturbed for log landings and temporary roads would require some amount of soil disturbance through removal of vegetation cover, excavation of soil, and construction of drainage to facilitate logging operations. At the end of operations, these areas of disturbed soils would be rehabilitated by shaping disturbed soils to provide natural drainage, and restoring ground cover with vegetation or mulch to protect the soils from erosion.

The estimated total area of ground disturbance for skid trails, temporary roads and log landings for the Lower Broad River project, 1205-1382 acres, is to identify the area that could potentially receive detrimental disturbance within the project area. Operations within the stands to remove commercial trees would require skidding to bring the trees into the log landings for processing and loading for truck transport. Skidding operations generally make 2 to 3 passes along skid trails; however they are generally not excavated to open the route. These trails typically have woody debris left on the ground surface to provide cover and minimize erosion caused by overland flow (BMP).

Implementation monitoring of forestry best management practices (BMPs) is an ongoing activity conducted in South Carolina under the direction of the South Carolina Forestry Commission, along with the USDA Forest Service as a cooperator. Recent surveys across the state on various practices and ownerships have documented compliance with the BMP direction and the resulting impacts to soil and water resources. Compliance rates of 94.0% were noted for harvesting systems (Sabin, 2012).

Many indirect effects are possible when soil conditions are compromised. Compaction can decrease water infiltration rates, leading to increased overland flow and associated erosion and sediment delivery to streams. Compaction decreases gas exchange (oxygen), which in turn degrades sub-surface biological activity and above ground forest vitality. Rutting and displacement cause the same indirect effects as compaction and also channel water in an inappropriate fashion, increasing erosion potential.

Timber harvest operations remove biomass and site organic matter and thus affect nutrient cycling. Generally, nutrient losses are proportional to the volume of biomass removed from a site. Nutrients are lost during harvesting by removing the stored nutrients in trees, and additional nutrients are lost if the litter layer and woody debris are removed, more common in whole tree harvesting systems. Amounts of nutrient loss from a site will vary with forest types and site conditions (Grier et al, 1989). The amount of nutrients present in the trees will also vary with stand age and development of the humus layer (Grier et al., 1989).

Indirect effects of soil nutrient loss include reduced growth and yield and increased susceptibility to pathogens, such as root disease and insect infestation. Precipitation and weathering of rocks will continue to make additional nutrients available on site. Annual needle, leaf, and twig fall, forbs and shrub mortality will continue to recycle nutrients as well.

A majority of the proposed thinning and restoration activities would harvest stem only, leaving tree branches and needles remaining onsite, with the exception of small tree/biomass thinning which remove the whole tree from the site. Nutrient removal from intermediate thinning or regeneration harvests (where harvesting the stem only) is significantly less than that of whole tree harvesting. In the study performed by (Mann et. al, 1988) when whole tree harvesting was compared to traditional sawtimber/pulpwood thinning it found that whole tree thinning resulted in a disproportionately greater nutrient removal because of the high nutrient concentrations in twigs and branches of trees.

In addition, Johnson and Curtis (2001) found that, on average, forest harvesting in North America had little or no effect on soil carbon (C) and nitrogen (N). Concentrations of C and N may have a slight decrease within the first year of harvesting but is not substantial or prolonged (Knoepp and Swank 1997). Nutrient loss in all cases is eventually replaced by soil weathering and natural inputs (Pritchett and Fisher, 1979). Although nutrients are replaced, cutting alters the processes that regulate nutrient cycling, which frequently accelerates nutrient leaching and loss in dissolved form. However, the soils on the forest have sufficient levels of nutrients including nitrogen, phosphorus and potassium to maintain soil productivity and vegetation often responds with rapid growth after thinning.

Following the recommended application rates, and adhering to the Forest Plan standards for herbicide use, no damage or effect to soil productivity would be expected from the application of herbicide treatments.

To summarize, by maintaining organic matter and ground cover on at least 85 percent of the site, nutrient cycling and availability should not be altered. The mitigations and Best Management Practices are prescribed to achieve this desired outcome. Localized losses may occur at log landings or along some temporary roads.

Effects of Timber Harvesting

By practicing a “light hand on the land” policy during all soil disturbance activities, by adhering to design criteria common to all action alternatives and following Forest Plan direction, long-term soil productivity would be maintained. In addition, fuel loadings throughout most of the analysis area would be reduced from timber harvesting and prescribed fire and the construction of temporary roads would improve overall access for fire suppression needs. These actions would reduce the probability of a future accumulation of fuels and wildfire hazard, which could impair long-term productivity.

Effects of Log Landing and Road Construction and Road Decommissioning

Pre-planning in the Lower Broad River project area has identified the need for new system roads to access ten stands to be thinned, totaling about three miles in length, or about 16 acres of disturbance. These roads would be closed at the completion of timber management activities. Log landings, an estimated one half acre landing per 30 acres of harvest area, would also be closed and rehabilitated to restore drainage and ground cover, resulting in a return to desired soil productivity levels within three to five years. Decommissioning of system roads would begin the

process of restoring soil productivity along treated roadbeds, and result in reduction of erosion and sediment to nearby streams. The treated segments would have an improvement in soil productivity as vegetation becomes established and more natural water movement occurs across the areas.

Effects of Road Maintenance on System Roads

All Forest Service system roads built in the past have a lasting effect on soil productivity due to compaction, displacement of soil horizons, and changes to soil functions as a result of construction and use of the roads. There are approximately 43 miles of existing system roads identified for use in the project area stands. Their maintenance for recreation, fire control, and vegetation management requires ongoing use, which results in compaction and displacement throughout the project area. Most of the system roads proposed for use in the project stands need standard maintenance work, e.g. blading of the roadbed, clean ditches and culverts, culvert replacement, add surface gravel when needed. These activities may increase short-term erosion and sediment movement from road surface runoff initially but should be minimal, especially on road segments that occur at upper slope landscape positions, low in road surface gradient, or at adequate buffer distances from stream channels. Road maintenance includes culvert installation, blading of road surfaces, and brushing along cut or fill slopes, and typically improves drainage and decreases erosion from water channeling down the road surface in the long run.

Cumulative Effects of Alternative 2

The scope of the analysis considered for cumulative effects to soils for the Lower Broad River project is the same as that of the project area; 8,710 acres of proposed action stands. Effects from past actions, and future planned actions in this analysis when combined are used to estimate cumulative effects. Cumulative erosion estimates are contained in the erosion/sediment analysis located in the project record.

There are areas within the proposed action stands with soil disturbance from past actions that would not be considered recovered from compaction and/or displacement. Most of these areas are in former road corridors or log landings where operations caused compaction and/or erosion. Most of these roads have not been used for heavy equipment operations since the previous harvest activities.

Approximately 3,100 acres within the Proposed Action stands have been prescribe burned since 2007, primarily during the dormant season of the year for fuel reduction and wildlife habitat improvements. This area covers about 35 percent of the proposed action acres. Most of the ground disturbance in these treatments would be dozer constructed fire control lines which have been rehabilitated following completion of burns and comprise a small percentage of the total acres. No additional prescribed burns are planned by this project decision.

In summary, the proposed action alternative combined with all past, present, and reasonably foreseeable management activities would affect soil productivity in the project area. Foreseeable activities include timber harvest, National Forest system road management and maintenance, Forest recreation maintenance and management, and fire management. The combined effects of

most future activities would cumulatively improve soil productivity, primarily by reducing impacts from roads, and improving forest health of the residual stands.

At the scale of the project area, the contribution of cumulative impacts by the Lower Broad River Project would not be significant on soil productivity or the soil resource. Forest Service activities would meet standards for maintaining soil productivity through proper implementation of management requirements and the prescribed mitigation measures.

Direct and Indirect Effects of Alternative 3

Alternative 3 for the Lower Broad River project is a modification of Alternative 2 to respond to two issues identified during the scoping period. The modifications to proposed treatments would result in changes in the previously discussed direct effects, primarily due to a reduction in the total acres treated. Alternative 3 reduces total acres to be treated from 8,710 acres to 8,105 acres. Shortleaf pine restoration acres would be reduced from 62 to 42 by dropping one proposed stand. Harvest methods for regeneration objectives would shift from clearcut with reserves to seedtree method to regenerate loblolly. The alternative would also harvest from existing system roads with no temporary roads created, reducing ground disturbance.

Impacts from ground-disturbing activities would have the same effects on soil productivity and quality as described in Alternative 2. One difference in the effects would be the entry into seedtree harvest areas to remove residual seedtrees remaining as seed sources, within 3 to 5 years of the initial treatment. This entry would require additional ground disturbance from opening of access routes and operation of felling equipment and skidders to remove the seedtrees. This level of disturbance would be minimal compared to the initial harvest.

Table 3.1.4 displays the acres of ground disturbance caused by proposed activities in Alternative 3, using the same assumptions for area and extent of disturbance.

Table 3.1.2-2. Acres of Ground Disturbance - Alternative 3

Activity	Number of sites or Miles	Assumptions	Acres of soil Impacted
Log Landings	326 landings (1 landing per 25 acres)	1/3 to ½ acre per landing	107-163
Temporary Roads	0 miles	Roadbed and shoulders - 2.0 acres disturbed per mile	0
Skid Trails	10-12% of treatment areas	Skid trails not bladed, trees removed from corridor	815-978
FS System Roads – reconstruction/recondition	43.0 miles	Roadbed and shoulders – 3.0 acres disturbed per mile	130
FS System Roads – new construction	0.1 miles	Roadbed and shoulders – 5.6 acres disturbed per mile	0.5
FS System Roads - decommission	4.05 miles	Roadbed and shoulders – 2.4 acres disturbed per mile	9.3
Total Acres of Ground Disturbance			1061-1280
Percent of Project Area			13 to 15 %

Cumulative Effects of Alternative 3

The scope of the analysis considered for cumulative effects to soils for the Lower Broad River project is the same as that of the project area; 8,153 acres of proposed action stands. Effects from past actions, and future planned actions in this analysis when combined are used to estimate cumulative effects.

Cumulative effects for Alternative 3 would be similar to Alternative 2, although reduced in extent due to the reduction in area disturbed for vegetation treatments and the reduction in acres for temporary roads.

3.1.3 Air Quality

Affected Environment

Air pollutants of most concern include ozone, particulate matter, sulfur dioxide, nitrogen oxides and mercury.

Ozone is a pollutant formed by emissions of nitrogen oxides and volatile organic compounds in the presence of sunlight. Nitrogen oxides (NOx) are released when any fuel is combusted at very high temperatures; major sources of NOx include automobiles, power plants and industrial boilers. Volatile organic compounds (VOCs) are emitted from both human and natural sources, including chemical manufacturing, gasoline-powered vehicles, trees and vegetation. Research has shown that in the southern US there is an overabundance of naturally-occurring VOCs, and thus ozone formation is "NOx-limited”. This means that the concentration of ambient ozone is primarily dependent on the amount of nitrogen oxide emitted into the air. When ozone is formed, it causes human health concerns as well as negative impacts to vegetation. Specifically, elevated ozone concentrations can reduce the health and vigor of sensitive vegetation and reduce plant growth. The US Environmental Protection Agency (EPA), as directed by Congress, has set a national ambient air quality standard (NAAQS) of 0.075 parts per million (ppm) to protect both

human health and the environment. The Enoree Ranger District is meeting NAAQS for ozone [*Fiscal Year 2014 Monitoring and Evaluation Annual Report, Sumter National Forest* (2014 Monitoring Report)].

Particulate matter is a mixture of extremely small particles made up of soil, dust, organic chemicals, metals, and sulfate and nitrate acids. The size of the particles is directly linked to health effects, with smaller particles causing the worst impacts to human health. Additionally, particulate matter is the main cause of visibility impairment. These tiny particles absorb and reflect light which diminishes scenery views. Regional haze usually covers large geographical areas, and many local and regional sources of pollution contribute to the degraded visibility conditions. EPA has set NAAQS for ultra-small (less than 2.5 microns in diameter) particulate matter on both a short-term (24-hour) and annual basis to protect human health and visibility. The 24-hour fine particulate matter (PM2.5) NAAQS to protect both humans and the environment is currently set at 35µg/m3, while the annual PM2.5 NAAQS for human health is 12µg/m3. The Enoree Ranger District conducts activities, particularly prescribed fire, that contribute to air pollution. With the increasing prescribed fire program, it is important to assess whether there is any indication that local and regional PM2.5 levels are mirroring that trend. Based on the 2013 Monitoring Report, PM2.5 concentrations do not appear to be correlated with PM2.5 emissions from prescribed fires. The Enoree Ranger District is meeting NAAQS for fine particulate matter (2013 Monitoring Report).

Sulfur and nitrogen deposition can cause stream acidification and leaching of important soil nutrients needed for healthy terrestrial and aquatic biota. Nitrogen deposition can also cause eutrophication or nutrient enrichment that negatively impacts water quality, aquatic biota, and may increase invasive plant growth. Sulfur comes primarily from the combustion of coal at electrical generating units. Nitrogen compounds are derived from both the combustion of fuel at very high temperatures (such as in power plants, industrial boilers, and automobiles) as well as from various agricultural processes. Although EPA has considered setting a multi-pollutant NAAQS to address deposition-related affects, they have decided there currently is not enough scientific information to set one standard that would adequately protect the diverse ecosystems across the country. This proposal does not have the potential to affect sulfur or nitrogen deposition and will not be evaluated further.

Mercury is another important environmental contaminant that reaches the forest primarily through atmospheric deposition. The primary source of anthropogenic mercury is the combustion of coal. Mercury is fairly stable and accumulates in the environment until conditions are right for dispersal. This can occur by wildland fires ejecting the mercury back into the atmosphere, or when associated with wetlands where it can be converted via sulfate reduction to its most toxic form, methyl mercury (MeHg). The MeHg is ingested by aquatic organisms and bioaccumulates as it makes its way through the food web, and can affect humans when too many fish are consumed in one week. Unhealthy levels of MeHg have led to fish consumption advisories in almost every state. Methyl mercury has also been found in numerous species of wildlife. EPA regulates the amount of mercury that is emitted into the air from many different sources, including power plants, municipal waste combustors and medical waste incinerators. Frequent low intensity fires may actually help in the sequestration of mercury by leaching mercury deep

into the soil where it would be less available for runoff (Waldrop 2009). This proposal does not have the potential to affect mercury release into the atmosphere and will not be evaluated further.

Emission reductions over the past decade have been achieved as a result of new regulations, voluntary measures taken by industry, and the development of public-private partnerships. It is expected that air quality would continue to improve as recently adopted regulations are fully implemented, and as a result, it is anticipated that emissions of air pollution released within the air shed of the Sumter National Forest would continue to decline.

Direct and Indirect Effects of Alternative 1

This alternative has no direct effects on air quality since no additional management actions would be implemented. Prescribed burning is conducted under an existing forestwide decision and the existing condition indicates that air quality standards are being met. Air quality will continue to be monitored and reported in the biennial monitoring report.

Cumulative Effects of Alternative 1

Past, present and reasonably foreseeable projects on federal and private lands that result in impacts to air quality will continue to be monitored via the Environmental Protection Agency (EPA) monitoring stations across the state. Air quality is currently meeting standards for ozone and fine particulate matter (PM2.5).

Direct and Indirect Effects of the Action Alternatives

Impacts to air quality from timber harvest operations and other related activities could potentially occur as a result of the sustained use of heavy machinery which generates emissions in a localized area. Minor and temporary increases in carbon monoxide (CO), nitrogen oxides (NO_x), and hydrocarbons would occur as a result of proposed on-site operations.

In addition to tailpipe emissions from heavy equipment, increased vehicle traffic along paved, unpaved (dirt), and gravel roads, as well as the temporary disturbance of ground surface during vegetation management activities, could potentially cause increases in fugitive dust. These impacts would be temporary and limited to periods of high vehicle traffic and activity.

Road Construction, Reconstruction, Maintenance and Decommissioning

Minor and temporary increases in carbon monoxide (CO), nitrogen oxides (NO_x), and hydrocarbons would also occur as a result of proposed road operations; however, these operations would occur over a comparatively short time period and would not likely result in measureable effects to air quality.

Cumulative Effects from the Action Alternatives

Of all the forest management activities, prescribed burning has the greatest potential to impact air quality. Particulate matter is released during prescribed burning. According to South Carolina's Department of Health and Environmental Control (DHEC), no violations of air quality standards have occurred on the Sumter National Forest. Effects on air quality are brief and intermittent. Inhaling fine particulate matter produce from prescribed burning can adversely affect human health.

Past, present, and reasonably foreseeable activities are contained in the project record. These activities all contribute varying levels of pollutants to the atmosphere. Activities considered here when combined with other activity emissions would not cause exceedance of air quality standards. Monitoring stations are set up around the forest and district to record air quality data. Air quality standards are being met and not expected to change as a result of any of the action alternatives.

3.1.4 Climate Change and Carbon Storage

Affected Environment

On January 16, 2009, the Chief of the US Forest Service directed the national forests to consider climate change during project planning. National forests were directed to consider the impacts that climate change would have on meeting goals and objectives stated in Forest Plans and the effects that the project contributes to climate change. The US Global Changes Research Program published a 2009 report (USGCRP 2009) on climate changes on different regions. Predictions for the Southeast include: air temperature increases; sea level rise; changes in the timing, location and quantity of precipitation; and increased frequency of extreme weather events such as hurricanes, heat waves, droughts and floods. These predicted changes would affect renewable resources, aquatic and terrestrial ecosystems and agriculture, with implications for human health. Human greenhouse gas (GHG) emissions, primarily carbon dioxide emissions (CO^2), are the main source of accelerated climate change on a global scale.

Impacts of climate change in the southeast are discussed in the report *Forests and Climate Change in the Southeast USA* (McNulty, et. Al. 2013).

The key findings from the report are:

- Warming air temperatures likely will increase regional drying through increased forest water use via evapotranspiration (ET) regardless of changes in precipitation, and this drying will likely increase wildfire risk across SE USA forests.
- Longer growing seasons will likely increase the risk of insect outbreak and very likely will expand the northern range of some species, such as the southern pine beetle.
- Under most scenarios, increasing temperatures and decreasing precipitation will result in a greater uptake of soil water by forests and lead to reductions in streamflow.
- Despite climate and land use changes, forests in the southeast USA will likely continue to provide a sink of atmospheric carbon dioxide.

- The potential savannafication of the SE, in which forests are converted into more open woodlands due to a combination of hotter and drier conditions, could be one of the most profound climate change impacts in the USA.

The Template for Assessing Climate Change Impacts and Management Options (TACCIMO) was used to create a report that summarizes relevant literature that lists effects to resources related to climate change impacts.

The affected environment for climate change is two-fold. First, climate change may affect the natural resources on the Enoree RD and the objectives for the project area. Secondly, project activities may affect carbon storage ability and influence global climate. Only impacts from climate change on meeting project objectives will be considered as the scale of the project is too small to have global climate change impacts that are measureable.

Direct, Indirect and Cumulative Effects of Alternative 1

Alternative 1 would not result in any change to the current trend for carbon storage or release in the project area. Studies on longleaf pine (Pederson, Varner and Palik 2007) indicate that drought exacerbates mortality because increased evaporative demand reduces vigor, which predisposes trees to insect and disease. Peaks in wildfire activity would also add to this mortality. Extensive forests of loblolly pine now exist in the analysis area once dominated by mixtures of hardwoods, shortleaf pine, and less abundant loblolly pine forests. Declines in agriculture as a result of loss of soil productivity, led to the establishment of more loblolly pine across the piedmont and analysis area.

Past and present projects (Forest Service) including periodic prescribed burning, woodland creation and thinning (pulpwood, and intermediate) have reduced hazardous fuels, improved growing conditions for trees, and increased diversity of habitat conditions including development of understory grasses, forbs and shrubs on portions of national forest system lands. Current forest management activities on private lands have kept timberlands healthy and productively growing, thus avoiding/minimizing impacts from insect and disease activity.

The project area is currently a mosaic of open and forested habitats. Continued forest management activities on federal and private lands would provide for healthy diverse forests that would be more resilent to changes in climate.

Direct, Indirect and Cumulative Effects of the Action Alternatives

Adding diversity to the stands by providing more varied structure and composition along with reducing stand densities would make these forested areas more vigorous and reduce drought stress associated with a warmer and drier climate. This would make the forest better able to withstand climate change scenarios predicted for the Southeast.

Proposed road activities would have no affect on climate change given the small scale of the project.

Past, present and reasonably foreseeable projects/ongoing activities on federal and private lands include forest management, agriculture, grazing, homesites and road maintenance. It is unlikely that global climate change scenarios would impact these activities to any great degree since a majority of the Piedmont Region is devoted to keeping forested stands in a healthy productive state by thinning, regeneration harvests and prescribed burning.

