United States Department of Agriculture
Forest Service

Early Successional Habitat Creation Project

Environmental Assessment

Manchester Ranger District, Green Mountain National Forest
Bennington, Rutland, Windham and Windsor Counties, Vermont

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Cover page photo credits
Left: Bird species likely to benefit from the Early Successional Habitat Creation Project. From top to bottom: blue-winged warbler, indigo bunting, black-and-white warbler. Photos courtesy of Brett Hillman, USDA Forest Service

Right: Early successional habitat. Photo courtesy of USDA Forest Service staff

Contents

Chapter 1. Need for the Proposal

The United States Department of Agriculture - Forest Service is proposing the Early Successional Habitat Creation (ESHC) Project located on National Forest System lands on the Green Mountain National Forest, Manchester Ranger District. The project area falls within multiple towns and counties in southern Vermont (see Figure 1).

The ESHC Project is guided by management direction in the 2006 Green Mountain National Forest Land and Resource Management Plan, or Forest Plan (USDA Forest Service 2006a). The project proposal has been designed to move the existing condition of National Forest System lands within the project area toward specific Forest Plan goals and objectives and Management Area desired future conditions. The Forest Plan describes the major emphasis and desired future conditions for the following Management Areas where project activities are proposed:

- Diverse Forest Use
- Diverse Backcountry
- Remote Wildlife Habitat
- Robert T. Stafford White Rocks National Recreation Area
- Green Mountain Escarpment

The project is designed to increase the regenerating age class (0 to 9 years old) of forested stands on up to 15,000 acres over a 15-year period to provide habitat for neotropical migrant passerine birds (or perching birds) and other wildlife species requiring early successional habitats. Proposed project activities, chiefly commercial timber harvests, would create temporary openings in lowland and upland habitats across a large portion of the Manchester Ranger District.

The ESHC Project Environmental Assessment document complies with the National Environmental Policy Act (NEPA). The application of NEPA requires public participation, the disclosure of environmental effects of proposed activities, and preparation of a decision document providing specific direction for project implementation. The environmental analysis for the proposed ESHC Project management activities is documented in this site-specific environmental assessment, and is tiered (40 Code of Federal Regulations 1508.28) to the Final Environmental Impact Statement and Record of Decision for the Forest Plan (USDA Forest Service 2006b and 2006c). The information and analysis in those documents applying to the ESHC Project Environmental Assessment is incorporated by reference.

Environmental effects are disclosed assuming application of all relevant Forest Plan standards and guidelines (Forest Plan, Chapters 2 and 3), and project specific design criteria (Appendix B). A Forest Service interdisciplinary team of resource specialists will annually review final timber sale plans including harvest treatment methods selected for each stand and associated road access needs prior to actual implementation. Resource inventory and survey work necessary for protective measure compliance would be conducted following project implementation guidance (USDA Forest Service 2019a). See Chapter 2, Section 2.2.5 for more details regarding the implementation process.

1.1 Proposed Project Location

The project area includes forested stands across the Manchester Ranger District extending from the Vermont-Massachusetts border north to Route 140 in Wallingford, VT and from the Vermont-New York border east to South Wardsboro Road in Wardsboro, VT (see Figure 1). The pool of stands where project activities would take place total 17,274 acres.

1.2 Purpose of Action

The Forest Plan goals, objectives, and management direction for the desired future condition of resources are the primary drivers for defining the purpose of the ESHC Project proposed action. Direction specific to the regenerating age class (forested stands 0 to 9 years old), also referred to as early successional habitat, was especially considered for this project.

1.2.1 Forest-wide Management Direction

The purpose of this action is to meet Forest Plan Goal 2 which is to promote management activities that maintain and restore the quality, amount, and distribution of habitats to produce viable and sustainable populations of native and desirable non-native plants and animals. In order to contribute to this goal, the Forest Plan identifies forest habitat type composition and age class objectives to ensure diversity of composition, structure, and function is maintained or increased on the Green Mountain National Forest.

The purpose of the ESHC Project is to achieve the following specific Forest Plan objectives (Forest Plan, pages 10 to 14):

- Increase the acreage of the regenerating age class (0 to 9 years) to provide a variety of habitat conditions for wildlife and balanced age-class distribution which include:
  - 10 to 20 percent aspen
  - 5 to 15 percent each of birch, mixedwoods/softwoods, and oaks
  - 5 to 10 percent northern hardwoods
- Increase aspen/birch forest and regenerating forest to support species preferring these habitats
- Manage aspen-birch habitat so 1 to 5 percent of National Forest System lands are of this type
- Provide for a sustainable supply of forest products which includes maintaining or improving forest health
- Restore and improve wetland resources

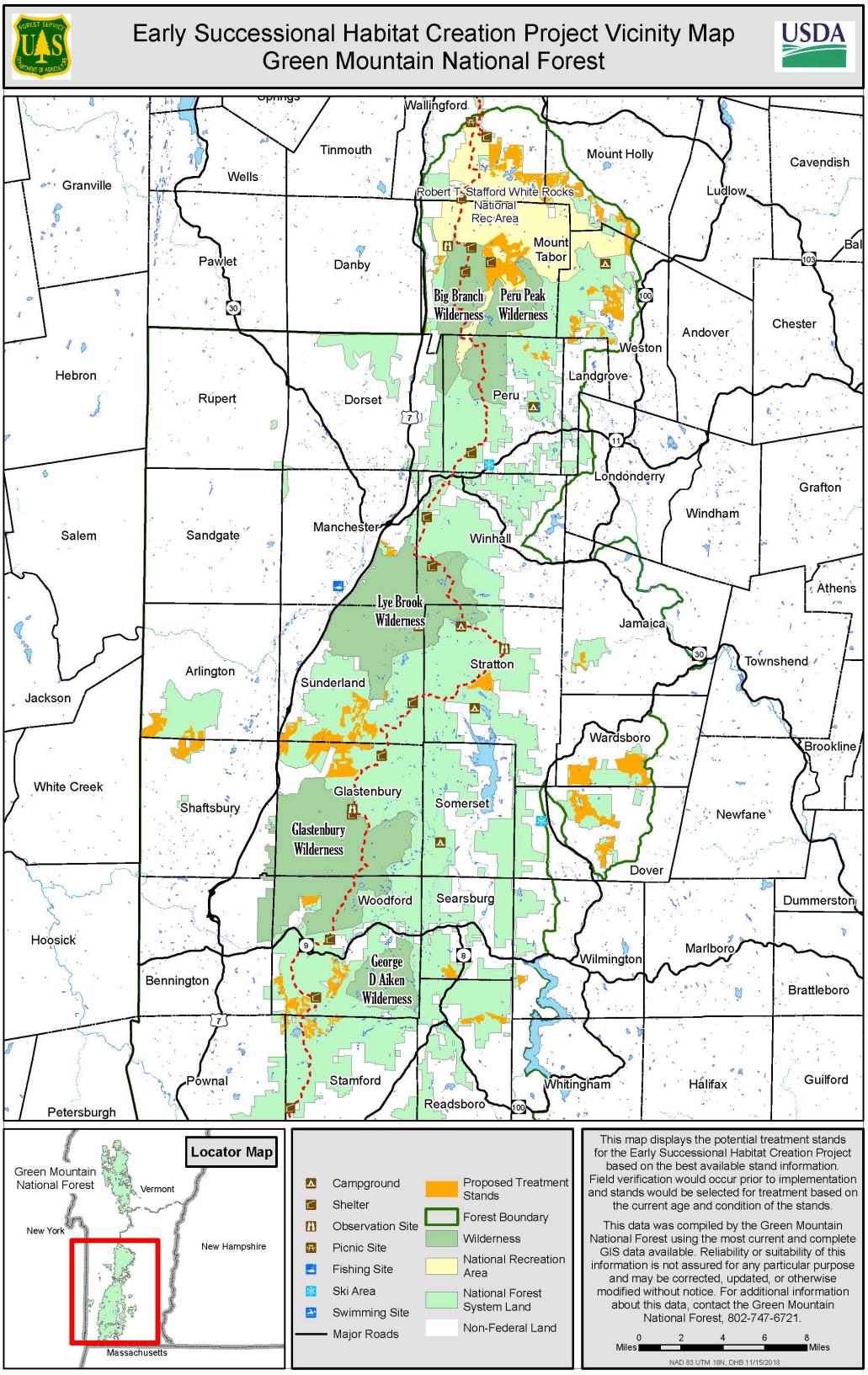

Figure 1: Project area vicinity map

1.2.2 Partner Collaboration

The shared management goals of our partners are also important considerations for the project purpose. The Mennen Environmental Foundation and the Ruffed Grouse Society have a mutual interest to increase the acreage of early successional habitat for bird species in southern Vermont consistent with Forest Plan direction. The Mennen Environmental Foundation is interested in maximizing neotropical migrant passerine diversity, while the mission of the Ruffed Grouse Society is to improve land for the ruffed grouse and American woodcock, two gamebird species requiring early successional habitat. Both organizations desire to work with the Forest Service to achieve Forest Plan goals and objectives that promote early successional habitat on National Forest System lands. They have helped the Forest Service during the planning stage of the project.