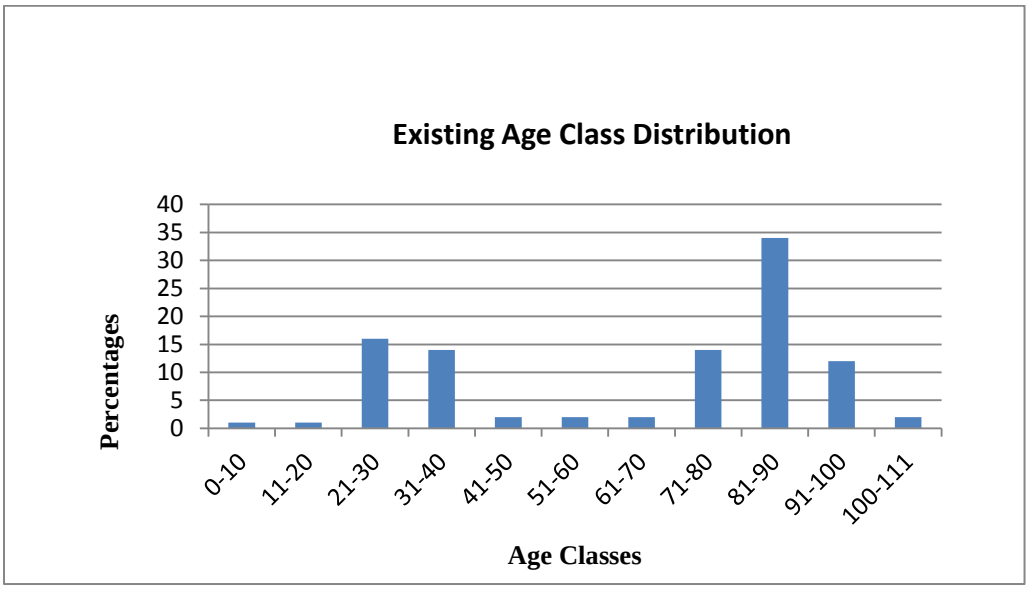
3.2 Biological Environment

3.2.1 Forest Vegetation

Affected Environment

The majority of USFS lands in the Lower Broad Analysis Area (LB) are dominated by even-aged stands of loblolly pine (79 percent). Hardwood dominated stands comprise approximately 21 percent of lands in LB are primarily found along perennial stream courses. Hardwoods can also be found as small inclusions within predominately pine stands and in mixed stands, which contain a relatively even mix of pine and hardwood species. Major hardwood species include sweetgum (Liquidambar styraciflua), red maple (Acer rubrum), yellow poplar (Liriodendron tulipifera L.) and a variety of oaks (Quercus spp.). Figure 3.2.1-1 summarizes the existing age class distribution of forested federal lands in LB.

Figure 3.2.1-1. Existing Age Class Distribution of Forested Stands in the Lower Broad Analysis Area



There are 15,614 acres of National Forest over 22 compartments in LB. The area consists of about 1 percent early successional habitat, 1 percent sapling/pole, 34 percent mid successional, and 65 percent late successional.

Plant communities in LB are common to managed loblolly pine forests. Species composition has been influenced in the past by timber harvest, prescribed fires, and altered soil conditions.

Common shrub-subcanopy vegetation in these areas includes dogwood (Cornus florida), blackberry (Rubus sp.), sumac (Rhus sp.), hornbeam (Carpinus caroliniana), sourwood (Oxydendrum arboreum) and blackgum (Nyssa sp.), as well as seedlings and saplings of overstory species, including red maple (Acer rubrum), sweetgum (Liquidambar styraciflua), oak (Quercus spp.), and loblolly and some shortleaf pine (P. echinata). Understory vegetation varies from location to location depending on soil conditions, frequency of disturbance, and the level of available moisture. In general, the level of ground cover is most affected by the amount of light reaching the forest floor, with those sites having the least canopy cover capable of supporting larger woody plant communities. These conditions are common in areas that once served as old log landings in past harvests, as well as near roadsides. Understory vegetation in these areas may include greenbriar (Smilax sp.), poison ivy (Toxicodendron radicans), honeysuckle (Lonicera sp.), blackberry, and beautyberry (Callicarpa americana), as well as a variety of grasses and legumes. The amount of hardwood seedling development in a given stand is directly correlated with the amount of crown closure and frequency of prescribed burns. Understory hardwood seedling development consists primarily of sweetgum and red maple, with a relatively smaller proportion of oak, depending on available seed sources. Sweetgum is the most common species, accounting for up to 60 percent of all woody understory production in the southern Piedmont of Georgia and South Carolina (Kormanik, No date). The majority of woody understory production in stands consists of soft mast and non-mast producing species.

Many of the stands within LB are currently showing signs of slowed growth and thinning crowns as a result of over-competition for light, moisture and nutrients. These conditions can lead to susceptibility to infestations and outbreaks of the southern pine beetle. Southern pine beetle outbreaks occur on a cyclical basis on the Sumter NF, most often occurring in densely stocked stands or in mature pine stands. Evidence of fusiform rust and littleleaf disease are also found throughout the area. Scattered areas of non native invasive plants have been noted in LB and a recent decision allows treatment of invasive pest plants.

Direct and Indirect Effects of Alternative 1

Under the No Action alternative, no thinning, regeneration or gully restoration would occur. Without the increased light to the forest floor provided by thinning activities, understory development would be limited to that produced naturally, and that produced as a result of occasional prescribed burns. Understory development would be limited to woody plants, such as sweetgum, red maple, pine seedlings, blackberry and dogwood. Only small increases in grasses and legumes would occur, most often near roadsides. Soil conditions on sites proposed for commercial thinning in Alternatives 2 and 3 would remain intact, and no reductions in soil plant productivity would occur as a result of log landing construction and skid trail use.

Hardmast species would remain in minor proportion in predominately pine stands throughout LB and opportunities to promote their development within these stands would be limited to the occurrence of natural disturbance (where competition from pine would also occur). Hardwood stands along major stream courses would be largely unaffected.

In the absence of thinning, and specifically the removal of diseased trees, the general health of forest stands in LB may gradually decline and stabilize at a new lower level. Trees affected by

littleleaf disease will continue to decline and increase the risk of Southern Pine Beetle outbreaks. Fusiform infects the new growth and the resulting galls will grow and weaken the pine tree. The infected pines are more vulnerable to insect outbreaks and breaking due to wind or ice damage. Forest stands in LB would continue to develop crowded conditions, resulting in greater competition for nutrients, decreased growth and increased potential for infection and insect attack, as well as increased natural mortality rates. Sites proposed for regeneration in Alternatives 2 and 3 would begin to suffer greater mortality of mature trees, and increased potential for southern pine beetle attacks. Given the real possibility of southern pine beetle attacks under these conditions, salvage logging operations may be necessary in the event of a southern pine beetle outbreak.

Natural phenomena would be the sole source of vegetative change. Age-class distribution and species composition would remain essentially unchanged. There would be decreases in site index as the soil erodes and site productivity declines. Non-productive sites would remain non-productive.

Cumulative Effects of Alternative 1

Cumulative effects associated with Alternative 1 (No Action alternative) may include a decrease in the productivity of forest stands as a result of competition for light, water and nutrients. These effects would increase the potential for southern pine beetle outbreaks, and the potential for outbreaks to spread to other national forest areas and private lands in the project area. Although biodiversity would increase in the understory as a result of periodic prescribed burn treatments in some stands, diversity in the canopy and sub-canopy would likely remain at current levels. Past timber management activities on private lands and other areas on the Enoree Ranger District have improved forest health by thinning overstocked stands and establishing younger stands making them more resistant to insect and disease.

Direct and Indirect Effects of the Action Alternatives

Vegetation management activities proposed for LB would have a variety of effects on forest vegetation. These effects are described below, with reference to the type of activity.

Thinning

Thinning would have slightly different effects on vegetation, depending primarily on the age class of the stand and the level of harvest extraction. Trees with thinning crowns, poor form, and insect damage or disease are generally the trees removed during thinnings. Thinning activities in LB would provide more growing space for individual trees and improve the health of the forests in the area. Evidence suggests that the increase in tree growth vigor and selective culling of diseased and stressed trees will significantly reduce the risk of loss from fusiform rust and southern pine beetle attacks (Belanger et al., 2000). Since stands in LB are predominately even aged, no effects on age class distribution would be expected.

Thinning generally results in greater light penetration to the forest floor, and as a result, induces both woody and herbaceous understory growth. Vegetation diversity on the forest floor would

increase immediately following timber harvest, with the greatest diversity and abundance likely to occur within the first six to eight years (Miller et al., 1995). The abundance of grasses and forbs would slowly diminish as the tree canopy closed.

Thinning activities do come with some biological risks, including potential for physical damage that can occur: to residual trees as a result of the harvesting process, to soils on which future plant growth and/or biomass production may be reduced (i.e., on highly eroded or compacted areas), and to existing shrub and herbaceous vegetation damaged as a result of the harvesting process. Physical damage to residual trees as a result of harvesting activities is normally minor. Sites would be reviewed and approved prior to harvest to ensure that log landing and skid trail locations are appropriately planned to minimize soil impacts and damage to residual trees. In addition, log landings and skid trails roads would be reseeded with grass and/or legumes following harvesting activities. This would increase the proportion of the stand covered by grasses and legumes, provide forage for wildlife, and decrease the amount of time required to rehabilitate compacted or disturbed soils. Damage to existing shrub and herbaceous vegetation during the harvesting process would be temporary, and plants in the understory would quickly regain their vigor due to increased light availability to the forest floor. Some species, such as sweetgum would increase in the understory and midstory due to the increased sunlight.

Thinning in the dense pine forest provide an opportunity to address the Sumter LRMP goals and objectives. Specifically thinning reduces the risk of insect and disease outbreaks by improving tree vigor, which addresses LRMP Goal 17. The thinnings address Objective 17.01, *"Improve forest health on 10,000 to 50,000 acres of pine forest by reducing stand density."* The thinning also addresses the Healthy Forest Restoration Act by reducing fuels. Thinning will also reduce stand basal area in dense pine stands. In the desired conditions section of 10B and 7E2 the LRMP states "*Pine stands are maintained at moderate to low densities (less than 100 square feet/acre basal area) to reduce susceptibility to southern pine beetle attack and promote understory development*". Thinning addresses concerns with basal area conditions over 100 square feet/acre by reducing the basal areas to 60-70 square feet/acre in these heaver stocked pine stands.

Regeneration (Clearcut with Reserves, Shortleaf Restoration or Seedtree Harvest)

All of the sites proposed for regeneration consist of loblolly pine stands that are greater than 59 years old. These stands are reaching maturity, as a result, are increasingly more susceptible to mortality from southern pine beetle attacks and disease. As a result of regeneration activities, these sites would be returned to an early successional stage, which would provide an opportunity for pioneer species of plants and animals requiring open canopy habitat for their development. The regeneration harvests would also help in balancing age class distribution by regenerating late successional age classes (60+ years) into early successional age classes (0-10).

In the summer (June-September) immediately following the harvest, the regeneration areas would be prepared through the use of herbicides (see below Herbicide for effects).

Herbicide effects: The action would focus on eliminating competing species in the direct vicinity of planted or naturally regenerated pine and hardmast seedlings. These treatments are commonly

employed in the Southeast to reduce competition from early pioneering species, such as sweetgum, poplar and invasive weeds to improve the growth, health and success rate of the regenerating stand (Muir et al., 1998; Schultz, 1997). Pine and hardwood seedling growth is inversely related to the amount of competition from pioneer species (Schultz, 1997; Kormanik et al., 1995). As a result of the proposed treatments, regenerating loblolly pine and hardmast hardwood stands would have greater seedling success, growth and ability to resist pathogens and insect attacks, resulting in a long-term, moderate, beneficial impact on vegetation within the treatment sites. Due to the direct foliar method of herbicide application, collateral losses of preferred species from accidental herbicide exposure are anticipated to be minimal. No collateral losses would be anticipated from hack-and-squirt treatments.

Regenerated areas would be surveyed for tree stocking and plant survival approximately three years following the initial seed cut, at which time regeneration areas would be evaluated for additional treatment requirements. Release treatments are commonly employed in the Southeast to reduce competition from early pioneering hardwoods, such as sweetgum, and improve the growth of the regenerating stand (Muir et al, 1998; Schultz, 1997). Pine seedling growth is inversely related to the amount of competition from pioneer species, and high levels of competition for light, nutrients, and water can increase the potential for damage from southern pine beetle attacks (Schultz, 1997). Following release treatments, preferred species have increased phloem starch concentrations, oleoresin production and exudation pressure, crown growth, and phloem thickness. All of these changes combine to reduce the risk of Southern pine beetle attack (Schultz, 1997).

Given adequate stocking, (this is generally the rule rather than the exception (Cain, 1995)), regeneration areas would be evaluated for the need for chemical release. Because herbicides were used in the site preparation, the areas needing herbicide release would be greatly reduced and only be used in stands where there are more than 100 stems per acre of sweetgum, yellow poplar, American elm and maple.

Regeneration harvests of older pine forest provide an opportunity to address the Sumter LRMP goals and objectives. Specifically regeneration allows a new crop of desirable tree species to become established. These desirable trees have improved growth rates and reduced risk of insect and disease. The trees replaced by the new crop were declining in both growth and vigor and were more inclined to outbreaks of insect and disease and less productive. By improving growth rates and reducing losses to insects and disease and allowing for timber harvests regeneration harvest address LRMP Goal 18, "*Provide a sustainable supply of wood products*". Regeneration harvests also addresses LRMP 8 and Objective 8.03, "*Create conditions to restore dry-mesic oak, oak-pine and pine-oak forest communities o 20,000 acres currently in loblolly pine stands in the piedmont over the 10-year planning period*". These goals are met by favoring oak/hickory regeneration over weedy hardwood species (maple, gum, polar, elm) as well as loblolly pine.

Connected Actions

Control of invasive plants would be a priority in areas proposed for timber harvests. A recent decision to treat exotic, invasive plants has been signed. Areas planned for herbicide treatments would target kudzu, privet, trifoliate orange, autumn olive and bamboo. Invasive plants in and

adjacent to proposed stands for timber harvest would be treated to reduce spread of invasive plants and allow native plants to reclaim site.

Erosion control activities are used to mitigate soil compaction on log decks, skid trails and temporary roads. Native grasses, where possible, would be used in erosion control activities. Some non-native, non-invasive plants species may be seeded also. The species mix would consist of plants that are beneficial to wildlife. These erosion control activities would create areas of grasses and forbs within harvested stands, but would eventually be shaded out as the tree canopy closed.

Wildlife Habitat Improvements include leaving hard mast producers that are 8 inches or greater at diameter breast high (DBH). These trees would provide a seed source for wildlife.

Bladed Firelines would be constructed to keep prescribed fire out of regeneration areas. Bladed firelines are estimated at one dozer width wide (8 to 10 feet width). Additional clearance is usually needed for pushing brush and logs away from the fireline and construction of water lead-out structures and water-bars. This can cause disturbance to understory grasses and shrubs mostly and occasional bark damage to larger trees. This can cause injury and death to minor amounts of vegetation adjacent to the firelines. Reconstruction of firelines would have fewer impacts since vegetation has had time to recover and there is minor removal of additional vegetation during reconstruction and reuse of firelines.

Road construction result in the clearing of vegetation along the road right-of-way (ROW) and disturbance and compaction of soils along the road travel way. Thus, road construction results in both the direct removal of vegetation and a reduction in the ability of soils along the road way to support plant growth.

The extent of the vegetation clearing and reduction of future plant production is dependent on the type of road constructed and its intended duration of use. Impacts from temporary roads are generally temporary, as they are rehabilitated following harvest through grading and reseeding the roadbed with grasses and legumes. Soil compaction effects on these sites are generally long term, and as a result, soil productivity along temporary roads can be reduced for decades. In contrast, system road construction results in the removal of vegetation and reduced soil productivity in the road right-of-way over the duration of the use of the road.

Direct and Indirect Effects of Alternative 2

Clearcut with reserves and shortleaf pine restoration would require the removal of all loblolly pine while retaining healthy shortleaf pine on site. Hard-mast producing hardwoods greater than 8 inches in diameter at breast height (dbh) would also remain on site for wildlife benefit. Immediately following the regeneration harvests, grasses and legumes and early pioneering hardwood species would begin to grow in response to the newly opened canopy, as well as in those areas reseeded after construction of log landings and skid trails.

Clearcutting as the Optimum Method

Clearcutting with reserves is the optimum regeneration method and would result in a two-aged stand. Leaving healthy shortleaf pine and desirable hard mast as the reserve overstory trees would add structural and compositional diversity to the stand. It would result in better spacing on planted trees when compared to natural regeneration under the seedtree method. There would be no damage to tree seedlings and no additional soil compaction as compared to the seedtree method. Seedtree removal in three to five years would result in some damage to understory trees, additional soil disturbance during logging, understocked areas and visual impacts.

The use of clearcutting with reserves is the optimum method for regeneration of shortleaf pine in designated units. This silvicultural method would limit the growth of loblolly pine regeneration that could directly impact shortleaf pine survival and establishment. Loblolly pine occupies a growing site quicker and initially grows faster than shortleaf pine. Therefore, the clearcutting with reserves method will ensure that the site is dominated by native shortleaf pine in the short and long term.

Clearcut with reserves method is consistent with the Forest Plan (Appendix H). Regulations (36 CFR 219.15) require that vegetation management practices be chosen that are appropriate to meet the objectives and requirements of the Forest Plan.

Following the herbicide treatment during the winter months (January-March) loblolly pine and shortleaf pine (shortleaf pine restoration stands only) in alternative 2 would be planted on 7’x10’ spacing. Overtime the loblolly and shortleaf pine (shortleaf pine restoration sites only) would take over site and shade out grasses and legumes and early pioneering hardwood species.

In general, implementation of the activities proposed under Alternative 2 would result in an increase in the health and diversity of vegetation in LB. Thinning operations would result in an initial early increase in the proportion of areas with grass and legume coverage. This coverage would slowly decline with development of woody vegetation in the shrub and subcanopy layers, and as the forest canopy slowly closes.

Thinning would remove both non-hardmast producing hardwoods (sweetgum, elm, poplar and maple) and softwoods (loblolly pine), while quality hardmast-producing hardwoods would be preserved when found greater than 8 inches dbh. As described above, thinning operations would result in better tree spacing, reduce competition among the remaining trees for light and nutrients and improve the health and growth of the residual stand. Hardwood stands along major stream courses would be largely unaffected. Federal guidelines requiring the cleaning of harvesting equipment would be followed to prevent the spread of noxious plants into newly harvested areas.

Clearcut with reserves and shortleaf restoration sites would progress through successional changes as described above. These sites would be site prepared using herbicides. A selective treatment would be used with Triclopyr (Garlon 3A or equivalent), Imazapyr (Arsenal AC or equivalent), and Glyphosate (Accord XRT II or equivalent) in the first years after regeneration harvest. This chemical site prep would favor the planted loblolly and shortleaf pine, as well as hardmast-producing hardwoods. Natural loblolly pine, sweetgum, red maple, and yellow poplar

and American elm would be the focus of the herbicide treatments and would be prescribed when these species total 100 stems or more per acre. Impacts on non-target vegetation would be minor, due to the use of direct foliar spray herbicide delivery methods (USDA, 1989b). The species to be treated that are over 6 feet tall would be controlled using the hack and squirt method. This method involves using a hatchet to cut into the tree surface of larger (greater than 6 feet tall) targeted vegetation and Imazapyr (Arsenal AC or equivalent) and triclopyr (Garlon 3A) herbicide is sprayed/injected into the cut area. A cutting tool, such as a hatchet, machete or sandvik, would make the cuts. All downed vegetation would be left on-site to decompose.

Chemical site prep in most situations greatly reduces the need for a chemical release in regeneration areas; however, the treatment may be needed is some situations. These situations would include seeding of undesirable species from adjoining stands, undesirable species missed during chemical site prep treatment, or chemical failure caused by unforeseen weather conditions just after application (such as a prolonged drought). If needed, the second application (chemical release) would use the same herbicides and follow the use the same guidelines as the chemical site prep. The chemical release, if needed, would be applied after the third year survival check.

Pre-commercial would be used to reduce loblolly density, when stocking level exceeds 700 seedlings per acre. Pre-commercial thinning would also be used to release hardmast seedlings from pine regeneration. After pre-commercial thinning is completed remaining regeneration would respond in both diameter and height growth. Native grasses and legumes would also respond to the added daylight and remain until crown closer.

Road construction operations under Alternative 2 would result in the clearing of vegetation along approximately < one mile of temporary road. These temporary roads would be bedded and reseeded following the completion of harvest operations, providing additional sites within LB with grass and legume coverage. Road construction operations would also include approximately four miles of Forest Service system roads that would be decommissioned. Decommissioning work may include but is not limited to removing culverts, restoring normal drainage function, removing road ditching, blocking the road from further access, out-sloping to improve drainage and water-barring and reseeding with native and desired non-native vegetation. Once the work is completed on the temporary and decommissioned road sites small trees would quickly develop along these sites from seed sources in the nearby stands; however, these areas would continue to have reduced soil productivity and full recovery may take many years (USDA, 1989b, USDA, 1985).

Direct and Indirect Effects of Alternative 3

In seedtree regeneration (alternative 3) stands several quality pines would remain on the site as a source of seed after initial harvest. Seed trees remaining would be generally loblolly pine, but when present, shortleaf pine would be left to encourage regeneration of this species. These trees would remain to provide seed to the area until adequate regeneration is achieved (approximately three to four years). Immediately following the regeneration harvests, grasses and legumes and early pioneering hardwood species would begin to grow in response to the newly opened canopy, as well as in those areas reseeded after construction of log landings and skid trails. Pines in the

seedtree regeneration areas would be slower to develop in these openings, because they would have to reproduce from seed and compete with herbaceous species.

In seedtree stands (alternative 3) given adequate stocking, (this is generally the rule rather than the exception (Cain, 1995)), seedtrees would be harvest from regeneration areas. Following adequate stocking and successful release, a seedtree harvest would follow in seedtree harvest area (alternative 3). This action would cause some loss (up to a quarter of the area) to residual regeneration.

Finally, after seed tree removal, a pre-commercial thin would be utilized in alternative 3. Pre-commercial consists of felling, deadening or removing trees to reduce tree stocking in overstocked stands. In most natural pine regeneration areas, stocking is well over a thousand pine seedlings per acre. This dense stocking leads to reduced vigor and growth increasing insect and disease problems. Dense stocking also reduces opportunity for establishing an oak and hickory component. Pre-commercial thinning would accelerate diameter growth on remaining steams, maintain stand density range, and to improve the vigor and quality of remaining trees. Pre-commercial thinning would also remove pine competition from oak and hickory seedlings allowing for their establishment. Pre-commercial would be accomplished using hand tools such as chainsaws, brush saws and others.

Seedtree Regeneration - No New Road Construction

Impacts associated with this alternative would be similar for those described for Alternative 2 above, except for utilizing seedtree method to naturally regenerate loblolly pine and the dropping of temporary roads.

Following adequate stocking and successful release, a seedtree harvest would follow in regeneration areas. This action would cause some loss (up to a quarter) to residual regeneration and would have some effect on the overall stocking of the areas. The originally and skid trails decks are re-opened and vegetation is disturbed on the decks and skid trails. These areas would be re-seeded with native and nonnative noninvasive vegetation. Small trees would quickly develop along these sites from seed sources in the nearby stands; however, these areas would continue to have reduced soil productivity and full recovery may take many years (USDA, 1989b, USDA, 1985).

The dropping of the temporary roads would eliminate 110 acres of regeneration, 474 acres of thinning, and 20 acres of shortleaf restoration. These roads are needed to access the areas.

Cumulative Effects of the Action Alternatives

Cumulative effects associated with the proposed vegetation management relative to expected future successional changes and species composition are generally described above under each alternative. In those sites that also undergo proposed vegetation management operations in addition to prescribed burning operations, additional largely beneficial cumulative effects may be observed.

The combined use of thinning and prescribed burns is considered optimal for maintaining an abundant source of understory vegetation for wildlife browse (Cain, 1995; Haywood et al., 1998; Schultz, 1997; USDA, 1989b).

Prescribed Burning would promote more open conditions in the understory and would tend to favor pine, oak, and hickory species over less desirable species of maple, sweetgum, poplar, and, elm (Southern Appalachian Assessment "terrestrial report" pages 94-96). Native grasses and forbs would dominate cover in the understory. Prescribed burning would also reduce chances of larger and more intense wildfires. There are risks involved with prescribed fire. These risks include needle scorch in pine trees, tree mortality, loss of timber grade in hardwoods, and etc. The risks involved with prescribed burning would be minimal when fire prescriptions are followed.

Vegetation management operations under Alternatives 2 and 3 would generally result in an increase in the health and vegetative diversity of stands with proposed treatments. Sites with proposed regeneration operations would provide age class diversity in LB, and promote the development of early successional species and habitats. Past timber sales in the area have opened up stands encouraging the growth of grasses in the understory. As the sunlight reaches the forest floor, grasses and forbs would respond. Regeneration addresses the desired conditions in management prescriptions in the 2004 Sumter LRMP. In **Management Prescription 10.B High Quality Product Forest products,** the desired condition includes **"***10 to 17 percent of the landscape of the forested land is in early-successional conditions"*. In **Management Prescription 9.A.3 Watershed Restoration Areas,** *Mid and late successional forests are common, but 4 to 10 percent of the forested land is in early-successional forest conditions"*. Currently eight percent of the forested area in management prescription 10B is in or planned for early-successional habitat (age class 0-10). Seventeen hundred thirty one acres of regeneration are proposed, which would provide an additional two percent in the 0-10 age class. Currently there is no early-successional habitat in management prescription 9.A.3. Over 414 acres of regeneration are proposed, which would provide an additional four percent in the 0-10 age class. Tables 3.2.1-2 and 3.2.1-3 are broken down by forest community type and age class distribution for management prescription areas 10B and 9.A.3.

Herbicide use is either proposed or planned for various projects within LB. A recent decision to treat exotic, invasive plants has been signed. Areas planned for herbicide treatments would target kudzu, privet, trifoliate orange, autumn olive and bamboo. These herbicide treatments would slow the spread of these non-natives and would allow native plants to reclaim the site.

Past thinning and regeneration has been accounted for in this analysis. There has not been any thinning (first thinning and intermediate thinning) or regeneration harvest implemented or planned in 9A3 management area for LB since the mid 1990's. There are 73 acres of regeneration that has been implemented in LB in management area 10B.

In 2002-2003, the outbreak of Southern Pine Beetle (SPB) was severe. There were multiple spots scattered across the western side of the district. The majority of the spots were under an acre. The outbreak lasted over a year. Because of the overstocked conditions and over-mature pine forest, outbreaks of SPB are expected to continue. Salvage of SPB spots would occur as needed.

Private Lands

Several private timber stands have either been cleared or harvested in the last 5-7 years in LB. Private timber lots are often managed on short rotation cycles in the Piedmont for pulpwood production (USDA, 1985). Thus, it is highly likely that these areas and other privately owned timber areas would be regularly harvested in the future on a short rotation cycle (20-30 years). National Forest lands are managed on a longer rotation cycle (60+ years). This longer rotation cycle allows for the management of a larger variety of age classes, and more diverse forest communities through intermediate thinning and prescribed burning operations. The maintenance of a more diverse forest community helps to offset the lack of species and age class diversity that often occurs on private lands in short rotation timber use.

Table 3.2.1-2. Age Class Distribution for management Prescription Area 10.B

YEAR 2015 (before) WORKING GROUP ACRES Rx 10.B ASSOCIATED with LOWER BROAD (9,362)								
Age Class	Pine		Upland Hardwoods		Bottomland Hardwoods		Totals	
	Acres	%	Acres	%	Acres	%	Acres	%
0-10	60	1	0	0	0	0	60	1
11-20	139	1	0	0	0	0	139	1
21-30	1815	19	0	0	0	0	1815	19
31-40	1214	13	13	0	0	0	1227	13
41-50	169	2	26	0	0	0	195	2
51-60	38	0	0	0	0	0	38	0
61-70	100	1	0	0	0	0	100	2
71-80	1063	11	121	1	0	0	1184	13
81-90	2695	29	907	10	104	1	3706	40
91-100	173	2	371	4	25	0	569	6
101-110	57	1	108	1	164	2	329	4
Total	7523	80	1546	17	293	3	9362	100

YEAR 2020 (After) WORKING GROUP ACRES Rx 10.B ASSOCIATED with LOWER BROAD (9,362)								
Age Class	Pine		Upland Hardwoods		Bottomland Hardwoods		Totals	
	Acres	%	Acres	%	Acres	%	Acres	%
0-10	1791	19	0	0	0	0	60	19
11-20	139	1	0	0	0	0	139	1
21-30	1815	19	0	0	0	0	1815	19
31-40	1214	13	13	0	0	0	1227	13
41-50	169	2	26	0	0	0	195	2
51-60	38	0	0	0	0	0	38	0
61-70	68	1	0	0	0	0	100	1
71-80	602	6	121	1	0	0	1184	8
81-90	1592	17	907	10	104	1	3706	28
91-100	85	1	371	4	25	0	569	5
101-110	10	0	108	1	164	2	329	3
Total	7523	80	1546	17	293	3	9362	100

Table 3.2.1-3. Age Class Distribution for management Prescription Area 9.A.3

YEAR 2015 (before) WORKING GROUP ACRES Rx 9A3 ASSOCIATED with LOWER BROAD (3,276)								
Age Class	Pine		Upland Hardwoods		Bottomland Hardwoods		Totals	
	Acres	%	Acres	%	Acres	%	Acres	%
0-10	0	0	0	0	0	0	0	0
11-20	0	0	0	0	0	0	0	0
21-30	381	12	0	0	0	0	381	12
31-40	751	23	0	0	0	0	751	23
41-50	86	3	0	0	0	0	86	3
51-60	144	4	0	0	0	0	144	4
61-70	50	2	0	0	0	0	50	2
71-80	381	12	20	1	8	0	409	12
81-90	943	29	40	1	0	0	983	30
91-100	320	11	3	0	75	2	398	13
101-110	0	0	46	1	0	0	46	1
Total	3056	94	109	3	83	3	3248	100

YEAR 2020 (After) WORKING GROUP ACRES Rx 9A3 ASSOCIATED with LOWER BROAD (3,276)								
Age Class	Pine		Upland Hardwoods		Bottomland Hardwoods		Totals	
	Acres	%	Acres	%	Acres	%	Acres	%
0-10	428	13	0	0	0	0	428	13
11-20	0	0	0	0	0	0	0	0
21-30	381	12	0	0	0	0	381	12
31-40	751	23	0	0	0	0	751	23
41-50	86	3	0	0	0	0	86	3
51-60	80	2	0	0	0	0	80	2
61-70	37	1	0	0	0	0	37	1
71-80	216	7	20	1	8	0	244	7
81-90	757	23	40	1	0	0	797	24
91-100	320	11	3	0	75	2	398	13
101-110	0	0	46	1	0	0	46	1
Total	3056	95	109	3	83	3	3248	100

3.2.2 Non-native Invasive Plants (NNIS) and Rare Communities

Affected Environment

Rare Plant Communities

Rare communities are plant associations or assemblages of plants and animals that occupy a small portion of the landscape but contribute significantly to plant and animal diversity. Wildlife

and plants found in these areas are a combination of species commonly found across the forest, and species that are almost always found in or near these more specialized habitats. Rare communities can be forested or non-forested and address a wide-range of habitat conditions, from basic mesic coves to natural woodlands and rock outcrops. Some may be found as inclusions within larger stands and others may be larger. In coordination with Natureserve and other partners, a list of rare communities which are imperiled globally, or represent habitat for state or globally-impaired species, was developed for the Revised Land and Resource Management Plan Sumter National Forest (Forest Plan). This list continues to be updated as information on rare species and their habitats are compiled throughout the range of the species. Rare communities of significance on the Enoree Ranger District include the following:

Table 3.2.2-1. Rare Plant Communities with Potential to occur on the Enoree Ranger District, Sumter National Forest[4].

Rare Plant Community Group	Rare Plant Community
Bogs, Seeps, and Ponds	Piedmont Gabbro Upland Depression Forest Atlantic Upland Depression Willow Oak Swamp Forest Piedmont Low Elevation Headwater Seepage Swamp
Riverine Vegetation	Floodplain Canebrake Southern Piedmont Oak Bottomland Forest American Beech-Southern Sugar Maple/Common Pawpaw Forest Piedmont Triassic Basin Oak Bottomland Forest
Basic Mesic Forest	Basic Piedmont Mesic Mixed Hardwood Forest
Cliffs and Bluffs	Granite Dome or Dome Woodland
Rock Outcrops	Granitic Flatrock
Glades, Barrens, and Associated Woodlands	Piedmont Blackjack Prairie Piedmont Diabase Barren Piedmont Acid Hardpan Woodland Piedmont Montmorillonite Woodland Xeric Hardpan Forest Mafic Xeric or Dry-Mesic Piedmont Oak Forest Mafic Shortleaf Pine-Oak Woodland Rich Granitic Lower Piedmont Deciduous Woodland Southern Inner Piedmont Mafic Barren
Abandoned Mines	

Five sites were identified as rare communities within the Lower Broad Analysis Area. Site one is located on a steep, northeast-facing bluff just north of stand 8 in compartment 55. This site has a mix of mature and middle-aged canopy trees and a rich herbaceous layer with two state-listed species (James' sedge and hairy yellow violet). Site two is located on a series of northeast-facing

[4] Based on "Carolinas and Georgia Piedmont Vegetation" (Natureserve 2001).

bluffs just north of stand 3 and 13 in compartment 56. The site is made up of mature mesic-site species with a rich herbaceous layer. This site has a creek with boulders and small waterfalls which is very unique for the Enoree Ranger District. Site three is located on a series of north-facing bluffs in compartment 109 stand 11. There are large glades of maidenhair fern intermixed with thickets of Christmas fern, giving the understory a striking appearance. Fifteen plants of the state listed James' sedge were found in one ravine in this natural area. Canada horsebalm and maidenhair fern were also very common in this site, which is unique because it is not seen anywhere else in the analysis area. Site four is located on northeast-facing bluff just north of stands 6 and 9 in compartment 111. Large colonies of mayapple with mature mesic-site overstory trees create this rare community. There are also numerous clumps of the state-listed rare James' sedge within this site. The last site is located on a steep, northeast-facing bluff just north of stand 6 in compartment 117. The canopy layer is made up of 30-40" diameter at breast height white oak and red oak trees. Mounds, light gaps and dead tree boles on the forest floor along with the size of the trees give the appearance this stand could be considered old growth.

Direct and Indirect Effects of Alternative 1

Under this alternative, proposed actions (commercial thinning, regeneration clearcut with reserves, shortleaf pine restoration, shelterwood with reserves, chemical site preparation, mechanical site preparation, tree planting, pre-commercial thinning, road decommissioning and road relocation) and connected actions (road work, erosion control and right-of way acqusition) would not occur. Current management activities would continue in the project area.

There would be no direct effects to any of the rare communities under this alternative since no activities would take place.

There would be no indirect effects to any of the rare communities under the No Action alternative.

Connected Actions

There would be no effects to any of the rare communities related to connected actions since none would occur with the No Action alternative.

Cumulative Effects of Alternative 1

There are other projects being implemented and/or planned on the Enoree Ranger District that would continue under the No Action alternative. Projects include timber harvesting, prescribed burning for hazard fuel reduction and wildlife habitat improvement, road maintenance, and trail construction and maintenance. With the No Action alternative, no additional activities would take place so there would be no additional cumulative effects within the project area or across the district.

Direct and Indirect Effects of Alternative 2

The rare plant communities in compartment 55 stand 8, compartment 56 stand 3 and 13,

compartment 109 stand 11, compartment 111 stand 6 and 9 and compartment 117 stand 6 are designated as hardwood inclusions within the harvest unit and adjacent to the harvest units.and as such would not be directly affected by vegetation management practices. Forest Plan Standard FW-24 states: "In the piedmont, hardwood inclusions (1/2 acre in size or larger) in pine stands dominated by hard and soft mast producing trees (i.e., oaks, hickories, walnuts, black gum, black cherry, persimmon) will be retained."

Regeneration of the adjacent timber would increase the amount of sunlight along the edges of the rare plant communities, potentially affecting soil temperatures, moisture availability, and vegetation composition. This could potentially have an adverse effect on the edges of the rare plant communities in compartment 55 stand 8, compartment 56 stand 3 and 13, compartment 109 stand 11, compartment 111 stand 6 and 9 and compartment 117 stand 6.

Connected Actions

All connected actions would not take place within the rare plant communities. There would be no effect from skidding, decking, and hauling of logs, seed tree removal, and road maintenance and temporary road construction.

NNIS

Non-native invasive plant infestations are increasing on the Enoree Ranger District. Between 35 and 45 acres of non-native invasive plants were documented as occurring in or adjacent to stands proposed for management. On the Sumter National Forest, NNIS threaten biological resources, forest and watershed health, rare communities, and habitat for rare, threatened and endangered species. Sites most heavily infested by NNIS plants are found along forest edges and openings, old home sites, open and closed roads, wildlife openings and floodplains. Oswalt (2004) found that 40% of forest inventory and analysis (FIA) plots sampled in South Carolina contained at least one NNIS plant species, and that sites of high infestation were most often correlated with high moisture and/or high light. Table 3.2.2-2 lists non-native invasive plant species within or adjacent to the stands proposed for thinning within the proposed action.

Table 3.2.2-2. Non-native Invasive Species Found in the Lower Broad Project Area

Common Name	Latin Name
Autumn olive	*Eleagnus umbellate*
Chinaberry	*Melia Azedarach*
Chinese Privet	*Ligustrum sinsense*
Japanese honeysuckle	*Lonicera japonica*
Trifoliate Orange	*Citrus trifoliate*
Chinese Lespedeza	*Lespedeza cuneata*
Russian Olive	*Elaeagnus angustifolia*
Chinese wisteria	*Wisteria sinensis*
Sawtooth oak	*Quercus acutissima*
Thorny olive	*Elaeagnus pungens*

Direct, Indirect and Cumulative Effects of Alternative 1

Under the no action alternative, no additional ground-disturbing activities would take place, or activities which would increase availability of light for rapidly growing opportunistic non-native invasive plant species. Alternative 1 is expected to have no direct or indirect effects on the spread of non-native invasive plants, and no impacts to rare communities since no additional activities will occur.

No cumulative effects of Alternative 1 on the introduction and spread of non-native invasive plants are anticipated, and on rare plant communities, as no direct or indirect effects are anticipated. Ongoing projects associated with other decisions, include timber harvesting, prescribed burning for hazard fuel reduction and wildlife habitat improvement, fire line reconstruction, road, trail, utility line and wildlife opening maintenance and herbicide use would continue, but there would be no additional cumulative effects associated with the no action alternative.

Direct, Indirect Effects of Alternative 2

Harvest activities would improve conditions for the spread of non-native invasive plant species, by increasing light to the forest floor, creating bare soil providing a microsite for establishment and by introducing equipment from other areas on site, which can bring in invasive plant species propagules, increasing the chances of establishment (Miller et. Al., 2010). Project design criteria, such as invasive plant treatments would minimize or eliminate the direct and indirect effects of activities proposed in Alternative 2, on the introduction and spread of non-native invasive plant species within these stands, particularly in areas of more continuous National Forest management. An existing forest-wide decision is in place to treat NNIS. NNIS for this project would be treated to ensure they do not spread from project activities or become a threat to the successful establishment of native vegetation. Only non-invasive annual or native vegetation would be planted in areas associated with this proposal and no invasive plants would be intentionally introduced.

Indirectly, project activities would provide microsites for non-native invasive plants once soil has been disturbed. If non-native invasive plants are treated, these sites are likely to become dominated by native vegetation. Given that the design criteria is followed, indirect effects on the project would be minimized as treatments would allow native species to occupy the site particularly in areas where prescribed burning occurs and areas of less fragmented ownership patterns.

Cumulative Effects of Alternative 2

The cumulative effects of project activities may increase the spread of non-native invasive plants, especially considering the broken ownership patterns and the incidence of non-native invasive plants on private lands. Non-native invasive plants continue to increase throughout the state and few incentives exist for private land owners to control these species once established. Many invasive plants colonize roadside habitats, and will continue to spread if left uncontrolled. Statewide, opportunities exist for private and state landowners to cost share with federal agencies

to control invasive plants through Wyden amendment authorities, allowing the (National) Forest to treat adjacent lands when invasive plant populations pose a threat. The project areas would be monitored for the introduction and spread of NNIS. NNIS treatments are possible on adjacent private lands if needed for control of NNIS onto National Forest system lands.

3.2.3 Wildlife: Management Indicator Species

Affected Environment

A wide variety of wildlife species occur throughout the Enoree Ranger District of the Sumter National Forest. Wildlife habitat in the project area consists of loblolly pine and mixed pine-hardwood stands of varying ages, hardwood inclusions, some open habitats and wildlife openings. Several understory species associated with the proposed treatment stands are important sources of food and cover for wildlife and also provide nesting habitat for some species.