1.3 Need for Action

The need for action is determined by the difference between the existing condition and desired future condition within the project area. There is a need to:

- Create desired early successional habitat conditions (see Table 1)
- Promote aspen-birch habitat type
- Maintain forest health
- Improve wetland habitat
- Provide forest products to the local economy

Timber harvesting is the primary tool to achieve these Forest Plan objectives and moving management toward desired future conditions for creating and maintaining healthy, productive forests and quality habitats (Forest Plan, page 15). It is also used to enhance habitats and features of particular value to certain plant and animal species where that habitat is uncommon in the forest, such as aspen, upland openings, hemlock, and oak. A wide range of even-aged and uneven-aged silvicultural harvest methods are available to achieve these objectives (Forest Plan, pages 23 to 25).

1.3.1 Create Early Successional Habitat Conditions

The key need this project addresses is the discrepancy between the existing and desired amount of early successional habitat on the Manchester Ranger District. Inventory data demonstrates a lack of forested stands within the 0 to 9 year age class (see Table 1).

Regenerating forest stands 0 to 9 years old provide important early successional habitat for a number of wildlife species. These include species such as ruffed grouse, woodcock, wild turkey, deer, bear, bobcat, and snowshoe hare, as well as many passerines such as the eastern bluebird, chestnut-sided warbler, common yellowthroat, song sparrow, and American goldfinch (USDA Forest Service 2006b).

Table 1: Comparison of existing amounts of 0 to 9 year old forested stands and Forest Plan objectives on the Manchester Ranger District.

Habitat Type	Existing Condition (percent)	Forest Plan Objectives (percent)[1]
Northern Hardwood	<1	5-10
Mixedwood	<1	5-15
Softwood	<1	5-15
Aspen	13	10-20
Birch	<1	5-15
Oak	<1	5-15
All Habitat Types	<1	N/A

[1] Age class objectives only apply to suitable lands using even-aged silvicultural systems within the Diverse Forest Use, Diverse Backcountry, Remote Wildlife Habitat, and Green Mountain Escarpment Management Areas (Forest Plan, page 11).

The focus of this project is to provide early successional habitat for neotropical migrant passerine birds. Neotropical migrant passerines include all species of perching birds that breed in the United States and/or Canada and winter in Mexico, Latin America, the Carribbean, and/or South America. The Neotropical Migratory Bird Conservation Act lists 386 species falling into this category, including the five passerines listed above. A number of species on the list, such as the eastern towhee and chestnut-sided warbler, occur in Vermont, breed in early successional habitats, and are declining in population (Sauer et al. 2017) in part because of habitat loss within their breeding season ranges. In addition, many other neotropical migrants nesting in mature forest, such as the blue-headed vireo, black-throated blue warbler, and Swainson's thrush, forage extensively in early successional habitats after the young have fledged (Chandler et al. 2012).

1.3.2 Promote Aspen-Birch Habitat Type

Inventory data also shows the existing aspen-birch habitat type only makes up 2.1 percent of National Forest System lands on the Manchester Ranger District, which is within the lower range of the Forest Plan composition objective of one to five percent. This habitat type is early successional in nature, so efforts to increase early successional habitat in general would likely increase aspen-birch habitat.

1.3.3 Maintain Forest Health

The vast majority of stands considered for treatment are infected by beech bark disease, which causes fungal infections leading to severe defects and mortality in beech trees. There is a need to salvage or remove these diseased trees while creating conditions favorable for other tree species, such as aspen and birch, to regenerate and fully utilize the site, providing an indirect benefit of this project. Beech is one of the most shade-tolerant tree species in the project area and also sprouts vigorously. In many stands with shaded conditions, beech is the only regeneration in the understory and would eventually replace the overstory trees. However, these beech trees would be short-lived due to disease and unable to maintain full forest canopy. As they die, they would in turn be replaced by more beech regeneration. This cycle would continue into the foreseeable future without treatment.

1.3.4 Improve Wetland Habitat

Part of Forest Plan Goal 4 is to maintain or restore wetland habitats (Forest Plan, page 13), and management can help improve the condition of this resource (Forest Plan, page 22). Wetland areas associated with beaver activities along perennial streams exist throughout the project area. Some species not typically found in upland habitat favor early successional wetland habitat, such as the yellow warbler and willow flycatcher. The creation of early successional habitat conditions adjacent to and within wetlands would benefit these species.

1.4 Public Involvement and Collaboration

Formal public involvement for the ESHC Project was initiated by the legal notice published in the Rutland Herald on May 10, 2018 for the *Early Successional Habitat Creation Project: Notice of Proposed Action and Opportunity to Comment* scoping document (USDA Forest Service 2018a). The legal notice announced a 30-day public comment period ending June 11, 2018. An email notice for the availability of the scoping document was simultaneously distributed to 247 individuals, organizations, towns and agencies, and was also posted on the Green Mountain National Forest website at: https://www.fs.usda.gov/project/?project=53629. Additionally, the project was listed in the quarterly Green Mountain National Forest Schedule of Proposed Actions beginning in April 2018 and updated quarterly with the project status since that time.

Prior to distribution of the scoping document, a public meeting attended by 34 people was held in Manchester, VT on March 26, 2018 to share information about the project, answer questions, and obtain input for proposed management activities. Input received was used to help finalize the proposed action.

The feedback provided by the overall public involvement efforts together with resource inventory conducted by Forest Service staff was the basis for the analysis documented in this environmental assessment.

1.5 Public Issues

Public issues were identified from the 36 comment responses to the May 2018 scoping document during the 30-day comment period, and highlight effects or unintended consequences that may occur from the proposed action. Issues help determine when there are unresolved conflicts concerning alternative uses of available resources. They also provide opportunities to disclose effects in a comparative format and design the project to reduce effects to an acceptable level.

Issues are the primary drivers to focus the environmental analysis on meaningful resource concerns. Forest Service staff reviewed all comments and categorized relevant issues as either substantive or minor according to the potential magnitude of their associated effects. The *Early Successional Habitat Creation Project Scoping Comments - Content Analysis and Response to Comments* report (USDA Forest Service 2019b) documents how public issues were addressed during the ESHC Project analysis process.

1.5.1 Substantive Issues

Substantive issues indicate a potential need for alternative uses of resources because of unresolved conflicts or development of design criteria to reduce the potential for adverse effects. These issues are addressed with a detailed analysis for each relevant resource in the environmental assessment (see Chapter 3). Four substantive issues were identified from public comments for the ESHC Project proposal. An issue statement was developed for each issue to provide a clear relationship between the cause and potential effect for the resource of concern.

The substantive issues include:

Issue 1. The degree of proposed roadbuilding would disrupt habitat connectivity, result in habitat fragmentation, and have negative effects on water quality and other forest resources.

Issue 2. Project activities would negatively impact black bear habitat and important regional black bear habitat connectivity in the Dover and Wardsboro area.

Issue 3. Whole tree harvesting would result in insufficient retention of coarse woody material on the forest floor, which would have negative effects on wildlife habitat and soil productivity.

Issue 4. Treating spruce-fir stands would convert this under-represented habitat type to young hardwood forests.