Management Indicator Species (MIS) are those whose presence in a certain location or situation at a given population level indicate a particular environmental condition. Their population changes are believed to indicate effects of management activities on a number of other species. MIS are representative of the diversity of species and associated habitats and can be used as a tool for identifying specialized habitats and creating habitat objectives and standards and guidelines. The MIS concept is to identify a few species that are representative of many other species and to evaluate management direction by the effects of management on MIS habitats. Both population and habitat data are used to monitor MIS on National Forests. The 2004 Revised Land and Resource Management Plan, Sumter National Forest (Forest Plan) lists 13 species as MIS; 12 are avian species and one is a mammal.

Trends in MIS populations are normally assessed relative to trends in their respective habitats. This section focuses on terrestrial MIS. Aquatic species are addressed in the Aquatic Communities section. Sumter National Forest MIS are listed in Table 3.2.3-1, along with general comments regarding their habitats. General discussions of these species and their relationship to monitoring can be found in the Forest Plan.

Table 3.2.3-1. Management Indicator Species for the Sumter National Forest

Species	Habitats
Acadian Flycatcher *Empidonax virescens*	Uses mesic sites with a diverse canopy structure; found in heavily wooded deciduous bottomlands, swamps, riparian thickets, and in the wooded ravines of drier uplands
American Woodcock *Scolopax minor*	Often found in shrub- and seedling-dominated regeneration areas in association with riparian areas; requires moist soil conditions for feeding
Black Bear *Ursus americanus*	Trends in population indices and harvest levels will be used to help evaluate the results of management activities on this high profile species
Brown-headed Nuthatch *Sitta pusilla*	Uses open, mid-late successional pine (age classes over 20 years); not common in dense stands of pines; will overwinter
Eastern Wild Turkey *Meleagris gallopavo*	This species is most common in extensive bottomland forests where the understory is moderate; also occurs in extensive upland hardwood or mixed forests, less so in pine forests
Field Sparrow *Spizella pusilla*	Uses woodland, grassland, and savanna habitats; fairly common in old fields, open brushy woodlands, and forest edge habitats

Species	Habitats
Hooded Warbler *Wilsonia citrina*	Uses mesic deciduous forest with a shrubby understory; frequents dense thickets; fairly common in upland and bottomland woodlands
Northern Bobwhite *Colinus virginianus*	Uses fields, grasslands, brushy habitats, and open woodlands; significantly declining over most of its range due to habitat loss and changes in farming practices
Pileated Woodpecker *Dryocopus pileatus*	Uses mature and extensive forests, primarily in deciduous forests; occurs in both deep woods and swamps as well as in rather open and upland forests; excavates nesting and roosting cavities
Pine Warbler *Dendroica pinus*	Uses middle-aged to mature open pine forest; seldom in hardwoods; overwinters throughout much of its breeding range
Prairie Warbler *Dendroica discolor*	Frequents brushy old fields, open pine stands, and other early successional habitats
Scarlet Tanager *Piranga olivacea*	Uses mature deciduous forest and some mixed conifer-hardwood forests; requires large areas of forest for breeding
Swainson's Warbler *Limnothlypis swainsonii*	Uses canebrakes and other early-successional riparian habitats

Based on habitat within the project area and the biological requirements of the species, eight MIS are considered and analyzed in this Environmental Assessment (EA). The remaining five species are not discussed in detail. Listed in Table 3.2.3-2 are the species that are excluded from analysis and the reason why they are not addressed for this project.

Table 3.2.3-2. Management Indicator Species excluded from analysis in the Lower Broad Analysis Area, Enoree Ranger District, Sumter National Forest

Species	Reason for Exclusion from Analysis
Acadian Flycatcher *Empidonax virescens*	This species is an indicator for trends in frequency of occurrence in riparian habitats. Proposed management activities would not take place within riparian areas so this species was excluded from analysis.
American Woodcock *Scolopax minor*	This species is an indicator for trends in frequency of occurrence in early successional riparian habitats. Proposed management activities would not take place within riparian areas so this species was excluded from analysis.
Black Bear *Ursus americanus*	This species is uncommon on the Enoree Ranger District so it was exluded from analysis.
Scarlet Tanager *Piranga olivacea*	This species is an indicator for trends in frequency of occurrence in oak forests and the effectiveness of management for maintaining oak forests. Proposed management activities would not occur in this habitat so this species was excluded from analysis.
Swainson's Warbler *Limnothlypis swainsonii*	This species is an indicator for presence and trends in frequency of occurrence in canebrakes and other early-successional riparian habitats. Proposed management activities would not take place within riparian areas so this species was excluded from analysis.

Vegetation manipulation changes the diversity and abundance of wildlife species in a given area. Planning regulations define diversity as "the distribution and abundance of different plant and animal communities and species within [an] area…" (36 CFR 219.3(g)). In general, forested areas that are in various stages of development and include periodic openings support a wide diversity of species and habitats. Management activities that result in different types of habitats, including prescribed burning, thinning and herbicide use, tend to increase wildlife diversity. Impacts beneficial to wildlife are typically greater with a combination of management activities versus any of the treatments separately. Table 3.2.3-3 lists the MIS that occur or have habitat within the proposed project area. These are the species that are analyzed in this EA. Following the table are effects to these MIS by alternative.

Table 3.2.3-3. Habitat associations of Management Indicator Species that occur or have habitat within the Lower Broad Analysis Area, Enoree Ranger District, Sumter National Forest

Habitat Association	Species
Early Successional/Disturbance Dependent	Field Sparrow, Northern Bobwhite, Prairie Warbler
Late Successional Pine	Brown-headed Nuthatch, Pine Warbler
Mixed Pine-Hardwood Forest	Eastern Wild Turkey, Hooded Warbler, Pileated Woodpecker

Direct, Indirect and Cumulative Effects of Alternative 1

Under this alternative, proposed activities (commercial thinning, regeneration clearcut with reserves, shortleaf pine restoration, shelterwood with reserves, site preparation, tree planting, chemical release, pre-commercial thinnings, and road decommissioning/road relocation) and connected actions (road work, erosion control, rights-of-way acquisition, and skidding/decking/hauling of logs) would not occur. The natural resources and ecological processes within the project area would continue at the existing level of human influence. The characteristics of the forest environment would be affected primarily by natural disturbances such as insects, disease and weather events. Custodial management of recreation areas, roads, prescribed burning, and other projects already approved under prior decisions would continue under the No Action alternative.

Direct Effects

Under the No Action alternative, there would be no direct effects on management indicator species since no activities would take place.

Indirect Effects

MIS associated with early successional/disturbance dependent habitats (field sparrow, northern bobwhite, prairie warbler)

Field sparrow, northern bobwhite and prairie warbler use open, early successional habitats that are maintained by frequent disturbance. Additional habitat for these species would not be restored or enhanced under the No Action alternative. Under alternatives 2 and 3, several proposed treatments would benefit these species (commercial thinning, regeneration clearcutting with reserves, shortleaf pine restoration and shelterwood with reserves). Under the No Action alternative, these activities would not take place. Without these treatments, many stands within the project area would continue to develop into mature mixed pine-hardwood forests with dense midstories dominated by sweetgum and other shade-tolerant woody plants and little herbaceous vegetation on the forest floor. These conditions would not provide suitable habitat for early successional/disturbance dependent species.

MIS associated with late successional pine (brown-headed nuthatch, pine warbler)

The No Action alternative would benefit those MIS that use late successional pine forests, such as brown-headed nuthatch and pine warbler, since a more mature and continuous forest canopy would develop under this alternative. Over time seedling/sapling habitat within the project area

would develop into poletimber habitat, which would then develop into sawtimber habitat. This progression would result in a more mature and continuous forest canopy dominated by pines, benefiting wildlife that is associated with late successional pine habitats. However, over a prolonged period of time, the abundance of sweetgum and other pioneering species within the project area would increase, and these would slowly replace pine and preferred hard mast species. This condition would be detrimental to those species that use late successional pine forests.

MIS associated with mixed pine-hardwood forest (eastern wild turkey, hooded warbler, pileated woodpecker)

The No Action alternative would benefit those MIS that use mature forest for foraging and cover, such as the eastern wild turkey, hooded warbler and pileated woodpecker, since a more mature and continuous forest canopy would develop under this alternative. However, over a prolonged period of time the abundance of pioneering species within the project area would increase and would slowly replace pine and preferred hard mast species. This condition would be detrimental to these species. Additionally, less edge would be created with the No Action alternative providing less foraging areas for eastern wild turkey.

Cumulative Effects

Other management activities that have taken place on the Enoree Ranger District include prescribed burning, timber sales, precommercial thinning and release of timber, southern pine beetle control, drum chopping for site preparation and tree planting, recreation trail reconstruction and maintenance, seeding of roads, skid trails, firelines and log decks, additional road maintenance (grading, brushing, and mowing), and road decommissioning. Most of these activities are expected to continue in the near future at approximately the same levels.

The Forest Service is proposing the Chester County Stream and Riparian Restoration/Enhancement Project to restore and enhance the hydrologic and aquatic functions on approximately 18 miles of streams within four watersheds. The project would take place in Chester County north of the Lower Broad Analysis Area. The Chester County Stream and Riparian Restoration/Enhancement Project is not likely to contribute to cumulative effects on PETS species or their habitats.

The Forest Service is also proposing to restore hydrological features and forest composition within approximately 974 acres along the Broad River in Union, Chester and Fairfield Counties. The wetland restoration project is not likely to contribute to cumulative effects on PETS species or their habitats.

Private lands within or adjacent to the proposed project areas are made up of timberland, home sites, pastures, and farmland. Intensive timber management activities on private lands, including thinning, regeneration cuts and road building, have occurred heavily over the past 10 years within some of these areas.

With the No Action alternative, no additional activities would take place so there would be no additional cumulative effects within the project area or across the District.

Direct, Indirect and Cumulative Effects of Alternative 2

Direct Effects

Direct effects are not expected to occur to MIS. All MIS are highly mobile avian species that would relocate to undisturbed areas if they were displaced by proposed activities. However, it is possible that if any of these species were nesting during proposed activities nests and nestlings could be lost. These effects are considered minor since only a portion of the area would be managed at any one time. In addition, project activities would have to occur at the exact time when species are most vulnerable and also occur over successive years to have substantial impacts. This is unlikely given past management practices. Additionally, avian species will re-nest multiple times throughout the nesting season, so no significant decrease in MIS reproductive potential is expected.

Herbicide application as proposed in this alternative is not expected to have a direct effect on MIS. While the use of some herbicides can have direct effects on wildlife by causing injury or mortality from direct spray, drift or ingestion of contaminated food or water, those herbicides proposed in this alternative, namely imazapyr, triclopyr, aminopyralid and glyphosate, are practically non-toxic to birds and other wildlife species.

Imazapyr is practically non-toxic to terrestrial animals and birds. The acute oral LD_{50}[5] of imazapyr for mallard ducks (*Anas platyrhynchos*) and northern bobwhites (*Colinus virginianus*) are both greater than 2,150 mg/kg (US Forest Service 2004a). Acute toxicity studies in northern bobwhites and mallard ducks found no adverse effects at dietary concentrations up to 5,000 ppm (Fletcher et al. 1984a, b). Imazapyr is rapidly eliminated in the urine and feces of animals and is not known to accumulate in animal tissues (Miller et al. 1991).

The acute oral LD_{50} of triclopyr for mallard ducks and northern bobwhites are 1,698 mg/kg and 2,935 mg/kg, respectively (US Forest Service 2011). A one-generation reproduction study showed no reproductive effects, symptoms of toxicity, or abnormal behavior when mallards were given up to 500 ppm of triclopyr in their diet for a 20-week period, including ten weeks prior to egg laying and ten weeks during egg laying. Newton et al. (1990) predicted that triclopyr would not be present in animal forage in doses large enough to cause either acute or chronic effects to wildlife, and concluded that the tendency for triclopyr to dissipate quickly in the environment would preclude any problems with bioaccumulation in the food chain.

Aminopryalid is practically non-toxic to birds based on acute exposure to northern bobwhites that resulted in an LD_{50} value of greater than 2,250 mg/kg (EPA 2005). In 5-day dietary studies

[5] Acute toxicity is commonly measured by the lethal dose (LD) that causes death in 50 percent of treated laboratory animals. LD_{50} indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per kilogram (mg/kg). Chemicals are highly toxic when the LD_{50} value is small and practically nontoxic when the value is large.

with northern bobwhites and mallard ducks, LC_{50}[6] concentrations were greater than 5,000 (EPA 2005). The mammalian toxicity of aminopryalid is relatively well-characterized in experimental mammals in a series of toxicity studies that are required for pesticide registration (US Forest Service 2007). In rats, mice, rabbits, and dogs, aminopryalid has low acute and chronic oral toxicity. For example, Brooks (2001) found that in rats the acute oral LD_{50} is greater than 5,000 mg/kg for aminopyralid. It seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals. Results of acute exposure studies in birds indicate that avian species appear no more sensitive than mammals to aminopyralid in terms of acute lethality (US Forest Service 2007).

Glyphosate is of relatively low toxicity to birds. The acute oral LD_{50} of glyphosate for northern bobwhite is greater than 2,000 mg/kg (US Forest Service 2011b). Avian reproduction studies yielded no reproductive effects at dietary exposure levels of up to 1,000 ppm (US Forest Service 1989). The effects of glyphosate on wild mammals have been examined in numerous field studies (Sullivan and Sullivan 2000; Santillo et al. 1989). These studies indicate that glyphosate will not cause unreasonable adverse effects to wildlife species.

Indirect Effects

MIS associated with early successional/disturbance dependent habitats (field sparrow, northern bobwhite, prairie warbler)

Commercial thinning, clearcutting with reserves, shortleaf pine restoration, and shelterwood with reserves would benefit MIS associated with early successional/disturbance dependent habitats. Within one to two years after treatments, native grasses and forbs would become established in the understories of these forest stands, further improving habitat conditions. Early successional habitat would, however, be a short-term condition. As stands matured, habitat would become less suitable for these species.

MIS associated with late successional pine habitats (Brown-headed Nuthatch, Pine Warbler)

These MIS use middle-aged to mature pine habitats, although pine warblers can be found in pine woods in a variety of age classes. Commercial thinning, regeneration harvests, and shortleaf pine restoration would remove mature pines, reducing habitat in the short-term for these species. Brown-headed nuthatches are year-round residents that nest in dead trees near or in pines. This species would take advantage of any standing snags left during project activities, but otherwise would have to move to other areas dominated by mature pines to nest. Once the shortleaf pine (restoration stands) matures, then it would provide suitable habitat for MIS associated with late successional pine habitats.

[6] Acute toxicity is sometimes measured by the lethal concentration that causes death in 50 percent of treated laboratory animals (LC_{50}). LC values usually refer to the concentration of a chemical in air, but it can also mean the concentration of a chemical in water. LC_{50} indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per liter (mg/l). Chemicals are highly toxic when the LC_{50} value is small and practically nontoxic when the value is large.

MIS associated with mixed pine-hardwood forest (eastern wild turkey, hooded warbler, pileated woodpecker)

Eastern wild turkey is most common in extensive bottomland forests where understory is moderate; however, they do occur in a variety of habitats, including mature pine forests. There would be a short-term decrease of mature pine forest due to commercial thinning, regeneration harvests, and shortleaf pine restoration; however, this habitat type is not limited across the Sumter National Forest and forest stands would develop into mature mixed pine-hardwood forests in the long-term. Eastern wild turkey would also benefit from site preparation because it would improve foraging and brood-rearing habitat within the understory.

Hooded warblers primarily inhabit deciduous forests, but are also found in the dense understories of mixed pine-hardwood forests. Project activities would reduce habitat for hooded warbler. However, mixed pine-hardwood forests with dense understories are common on the Enoree Ranger District, so habitat for this species would remain abundant on National Forest land.

Pileated woodpeckers are year-round residents that occupy mature forests with abundant snags. There would be a short-term reduction in habitat for this species with the implementation of this project as mature trees would be removed. However, pileated woodpecker would use any snags that are left after the harvest to forage for insects and insect larvae. Once project stands mature, the habitat would be available for this species.

This alternative proposes herbicide treatments for site preparation and release of crop trees. Desirable hard and soft mast producing species and healthy shortleaf pine would not be targeted during herbicide treatments. Indirect effects associated with herbicide release consist of modifications to understory vegetation which may alter nesting, roosting, foraging and wintering habitats of MIS. These modifications are not expected to have detrimental effects to MIS.

Cumulative Effects

This cumulative effects analysis tiers to the Management Indicator Species Population and Trends (USDA 2001) document that provides context for species and their habitats across the Sumter National Forest.

The proposed action is expected to increase habitat for some groups of MIS (those associated with early successional/disturbance dependent habitats), while at the same time result in short-term habitat loss for other groups of MIS (those associated with late successional pine habitats and mixed pine-hardwood forests). Any short-term habitat loss associated with this project is not expected to adversely affect population trends of MIS.

MIS associated with early successional/disturbance dependent habitats (field sparrow, northern bobwhite, prairie warbler)

All MIS associated with early successional/disturbance dependent habitats are experiencing population declines across their geographic range and on the Sumter National Forest. From 1992 to 2004, field sparrow, northern bobwhite, and prairie warbler populations on the Francis Marion

and Sumter National Forests (FMS) declined 19.1%, 10.0%, and 8.1% per year, respectively (La Sorte et al. 2007). The most commonly accepted reason for decline is habitat loss and fragmentation. The proposed action would increase breeding, foraging and wintering habitat for these species.

MIS associated with late successional pine habitats (brown-headed nuthatch, pine warbler)

Brown-headed nuthatch populations have increased 5.4% per year on the FMS from 1992 to 2004. Pine warbler populations have remained relatively stable (0.2% annual decline) over the same period of time (La Sorte et al. 2007). The population stability of these MIS is a reflection of the quantity and quality of available habitats on the Sumter National Forest. The implementation of alternative 2, along with other activities on the Sumter National Forest and surrounding private lands, is not expected to adversely affect species that use late successional pine habitats.

MIS associated with mixed pine-hardwood forest habitats (eastern wild turkey, hooded warbler, pileated woodpecker)

Populations of eastern wild turkey suffered dramatic declines in the early 1900s. Aggressive stocking programs successfully reintroduced this species to most of its eastern range where populations continue to increase. Eastern wild turkey uses upland forests of oaks, hickories, and pines as well as bottomland forest. Habitat management should center on maintaining mature bottomland hardwood forest, open upland forests, and scattered openings dominated by herbaceous cover. Under this alternative no management activities would occur within bottomland hardwood habitats. Proposed commercial thinning, regeneration harvests, and shortleaf pine restoration would result in in short-term availability of grass- and forb-dominated openings, benefiting eastern wild turkey.

Hooded warbler populations have declined 0.6% annually during 1992-2004 (La Sorte et al. 2007). Although project activities would result in lost habitat for this species, mature mixed pine-hardwood forests with well-developed understories are common across the District. Cumulative effects of the proposed action are not expected.

Trend estimates indicate that populations of pileated woodpeckers are stable across the southeastern United States. Pileated woodpeckers use extensive areas of late successional coniferous and deciduous forest. However, young forests that retain scattered, large, dead trees also provide suitable habitat. This species is versatile in utilizing various forest habitats and adapts well to human habitation. Habitat exists for pileated woodpeckers on private property across the Piedmont, including in rural and suburban settings. The implementation of alternative 2 is not expected to have adverse cumulative effects on this species.

Direct, Indirect and Cumulative Effects of Alternative 3

Direct, indirect and cumulative effects to MIS under this alternative would be similar to alternative 2. The ways in which timber is thinned and regenerated under alternative 3 does not substantially differ from alternative 2.

Under alternative 3, there would be fewer acres that would be commercially thinned; there would be fewer acres of regeneration treatments; and there would be fewer acres restored to shortleaf pine. This reduction in thinning, regeneration and shortleaf pine restoration would result in fewer acres of short-term early successional habitat, which could be used by MIS associated with early successional/disturbance dependent habitats. MIS associated with late successional pine forests and mixed pine-hardwood forests would benefit from fewer acres being regenerated.

3.2.4 Proposed, Endangered, Threatened, and Sensitive (PETS) Species

Affected Environment

Several proposed, endangered, threatened and sensitive (PETS) plant and animal species occur throughout the Enoree Ranger District of the Sumter National Forest. Habitat in the project area consists of loblolly pine stands of varying ages, hardwood inclusions, some open habitats and wildlife openings. For additional information and descriptions of affected environment for PETS species and associated habitats see the *Final Environmental Impact Statement Revised Land and Resource Management Plan, Sumter National Forest* (Forest Plan).

A Biological Assessment/Biological Evaluation (BA/BE) was prepared to determine whether the Lower Broad Analysis Area proposed action is likely to affect any PETS species or their habitats. This BA/BE is included in this EA as an appendix item and includes the list of PETS species for the Sumter National Forest. All species on this list were considered for this BA/BE. Using a step-down process, species and potential habitat in the project area were identified by:

1) Evaluating the location and nature of the proposed project;
2) Considering the species' range, life history, and available habitat information;
3) Reviewing records of known PETS species occurrences, which includes data from the South Carolina Heritage Trust Geographic Database of Rare, Threatened, and Endangered Species; and
4) Reviewing the USFWS's *South Carolina List of At-Risk, Candidate, Endangered and Threatened Species* for Chester, Fairfield, Newberry and Union Counties (2015).

Bald eagles (*Haliaeetus leucocephalus*) occur within the project area and are addressed in the BA/BE. Potential habitat exists for Bachman's sparrow (*Peucaea aestivalis*) and migrant loggerhead shrike (*Lanius ludovicia migrans*). These species are also addressed in the BA/BE. All other species on the Sumter National Forest PETS list were eliminated from this analysis because they are not known to occur within the project area and they lack suitable habitat.

<u>Direct, Indirect and Cumulative Effects of Alternative 1</u>

Under this alternative, project activities would not occur. The natural resources and ecological processes within the project area would continue at the existing level of human influence. The characteristics of the forest environment would be affected primarily by natural disturbances such as insects, disease and weather events. Custodial management of recreation areas, roads, prescribed burning, and other projects already approved under prior decisions would continue under the No Action alternative.

Direct Effects

Under the No Action alternative, there would be no direct effects on PETS species or their habitats since no activities would take place.

Indirect Effects

There would be no indirect effects to bald eagles, Bachman's sparrows, or migrant loggerhead shrikes under the No Action alternative since no activities would occur.

Cumulative Effects

Other management activities that have taken place on the Enoree Ranger District include prescribed burning, timber sales, precommercial thinning and release of timber, southern pine beetle control, drum chopping for site preparation and tree planting, recreation trail reconstruction and maintenance, seeding of roads, skid trails, firelines and log decks, additional road maintenance (grading, brushing, and mowing), and road decommissioning. Most of these activities are expected to continue in the near future at approximately the same levels.

The Forest Service is proposing the Chester County Stream and Riparian Restoration/Enhancement Project to restore and enhance the hydrologic and aquatic functions on approximately 18 miles of streams within four watersheds. The project would take place in Chester County north of the Lower Broad Analysis Area. The Chester County Stream and Riparian Restoration/Enhancement Project is not likely to contribute to cumulative effects on PETS species or their habitats.

The Forest Service is also proposing to restore hydrological features and forest composition within approximately 974 acres along the Broad River in Union, Chester and Fairfield Counties. The wetland restoration project is not likely to contribute to cumulative effects on PETS species or their habitats.

Private lands within or adjacent to the proposed project areas are made up of timberland, home sites, pastures, and farmland. Intensive timber management activities on private lands, including thinning, regeneration cuts and road building, have occurred heavily over the past 10 years within some of these areas.
With the No Action alternative, no additional activities would take place so there would be no additional cumulative effects within the project area or across the District.

Direct, Indirect and Cumulative Effects of Alternative 2

Direct Effects

Bald eagles are known to occur within and adjacent to the project area. Active nests (active in 2015) occur in compartment108, which is approximately a half mile from the project area, and in compartment 116, which is located within the project area. The compartment 116 nest is located in stand 11 (proposed clearcut with reserves) and immediately adjacent to stand 6 (proposed intermediate thin). Additionally, the Broad River is used as foraging habitat and

much of the project area along the Broad River may provide potential nesting or roosting habitat.

Proposed activities (commercial thinning, regeneration clearcut with reserves, shortleaf pine restoration, shelterwood with reserves, site preparation, tree planting, chemical release, pre-commercial thinnings, and road decommissioning/road relocation) and connected actions (road work, erosion control, rights-of-way acquisition, and skidding/decking/hauling of logs) could directly affect bald eagles if they were using any of the project stands for roosting or nesting. Bald eagles using the known nest in compartment 116, stand 11, would be particularly susceptible to direct effects from project activities. To avoid adverse direct effects, Forest Plan Standard FW-28 would be followed. If other nests are found before or during project implementation, then Forest Plan Standard FW-28 would also apply.

Bachman's sparrows and migrant loggerhead shrikes are not known to occur within the project area, but potential habitat exists. Direct effects are not expected to occur to Bachman's sparrow or migrant loggerhead shrike. These highly mobile avian species would relocate to undisturbed areas if they were displaced by proposed activities. However, it is possible that if project activities were to occur during the breeding season, nests and nestlings could be lost due to the activities. These effects are not expected to significantly reduce reproductive success since only a portion of the area would be managed at any one time and avian species will re-nest multiple times throughout the nesting season. In addition, these activities would have to occur at the exact time when species are most vulnerable and also occur over successive years to have substantial impacts. This is unlikely given past management practices.

Herbicide application as proposed in this alternative is not expected to have a direct effect on bald eagles, Bachman's sparrows or migrant loggerhead shrikes. While the use of some herbicides can have direct effects on wildlife by causing injury or mortality from direct spray, drift or ingestion of contaminated food or water, those herbicides proposed in this alternative, namely imazapyr, triclopyr, aminopyralid and glyphosate, are practically non-toxic to birds and other wildlife species.

Imazapyr is practically non-toxic to terrestrial animals and birds. The acute oral LD_{50}[7] of imazapyr for mallard ducks (*Anas platyrhynchos*) and northern bobwhites (*Colinus virginianus*) are both greater than 2,150 mg/kg (US Forest Service 2004a). Acute toxicity studies in northern bobwhites and mallard ducks found no adverse effects at dietary concentrations up to 5,000 ppm (Fletcher et al. 1984a, b). Imazapyr is rapidly eliminated in the urine and feces of animals and is not known to accumulate in animal tissues (Miller et al. 1991).

The acute oral LD_{50} of triclopyr for mallard ducks and northern bobwhites are 1,698 mg/kg and 2,935 mg/kg, respectively (US Forest Service 2011). A one-generation reproduction study showed no reproductive effects, symptoms of toxicity, or abnormal behavior when mallards were given up to 500 ppm of triclopyr in their diet for a 20-week period, including ten weeks prior to

[7] Acute toxicity is commonly measured by the lethal dose (LD) that causes death in 50 percent of treated laboratory animals. LD_{50} indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per kilogram (mg/kg). Chemicals are highly toxic when the LD_{50} value is small and practically nontoxic when the value is large.

egg laying and ten weeks during egg laying. Newton et al. (1990) predicted that triclopyr would not be present in animal forage in doses large enough to cause either acute or chronic effects to wildlife, and concluded that the tendency for triclopyr to dissipate quickly in the environment would preclude any problems with bioaccumulation in the food chain.

Aminopyralid is practically non-toxic to birds based on acute exposure to northern bobwhite that resulted in an LD_{50} value of greater than 2,250 mg/kg (EPA 2005). In 5-day dietary studies with northern bobwhites and mallard ducks, LC_{50}[8] concentrations were greater than 5,000 (EPA 2005). The mammalian toxicity of aminopyralid is relatively well-characterized in experimental mammals in a series of toxicity studies that are required for pesticide registration (US Forest Service 2007). In rats, mice, rabbits, and dogs, aminopyralid has low acute and chronic oral toxicity. For example, Brooks (2001) found that in rats the acute oral LD_{50} is greater than 5,000 mg/kg for aminopyralid. It seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals. Results of acute exposure studies in birds indicate that avian species appear no more sensitive than mammals to aminopyralid in terms of acute lethality (US Forest Service 2007).

Glyphosate is of relatively low toxicity to birds. The acute oral LD_{50} of glyphosate for northern bobwhite is greater than 2,000 mg/kg (US Forest Service 2011b). Avian reproduction studies yielded no reproductive effects at dietary exposure levels of up to 1,000 ppm (US Forest Service 1989). The effects of glyphosate on wild mammals have been examined in numerous field studies (Sullivan and Sullivan 2000; Santillo et al. 1989). These studies indicate that glyphosate will not cause unreasonable adverse effects to wildlife species.

Indirect Effects

Bald eagle. Activities that involve tree removal (namely, commercial thinning, regeneration clearcut with reserves, shortleaf pine restoration and shelterwood with reserves) could affect the availability of potential roost and nest trees, particularly in those treatment stands near the Broad River. However, considering the amount of available habitat within the surrounding areas, any loss of potential nest or roost sites is insignificant and would not have an adverse indirect effect on bald eagles. The existing bald eagle nest in compartment 116 would not be affected by project activities. Forest Plan Standard FW-28 would protect the nest and surrounding canopy from disturbance or modification.

Bachman's sparrow, migrant loggerhead shrike. Habitat for Bachman's sparrow and migrant loggerhead shrike would improve with the implementation of this project. Commercial thinning, regeneration cuts, shortleaf pine restoration, and shelterwood harvests would result in short-term early successional conditions, which would provide suitable habitat for these species.

[8] Acute toxicity is sometimes measured by the lethal concentration that causes death in 50 percent of treated laboratory animals (LC_{50}). LC values usually refer to the concentration of a chemical in air, but it can also mean the concentration of a chemical in water. LC_{50} indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per liter (mg/l). Chemicals are highly toxic when the LC_{50} value is small and practically nontoxic when the value is large.

Cumulative Effects
The cumulative effects of the proposed project in combination with other past, present, and future actions (see above) are not anticipated to result in any measurable loss of the evaluated species or their habitats.

Direct, Indirect and Cumulative Effects of Alternative 3

Direct, indirect and cumulative effects to bald eagles, Bachman's sparrows and migrant loggerhead shrikes under this alternative would be similar to alternative 2. The ways in which timber is thinned and regenerated under alternative 3 does not substantially differ from alternative 2.

Under alternative 3, there would be fewer acres that would be commercially thinned; there would be fewer acres of regeneration treatments; and there would be fewer acres restored to shortleaf pine. This reduction in thinning, regeneration and shortleaf pine restoration would result in fewer acres of short-term early successional habitat, which could be used by Bachman's sparrows and migrant loggerhead shrikes.

3.2.5 Migratory Birds

Affected Environment

The Forest Service is recognized as a national and international conservation leader and plays a pivotal role in the conservation of migratory bird populations and their habitats. Within the National Forest System, conservation of migratory birds focuses on providing a diversity of habitat conditions at multiple spatial scales and ensuring that bird conservation is addressed when planning for other land management activities.

The Enoree Ranger District occurs within a geographic area known as the piedmont in South Carolina. This area is associated with Bird Conservation Region (BCR) 29 – Southern Piedmont. The 47 million-acre BCR 29 is a transitional area between the coastal plain and the Appalachian Mountains that is dominated by pine and mixed pine-hardwood forests with some interior wetlands, reservoirs and riverine systems. This BCR provides habitat for 140 breeding bird species, many of which have experienced steep population declines in recent decades.

The following sources, along with an analysis of species' range, life history, and available habitat information, were reviewed to identify priority migratory birds that are likely to occur in the project area: (1) Partners in Flight (PIF) Priority Bird List for BCR 29 (ACJV 2014); (2) USFWS Birds of Conservation Concern for BCR 29 (USFWS 2008); (3) South Carolina Breeding Bird Atlas (SCDNR 2014); and (4) *The Land Manager's Guide to the Birds of the South* (Hamel 1992). The results of this analysis produced the following table of priority migratory birds that are associated with and potentially affected by the project in the Lower Broad Analysis Area.

Table 3.2.5-1. Priority Migratory Birds for the Lower Broad Analysis Area, Enoree Ranger District, Sumter National Forest

Species	Habitat Association
Bald Eagle *Haliaeetus leucocephalus*	Near water (estuaries, lakes, large ponds, open marshes, shorelines); seldom in deep woods
Brown Thrasher *Toxostoma rufum*	Forests with well-developed forest understories or thickets
Brown-headed Nuthatch *Sitta pusilla*	Mature pine or mixed pine-hardwood forests
Carolina Wren *Thryothorus ludovicianus*	Forests with well-developed forest understories or thickets
Chuck-will's-widow *Caprimulgus carolinensis*	Pine/hardwood forest types, especially near open areas
Eastern Towhee *Pipilo erythrophthalmus*	Forests with well-developed forest understories or thickets
Eastern Wood-Pewee *Contopus virens*	Mature pine or mixed pine-hardwood forests
Field Sparrow *Spizella pusilla*	Woodland, savanna, grassland
Indigo Bunting *Passerina cyanea*	Woodland, savanna, grassland
Kentucky Warbler *Oporonis formosus*	Forests with well-developed forest understories or thickets
Northern Bobwhite *Colinus virginianus*	Woodland, savanna, grassland
Northern Flicker *Colaptes auratus*	Mature pine or mixed pine-hardwood forests
Pine Warbler *Dendroica pinus*	Mature pine or mixed pine-hardwood forests
Prairie Warbler *Dendroica discolor*	Woodland, savanna, grassland
Red-headed Woodpecker *Melanerpes erythrocephalus*	Mature pine or mixed pine-hardwood forests
Whip-poor-will *Caprimulgus vociferus*	Pine/hardwood forest types, especially near open areas
White-throated Sparrow *Zonotrichia albicollis*	Forests with well-developed forest understories or thickets
Wood Thrush *Hylocichla mustelina*	Forests with well-developed forest understories or thickets
Yellow-throated Vireo *Vireo flavifrons*	Mature pine or mixed pine-hardwood forests

All other migratory bird species that occur in BCR 29 were excluded from analysis because they were not identified as PIF priority species or USFWS birds of conservation concern, the project area occurs outside of their known breeding, wintering, or migratory range, and/or suitable habitat does not exist within the project area.

Direct, Indirect and Cumulative Effects of Alternative 1

Under this alternative, proposed activities (commercial thinning, regeneration clearcut with reserves, shortleaf pine restoration, shelterwood with reserves, site preparation, tree planting, chemical release, pre-commercial thinnings, and road decommissioning/road relocation) and

connected actions (road work, erosion control, rights-of-way acquisition, and skidding/decking/hauling of logs) would not occur. The natural resources and ecological processes within the project area would continue at the existing level of human influence. The characteristics of the forest environment would be affected primarily by natural disturbances such as insects, disease and weather events. Custodial management of recreation areas, roads, prescribed burning, and other projects already approved under prior decisions would continue under the No Action alternative.

Direct Effects

Under the No Action alternative, there would be no direct effects on priority migratory birds since no activities would take place.

Indirect Effects

There would be no indirect effects to priority migratory birds under the No Action alternative since no activities would occur.

Cumulative Effects

Other management activities that have taken place on the Enoree Ranger District include prescribed burning, timber sales, precommercial thinning and release of timber, southern pine beetle control, drum chopping for site preparation and tree planting, recreation trail reconstruction and maintenance, seeding of roads, skid trails, firelines and log decks, additional road maintenance (grading, brushing, and mowing), and road decommissioning. Most of these activities are expected to continue in the near future at approximately the same levels.

The Forest Service is proposing the Chester County Stream and Riparian Restoration/Enhancement Project to restore and enhance the hydrologic and aquatic functions on approximately 18 miles of streams within four watersheds. The project would take place in Chester County north of the Lower Broad Analysis Area. The Chester County Stream and Riparian Restoration/Enhancement Project is not likely to contribute to cumulative effects on PETS species or their habitats.

The Forest Service is also proposing to restore hydrological features and forest composition within approximately 974 acres along the Broad River in Union, Chester and Fairfield Counties. The wetland restoration project is not likely to contribute to cumulative effects on PETS species or their habitats.

Private lands within or adjacent to the proposed project areas are made up of timberland, home sites, pastures, and farmland. Intensive timber management activities on private lands, including thinning, regeneration cuts and road building, have occurred heavily over the past 10 years within some of these areas.

With the No Action alternative, no additional activities would take place so there would be no additional cumulative effects within the project area or across the District.

Direct, Indirect and Cumulative Effects of Alternative 2

Direct effects

Direct effects are not expected to occur to priority migratory birds. All priority migratory birds are highly mobile avian species that would relocate to undisturbed areas if they were displaced by proposed activities. However, it is possible that if any of these species were nesting during project activities, nests and nestlings could be lost due to the activities. These effects are considered minor since only a portion of the area would be managed at any one time. In addition, project activities would have to occur at the exact time when species are most vulnerable and also occur over successive years to have substantial impacts. This is unlikely given past management practices. Additionally, avian species will re-nest multiple times throughout the nesting season, so no substantial decrease in reproductive potential is expected.

Herbicide application as proposed in this alternative is not expected to have a direct effect on bald eagles, Bachman's sparrows or migrant loggerhead shrikes. While the use of some herbicides can have direct effects on wildlife by causing injury or mortality from direct spray, drift or ingestion of contaminated food or water, those herbicides proposed in this alternative, namely imazapyr, triclopyr, aminopyralid and glyphosate, are practically non-toxic to birds and other wildlife species.

Imazapyr is practically non-toxic to terrestrial animals and birds. The acute oral LD_{50}[9] of imazapyr for mallard ducks (*Anas platyrhynchos*) and northern bobwhites (*Colinus virginianus*) are both greater than 2,150 mg/kg (US Forest Service 2004a). Acute toxicity studies in northern bobwhites and mallard ducks found no adverse effects at dietary concentrations up to 5,000 ppm (Fletcher et al. 1984a, b). Imazapyr is rapidly eliminated in the urine and feces of animals and is not known to accumulate in animal tissues (Miller et al. 1991).

The acute oral LD_{50} of triclopyr for mallard ducks and northern bobwhites are 1,698 mg/kg and 2,935 mg/kg, respectively (US Forest Service 2011a). A one-generation reproduction study showed no reproductive effects, symptoms of toxicity, or abnormal behavior when mallards were given up to 500 ppm of triclopyr in their diet for a 20-week period, including ten weeks prior to egg laying and ten weeks during egg laying. Newton et al. (1990) predicted that triclopyr would not be present in animal forage in doses large enough to cause either acute or chronic effects to wildlife, and concluded that the tendency for triclopyr to dissipate quickly in the environment would preclude any problems with bioaccumulation in the food chain.

Aminopyralid is practically non-toxic to birds based on acute exposure to northern bobwhite that resulted in an LD_{50} value of greater than 2,250 mg/kg (EPA 2005). In 5-day dietary studies with

[9] Acute toxicity is commonly measured by the lethal dose (LD) that causes death in 50 percent of treated laboratory animals. LD_{50} indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per kilogram (mg/kg). Chemicals are highly toxic when the LD_{50} value is small and practically nontoxic when the value is large.

northern bobwhites and mallard ducks, LC_{50}[10] concentrations were greater than 5,000 (EPA 2005). The mammalian toxicity of aminopyralid is relatively well-characterized in experimental mammals in a series of toxicity studies that are required for pesticide registration (US Forest Service 2007). In rats, mice, rabbits, and dogs, aminopyralid has low acute and chronic oral toxicity. For example, Brooks (2001) found that in rats the acute oral LD_{50} is greater than 5,000 mg/kg for aminopyralid. It seems reasonable to assume the most sensitive effects in wildlife mammalian species will be the same as those in experimental mammals. Results of acute exposure studies in birds indicate that avian species appear no more sensitive than mammals to aminopyralid in terms of acute lethality (US Forest Service 2007).

Glyphosate is of relatively low toxicity to birds. The acute oral LD_{50} of glyphosate for northern bobwhite is greater than 2,000 mg/kg (US Forest Service 2011b). Avian reproduction studies yielded no reproductive effects at dietary exposure levels of up to 1,000 ppm (US Forest Service 1989). The effects of glyphosate on wild mammals have been examined in numerous field studies (Sullivan and Sullivan 2000; Santillo et al. 1989). These studies indicate that glyphosate will not cause unreasonable adverse effects to wildlife species.

Indirect effects

Migratory birds associated with woodland, savanna and grassland habitats (field sparrow, indigo bunting, northern bobwhite, prairie warbler)

Commercial thinning, clearcutting with reserves, shortleaf pine restoration, and shelterwood with reserves would benefit migratory birds associated with woodland, savanna and grassland habitats. Within one to two years after treatments, native grasses and forbs would become established in the understories of these forest stands, further improving habitat conditions. Early successional habitat would, however, be a short-term condition. As stands matured, habitat would become less suitable for these birds.

Migratory birds associated with mature pine or mixed pine-hardwood forests (brown-headed nuthatch, eastern wood-pewee, northern flicker, pine warbler, red-headed woodpecker, yellow-throated vireo)

Commercial thinning and regeneration treatments would affect habitat availability for migratory birds associated with mature pine or mixed pine-hardwood forests. Mature pine trees would be removed during proposed treatments, resulting in short-term early successional habitat. However, after a few years the trees would mature and once again provide suitable habitat for species associated late seral stage forests. Shortleaf pine restoration would also result in the immediate loss of mature pine forest. However, once the shortleaf pine matures, habitat would become available for these species.