1.5.2 Minor Issues

Minor issues are not addressed or are discussed only briefly in the environmental assessment, because they do not indicate unresolved conflicts. These issues are derived from public and Forest Service concerns and although they also help focus the meaningful analysis of effects, they are not discussed at the same level of detail as substantive issues in Chapter 3.

1.6 Pre-decisional Objection Process

The proposed ESHC Project would implement the Forest Plan and thus is subject to subparts A and B under the 36 Code of Federal Regulations part 218. These regulations provide for a project level pre-decisional administrative review (objection) process. In order to be eligible to object the draft decision notice for this project prior to implementation, timely submittal of specific written comments during the designated public comment period was required. The 30-day comment period from May 11 to June 11, 2018 for the *Early Successional Habitat Creation Project: Notice of Proposed Action and Opportunity to Comment* scoping document was the only opportunity for public comment for this project.

1.7 Decisions to be Made

The District Ranger for the Manchester Ranger District is the responsible official for the ESHC Project. The District Ranger will make the following decisions after reviewing the environmental assessment, supporting project record, and public comments received during the comment period:

- Determine whether the proposed action complies with Forest Plan direction including

Forest-wide and Management Area standards and guidelines

- Determine whether a finding of no significant impact or an environmental impact statement is warranted based on the disclosure of effects in the environmental assessment

If no environmental impact statement is needed, the following decisions will be made:

- Determine whether the ESHC Project will proceed as proposed or needs to be modified by an alternative to address issues
- Determine which specific design criteria should be implemented as part of the project to ensure resource protection
- Determine what monitoring requirements, if any, should be applied during or after project implementation

Chapter 2. Proposed Action and Alternatives

Chapter 2 includes descriptions of the following alternatives analyzed in detail as part of this environmental assessment:

- Alternative A: No Action
- Alternative B: Proposed Action

Alternative development was considered by the Forest Service interdisciplinary team and the Responsible Official to address the substantive issues discussed in Chapter 1. There were no unresolved conflicts identified from public issues warranting additional action alternatives for detailed analysis.

2.1 Alternative A: No Action

Alternative A provides a baseline for comparing the environmental effects of the Proposed Action. There would be no implementation of any of the management activities proposed in Alternative B. Management activities previously approved within the project area would still be implemented. Other ongoing routine management activities associated with existing infrastructure would also continue such as road and trail maintenance.

2.2 Alternative B: Proposed Action

Alternative B consists of management activities developed to meet the purpose and need for the ESHC Project as described in the May 2018 scoping document (USDA Forest Service 2018a). Some modifications have been made to address public comments received during the 30-day public comment period, and additional Forest Service specialist review of the management activities originally proposed. The primary modifications include:

- Reduction in the proposed miles of permanent Operational Maintenance Level 1 and temporary roads needed to access proposed harvest treatment stands from up to 75 miles initially proposed to a revised maximum of 25 miles; the reduction is based on a more accurate determination of maximum skidding distance to existing roads from one-quarter mile (1,320 feet) to just under one-half mile (2,500 feet)
- Addition of compartment 27, stand 29 (eight acres) to the list of proposed stands for harvest treatment
- Elimination of five stands totaling 145 acres (compartment 92, stands 8, 30, and 42; and compartment 94, stands 6 and 7) to address concerns associated with American marten habitat

Table 2 summarizes the Proposed Action (Alternative B) management activities designed to increase early successional habitat conditions, promote aspen-birch habitat, maintain forest health, and improve wetland habitat across the Manchester Ranger District.

Table 2: Summary of proposed management activities.

Management Activity	Amount Proposed
Harvest treatments	• Up to 15,000[1] acres

Developing road infrastructure	• Construct up to 25 miles of new roads[2]. This includes:
	  ○ Approximately 15 miles located on existing unclassified roads[3]
	  ○ Approximately 10 miles located where no road template exists
	  ○ Up to 17 of the 25 miles may be permanent roads; the rest would be temporary roads
	• Up to nine miles of existing system roads may need reconstruction

Site preparation for natural regeneration (mechanized equipment, hand tools, and/or prescribed fire)	• Up to 15,000 acres
Wetland habitat enhancement	• Up to nine acres of vegetation treatments • Installation of up to 18 bird nesting boxes
Placement of interpretive signs	• Up to five signs in high-visibility areas

[1] Up to 1,000 acres annually for a 15-year period from a pool of stands totaling 17,274 acres.

[2] An average of 1.67 miles annually; although this amount could vary from year to year, the maximum 25 miles would not be exceeded.

[3] Unclassified roads are existing roads not managed as National Forest System roads. In some situations, existing snowmobile trails follow the same template as unclassified roads.

2.2.1 Harvest Treatments

Potential harvest treatments are proposed for stands totaling up to 15,000 acres with between 500 to 1,000 acres harvested annually over a 15-year period (see Appendix A and Appendix D). This acreage would come from a pool of stands totaling 17,274 acres. Each stand proposed for harvest, the associated Management Area, and size in acres are provided in Appendix A. All activities are designed to be consistent with all Forest-wide and Management Area standards and guidelines in the Forest Plan. The key Forest Plan standards identify, by Management Area, restrictions on the size of created temporary openings (see Table 3).

Stands proposed for treatment were selected based on proximity to existing roads, presence of aspen/paper birch, presence of beech infected with beech bark disease, presence of declining overstory with limited suitable tree regeneration (meaning no or minimal tree regeneration or existing regeneration is more than 50 percent beech) in the understory to grow into the overstory, and economic viability of potential harvests.

Table 3: Proposed harvest acres for each Management Area.

Management Area	Total area of land in potential treatment pool (acres)	Maximum Temporary Opening Size (acres)[1]
Diverse Forest Use	7,639	30
Diverse Backcountry	3,491	20
Remote Wildlife Habitat	2,409	20
Green Mountain Escarpment	1,176	30
Robert T. Stafford White Rocks National Recreation Area	2,559	5
Total	**17,274**	

[1] Forest Plan Forest-wide and Management Area standards (Forest Plan, pages 26, 59, 61 and 80).

Harvest methods proposed include even-aged regeneration (clearcut with reserves, patch cuts, and shelterwood) and uneven-aged treatments (group selection) to create temporary openings (see Table 4). Approximately 80 percent (12,000 acres) of total acres proposed for harvest are estimated to have even-aged regeneration harvest methods prescribed while the remainder (3,000 acres) would use uneven-aged treatments.

Table 4: Description of proposed timber harvest methods.

Harvest Treatment Method	Description	Example Photograph
Clearcut with reserves	Creates a temporary opening of greater than five acres. At least five percent of each stand would be reserved from harvest to provide wildlife trees and greater structural diversity.	
Patch cuts	Creates a temporary opening of three to five acres. Trees with high wildlife value, such as those with cavities or exfoliating bark, can be reserved from harvest.	

Harvest Treatment Method	Description	Example Photograph
Shelterwood	A portion of the existing overstory is retained to provide shelter to regeneration, to allow vigorous young trees to continue growing, and/or to provide greater forest structure. Trees with high wildlife value are also retained individually or in clumps.	
Group selection	Group openings are created throughout a stand ranging in size from one to two acres in order to provide early successional benefits. Group openings are scattered throughout the stand to equal 10 to 20 percent of the total stand acres.	

Photo Credits: Clearcut with reserves and group selection courtesy of Scott Wixsom, USDA Forest Service;
Patch cuts and shelterwood courtesy of Brian Lockhart, USDA Forest Service, Bugwood.org

Harvest treatment acres would be sited adjacent to each other over multiple time intervals within a 15-year time frame starting from project initiation. This would create a mosaic of varied habitats (in terms of age-class and species composition) within close proximity (see Figure 2 for a visual example of an area with three treatments over 15 years). Note temporary openings would not be created directly adjacent to previously regenerated areas until the average height of the adjacent area reaches a minimum of 15 feet (Forest Plan, page 26).