[10] Acute toxicity is sometimes measured by the lethal concentration that causes death in 50 percent of treated laboratory animals (LC_{50}). LC values usually refer to the concentration of a chemical in air, but it can also mean the concentration of a chemical in water. LC_{50} indicates the dose of a chemical per unit body weight of an animal and is expressed as milligrams per liter (mg/l). Chemicals are highly toxic when the LC_{50} value is small and practically nontoxic when the value is large.

Migratory birds associated with forests with well-developed forest understories or thickets (brown thrasher, Carolina wren, eastern towhee, Kentucky warbler, white-throated sparrow, wood thrush)

Brown thrasher, Carolina wren, eastern towhee and white-throated sparrow are more likely to benefit from clearcutting with reserves, first and intermediate thinning, and shelterwood treatments because these species tend to use areas with early-successional habitat (thickets). On the other hand, Kentucky warbler and wood thrush tend to use well-developed understories of mature forests. Thinning and regeneration cuts would result in an immediate loss of habitat for these species.

Migratory birds associated with pine/hardwood forest types, especially near open areas (chuck-will's-widow, whip-poor-will)

Effects of the proposed action on these species would be the same as those on migratory birds associated with mature pine or mixed pine-hardwood forests.

Migratory bird associated with water and seldom in deep woods (bald eagle)

Activities that involve tree removal (namely, commercial thinning, regeneration clearcut with reserves, shortleaf pine restoration and shelterwood with reserves) could affect the availability of potential roost and nest trees, particularly in those treatment stands near the Broad River. However, considering the amount of available habitat within the surrounding areas, any loss of potential nest or roost sites is insignificant and would not have an adverse indirect effect on bald eagles. The existing bald eagle nest in compartment 116 would not be affected by project activities. Forest Plan Standard FW-28 would protect the nest and surrounding canopy from disturbance or modification.

Cumulative Effects

All priority migratory birds are PIF priority species or USFWS birds of conservation concern. They are designated as such because they are experiencing various levels of population decline within BCR 29. The proposed action is expected to increase habitat for some groups of priority migratory birds (those associated with woodland, savanna, and grassland habitats), while at the same time result in short-term habitat loss for other groups of priority migratory birds (those associated with mature pine or mixed pine-hardwood forests; pine/hardwood forest types, especially near open areas; forests with well-developed understories). Any short-term habitat loss associated with the proposed action is not likely to adversely affect population trends at the BCR level.

Direct, Indirect and Cumulative Effects of Alternative 3

See Chapter 2 in this EA for specific differences between alternatives 2 and 3.

Direct, indirect and cumulative effects to priority migratory birds under this alternative would be similar to alternative 2. The ways in which timber is thinned and regenerated under alternative 3 does not substantially differ from alternative 2.

Under alternative 3, there would be 474 fewer acres that would be commercially thinned; there would be 110 fewer acres of regeneration treatments; and there would be 20 fewer acres restored to shortleaf pine. This reduction in thinning, regeneration and shortleaf pine restoration would result in fewer acres of short-term early successional habitat, which could be used by birds associated with woodland, savanna and grassland habitats. Birds associated with mature forests, well-developed understories, and pine/hardwood forests would benefit from fewer acres being regenerated.

3.2.6 Aquatic Communities

Affected Environment

The proposed timber project is located in the Lower Broad watershed. District watersheds contain a warm water aquatic community that includes fish, crayfish, aquatic insects, macroinvertebrates and mollusks. The warm water aquatic community serves as a management indicator that is monitored to indicate the effects of management on riparian resources. Aquatic species that may occur in the project area watershed are listed in the following tables.

Table 3.2.6-1 Fish species known to occur in the Broad River watershed (Rhode, et.al. 2009).

Scientific Name	Common Name		Scientific Name	Common Name
Aphredoderidae	**Pirate Perches**		**Cyprinidae**	**Carps and Minnows**
Aphredoderus sayanus sayanus	Eastern pirate perch		*Hybopsis hypsinotus**	Highback chub
Catostomidae	**Suckers**		*Nocomis leptocephalus**	Bluehead chub
Carpiodes cyprinus	Quillback		*Notemigonus crysoleucas*	Golden shiner
Catostomus commersoni	White sucker		*Notropis altipinnis*	Highfin shiner
*Erimyzon oblongus **	Creek chubsucker		*Notropis chorocephalus**	Greenhead shiner
*Hypentelium nigricans**	Northern hog sucker		*Notropis cummingsae*	Dusky shiner
Minytrema melanops	Spotted sucker		*Notropis hudsonius*	Spottail shiner
Moxostoma macrolepidotum	Shorthead redhorse		*Notropis lutipinnis*	Yellowfin shiner
Moxostoma robustum 1980*	Robust redhorse		*Notropis petersoni*	Coastal shiner
Moxostoma rupiscartes	Striped jumprock		*Notropis procne*	Swallowtail shiner
Centrarchidae	**Sunfish**		*Notropis scepticus*	Sandbar shiner
*Centrarchus macropterus**	Flier		*Semotilus atromaculatus**	Creek chub
Enneacanthus gloriosus	Bluespotted sunfish		**Esocidae**	**Pikes**
*Lepomis auritus**	Redbreast sunfish		*Esox americanus**	Redfin pickerel
Lepomis cyanellus	Green sunfish		*Esox niger*	Chain pickerel
Lepomis gibbosus	Pumpkinseed		**Ictaluridae**	**Bullhead Catfishes**
Lepomis gulosus	Warmouth		*Ameiurus brunneus*	Snail bullhead
*Lepomis macrochirus**	Bluegill		*Ameiurus catus*	White catfish
Lepomis marginatus	Dollar sunfish		*Ameiurus natalis**	Yellow bullhead
Lepomis microlophus	Redear sunfish		*Ameiurus nebulosus*	Brown bullhead
Micropterus dolomieu	Smallmouth bass		*Ameiurus platycephalus*	Flat bullhead
Micropterus salmoides	Largemouth bass		*Ictalurus punctatus*	Channel catfish
Pomoxis annularis	White crappie		*Noturus gyrinus*	Tadpole madtom

Scientific Name	Common Name		Scientific Name	Common Name
Pomoxis nigromaculatus	Black crappie		*Noturus insignis*	Margined madtom
Clupeidae	**Herrings**		*Pylodictis olivaris*	Flathead catfish
Alosa sapidissima	American shad		**Lepisosteidea**	**Gars**
Dorosoma cepedianum	Gizzard shad		*Lepisosteus osseus*	Longnose gar
Dorosoma petenese	Threadfin shad		**Moronidae**	**Temperate Basses**
Cyprinidae	**Carps and Minnows**		*Morone saxatilis*	*Striped bass*
Clinostomus funduloides	Rosyside dace		**Percidae**	**Perches**
Ctenopharyngodon idella	Grass carp		*Etheostoma collis*	Carolina darter
Cyprinella chloristia	Greenfin shiner		*Etheostoma olmstedi*	Tessellated darter
Cyprinella labrosa	Thicklip chub		*Etheostoma thalassinum*	Seagreen darter
Cyprinella nivea	Whitefin shiner		*Perca flavescens*	Yellow perch
Cyprinella pyrrhomelas	Fieryblack shiner		*Percina crassa*	Piedmont darter
Cyprinella zanema	Santee chub		*Percina nigrofasciata*	Blackbanded Darter
Cyprinus carpio	Common carp		*Stizosteddion vitreum*	Walleye
Hybognathus regius	Eastern silvery minnow		**Poeciliidae**	**Livebearers**
Hybopsis rubrifrons	Rosyface chub		*Gambusia holbrooki.*	Eastern mosquitofish

Fish species sampled in within the analysis area are denoted with. *

The robust redhorse is ranked as G1 (critically imperiled) by NatureServe (2014). This ranking indicates that the species is at a very high risk of extinction due to extreme rarity (often five or fewer populations), very steep population declines, or other factors. Robust redhorse is also listed as endangered by the American Fisheries Society (AFS; Jelks et. al. 2008) indicating the species is in danger of extinction throughout all or a significant portion of its range. AFS lists the snail bullhead, flat bullhead and Carolina darter as vulnerable (Jelks et. al. 2008). This indicates that the species may become endangered or threatened by relatively minor disturbances to their habitat(s), or that they deserve careful monitoring of their distribution and abundance in continental waters of the United States to determine their status. The Carolina darter is also ranked as G3 by NatureServe, indicating it is at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

The SC Comprehensive Wildlife Conservation Strategy (Kohlsaat et. al. 2005) includes the South Carolina's Priority Species List. These species warrant conservation concern to maintain diversity in South Carolina waters. The species are ranked in conservation priority as moderate, high and highest. The robust redhorse is ranked as highest priority. The quillback, Santee chub, seagreen darter, Piedmont darter and Carolina darter are ranked with a high priority. The greenfin shiner, thicklip chub, fieryblack shiner, highback chub, snail bullhead, white catfish, flat bullhead and striped bass are all ranked with a moderate priority.

Table 3.2.6-2. Crayfish species known to occur in the Broad River watershed (Eversole and Jones 2004).

Scientific Name	Common Name	Conservation Status			
		NatureServe	State	AFS	State Priority
Cambaridae					
Cambarus acuminatus	Acuminate crayfish	G4	S4	CS	
Cambarus howardi	Chattahoochee crayfish	G3		CS	
Cambarus latimanus	Variable crayfish	G5	S4?	CS	
Cambarus reduncus	Sickle crayfish	G4G5	S4	CS	
Cambarus reflexus	Pine savannah crayfish	G4	S3	CS	Highest
Cambarus spicatus	Broad River spiny crayfish	G2	S3	V	High
Cambarus striatus	Ambiguous crayfish	G5		CS	
Distocambarus carlsoni	Mimic crayfish	G2G3		T	Highest
Distocambarus crockeri	Piedmont praire burrowing crayfish	G3	S3	T	High
Distocambarus youngineri	Newberry burrowing crayfish	G1	S1	E	Highest
Fallicambarus fodiens	Digger crayfish	G5		CS	
Faxonella clypeata	Ditch fencing crayfish	G5	S2?	CS	Moderate
Procambarus acutus	White river crawfish	G5	S5	CS	
Procambarus chacei	Cedar Creek crayfish	G4	S4	CS	Moderate
Procambarus clarki	Red swamp crayfish	G5		CS	
Procambarus enoplosternum	Black mottled crayfish	G4G5		CS	Moderate
Procambarus troglodytes	Eastern red swamp crayfish	G5	S4S5	CS	

The Newberry burrowing crayfish is ranked as G1. The Newberry burrowing crayfish is also ranked as S1 by the SC Natural Heritage Program. The Broad River spiny crayfish is ranked as G2 (imperiled) and the mimic crayfish is ranked G2G3. The G2 ranking indicates that the species is at high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines or other factors. The ditch fencing crayfish is ranked as S2?. The Chattahoochee crayfish and the Piedmont prairie burrowing crayfish are ranked as G3 (vulnerable). The G3 ranking indicates that the species is at moderate risk of extinction due to very restricted range, very few populations (often 80 or fewer), recent and widespread declines or other factors. The Broad River spiny crayfish and Piedmont prairie burrowing crayfish are rated as S3 by the SC Natural Heritage Program. American Fisheries Society status ranks (Taylor et al 2007) include CS (currently stable), V (vulnerable), T (threatened), E (endangered) and E* (endangered, possibly extinct). The V rank indicates that the species mat become endangered or threatened by relatively minor disturbances to its habitat and deserves careful monitoring of its abundance and distribution. The T rank indicates that a species is likely to become endangered throughout all or a significant portion of its range. The E rank indicates a species is in danger of extinction throughout all or a significant portion of its range.

The SC Comprehensive Wildlife Conservation Strategy ranks the mimic crayfish, pine savannah crayfish, and Newberry burrowing crayfish as highest priority. The Broad River spiny crayfish and Piedmont prairie burrowing crayfish are rated as high priority. The ditch fencing crayfish, Cedar Creek crayfish and black mottled crayfish are all rated as moderate priority.

Table 3.2.6-3. Mollusk species known to occur in the Broad River watershed (Alderman 1990, 1998, 2005, 2009).

Scientific Name	Common Name	Conservation Status			
		NatureServe	State	AFS	State Priority
Corbiculidae					
*Corbicula fluminea**+	Asiatic clam				
Physidae					
Physa sp.	A freshwater snail				
Planorbidae					
Helisoma anceps	Two-ridge rams-horn	G5			
Pleuroceridae					
*Elimia catenaria**+	Gravel elimia	G4			
Unionidae					
Alasmidonta varicosa	Brook floater	G3	S?		Highest
*Elliptio complanata**+	Eastern elliptio	G5		CS	Moderate
Elliptio icterina	Variable spike				Moderate
Elliptio producta	Atlantic spike	G3		SC	Moderate
*Elliptio angustata**+	Carolina lance	G4		SC	Moderate
Lampsilis cariosa	Yellow lampmussel	G3G4		T	Highest
Lasmigona decorata	Carolina heelsplitter	G1	S1	E	Highest
Pyganodon cataracta	Eastern floater	G5		CS	
Strophitus undulatus	Creeper	G5		CS	Highest
Utterbackia imbecillis	Paper pondshell	G5		CS	
*Villosa delumbis**+	Eastern creekshell	G4		CS	Moderate
Villosa vibex	Southern rainbow	G5		CS	Highest
Viviparidae					
Campeloma decisum+	Pointed campeloma	G5			

Species found in area * and district +.

The project area's aquatic community includes one federally listed endangered species, the Carolina heelsplitter (a mussel) and one forest sensitive mussel species, the brook floater. They have heritage ranks of G1 and G3, respectively. Carolina heelsplitter and brook floater are known to occur in the Lower Long Cane Creek watershed. The Atlantic spike is also ranked as G3. The majority of mollusk species are unranked by the SC Natural Heritage Program. A non-native clam species, Asiatic clam, has widespread occurrence. American Fisheries Society status ranks are from Williams, et. al. 1992 and include CS (currently stable), U (undetermined), SC (special concern), T (threatened) and E (endangered).

The brook floater, Carolina heelsplitter, creeper, yellow lampmussel and Southern rainbow are ranked as highest priority by the SC Comprehensive Wildlife Conservation Strategy. The Eastern elliptio, Carolina lance, Atlantic spike, Eastern creekshell and variable spike are ranked as moderate priority.

Aquatic insect surveys have not been conducted in recent years.

Direct and Indirect Effects of Alternative 1

There would be no direct or indirect impacts to aquatic communities under this alternative. The aquatic community would remain in its present state and any current population trends would continue.

Cumulative Effects of Alternative 1

There would be no cumulative impacts to aquatic communities from the no action alternative.

Direct and Indirect Effects of Alternative 2

Alternative 2 proposes first thinning on (2,092 acres), intermediate thinning (4,264 Acres), shelterwood (256 acres), regeneration clearcut with reserves (2,083 acres), and shortleaf pine restoration (62 Acres). In addition, a combination of chemical and mechanical treatments would occur on the regeneration area following harvest and once the stand is stocked to releases desired trees.

Stands proposed to be treated are predominately in upland areas. There is no management proposed within riparian corridors. Connected actions include temporary road reconstruction and maintenance, skid road construction, log landing construction, mechanical and chemical site preparation and erosion control.

Timber Harvest and Connected Actions

Soil and vegetation disturbance occurring near streams from tree removal, log landings, road reconstruction and maintenance, skid roads/trails and site preparation could result in the addition of sediments to project area streams. Sedimentation can cause direct mortality to macroinvertebrate and fish life stages through burial and suffocation of eggs and larvae. Turbidity can cause gill damage which interferes with respiration, abrasion, changes in feeding behavior, and macroinvertebrate drift resulting in a shift in community dynamics. Indirectly, sediment can fill in and destroy habitat niches within a stream impacting reproductive success, refugia and food sources. Sediment deposition can result in a reduction of fish and macroinvertebrate density and biomass in a stream. There would be no removal of trees or site preparation activities within any riparian corridors or along the edges of gullies. Therefore, there should be no sediment impacts from tree removal. There would be no skid road/trail construction or crossings associated with riparian corridors. There is < one mile of temporary road proposed for this project. There would be no log landing or loading locations within any riparian areas. Skid roads and log landings would be revegetated immediately following harvest activities in individual units. Check dams would be installed as erosion control in ephemeral stream channels to slow the increased water flow from harvested areas where needed to reduce soil erosion and sedimentation into downstream intermittent and perennial stream reaches. Check dams would not be used in intermittent or perennial streams.

Forest standards from the Revised Land and Resource Management Plan, Sumter National Forest, 2004 (Forest Plan) and South Carolina Best Management Practices for Forestry (BMP) would be applied to all activities associated with this project. As a minimum, channeled ephemeral stream zones would extend 25 feet either side of channeled ephemeral streams. Minimum widths for perennial streams, ponds and wetlands are associated with slope class. At 0-30% slope, the minimum width is 100 feet; at 31-45%, 125 feet; and at 46+%, 150 feet. For intermittent streams the minimum widths associated with these slope classes are 50 feet, 75 feet and 100 feet respectively. The distance on Strom Thurmond Lake would be 200 feet. These lands

are unsuitable for timber production (FS 11.-24). Channeled ephemeral stream zones and riparian corridors are managed for large woody debris recruitment. Removal of large woody debris is determined on a case-by-case basis and should include interdisciplinary input. Logging slash should not be placed in streams (FW-13; FS 11.-2). For cable logging, at least partial suspension is required when yarding logs over ephemeral streams (FW-7).

Road Work

There would be 1.63 miles of road construction with the project. System road maintenance (43.4 miles) and temporary road (< one mile) would produce a sediment source through grading and ditching. Road decommissioning and relocation would occur on about four miles. Decommissioning would help reduce sediment and natural surface and groundwater flow. These activities would be accomplished in a manner that would prevent sediment runoff into area waters. Erosion control devices would be installed during road maintenance activities where needed to deter soil runoff from streams. Road ditch lines would not be routed toward stream crossings, but instead into vegetative buffers. Drainage from existing roadside ditches would be directed away from streams prior to filling or excavation activities.

There would be some replacement of rusting and failing culverts with road maintenance. If culverts are removed, stream banks and channels must be restored to natural size and shape and all disturbed soil must be removed and stabilized (FS 11.-23). New stream crossings would be evaluated and where necessary constructed so that they do not adversely impact the passage of aquatic organisms (FS 11.-8).

The removal and placement of stream culverts would produce sediment input to the stream. This activity may also impact individuals through direct mortality to those animals in the immediate area that cannot move quickly from the site during culvert replacement. Erosion control would be placed between the road and all waters prior to soil disturbance to prevent sediment loading. Excavated soils would not be placed next to the stream bank, but off-slope from the stream. Erosion control measures such as matting, silt fences, diversions and temporary rock sediment dams would be installed to trap sediment in areas where runoff water is leaving the project site. Erosion control devices would be maintained in working order throughout project activities and until plant growth is established and stable enough to control runoff and erosion. Riparian areas and stream crossings would be seeded and mulched as soil disturbance occurs. Stream culverts may be installed with aquatic organism passage crossings per (Riparian Corridor Standard 11.-8). These would consist primarily of bottomless arch culverts placed on the slope of the streambed. Culvert width would be equal to stream bank full width.

Streams and culvert replacement sites would be evaluated for the need of aquatic organism passage structures.

Rights-of-way acquisition

The acquisition and usage of 1.3 miles of rights- or-way would improve access to lands and reduce the use of poorly located roads.

Herbicide Use

Herbicide application would occur in clearcut units (2,145 acres) after harvest prior to planting and later for release of desired species. Shelterwood units (256 acres) would be treated with herbicide (chemical treatment) after final removal of loblolly overstory.

Imazapyr with water soluble dye and a d-limonene adjuvant would be used with hand application methods to target vegetation by speckling the leaf surfaces during the period of mid-June through September of the second or third growing season. This period is usually when rainfall is at the lowest during the year. Imazapyr and triclopyr would be used in hack - and - squirt application of targeted vegetation greater than six feet tall. There would be no broadcast application of herbicides. No herbicides would be applied in riparian corridors.

Imazapyr – Sunlight rapidly degrades imazapyr in aquatic systems with a half-life of three to five days in surface water. It is slowly degraded by soil microorganisms and can be relatively persistent in soils with a half-life of one to seven months. Imazapyr does not bind strongly to soils and can be highly available in the environment. Heavy rainfall can cause significant movement of the herbicide with soil particles and leaching up to 50 cm deep in soils. Imazapyr is of low toxicity to fish and aquatic invertebrates. The LC50s for channel catfish, bluegill sunfish, rainbow trout and Daphnia magna are all >100 mg/l. An imazapyr formulation, Habitat, is registered for use in aquatic environments (Tu et al 2001). The Environmental Protection Agency (EPA) determined that there is no risk to non-vascular aquatic plants, but there are ecological risks of concern with the use of imazapyr for non-target aquatic vascular plants. Toxicity studies indicate that imazapyr is highly toxic and expected to exert detrimental effects to aquatic vascular plants through runoff and drift. Indirect impacts to aquatic animal life can result from the loss of habitat, feeding or cover requirements. Imazapyr is not expected to bioaccumulate in aquatic organisms (EPA 2006).