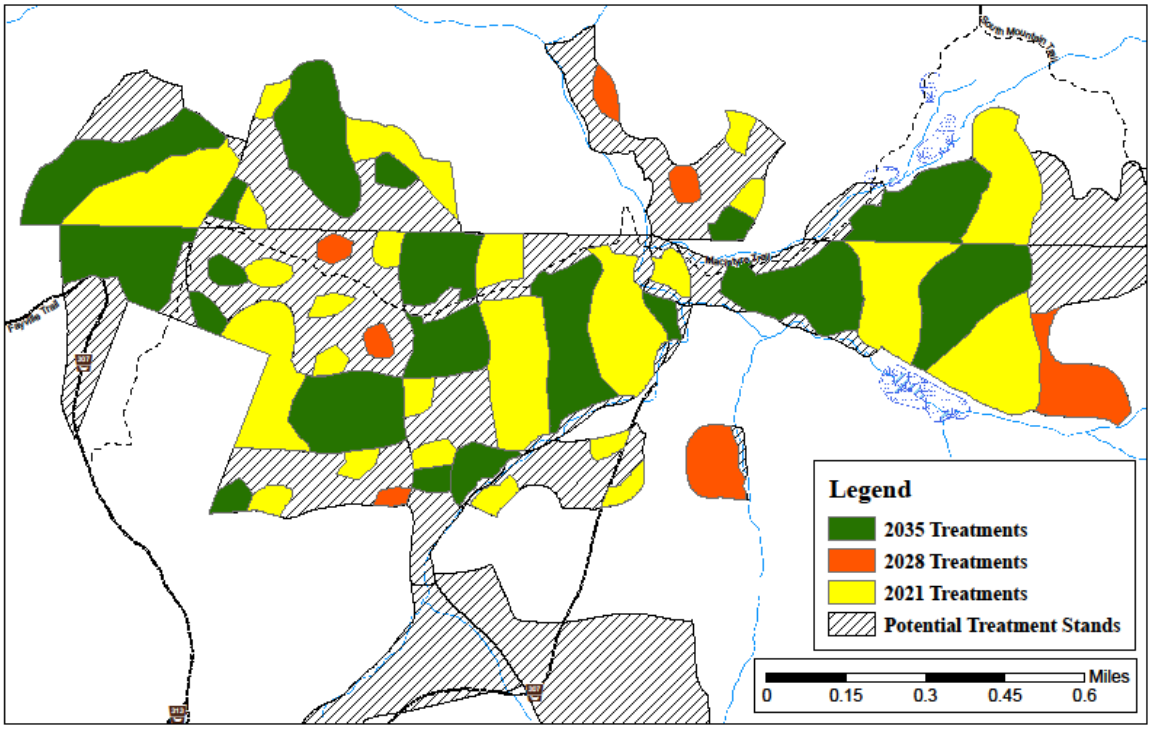

Figure 2: Example of treatment layout over time and space.

Table 5 provides the site-specific conditions and factors to be used for selection of the harvest method for each stand prior to timber sale planning and implementation (USDA Forest Service 2019a).

Table 5: Stand conditions, factors and considerations for harvest method selection.

Harvest Treatment Method	Conditions, Factors, and Considerations[1]
Clearcut with reserves	• In stands where the objective is to establish shade-intolerant species such as aspen and birch. • In stands where beech dominates the advance regeneration (greater than 50 percent of stocking) or where there is little advance regeneration.
Patch cuts	• In younger stands with aspen clumps where treatment of the entire stand is not economically feasible due to tree size, but where it is desirable to harvest the aspen because they are at an age when vigorous sprouting after harvest would occur. • In the Robert T. Stafford White Rocks National Recreation Area, where management direction limits opening size to five acres or less.
Shelterwood	• Where there are visual concerns, in stands having partial stocking of vigorous trees that would be desirable to retain, or where greater structural diversity is desirable. • In stands where the objective is to retain or regenerate existing native spruce-fir forest habitat type.

Harvest Treatment Method	Conditions, Factors, and Considerations[1]
Group selection	• Where there are visual concerns, in stands with variable stocking and quality, or in stands previously managed with group selection treatment. Lower quality areas would be treated first while higher quality areas would be retained for later groups. • In stands where the objective is to retain or regenerate existing native spruce-fir forest habitat type.
Whole tree harvesting[2]	• In stands where aspen clearcuts would be implemented to create optimum conditions for aspen regeneration (such as light and growing space). This is especially important in stands with existing aspen decline (due to age or disease) and limited sprouting potential.
Summer/dry ground harvesting	• In stands without existing vigorous aspen and paper birch, to create bare soil seedbed suitable for aspen and paper birch to establish by seed.

[1] This list of conditions, factors, and considerations is not exhaustive but provides a general guide for treatment selection when planning for implementation.
[2] Up to 20 percent (3,410 acres) of the total pool of stand acres considered for treatment.

In general, when aspen and/or birch are present, harvest treatments would be designed to regenerate these species. In stands with mature overstory trees and little or no acceptable regeneration in the understory, harvest treatments would also be designed to establish mid-tolerant species (such as red maple, yellow birch, northern red oak, and eastern white pine) and shade-intolerant species (such as aspen, paper birch, and black cherry). Areas dominated by native spruce-fir species would be maintained as spruce-fir by shelterwood or group selection treatments.

In stands dominated by beech regeneration, harvest treatments would be designed to reduce the amount of beech for the purpose of establishing other desired species, including aspen and birch. Silvicultural treatments such as single tree selection or group selection with small group size are ineffective in these stands, as they create light conditions favoring the understory beech. Further, removal of the diseased beech under these systems would cause beech sprouting, and these sprouts would also be favored by post-harvest light conditions. For these reasons, silvicultural treatments creating openings with full sunlight reaching the ground to favor species mid-tolerant to intolerant of shade would be preferred to reduce the amount of beech regeneration and increase species diversity.

Feral apple trees found within stands proposed for treatment would be retained, and if necessary, released from competing vegetation with hand tools.

2.2.2 Developing Road Infrastructure

Access to potential treatment areas was an important consideration during the development of the project proposal. The existing National Forest, town, and state road systems would be used for log truck and equipment access to forested stands for harvest activities. Existing roads may need maintenance or reconstruction to meet the appropriate standards. Permanent and temporary road construction would be needed to supplement the existing road system. Table 6 provides the

proposed road infrastructure for the project. Table 7 describes the difference between permanent Operational Maintenance Level (OML) 1 and temporary roads.

Approximately 25 percent of existing National Forest System roads (up to 9 miles out of 36 total miles) used to facilitate timber harvest may require reconstruction and the majority would require some maintenance. In general, OML 1 roads, which are closed to vehicle traffic, require more work than OML 2 through OML 5 roads, which are open to the public (see Appendix C for OML descriptions). In addition, up to 25 miles of new roads would be proposed to access harvest treatment areas. Of this, up to 17 miles may be constructed to permanent OML 1 road standards while the rest would be constructed to temporary road standards. All proposed road activities would be implemented using heavy mechanized power equipment and machinery.

Estimated miles of temporary roads, permanent roads, and maintenance and reconstruction of existing roads are part of the proposed action. The specific level, amount, and location of road infrastructure needed would be based upon site-specific conditions identified during project planning at the time of implementation. Design criteria (Appendix B) and Vermont Acceptable Management Practices (VANR 2018) would be used to minimize the impacts and costs of road use and construction. For example, existing roads would be used to the extent possible. If access cannot economically be achieved in accordance with the design criteria and acceptable management practices, then stands would be excluded from treatment.

Table 6: Road infrastructure proposed to access harvest treatment areas.

Road Infrastructure Activity	Conditions, Factors, and Considerations
Maintenance or reconstruction of existing roads	• Approximately 74 percent of the stands are estimated to be entirely within one-half mile of Forest System, town, or state roads. Current logging equipment is capable of skidding harvested timber this distance to existing roads (based on equipment limitations, risk to soil, and economic feasibility). • Up to nine miles[1] of existing National Forest System roads used to facilitate timber harvest may require reconstruction, and the majority would require some maintenance to meet the appropriate standard for their intended use by logging trucks and equipment. • Improvements may include clearing brush, limited road widening, gravel placement, installing and/or repairing culverts, and ditching and shaping of roads.
Construction of up to 25 miles of road over 15-years	• Where stands, or portions of stands, are located further than one-half mile from an existing road, road construction may be required. • Road construction may be permanent OML 1 roads or temporary roads. • Approximately 60 percent or 15 miles of roads would be constructed over known existing unclassified roads, such as snowmobile trails, existing roadbeds, old temporary roads, skid trails, or other types of trails. • The use of existing unclassified roads in locations where they currently compromise resources would be avoided whenever possible. Whether to construct roads in new locations to avoid exacerbating ongoing negative resource effects would depend partly on consideration of comparing the difference in effects between using existing road segments and constructing roads in new locations (USDA Forest Service 2019a).

Road Infrastructure Activity	Conditions, Factors, and Considerations
	• Construction would average approximately 1.67 miles annually. Although this amount may vary from year to year depending on site specific conditions, the maximum total 25 miles of new road would not be exceeded for the project.
Construction of up to 17 miles of OML 1 permanent road where site conditions warrant; this is a component of the 25 total miles proposed	• The construction of new permanent OML 1 roads or reconstruction or relocation of existing system or non-system roads may be necessary based on future resource management needs including but not limited to timber, vegetation and wildlife habitat management. • When existing permanent system roads are relocated, the replaced road would be decommissioned and closed. • Final road location needed to access each proposed treatment area would be determined by conditions such as soil type, soil moisture content, slope, stream crossings, and proximity to wetlands or other sensitive resources. • Forest Service timber and engineering staff would determine the appropriate locations which would be reviewed by relevant resource specialists prior to implementation (USDA Forest Service 2019a).
Construction of temporary roads where OML 1 permanent road is not warranted; this is a component of the 25 total miles proposed	• Temporary roads would be the preferred option for accessing stands. • When to choose temporary roads is dependent on a combination of anticipated future use (time interval before next entry or use of road) and site condition complexity factors such as whether the road follows an existing unclassified road or trail template, level of road infrastructure needed for harvest activities, slope, soil type, season of use, and size and frequency of stream crossings.

[1] An estimated 25 percent of the 36 miles of existing system roads under National Forest jurisdiction.

Table 7: Description of OML 1 and temporary roads.

OML 1 Road	Temporary Road
• Intermittent service roads closed to vehicle traffic when not needed for management activities • Constructed using native material as well as imported gravel • Drainage structures placed as needed • Width equals 14 feet with ditches or fill slope extending four feet wider than road surface • Drainage structures removed following use • Roads blocked with barriers to prohibit motorized vehicle access • Basic custodial maintenance performed during non-use to minimize damage to adjacent resources	• Minimum-standard roads designed for short-term use during a specific project • Built to the same width as an OML 1 road (14 feet), but strive for the minimum width needed to allow for the passage of equipment • Bridges, culverts and crossing structures removed after use • Road template returned to pre-use conditions after use as needed to stabilize soil and maintain natural stream hydrology. • Roads blocked with organic material, berms, or barriers to prohibit motorized vehicle access • Roadbed naturally re-vegetated

There would be no change in public motorized use of existing roads as a result of the proposed action. All roads currently open to public motorized use will remain open, and all roads currently closed to public motorized use will remain closed.

Existing log landings or openings and skid roads/trails meeting current Forest Plan standards and guidelines, and design criteria (Appendix B) would be used for proposed harvest activities. New log landings and skid roads/trails would also be constructed in locations needed to access all areas being considered for harvest. Landings are typically between one-quarter and one-half acre in size and require vegetation removal and some soil leveling. Ground-based logging systems would be used for felling and skidding of trees in all stands, including manual fell-skidder; feller/buncher-skidder-processor; and cut-to length (harvester-forwarder). Skidders may utilize grapples or cables.

2.2.3 Site Preparation and Planting

Site preparation would occur in all stands following harvest activities to create conditions favorable for establishing tree regeneration and to remove undesirable stems of existing saplings. This would be accomplished primarily with hand tools such as chainsaws or brushsaws. The use of mechanized equipment, such as tractors, would also be an option depending on site conditions.

Prescribed burning (which may include the construction of firelines) would be used in cases where desirable oak regeneration is present, or if there is a large amount of retained organic material left after harvest impeding seedling establishment. Fireline construction would be completed with small to mid-sized tracked excavators where fuel conditions warrant. Other sections would be constructed by other means such as hand tools, all-terrain vehicle with an attached plow, mower or other similar equipment.

Planting of oak and hickory species, or other species predicted to do well in future weather conditions, would be considered on south/west facing slopes and other appropriate sites as determined by a silviculturist (USDA Forest Service 2019a).

2.2.4 Wetland Habitat Enhancement

Within nine discrete beaver-influenced wetlands or wetland complexes within the project area (see Table 8 and Appendix D), trees would be felled, but not harvested, from the shorelines of these flowages. These treatments would extend approximately 100 feet upland of the shoreline. Leaving the trees on the ground to simulate natural wind throw events would provide valuable habitat for reptiles, amphibians, mammals, and invertebrates adjacent to or within wetlands. Up to nine total acres would be treated using these techniques or approximately one acre per wetland.

In addition, up to two bird nesting boxes may be installed around the perimeter of each wetland to provide cavity nesting habitat (total of 18 nesting boxes).

Table 8: Wetlands proposed for habitat enhancement.

Associated Stream	Compartment	Stand(s)	Management Area
North Alder Brook	89	2, 12, 46	Diverse Backcountry
Ball Mountain Brook UT	179	9	Remote Wildlife Habitat
Stamford Stream	128	56	Diverse Backcountry
	129	60, 63, 70, 71	
Big Branch	19	7, 10, 19	White Rocks NRA
Utley Brook UT	44	23, 25	Diverse Forest Use
City Stream UT	134	5, 8	Diverse Forest Use
Jenny Coolidge Brook UT	30	6	Diverse Forest Use
West Branch Deerfield River UT	122	2, 16	Diverse Forest Use
Ellis Brook	53	3, 8, 9	Diverse Forest Use

UT = Unnamed Tributary; NRA = National Recreation Area

2.2.5 Design Criteria

The ESHC Project interdisciplinary team developed site-specific design criteria to achieve multiple resource management objectives and to minimize or eliminate potential effects to natural and cultural resources in the project area (Appendix B). Design criteria include habitat enhancement features for wildlife, measures to reduce the spread of invasive species, and protective measures for rare plant and animal habitats, riparian areas, fisheries, soil and water resources, visual quality objectives, recreation opportunities, and cultural resources.

The Forest Service anticipates varying site-specific conditions to dictate which design criteria to apply depending on the type of harvest treatment method prescribed, level of road and location for access selected, and other site-specific factors. Although the ESHC Project has been planned with the best available information, all site-specific information will not be available until closer to the time of implementation when specific timber sales are planned. Forest Service staff will review and evaluate the specific activities selected annually over the 15-year life of the project, and conduct necessary field inventory and survey work following guidance provided by the *Early Successional Habitat Creation Project - Implementation Guide* (USDA Forest Service 2019a). The relevant required design criteria would then be identified to ensure resources are protected from management activities during implementation and environmental effects are minimized to acceptable levels.

Many resource and ground conditions may change during the 15-year implementation period. Completion of surveys and inventories closer to the actual time of implementation better ensures the most accurate information is used for compliance with Forest Plan standards and guidelines, and ESHC Project design criteria (Appendix B). An added benefit of this approach is the ability to adapt the design criteria within the defined parameters included in Appendix B if monitoring results demonstrate changes are needed to protect a given resource or better achieve objectives.

Chapter 3. Environmental Impacts

This chapter discloses the direct, indirect, and cumulative environmental effects to the physical, biological, social, and economic resources from the No Action and Proposed Action alternatives as described in Chapter 2. It consists of a description of the existing condition ("affected environment") for each resource area and discloses the environmental effects for the resource under each alternative.

Each resource section in Chapter 3 is organized in the following sequence:

Issues

Relevant substantive and minor issues from public comments and Forest Service review provide the primary basis for environmental effects.

Direct and Indirect Effects Analysis Area

The direct and indirect effects analysis area provides the "area of influence" where the effects are predicted to take place.

Affected Environment

The affected environment describes the existing conditions within the area of influence.

Direct and Indirect Effects

Direct and indirect effects are disclosed from the activities included under each alternative.

Cumulative Effects

Cumulative effects are disclosed from other past, present or foreseeable future actions on National Forest System and non-National Forest System lands that may overlap with the effects in time and space with those predicted for the alternative actions.