Triclopyr – There are two formulations of triclopyr; a triethamine salt and a butoxyethyl ester. In soils, both degrade to the parent compound, triclopyr acid. The average half-life of triclopyr acid in soil is 30 days. Offsite movement through surface or subsurface runoff is possible, as it is relatively persistent and has only moderate rates of soil particle absorption. In water, the salt formulation is soluble and may degrade in several hours with adequate sunlight. The ester form is not water soluble and can take significantly longer to degrade in water. It can bind with organic material in the water column and be transported and deposited as sediments. Triclopyr acid and the salt formulation are slightly toxic to fish and aquatic invertebrates. The LC50 for rainbow trout of the acid and the salt formulation is 117 mg/l and 552 mg/l respectively. For bluegill, the LC50 is 148 mg/l and 891 mg/l respectively. The ester formulation is highly toxic to fish and aquatic invertebrates with an LC50 of 0.74 mg/l for rainbow trout and 0.87 mg/l for bluegill sunfish. The ester formulation is readily absorbed through fish tissues and rapidly converted to triclopyr acid. The acid can be accumulated to a toxic level when fish are exposed to sufficient concentrations or for sufficient durations. There is a significant chance of acute lethal effects to fish exposed to low levels residues for more than six hours and delayed lethal effects have been seen in fish exposed to high concentrations for a short duration. If applied properly, triclopyr would not be found in concentrations adequate to kill aquatic organisms. However, some water bodies remain at risk of lethal contamination levels, especially those that

are shallow and have slow velocity where dissipation is slow and those that are heavily shaded where photodegradation is reduced (Tu et al 2001).

Aminopyralid- Results of the Aminopyralid risk assessment analysis conclude that sensitive fish species exposed to the proposed concentrations have an extremely low potential to receive doses that are above the toxicity index. The US EPA Pesticide Fact Sheet for Aminopyralid states that it has been shown to be practically non-toxic to fish and is not expected to bio-accumulate in fish tissue (http://www.epa.gov/opprd001/factsheets/aminopyralid.htm). This same fact sheet gives a 96-hour LC50dosage of 100 mg/L for rainbow trout and a NOEC of 1.3mg/L for young fathead minnows. while the highest concentration estimated from the proposed application rate is only 0.15 mg/L. = lethal concentration of 50%), or the concentration that does not produce effects (NOEC = no observable effect).

Glyphosate- Glyphosate is strongly absorbed to soil particles, which limits its movement into aquatic environments. It is unlikely to enter waters through surface or subsurface runoff, except when the soil itself is washed away by runoff. Most glyphosate found in waters likely results from runoff from vegetation surfaces, spray drift and direct overspray. In water, glyphosate is rapidly dissipated through absorption to suspended and bottom sediments where it persists until degraded by microbes with a half life of 12 days to 10 weeks. Technical glyphosate acid is practically nontoxic to fish and slightly toxic to aquatic invertebrates. The 96 hour LC50 is 120 mg/l in bluegill sunfish and 86 mg/l in rainbow trout. LC50 is defined as the concentration of a chemical, which kills 50% of a sample population in laboratory testing in a specified amount of time. The 48 hour LC50 in Daphnia (important food source for freshwater fish) is 780 mg/l. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms (http://extoxnet.orst.edu).

Adjuvants – An adjuvant is any compound (including surfactants) that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. There is little information on the effects of adjuvants to aquatic systems. Some adjuvants have the potential to be mobile and pollute surface or groundwater sources. The use of adjuvants near water may have adverse effects in some aquatic species (Tu et al 2001). It is recommended to use an adjuvant with the active ingredient of d-limonene, a byproduct of the citrus industry, for the herbicide applications. The formulated product is practically nontoxic to freshwater fish and slightly toxic to freshwater invertebrates on an acute basis (EPA 1994).

Forest Plan Standards and BMPs would be applied to all activities associated with this project. For all herbicide applications, the following forest wide standards apply. Application equipment, empty herbicide containers, clothes worn during treatment and skin are not cleaned in open water or wells. Mixing and cleaning water must come from a public water supply and be transported to the site (FW-47). Herbicide mixing, loading, or cleaning areas are not located within 200 feet of private land, open water or wells or other sensitive areas (FW-48). Weather is monitored and the project is suspended if temperature, humidity or wind becomes unfavorable as described (FW-42). Herbicides and application methods are chosen to minimize risk to human and wildlife health and the environment (FW-40). Minimum widths for perennial streams, lakes, ponds and wetlands are associated with slope class. At 0-30% slope, the minimum width is 100 feet; at 31-45%, 125 feet; and at 46+%, 150 feet. For intermittent streams the minimum widths associated

with these slope classes are 50 feet, 75 feet and 100 feet respectively. Soil active herbicides are not broadcast within channeled ephemeral stream zones. Stream zones are identified before treatment, so applicators can easily avoid them (FW-15). Pesticide mixing, loading, or cleaning areas are not located within the channeled ephemeral stream zone (FW-16). As a minimum, channeled ephemeral stream zones would extend 25 feet either side of channeled ephemeral streams. BMPs state to avoid applying pesticides if surface water is present in ephemeral streams.

Determination of Effect

There are no federally listed or forest sensitive aquatic species within the project area. This project may have direct impacts on individuals of the aquatic community through culvert replacement, but is not likely to impact community diversity. This project may have indirect impacts on the aquatic habitat from sediment input through road maintenance and reconstruction but is not likely to impact aquatic community diversity. The implementation of Forest Plan Standards associated with riparian areas and streams, site-specific design criteria and SC Best Management Practices would minimize impacts to the aquatic community.

Cumulative Effects of Alternative 2

Under the 2004 Plan Revision for the Sumter National Forest, a Watershed Condition Rank (WCR) was assigned to 5th level watersheds across the Forest. The Sandy River and Cannons Creek watershed received a rank of “Average”, which denotes that the potential to adversely affect aquatic resources as moderate and the Browns Creek watershed ranked “Below Average” the potential to adversely affect aquatic resources is high on a scale of low, moderate and high. Forest objectives in moderate ranked watersheds include maintaining and improving aquatic health through the implementation of the Riparian Corridor management prescription (11), conducting watershed assessments at the project level, and pre-project monitoring efforts to determine biota health. Sediment was determined to be a risk factor for aquatic species viability in this watershed.

Other activities across the project area include prescribed burning, wildlife opening maintenance, road reconstruction, non-native invasive species treatment, and various recreational activities. Each of these projects has been or will be analyzed for impacts to aquatic resources and mitigation measures implemented where needed. In addition to Forest activities, private land activities occur across the landscape within the Forest boundary. Currently ditching is extending directly to the stream channel causing increased sedimentation and turbidity.

Direct and indirect impacts to the aquatic community would be minimum and short term and are not likely to impact community diversity. There should be no cumulative impacts to the aquatic community from Lower Broad Analysis Area project activities with the implementation of Forest Plan Standards and Guidelines associated with riparian areas and streams and SC Best Management Practices.

Direct and Indirect Effects of Alternative 3

Alternative 3 would have effects similar to alternative 2 with the following changes: 474 acres less of intermediate thinning and 20 acres less of shortleaf restoration due to lack of road access. Stands would be proposed regenerated by clearcut would be converted using the seedtree method in the current alternative. There would be an additional reduction of 110 acres due to limited road access to seedtree stands. Road construction would decrease by 2.93 miles and road maintenance by ~0.4 miles.

Cumulative Effects of Alternative 3

Alternative 3 would have the same effects as alternative 2.

3.3 Social Environment

3.3.1 Recreation and Visual Resources

Affected Environment

Visitors come to the Sumter National Forest to participate in a wide variety of recreation opportunities in an outdoor setting. Since visitor perception of an outdoor setting is often greatly affected by changes in the visual quality of an area, these two resource areas are discussed together in this section.

Visual character in the piedmont on the Sumter National Forest is characteristic of a rural area, consisting of forested and agricultural landscapes. Forested areas are often in various stages of regeneration as a result of harvesting activities on both private and national forest system lands, while a patchwork of small rural farms often provide added visual contrast. Small, rural communities or residence groupings are periodically found throughout the area.

The Lower Broad Analysis Area, LBAA, is located in Management Area 4. The landscape character under these prescriptions is generally natural appearing. The sights and sounds of human activities are evident in many areas (USFS, 2004).

The Recreational Opportunity Spectrum (ROS) is used to classify types of recreation experiences available, or for specifying recreation experience objectives desired in certain areas. The ROS classes are: Primitive, Semi-Primitive Non-Motorized, Semi-Primitive Motorized, Roaded Natural, Rural and Urban. Roaded Natural ROS is characterized by predominantly natural-appearing environments with moderate evidences of the sights and sounds of man. Resource modification and utilization practices are evident, but harmonize with the environment. Rural ROS is characterized by a substantially modified natural environment. Resource modification and utilization practices are to enhance specific recreation activity and to maintain vegetative cover and soil, but harmonize with the natural environment. (USFS, 2004) The majority of the project area is listed with an ROS class of Rural. Less than 1 acre in the project area is identified with a Roaded Natural ROS.

Scenic Integrity Objectives (SIO) is established for each management prescription area in the Sumter NF (USDA, 2004). SIO is a desired level of excellence based on physical and sociological characteristics of an area and refers to the degree of acceptable alterations of the characteristic landscape (USFS, 2004). SIOs meet or exceed the ROS management direction. The management prescription areas within the project area have SIO's that include: High, Moderate and Low.

> *High:* Human activities are not visually evident to the casual observer. Activities may only repeat attributes of form, line, color, and texture found in the existing landscape character.
>
> *Moderate:* Landscapes appear slightly altered. Noticeable human created deviations must remain visually subordinate to the landscape character being viewed.
>
> *Low:* Landscapes appear moderately altered, human created deviations begin to dominate the valued landscape character being viewed but borrow valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed.

The project area fall within the following prescription areas;

- **7. E.1. Dispersed Recreation Areas (Piedmont Only)**
  - Unique to the piedmont, the desired condition is "Visitors may choose from a variety of high quality, well maintained dispersed recreational opportunities including, but not limited, to day hiking, mountain biking, horseback riding, photography, canoeing, kayaking, boating, fishing, hunting, waterfowl hunting, dispersed camping, and nature study. These areas include the foreground view shed of the Enoree, Tyger and Broad Rivers which are approximately ¼ mile from each side of the Enoree, Tyger, and Broad Rivers." "The landscape character is natural appearing with visitors enjoying a pleasing mosaic of tree species of various densities and stem forms, flowering trees, character trees and shrub species, park-like effects in the understory, fall color species, opportunities for photography, and minimal impacts from insect and disease outbreaks."
- **9. A.3. Watershed Restoration**
  - Desired condition "Areas with active erosion are restored with soil and water rehabilitation work to improve soil and productivity and water quality". People use these areas for hunting or other dispersed recreational activities. Recreational opportunities in this area include, but are not limited to driving for pleasure, day hiking, dispersed camping, backpacking, hunting, fishing, nature study, mountain biking, viewing and photographing scenery."
- **10.B. High Quality Forest Products (Piedmont Only)**
  - Emphasis applied to land capable of producing high quality, valuable sawtimber. The desired condition is to grow and sell saw log size timber (pine and hardwood) in a sustained manner on upland sites." "These areas are very accessible and provide a variety of recreational opportunities, foremost of which is hunting".

There are two developed recreation sites within the project area.

- Rocky Branch Seasonal Camp is located in compartment 112, stand. It is open for big game deer and turkey seasons; middle of September through January 4th, and for the month of April. It offers 10 primitive campsites and one vault toilet. The hand pump is no longer operational.
- Sandy River Boat Ramp is located in compartment 55, stand. The boat ramp is not within the proposed project of work, but road 406A, leading to the boat ramp, are within the proposed project; stands 2, 5, 11 and 12. The Boat Ramp has a concrete ramp and primitive grassy area for parking. Sandy River Boat Ramp provides access to the Broad River and is located approximately 50 yards upstream from the Broad River.

The project area is very popular for dispersed recreation use which includes:

- Hunting opportunities for varied game, including deer, wild turkey, rabbit, quail and woodcock.
- Broad River Canoe Trail. A large stretch of the Broad River Canoe Trail falls within the project area. Boating, fishing, duck hunting and wildlife viewing are very popular activities along the river. The Broad River was found to be "not eligible" for inclusion into the National Wild Scenic Rivers System based on a 1995 Forest Service study.
- Primitive camping opportunities are available for floaters wanting an overnight float trip down the river. Requests for primitive camping, visitor use permits are popular and are available for Forest Service lands only. There have been numerous requests for designated primitive camping sites along the river which can be accessed by road and vehicles, by non-boaters, but none have been designated or approved yet.
- Henderson Island. Is very popular for primitive camping and hunting activities.

Other site within or adjacent to the project area:

- Herbert Seasonal Campground is permanently closed at this time.
- Keitts Bridge, Broad River Access point on SR45.
- Strothers Boat Landing on SR34.

Table 3.3.1.1 Alternative 2 - Scenic Integrity Objective by Timber Management Activity

Alternative 2 SIO

Sum of SIO Acres	**Column Labels**				
Row Labels	**H - High**	**L - Low**	**M - Moderate**	**No data**	**Grand Total**
Clearcut with Reserves		1607.9	472.8	2.6	2083.3
First Thin	74.5	1632.2	383.0	2.0	2091.7
Intermediate Thin	91.7	2413.4	1755.7	3.0	4263.7
Shelterwood	71.2		137.2		208.5
Shortleaf Pine Restore	1.0	26.6	32.7	2.0	62.3
Grand Total	**238.5**	**5680.1**	**2781.4**	**9.5**	**8709.5**

Table 3.3.1.2 Alternative 3 - Scenic Integrity Objective by Management Activity

Alternative 3 SIO

Sum of SIO Acres	Column Labels				
Row Labels	**H - High**	**L - Low**	**M - Moderate**	**No data**	**Grand Total**
First Thin	74.5	1632.2	383.0	2.0	2091.7
Intermediate Thin	91.7	2031.1	1664.0	2.7	3789.6
Seedtree with Reserves		1497.5	472.8	2.6	1972.9
Shelterwood	71.2		137.2		208.5
Shortleaf Pine Restore		26.6	13.3	2.0	41.9
Grand Total	**237.5**	**5187.4**	**2670.3**	**9.3**	**8104.5**

*The GIS Scenic Integrity Objectives data layer used for this analysis contains minor mapping line errors which do not impact the analysis that was completed or the design criteria that were developed.

Direct and Indirect Effects of Alternative 1

No immediate impacts on visual resources are anticipated under the No Action alternative. The area would appear in character with closed-canopy forested conditions. While there would be no direct effects on recreation as a result of Alternative 1, minor indirect effects could occur to dispersed recreation within and adjacent to the project area over the long-term. Over time, forested areas within the project area would likely see a decrease in diversity of plants and wildlife, which may lead to a long-term, minor, localized, adverse impact on dispersed recreation from an associated decrease in opportunities for hunting, fishing and plant and wildlife viewing.

Longer term, adverse effects from southern pine beetle, SPB, would be more likely.

Tree mortality caused by the SPB could have adverse visual impacts due to high levels of down wood and snags or a general appearance of lack of care for the forest. Early pioneering hardwood species response to open forest conditions would bring about the development of predominantly non-mast producing species such as sweet gum, yellow poplar and red maple. Over time this could increase the scenic integrity of the area by providing a much broader array of fall color. An increase in fall color could bring about more forest visitors and increase in foot traffic.

Cumulative Impacts of Alternative 1

There would be no cumulative impacts from other forest management activities such as; first and intermediate thinning, site preparation following regeneration and shelterwood harvests that would include the use herbicide and mechanical preparation work on both federal and private lands. Cumulative impacts from prescribed burning would include heavy fuel loading from SPB killed trees, smoke management and air quality issues along with the possibility of no burning due to the aforementioned impacts. The lack of road reconditioning and reconstruction work would have no noticeable short term impacts on forest visitors, as road maintenance would occur on an annual basis and would continue to provide access into the general forest area and recreation opportunities.

Direct and Indirect Effects of Alternative 2

Commercial Thinning

Temporary impacts on recreation and visuals would occur as a result of timber harvest operations. Disturbance to recreation visitors may occur due to increased truck and logging equipment traffic, or by operations at the site that are either visible or audible from a designated recreation area. Some forest areas would be closed for hunting during logging operations. All impacts (e.g., noise, dust, vehicle emissions, closed access, presence of workers and equipment, etc.) from timber harvest operations would be short-term, and would only affect a very small proportion of forest users. Hunters could use other areas of the national forest for hunting during harvesting operations.

Commercial thinning would have temporary short term impacts on the visual character of the landscape during thinning operations. The implementation of design criteria would limit impacts to the SIO and developed recreation sites in the project area. Rocky Branch Seasonal Campground, Forest Service Road 412, Forest Service Road 406A leading to the Sandy River Boat Ramp have SIO of moderate and the SIO level will continue to be met. The Broad River Canoe Trail has an SIO of high and thinning operations would improve the SIO in the project area. With more sun light in the thinned stands, there would be an increase in compositional variety by an arrangement of vegetation of different sizes, shapes, species mixtures and colors. Overall, variation in the vegetative textures, sizes and types may be considered to have the benefit of providing increased visual variety in the landscape. Hardwood inclusions would be more visible during the fall, and would provide for greater fall seasonal color variety in the forest landscape. In the long term, thinning stands would improve visual quality and may also increase the diversity of some species in the area and increase hunting opportunities. However, impacts to the observer would vary, and some observers may not like the look of the area “opened up” (i.e. reduced tree density, visible skid trails and log landings).

There is some potential the thinning and harvest activities would open up areas that could be used illegally by OHV riders. Illegal use of Forest Service roads, skid trails and log landings would be handled by law enforcement.

Regeneration Clearcut with Reserves (including Shortleaf Pine Restoration)

Regeneration harvests would alter the local visual character of the area. Following the initial cut and site preparation treatments, the site would essentially be an open area with several large standing mature trees. The remaining mature trees would help add variety during the early stage in the stand’s development and provide some screening to reduce the impacts of the initial cut. Within its immediate vicinity, regeneration sites with reserves would visibly become an area where vegetation diversity is high, and size contrasts of vegetation are evident, this adds diversity to the stand. However, impacts to the observer would vary, and some observers may consider the visual quality of the site to be degraded until the stand develops further.

Shelterwood with Reserves

Shelterwood with reserves would have the same temporary and long term effects as regeneration with reserves. Recreation visitors may avoid recently-cut areas where shelterwood regeneration

methods have been used in the general forest area. Hiking is often slow-going and difficult in these areas; however, additional benefits for observing wildflowers, wildlife and better hunting may be expected. In general, these sites would likely be reduced in use for scenic viewing, but would be increased in use for hunting and wildlife viewing opportunities.

The foreground view shed of the Broad River is approximately ¼ mile on each side of the river. The distance varies and is determined by local terrain for how far one can see into a stand. The shelterwood regeneration sites identified along the Broad River would not infringe on the foreground view shed of the river. The SIOs would continue to be met along the Broad River corridor.

Site Preparation

Site preparation for regeneration with reserves and shelterwood with reserves after initial harvest would help reduce competition and open areas up and increase hunting opportunities. The use of herbicides (both for site preparation and later for release of crop trees in regeneration units) would have a temporary short term effect on visuals, but long term would help keep the stands opened up and improve visibility into the stands. Herbicide applications may cause browning and shriveling of treated vegetation but due to their short-term effects, would still meet the SIOs for the areas. Signs would be posted to notify forest users of herbicide use in the area.

Mechanical site preparation methods would expose soil and mechanically/manually cut and chopped vegetation would be visually displeasing for the first year after treatment. The visual impacts would become less as decomposition occurs and new vegetation re-sprouts. Vegetation response in the Piedmont region is rapid and would not be visible by the second year.

Road Work (including road decommissioning and road relocation)

Roads are currently part of the visual character of the landscape, and any visual impacts as a result of temporary road construction are generally temporary, slowly decreasing with the rehabilitation and growth of vegetation within the temporary road right-of-way. However, at the same time, these areas may also increase the recreation value for those national forest visitors (hunters) seeking easier access to interior forest areas. Noise, dust and vehicle emissions produced during the construction and closure phase of the temporary roads may disrupt recreation visitors. Road reconditioning and reconstruction activities improve access into the forest, so visitors can enjoy it for activities, such as picnicking, hiking, fishing, or hunting. However, these operations would be transient and would not result in a significant impact on the level of recreation use of the area.