3.1 Forest Habitat

3.1.1 Issues

The substantive issues (see Chapter 1, Section 1.5), indicator for effects and acceptable effects threshold associated with this resource include:

- The degree of proposed roadbuilding would disrupt habitat connectivity and result in habitat fragmentation.

  Indicator: A given forested stand's role in fostering habitat connectivity and buffering impacts from fragmentation as provided by the Vermont Department of Fish and Wildlife habitat block and connectivity report (Sorenson and Osborne 2014).

  Threshold: When project activities split or decrease the size of existing high priority habitat blocks as defined by Sorenson and Osborne (2014).

- Project activities would negatively impact black bear habitat and important regional black bear habitat connectivity in the Dover and Wardsboro area.

  Indicator: Changes in bear behavior and occupancy of impacted areas would indicate an affect.

  Threshold: When project activities deplete existing stocks of hard mast-bearing trees enough causing bears to no longer use areas they once occupied. Additionally, when habitat blocks become fragmented or important travel corridors are severed by project activities.

- Whole tree harvesting would result in insufficient retention of coarse woody material on the forest floor, which would have negative effects on wildlife habitat.

  Indicator: The number of trees retained per unit area serving as recruitment of downed wood to the forest floor.

  Threshold: Retention of uncut patches totaling five percent of each harvested area over five acres where basal area would be reduced below 30 square feet per acre; or retention of at least five wildlife trees[1] per acre harvested where basal area would be above 30 square feet per acre (Forest Plan, page 27).

- Treating spruce-fir stands would convert this under-represented habitat type to young hardwood forests.

  Indicator: The percentage of National Forest System land within the Manchester Ranger District made up of the native spruce-fir forest type.

  Threshold: Decline of the native spruce-fir forest type below current levels of five percent of National Forest System lands within the Manchester Ranger District.

Although not identified as a substantive issue, there is also concern the proposed harvest treatments are not within ecological historic levels for young forest (early successional habitat).

Indicator: The percentage of the Manchester Ranger District in the 0 to 9 age class at any given time.

Threshold: When the percentage of early successional habitat on the Manchester Ranger District exceeds five percent. This is the upper bound of the desired range for this habitat type as defined by the Vermont Agency of Natural Resource - Vermont Conservation Design summary report (Sorenson and Zaino 2018).

3.1.2 Direct and Indirect Effects Analysis Area

The analysis area for direct and indirect effects for forest habitat composition includes all National Forest System lands on the Manchester Ranger District (see Figure 1). This analysis area

[1]Two cavity or snag trees of the largest available diameter at breast height, live trees with exfoliating bark, den trees, nest trees, or yellow birch and red maple greater than 26 inch diameter at breast height considered “cull” or unacceptable growing stock. In areas lacking such cavity trees and snags, retain at least two trees of the largest available diameter at breast height with defects likely to lead to cavity formation.

encompasses the locations of all proposed activities, including timber harvest and road construction.

The temporal context for this analysis includes both short-term (within 20 years) and mid- to long-term (50 to over 100 years from now) scales. The short-term scale would be expected to encompass full implementation of all proposed vegetation treatments and the immediate impacts of all management activities on habitat conditions. The long-term scale would account for management actions or disturbances resulting in changes taking a longer time to detect, such as shifts in habitat conditions related to forest types, age class distribution of vegetation, and habitat juxtaposition.

3.1.3 Affected Environment

Forest habitat composition and structure help define the diversity of species and natural communities existing across the forest landscape. Diverse forest habitat is important because it supports viable and sustainable populations of plants and wildlife within the project area.

Landscape-scale habitat features

The *Vermont Agency of Natural Resources - Vermont Conservation Design Summary Report* identified important landscape and community-scale features across the state (Sorenson and Zaino 2018). Within the analysis area are many large blocks of mostly undeveloped land identified as the highest priorities for conservation. These are associated with the Southern Green Mountain and Taconic Mountains biophysical regions. Much of this land is either conserved (including National Forest System lands) or is too remote or mountainous to develop.

Included within the analysis area are two high-priority landscape-scale components: 1) Interior Forest Blocks; and 2) Connectivity Blocks. Interior Forest Blocks are a selection of habitat blocks that best provide interior forest conditions. There is little to no permanent habitat fragmentation from roads, agricultural lands, or other forms of development within these habitat blocks. Actively managed forests can still be included within these blocks. Along the spine of the southern Green Mountains and within the analysis area are four large Interior Forest Blocks of at least 50,000 acres in size. They are fragmented from each other by VT Route 9, Kelley Stand Road, and VT Routes 11/30. Other Interior Forest Blocks exist to the east of these and to the west in the Taconic Mountains.

Connectivity Blocks link larger areas of undeveloped habitat together, thus allowing for the movement of wildlife across the landscape. The highest priority Connectivity Blocks are those of greatest importance for wildlife movement and genetic exchange. Within the analysis area, these include the Interior Forest Blocks mentioned in the preceding paragraph as well as smaller blocks of land connecting Interior Forest Blocks and priority Surface Water and Riparian Areas to each other.

Black bears

Black bears are a wide-ranging species occurring in forested areas throughout the state of Vermont, including the analysis area. They forage in a wide variety of habitats during their active season, including wetlands, hardwood stands dominated by hard mast-bearing tree species (primarily beech and oak), and early successional habitat with grasses and forbs and/or a soft mast (such as apples and raspberries) component. They have been increasingly drawn to developed areas where birdfeeders and dumpsters provide an abundant supply of food. During the winter, black bears hibernate in hollowed-out dens in caves, tree cavities, streambanks, or under logs, brush, or rocks.

In the Town of Dover, black bears are drawn to the abundant stands of mast trees. On Whites Hill within Compartment 186, there is evidence of bears feeding on beech nuts and acorns. The presence of oak is noteworthy here because of the area's remoteness: most other oak stands in this part of the state are situated at more developed lower elevations. In addition, there is evidence of bears feeding on beech nuts on Rice Hill in Compartment 52.

Also within the analysis area is a regionally significant bear travel corridor (WRC 2014) which is effectively a link between a highest priority Connectivity Block and a highest priority Interior Forest Block across VT Route 100. This corridor includes the towns of Dover and Wardsboro.

Coarse woody material

Downed coarse woody material is limited in abundance in the analysis area where the majority of the forest is 80 to 100 years old. Forests of this age are structurally simple and do not have the old-growth, uneven-aged characteristics that tend to maximize the amount of wood on the forest floor. Most of the stands within the analysis area are 100 to 120 years away from reaching this stage of forest succession (Lorimer et al. 2001).

Although there is less wood on the forest floor than is ecologically desirable, the down wood present provides valuable habitat for a wide variety of taxa, including insects, reptiles, amphibians, and small mammals.

Spruce-fir habitat

Spruce-fir habitat within the analysis area typically occurs where there is a high water table (swamps), shallow soils over bedrock, or restricted rooting depth due to hardpan soil layers. All of these situations favor shallow-rooted species such as spruce (Burns and Honkala 1990). Spruce-fir habitat is important for a wide variety of wildlife species. For example, deer rely on this habitat type for winter cover and a number of bird species nest almost exclusively in spruce-fir stands. Currently, about five percent (or about 12,510 acres) of National Forest System lands within the analysis area are in forest types where native spruce-fir are the dominant species.

Early successional habitat

Although not a substantive issue, the amount of early successional habitat is an important resource given it is the primary objective of the ESHC Project proposal. Currently, less than one percent of uplands in the analysis area is in the regenerating (0 to 9 year old) age class (see Chapter 1, Table 1). Regenerating forest habitat is an important element of forest habitat diversity. Regenerating forests provide excellent early-successional habitat conditions important for many species of wildlife. Early successional habitat characteristics change gradually over time for as long as 20 years, after which these benefits for wildlife habitat diminish. The typical

progression of natural forest succession would lead to the loss of early successional habitat if regeneration harvests, moderate to large natural blow-downs, or other disturbance events do not occur across the landscape every ten to 20 years.

In addition to its wildlife value, the regenerating age class also creates structural diversity within a general forested area that is fairly uniform in terms of structure. Most of the lands within the analysis area are of similar age and origin, although there is some variation in composition. Early successional habitat helps create vertical and horizontal structure diversity by providing breaks in the forest canopy.

3.1.4 Direct and Indirect Effects

3.1.4.1 Alternative A: No Action

In the short- or long-term, effects to habitat connectivity and spruce-fir habitat resulting from Alternative A would be negligible. If no action is taken, connected land would remain connected and existing spruce-fir habitat would persist. In the short-term, effects to black bears would be negligible as hard mast stands would remain on the landscape. In the long-term, however, beech would likely die from beech bark disease and oak would be unlikely to regenerate without substantial disturbance. As a result, both of these sources of hard mast would likely be lost in the long-term.

Alternative A would likely be beneficial for the recruitment of downed coarse woody material by allowing natural forest succession to take place.

Only natural disturbances, such as wind and ice storms, fire, beaver activity, floods, insects and disease, and natural forest succession would lead to the development of new early successional habitat. Models of forest development in the Northeast generally predict patches of 0 to 15-year-old forest would comprise no more than two percent of the age class distribution under natural disturbance regimes (Lorimer and White 2003). Given most stands in the project area are mature, even-aged stands with a similar land use history, and given early successional habitat is defined as the 0 to 9 year age class in this document, it is expected early successional habitat resulting from natural disturbance over the mid- to long-term would comprise less than two percent of the unmanaged landscape.

3.1.4.2 Alternative B: Proposed Action

Landscape-scale habitat features

With the exception of ten stands in Compartment 192 totaling 386 acres, all of the proposed treatment areas are located within either high priority Interior Forest Blocks or Connectivity Blocks. Vegetation management itself, including commercial timber harvests, would not necessarily compromise the integrity of these important habitat features (Sorenson and Zaino 2018). However, road networks constructed to access timber have the potential to fragment habitat blocks.

Included in Alternative B is the construction of up to 25 miles of new roads over the life of the project. Of these 25 miles, a maximum of ten miles would be constructed where there are no

existing unclassified roads; the remaining 15 miles would be sited on existing unclassified roads. The latter has less of a likelihood to disconnect and fragment habitat blocks because road templates already exist. Class 4 town roads, which are permanent roads not maintained by towns or plowed in the winter, may fragment habitat and affect landscape connectivity (Sorenson and Zaino 2018). Although they are not maintained, they are available for use by motor vehicles. Therefore, Class 4 roads likely have more of a negative effect in terms of fragmenting habitat than do gated temporary or permanent OML 1 Forest Service roads or otherwise blocked to motor vehicle traffic and allowed to revegetate. According to the Vermont Agency of Natural Resources, Class 4 roads and most logging roads are fragmenting features for some species, but not necessarily for the wide-ranging species that are the focus of the habitat block analysis (VANR 2016a). It can then be concluded that while roads created as part of this project may have some fragmenting effects on certain taxa, such as fossorial invertebrates and amphibians, they are unlikely to have large-scale impacts to habitat connectivity.

Road construction in the Dover and Wardsboro area has the greatest potential to adversely affect habitat connectivity. All stands within Compartment 51, 52, 53, and 186 proposed for treatment are within, and nearly span the full width of, a highest priority Connectivity Block which serves the important function of connecting two of the highest priority Interior Forest Blocks. Any fragmenting effects within the Connectivity Block would be minimized through project design by working with Vermont Agency of Natural Resources staff prior to commencing project activities in these stands (Appendix B, Wildlife).

In conclusion, it is unlikely Alternative B would adversely affect the connectivity of the landscape. High priority habitat blocks would remain intact so the threshold for adverse effects would not be reached.

Black Bears

Concerns regarding black bears in the Dover and Wardsboro area center around two important habitat requirements of the species: 1) an abundant supply of hard mast; and 2) an unfragmented landscape to support the species' wide-ranging habits. Project activities have the potential to impact these important habitat attributes by removing mast-producing oak and beech from the landscape and fragmenting an important habitat block and travel corridor through the creation of roads.

While removing hard mast-producing species (oak in particular) in Dover may adversely affect black bears in this location, Alternative B may provide benefits as well since early successional habitat also supplies and provides for additional foraging opportunities. There would likely be opportunities to conserve and improve important hard mast-producing stands while also creating early successional habitat (Hammond 2018). For example, shelterwood treatments may be used to regenerate stands of oak while also yielding early successional habitat. The Forest Service would work with Vermont Agency of Natural Resource staff to minimize adverse effects to bear foraging habitat when planning activities in Compartments 52 and 186 per project design criteria (Appendix B, Wildlife). Provided adherence to this design criterion, adverse effects would be minimized and beneficial effects associated with increased abundance of early successional habitat and the regeneration of oak would be maximized. The changes to the composition and abundance of forage coupled with regenerating oak within these stands are anticipated to provide a net benefit to the black bear.

As previously discussed for landscape-scale habitat features, the types of roads proposed in Alternative B would not likely function as fragmenting features to a wide-ranging species like the black bear (VANR 2016).

In conclusion, project activities are not likely to adversely affect the connectedness of black bear habitat or the quantity of hard mast within Dover and Wardsboro with design criteria in place (Appendix B).

Coarse woody material

Whole-tree harvesting would only be considered in stands with existing aspen decline (due to age or disease) and limited sprouting potential (see Chapter 1, Table 5). In such instances, decreasing shade and physical interference from organic material would provide sprouts with a greater chance for survival. This treatment type would only be considered for an estimated 20 percent (approximately 3,410 acres) of the total proposed treatment acres within the project area. Based on a coarse analysis this may contain enough mature aspen stems to cut and rely on sprouting for regeneration. The actual percentage of acres treated through whole-tree harvesting would most likely be lower than 20 percent because many are unlikely to have high stocking of mature aspen.

All treatments involving the removal of timber would reduce the amount of downed coarse woody material simply because the harvested wood would never end up on the forest floor. With the application of Forest Plan standards for tree retention in harvested areas (Forest Plan, page 27), there would be an ample amount of woody material available to reach the forest floor providing important wildlife habitat.

Spruce-fir habitat

There would be no decrease to the percentage of native spruce-fir forest type as a result of proposed harvest activities, thus spruce-fir habitat would be maintained at the existing five percent across the analysis area. Although there are 601 acres of native spruce-fir forest type stands included in the total pool of stands proposed for harvest treatment in Alternative B, the silvicultural methods chosen would favor spruce-fir regeneration (see Chapter 1, Table 5).

Many shelterwood variants can be used to regenerate spruce-fir habitat types (Seymour 2018, Raymond et al. 2009, Seymour 1995, Seymour 1992). Group selection with smaller group sizes (one-half acre or less) is another viable method of regenerating spruce-fir habitat types (Seymour 2018). A combination of these methods, shelterwood group selection (in which shelter trees are retained within groups), is also a viable method (Seymour 2018, Leak et al. 2014). These methods provide partial shade, either from retained trees (shelterwood), edge trees (group selection), or a combination of retained and edge trees. Partial shade favors the establishment and growth of spruce-fir regeneration, thus maintaining this forest type on the landscape.

Early successional habitat

Up to 15,000 acres would be harvested in Alternative B over the life of the project. An estimated 80 percent of these harvests would be conducted using even-aged management harvest methods to regenerate the forest. The remaining 20 percent of stands would be treated with uneven-aged group selection harvest methods. By definition, stands treated with uneven-aged methods are not considered to be early successional since the stand would not be regenerated. Based on these percentages and the assumption stands proposed for treatment would be harvested following historical harvest entry schedules for past timber sales (Braun 2018a), this project would result in

a maximum of 3.2 percent of the total existing habitat within the analysis area to be in the 0 to 9 year age class at any point during the 15-year life of the project.

3.1.5 Cumulative Effects

The analysis area for cumulative effects on forest habitat composition consists of all lands within the extent of the National Forest proclamation boundary within the Manchester Ranger District. This area was chosen because it includes the area on which past, present and foreseeable future activities may have overlapping effects with the proposal. The analysis area is also extended to include high priority connectivity blocks adjacent to the proclamation boundary because the sum of small fragmenting activities within these blocks, regardless of land ownership, could have adverse effects on habitat connectivity. The cumulative effects analysis considers activities from approximately ten years ago to ten years after implementation of the final timber sale. A ten-year time frame was selected because it represents the approximate length of time after harvesting a stand would be considered to be in the regeneration (0 to 9 years) stage providing early-successional habitat. This time frame is also important when considering trends and changes in overall composition and age class distribution.