Pre-commercial Thinning

Reducing tree stocking would have similar visual impacts as those described for site preparation. Precommercial thinning would result in brown trees and make it difficult walking through recently treated areas. The areas would look displeasing in the short term. Trees would rapidly decompose and adverse effects would last only a few years. Only a portion of the area would be thinned and cut units would not be continuous. Portions of the project area would not be treated

at all and would be used by hunters and other forest visitors during the period that stands recover from treatments. In the long term, residual trees would grow faster and provide additional visual variety to the landscape as well as more hunting opportunities in the area.

Cumulative Effects of Alternative 2

Other activities in the project area include timber harvest on federal and private lands, prescribed burning, road maintenance, agriculture and grazing (private lands). Minor, localized, adverse impacts on dispersed recreation within and around the treatment areas may result in the short term. Long term, the recreational hunting and other dispersed activities would be improved. Therefore, impacts on recreation resulting from Alternative 2 would be minor.

Given the landscape pattern characteristics of the Piedmont area (the variety of land management activities taking place), significant cumulative impacts to visual quality and recreation are not expected.

Cumulative impacts on the visual quality of the LBAA may occur as a result of private logging activities within the watershed. These impacts would have the greatest potential to occur in areas where Federal land ownership is least continuous and adjacent to privately owned short rotation timber plots. The LBAA is made up of large privately owned plots of land interspersed with Federal land ownership.

Direct, Indirect and Cumulative Effects of Alternatives 3

Seedtree Regeneration – No Temporary Road Construction

Impacts associated with this alternative would be similar to those mentioned in Alternative 2. The change from a clear-cut with reserves to seed tree regeneration would have the same effect on recreational opportunities and the SIO would still be met utilizing either timber harvesting technique.

With no new temporary road construction as recommended in this alternative, any increase in hunting opportunities that they may have been created would be eliminated. There are plenty of other hunting opportunities in other areas within and out of the project area. The SIO would still be met within the project area.

The cumulative effects of Alternative 3 on recreational opportunities and the SIO are similar to those identified in Alternative 2.

Table 3.3.1.3 Compartment/Stands with Potential Effects to Recreation and Scenery

Compartment	Stand	Management Prescription	Effects
54	13	Shelterwood	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits.
54	15	First Thin	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits. Protect visual impacts to river corridor foreground view shed, 7.E.1 corridor from logging slash, skid trails and log landings. See Design Criteria.
55	2	Regeneration	Potential impacts from logging traffic to recreation users using Sandy River Boat Ramp. Visuals along FS road 406 and 406A. See Design Criteria.
55	5&11	Sawtimber Thin	Potential impacts from logging traffic to recreation users using Sandy River Boat Ramp. Visuals along FS road 406 and 406A. See Design Criteria
55	12	First Thin	Potential impacts from logging traffic to recreation users using Sandy River Boat Ramp. Visuals along FS road 406 and 406A. See Design Criteria
56	1	Shelterwood	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits.
57	11	Sawtimber Thin	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits. Protect visual impacts to river corridor foreground view shed, 7.E.1 corridor from logging slash, skid trails and log landings. See Design Criteria.
57	18	Shelterwood	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits.
57	26	First Thin	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits. Protect visual impacts to river corridor foreground view shed, 7.E.1 corridor from logging slash, skid trails and log landings. See Design Criteria.
58	7	Shelterwood	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits
58	8	Sawtimber Thin	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits. Protect visual impacts to river corridor foreground view shed, 7.E.1 corridor from logging slash, skid trails and log landings. See Design Criteria.
58	10	Shelterwood	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits.
58	11	Sawtimber Thin	Protect view shed of Broad River, approximately ¼ of mile, but will vary according to terrain and viewing limits. Protect visual impacts to river corridor foreground view shed, 7.E.1 corridor from logging slash, skid trails and log landings. See Design Criteria.
112	14	Sawtimber Thin	Potential impacts from logging traffic Rocky Branch Seasonal Camp. Follow Design Criteria.
112	3,4,6,7,8,10, 11,12,13,14, 16,18,32	Regeneration, First Thin and Sawtimber Thin	Potential impacts from logging traffic along FS Road 412 that Rocky Branch Seasonal Camp is located on and visual impacts. Follow Design Criteria.
113	3, 6, 7, 9, 10, 13, 14, 15, 16, 17	Regeneration, First Thin and Sawtimber Thin	Potential impacts from logging traffic along FS Road 412 that Rocky Branch Seasonal Camp is located on and visual impacts. Follow Design Criteria.

3.3.2 Cultural Resources

Affected Environment

Cultural resources include historic properties as defined in the National Historic Preservation Act (NHPA), cultural items as defined in the Native American Graves Protection and Repatriation Act (NAGPRA), archaeological resources as defined in the Archaeological Resources Protection Act (ARPA), sacred sites as defined in Executive Order 13007, *Protection and Accommodation of Access to "Indian Sacred Sites,"* to which access is provided under the American Indian Religious Freedom Act (AIRFA), and collections. As defined by the NHPA, a historic property or historic resource is any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP), including any artifacts, records, and remains that are related to and allocated in such properties. The term also includes properties of traditional religious and cultural importance (traditional cultural properties), which are eligible for inclusion in the NRHP as a result of their association with the cultural practices or beliefs of an Indian tribe or Native Hawaiian organization. Archaeological resources include any material of human life or activities that is at least 100 years old, and that is of archaeological interest.

Section 106 of the NHPA (PL 89-655) provides the framework for Federal review and consideration of cultural resources during Federal project planning and execution. The Advisory Council on Historic Preservation (ACHP) has promulgated the implementing regulations for the Section 106 process (36 CFR Part 800). The Secretary of the Interior maintains the NRHP and sets forth significance criteria (36 CFR Part 60) for inclusion in the register. Cultural resources may be considered "historic properties" for the purpose of consideration by a Federal undertaking if they meet NRHP criteria. The implementing regulations at 36 CFR 800.16(v) define an undertaking as "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; those requiring a Federal permit, license or approval; and those subject to state or local regulation administered pursuant to a delegation or approval by a Federal agency." Historic properties are those that are formally placed on the NRHP by the Secretary of the Interior, and those that meet the criteria and are determined eligible for inclusion.

A Memorandum of Understanding (MOU) has been signed between the Advisory Council on Historic Preservation, The South Carolina Department of Archives and History and the Francis Marion and Sumter National Forests (November 14, 2000). It was developed to comply with the terms of the Programmatic Agreement concerning the management of historic properties on national forest lands in the Southern Region, which was executed on November 19, 1992 and to satisfy the National Forest's responsibilities under Section 106 of the National Historic Preservation Act (NHPA). The MOU establishes Categorical Exclusions for routine and recurrent activities that are unlikely to affect heritage properties, including prescribed burns and new fireline construction.

Heritage surveys were conducted for the project area and two reports were prepared and sent to the South Carolina State Historic Preservation Office (SHPO) by the Forest Archaeologist.

Direct, Indirect and Cumulative Effects of Alternative 1

This alternative would have no effect on heritage resources.

Direct and Indirect Effects of Alternatives 2 and 3

This alternative would avoid impacts to known Class 1 and Class 2 heritage sites. Log landings, decks, log piles and temporary roads would not pass through or impact these sites. Monitoring by the sale administrator would protect these sites during timber harvest and other connected actions.

Concurrence letters were received on May 14, 2012 and August 16, 2012 from SHPO. SHPO concurred with the determination that "no properties eligible for listing in the National Register of Historic Places (Class 1) or unevaluated sites (Class 2) would be adversely affected by harvesting done within the Lower Broad Analysis Area if all operational restrictions (stipulations) outlined in letters from April 3 and July 11, 2012 are implemented for all Class 1 and Class 2 sites." All documents are contained in the project record.

Cumulative Effects of Alternatives 2 and 3

Avoidance of known sites combined with surveys of project areas and consultation with SHPO would avoid cumulative adverse impacts to heritage resources. Past pulpwood thinning sales and other site disturbing activities require heritage surveys prior to the start-up of activities. Activities categorically excluded under the MOU between the Forest Service and SHPO establishes activities including pre-commercial thinning, mechanized chipping and fireline construction and reconstruction as not needing surveys prior to the activity taking place.

3.3.3 Economics

Affected Environment

The economic analysis and project cost and revenue information are contained in the project file. Costs and revenues associated with restoration work are based on district and forest experience with similar activities.

The benefits of this project are stated in the Purpose and Need section and some of the benefits are intrinsic in nature. Economic values for these benefits have not been calculated. Revenue from timber provides funding to support other associated project work including but not limited to understory stand treatments (manual, mechanical, herbicide and prescribed burning treatments) and tree planting to provide more diverse habitat for wildlife and plants.

Costs for overhead, design and sale layout and project administration are similar between action alternatives and are not included. Costs incurred by the timber purchasers or other parties are also not included. The analysis is intended to be a relative comparison and disclosure of costs and benefits for the alternatives.

Direct, Indirect and Cumulative Effects of Alternative 1

No costs or revenues from the project would be realized under this alternative. Wood products would not be harvested and revenues would be foregone. Past, present and foreseeable future economic returns would be realized from other timber sales on the district and this alternative would have minimal effect on total economic return to the Sumter National Forest and counties. Intrinsic values of creating more diverse habitat for wildlife and plants and keeping stands thinned and healthy would not be realized under this alternative

Direct, Indirect and Cumulative Effects of the Action Alternatives

Two action alternatives were analyzed. Cost used in the economic analysis include timber hauling, system road reconstruction/reconditioning, temporary road construction, tree planting, manual and mechanical site preparation and herbicide treatments. Road construction, reconstruction maintenance and decommissioning are also included. Alternative 3 would not construct temporary or system roads for timber harvest and volume outputs would be reduce accordingly as well as benefits to be obtained.

Revenues are based on appraisals of fair market value for wood products and the expected volume to be cut. Benefits and costs for the alternatives are displayed in Table 3.3.3-1 and detailed transactions are contained in the project file.

Table 3.3.3-1. Economic Comparison of the Alternatives*

	Alternative 1	Alternative 2	Alternative 3
Present Value of Costs	0	$6,336,000	$5,757,000
Present Value of Benefits	0	$12,154,000	$11,353,000
Present Net Value	0	$5,818,000	$5,596,000
B/C Ratio	0	1.92	1.97

* rounded to nearest thousand dollars

The action alternatives produce nonmonetary benefits with the development of diverse habitat beneficial to wildlife and understory grasses, forbs and shrubs.

3.3.4 Environmental Justice and the Protection of Children

Affected Environment

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations, requires Federal agencies to identify and address any disproportionate adverse human health or environmental effects of its projects on minority or low-income populations. Each Federal agency must conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons or populations from participation in, denying persons or populations the benefits of, or subjecting persons or populations to discrimination under, such programs, policies, and activities because of their race, color, national origin, or income level.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, directs Federal agencies to "identify and assess environmental health risks and safety risks that may disproportionately affect children." This Executive Order requires Federal agencies to "ensure that [their] policies, programs, activities and standards address disproportionate risks to children."

An examination of environmental justice and effects of actions on environmental health risks and safety risks that may disproportionately affect children sets the stage for whether the action alternatives or the "No Action" alternative poses disproportionate environmental, health or safety risks to children, minorities or low-income populations or individuals requiring additional analysis be completed.

Table 3.3.4-1. Percentage of Minorities and Persons in Poverty in Fairfield, Newberry, Union and Chester Counties, South Carolina

Measures	Fairfield	Newberry	Union	Chester	South Carolina
Population, 2014 estimate	22,976	37,783	27,876	32,337	4,832,482
Black or African Americans, percent, 2013	58.8%	31.2%	31.7	37.0	27.9%
Other, percent, 2013	3.7%	10.5%	2.1	2.5	9.1%
Persons below poverty, percent, 2009-2013	22.7%	17.2%	18.7	21.6	18.1%

Sources: US Census Bureau, 2015

The project is located within the Enoree Ranger District which is contained within Fairfield, Newberry, Union and Chester Counties, South Carolina. Table 3.3.4-1 lists the population, percentage of minorities and persons in poverty within each of the counties comprising the project area, compared to the State of South Carolina as a whole.

Direct, Indirect and Cumulative Effects of Alternative 1

There would be no activities occurring under this alternative that would adversely affect minorities, persons below the poverty level or children. Therefore, no further environmental justice analysis from this alternative is necessary.

There are no past, present or reasonably foreseeable activities on federal and private lands that would overlap with this alternative to result in cumulative disproportionate adverse effects to minorities, persons below the poverty level or children.

Direct, Indirect and Cumulative Effects of Alternative 2

The proposed activities occur in counties that have a higher percentage of minorities and people below the poverty level than the state as a whole.

Noise generated during project activities may disturb adjacent residents or Forest users, although these impacts would be localized and temporary. The potential impacts resulting from Alternative 2 are not expected to adversely affect local communities adjacent to the project area regardless of race or income. Forestry and agricultural activities are common activities throughout the counties and are associated with much of the population's source of income and

rural farming/agricultural lifestyle. All members of the public would be restricted from work areas to maintain safety.

The activities proposed would not occur solely in areas where minority and low-income residents live as projects would occur entirely on federal lands. The activities conducted are dispersed geographically and over time affecting only portions of national forest system lands at one time. There are usually long time periods between timber entry cycles of about 15 years. Activities are ephemeral in nature and would not alter land use activities in the project area. Therefore, impacts to minorities and people in poverty would not be disproportionately affected by project work. Similarly, children would not be disproportionately affected. Therefore, further environmental justice analysis is not required.

There are no past, present or reasonably foreseeable activities on federal and private lands that would overlap with this alternative to result in cumulative disproportionate adverse effects to minorities, persons below the poverty level or children.

Direct, Indirect and Cumulative Effects of Alternative 3

Direct, indirect and cumulative effects of alternative 3 on minorities, persons below the poverty level or children would be the same as the proposed action.

3.3.5 Human Health and Safety

Affected Environment

The Forest Service Handbook (FSH), Forest Service Manual (FSM), and the *Revised Land and Resource Management Plan, Sumter National Forest* (Forest Plan) all provide guidance and establish required measures to protect human health and safety during forest management activities. The Sumter National Forest also has a spill response program in place to contain and remove contaminants, such as herbicides.

Direct, Indirect and Cumulative Effects of Alternative 1

This alternative would have no effect on human health and safety beyond current management actions in the area. Under the No Action alternative, no road improvements would occur, since none of the proposed vegetation management activities would occur.

Past, present and current activities in the area that have the potential to impact human health and safety include prescribed burning, road maintenance, approved timber harvesting and herbicide applications for non-native invasive plants. All of these activities will comply with Forest Plan direction to protect public health and safety and also include project-specific design criteria to reduce risks. Adverse cumulative effects to human health and safety are not expected from this alternative.

Direct and Indirect Effects of the Action Alternatives

Timber harvesting activities, temporary road construction, construction, reconstruction, maintenance and decommissioning of system roads and prescribed burning require the use of heavy equipment (such as dozers, skidders, log loaders, bush-hogs, tractors and trucks) and manual equipment (chain saws, brush axes, etc.). The use of mechanical and manual equipment and the movement of trees and logs present the highest potential for safety risks during harvest activities. There is a risk of injury to contract workers, Forest Service personnel and the public.

For all mechanical treatments in the project area, equipment operators must demonstrate proficiency with the equipment and be licensed to operate it. In addition, a helper must direct the operator where safety is compromised by terrain or limited sight distances (USDA, 1989b).

The private timber sale contractor conducting the harvest would be responsible for adhering to safety specifications during the entire harvest process.

These requirements include the:

- Installation of temporary traffic control devices on roads and trails open to public travel to warn users of hazardous or potentially hazardous conditions;
- Removal of logging slash from all trails open to the public;
- Development of a specific traffic control plan; and
- Installation of road closure devices, such as but not limited to barricades to control entry to the activity site (USDA, 2000a).

In accordance with Forest Service Health and Safety Code Handbook (FSH 6709.11), vegetation management activities require all Forest Service workers to wear safety equipment, including hard hats, eye and ear protection, chaps, and fire retardant clothes. Monitoring of compliance with the Forest safety code would be accomplished through on-site inspections and reviews of accident reports (USDA, 1989b). Any risks to workers or the public would be minor and temporary. Adherence to safety measures would minimize or eliminate adverse human health and safety effects

The herbicides proposed for use contain the active ingredients imazapyr, aminopyralid, and triclopyr. Limonene is the adjuvant to be used and a water soluble dye would be mixed in. The herbicides would be applied by direct foliar spray from backpack sprayer equipment or by spray bottle using the “hack and squirt method”. There would be no broadcast spraying of herbicides. A herbicide risk assessment has been completed and can be found in the project file.

Herbicide applications have the potential to adversely affect public and worker health and safety. Contractors applying herbicides have the potential to be inadvertently directly exposed to the herbicide as a result of drift or accidental contact during spraying. They can be indirectly exposed by contact with the herbicide residue on plant surfaces. They have the potential to be harmed as a result of an accidental spill of the herbicide during mixing, loading and spraying.

Only herbicides and additives registered by the United States Environmental Protection Agency (USEPA) and approved by the USFS are proposed for use, and only a certified pesticide applicator would train the crew and supervise the application (USDA, 1989b). By following label directions, the use of herbicides would not be expected to harm contractor workers, Forest Service employees and the public in the area. Drift is negligible from these application methods and wearing personal protective equipment[11] [required by Occupational Safety and Health Administration (OSHA)] minimizes exposure from sprayed plant material. Personal cleaning after use also reduces the risk of further contamination.

In accordance with FSH 7109.11, public exposure to herbicides would be minimized by the clear placement of notice signs at application sites, especially in areas of anticipated visitor use. Forest Plan standards would be followed relative to application of herbicide (see pages 2-13 through 2-14). The following standards apply to this EA: FW-34, 35,40, 41,43, 44, 46, 47 and 48.

Accidental spills of herbicides or additives may pose a risk to human health and safety. Trucks containing herbicide or tank mixed herbicide would not be allowed to park within 200 feet of a stream or pond. In the event of an accidental spill, the previously prepared spill plan (FSM 2109.12) would be implemented to contain and clean up the spill and notify the appropriate agencies and individuals (USDA, 1989b).

Monitoring and inspections during and after the project would be used to ensure that proper procedures were followed.

Road construction, reconstruction, maintenance and decommissioning would improve safety conditions for Forest personnel and users during project activities. While this would have a beneficial effect on human health and safety, this effect would not be significant.

Cumulative Effects of the Action Alternatives

Past, present, and future actions in and adjacent to the project area on federal and private lands include vegetation management, agriculture and grazing. All activities would comply with established standards in the Forest Plan to protect workers, Forest Service employees and the public. Herbicide use in the area is currently ongoing with already approved projects. All projects follow Forest Plan standards and risk assessments have been completed that involve the use of herbicide. Projects do not cumulatively add upon one another to result in adverse effects to human health and safety and are separated by area and different times.

Adherence to Forest Plan standards and project specific design criteria would avoid substantial adverse cumulative impacts to human health and safety from the action alternatives.

[11] Workers are required to wear a hard hat with plastic liner, waterproofed boots and gloves and other safety clothing. First aid equipment, including eyewash bottles and wash water separate from drinking water, are required to be on-site during application.

3.4 Irreversible and Irretrievable Commitment of Resources

Irreversible commitments of resources are those resources that have been destroyed, removed or deteriorated to the point that renewal can occur only over a long period of time or at a great expense. Examples of this include the loss of a species endemic to a certain site or mineral extraction. Irretrievable commitments represent resource opportunities that are foregone or cannot be realized during the planning period. These decisions are reversible, but the production opportunities foregone are irretrievable. Power line rights-of-way or a road that is kept clear of trees and other vegetation are examples of irretrievable commitments of resources.

There are no irreversible or irretrievable commitment of resources associated with the alternatives. Project work is consistent with direction established in the Forest Plan and effects detailed in the Forest Plan EIS.

Chapter 4 - Consultation and Interdisciplinary Team

Federal, State, local agencies were contacted during the development of this environmental assessment. In addition, individuals were contacted based on the District-wide mailing list. This list is located in the project file.

Interdisciplinary Team

Jeff Magniez	Sumter Zone Wildlife Biologist
Dick Rightmyer	Soil Scientist
Mike Harmon	District Archaeologist
John Richardson	District Silviculturist
Luis Mundo	Forest Engineer
John Hodges	Enoree Engineering Technician
Thomas Scott	Fisheries Biologist
Carrie Miller	Biological Technician
Alice Riddle	District Recreation Planner

Other Agencies Consulted

South Carolina History and Archives, State Historic Preservation Office
United States Fish and Wildlife Service

Public Agency Responses/Contacts

South Carolina Archives and History Center, State Historic Preservation Office
United States Fish and Wildlife Service
Dick Artley

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Appendices

Appendix A - Project Maps

Appendix B – Treatment Compartments and Stands

Appendix C – Biological Assessment/Biological Evaluation