Past, present, and future actions on National Forest System lands resulting in or potentially resulting in effects to forest habitat composition and age class are primarily from management activities included in the Nordic, Dorest-Peru, South of Route 9 and Somerset integrated resource projects. This includes commercial timber management, and non-commercial vegetation management such as maintenance of permanent upland openings, apple tree release, and the treatment of non-native invasive plant species. Construction or maintenance of roads and trails could alter habitat conditions as well by fragmenting the landscape and creating barriers to wildlife movement.

Vegetation management is limited on non-National Forest System lands within the analysis area. The percentage of state- and privately-owned lands under ten years of age is believed to be below one percent and substantial increases in timber harvesting are not anticipated in the foreseeable future (Braun 2018b, McCullough 2018, Schneski 2018, Thornton 2018).

Landscape-scale habitat features

The amount of harvesting and road construction from all activities are not anticipated to have an adverse cumulative effect, because conducting the extent of timber harvesting and road building required to create an adverse fragmenting effect would be neither practical nor allowable under the Forest Plan and is not expected to happen on non-National Forest System lands.

Black bears

The only other project that has occurred or is expected to occur on National Forest System lands during the specified analysis time frame potentially affecting black bears in the Dover and Wardsboro area is the continued maintenance of a wildlife opening and feral apple orchard along Cobb and Reed Road in Wardsboro. The total size of this managed area is 37 acres. Given that management fosters soft mast at this site, this activity likely benefits black bear populations. Since Alternative B would provide early successional habitat while maintaining important stands of hard mast trees, Forest Service projects in this area are beneficial to black bear foraging habitat.

There are proposed development projects on private lands in Dover having the potential to adversely affect black bear foraging habitat, as well as the regionally significant bear travel corridor (Sabetto 2018). This development includes snowmaking pipeline construction at Mount Snow ski resort, and the Boulder Ridge housing development. These projects will take place at least one mile from any stands proposed for treatment. Because of the distance and since Alternative B is not likely to result in adverse effects to black bears, activities are not anticipated to exacerbate any issues caused by the proposed development on non-National Forest System land. In fact, the project area would continue to serve as a refuge for black bears from encroaching development on other lands.

Coarse woody material

Past, present, and future timber harvests on all lands would have cumulative effects associated with the recruitment of downed coarse woody material. Commercial timber sales, which have occurred and will continue to occur throughout the Manchester Ranger District over the course of the analysis period, would remove timber that otherwise would have ended up on the forest floor if natural forest succession was allowed to take place. However, because of Forest Plan standards governing the retention of live trees and snags, the effects are not anticipated to be adverse.

Spruce-fir habitat

Since there are no direct or indirect effects to native spruce-fir habitat, there are no cumulative effects from this project.

Early successional habitat

All past, present, and future timber harvests were considered in estimating the percentage of National Forest System lands within the Manchester Ranger District in the 0 to 9 year age class each year during the analysis period (Braun 2018a). Early successional habitat resulting from natural disturbance was estimated and included in the analysis as well. At most, four percent of these lands would be within the 0 to 9 year age class. When considering the contribution of non-National Forest System lands to this age class (below one percent) and since substantial increases in timber harvesting are not anticipated in the foreseeable future, the percentage of forested lands across the analysis area in the 0 to 9 age class would be even lower.

When only considering the National Forest System lands within the analysis area suitable for timber production (lands allocated to Management Areas where age class objectives apply), the highest amount of the 0 to 9 year age class would be about six percent. Although this would meet the 0 to 9 year age class objective on suitable lands for all habitat types except aspen (see Chapter 1, Table 1), it would still be at the low end of the desired range at the peak of project implementation.

3.2 Threatened, Endangered, and Sensitive Wildlife

Threatened, endangered, and sensitive wildlife species collectively include animal species federally-listed as threatened or endangered under the Endangered Species Act as well as Regional Forester Sensitive Species. Regional Forester Sensitive Species, referred to as "sensitive" species in this section, include animal species identified by the Forest Service for which population viability is a concern.

3.2.1 Issues

Although no issues were identified for threatened, endangered and sensitive wildlife species, the Endangered Species Act requires federal activities to not jeopardize the continued existence of any species federally listed or proposed as threatened or endangered. In addition, it is Forest Service policy to prevent the loss of viability for sensitive species at the Forest level (Forest Service Manual 2670).

The Biological Evaluation prepared for the ESHC Project (Hillman 2018) was used to describe the affected environment and disclose the environmental effects for threatened, endangered, and sensitive wildlife species.

3.2.2 Direct and Indirect Effects Analysis Area

The analysis area for direct and indirect effects for threatened, endangered, and sensitive wildlife species is all suitable habitats located within the ESHC Project area. This analysis area includes the locations of proposed management activities potentially impacting these species or their habitats.

The temporal context for this analysis includes both short-term (within 20 years) and mid- to long-term (50 to over 100 years from now) scales. The short-term scale would be expected to encompass full implementation of all proposed vegetation treatments and the immediate impacts of all management activities on habitat conditions. The long-term scale would account for management actions or disturbances that may result in changes taking more time to detect, such as shifts in habitat conditions related to forest types, age class distribution of vegetation, and habitat juxtaposition.

3.2.3 Affected Environment

Threatened and Endangered Species

The federally-listed threatened and endangered species known to occur on or near the Green Mountain National Forest are provided in Table 9.

The Green Mountain National Forest has only historical occurrence records for the gray wolf. This species is not known to occur on the Forest and its presence at any time in the near future is unlikely. A breeding population of the Canada lynx was recently discovered in northern Vermont and while individuals were recently observed wandering as far south as the project area, it is highly unlikely southern Vermont can support a breeding population. Moreover, project activities would not take place in the Canada lynx's preferred habitat. Considering their low likelihood of occurrence in the project area, the gray wolf and Canada lynx are not included further in this analysis.

The Indiana bat occurs on and near the Green Mountain National Forest during its active season and may occur in the few stands within the project area located at low elevations (maternity roosting colonies are found in areas below 1,100 above sea level). The bat may also occur within five miles of known hibernacula, the closest of which, Skinner Hollow Cave in Manchester, is nearly four miles from stands proposed for treatment. Indiana bats roost in trees larger than eight inches diameter at breast height with cavities or exfoliating bark.

The northern long-eared bat is found at higher elevations and roosts in smaller trees (as small as three inches diameter at breast height) than the Indiana bat and is likely to be present throughout the project area during the summer. The closest known hibernaculum is over a mile from any stands proposed for treatment. While the populations of both species have been decimated by white-nose syndrome, they have been documented recently near the project area.

Table 9: Species listed as threatened or endangered under the Endangered Species Act with current or historic occurrence in Vermont and on the Green Mountain National Forest.

Common Name	Scientific Name	ESA Status	Status on Green Mountain National Forest	Likelihood of Occurrence in Project Area
Gray wolf	*Canis lupus*	Endangered	Historic	Low
Canada lynx	*Lynx canadensis*	Threatened	Unknown	Low
Indiana bat	*Myotis sodalis*	Endangered	Current	Moderate
Northern long-eared bat	*Myotis septentrionalis*	Threatened	Current	High

Regional Forester Sensitive Species

This section includes consideration of sensitive wildlife species for which the Forest Service has identified population viability is a concern. There are 20 sensitive wildlife species listed for the Green Mountain National Forest. Table 10 provides the likelihood of occurrence in the project area for each species.

Table 10: Regional Forester Sensitive Species for the Green Mountain National Forest.

Common Name	Scientific Name	State Conservation Rank[1]/Status[2]	Likelihood of Occurrence in Project Area
Eastern small-footed bat	*Myotis leibii*	S1/Threatened	Moderate
Little brown bat	*Myotis lucifugus*	S1/Endangered	High
Tri-colored bat	*Perimyotis subflavus*	S1/Endangered	Moderate
Common loon	*Gavia immer*	S3	Low
Peregrine falcon	*Falco peregrinus anatum*	S3	Low
Bicknell's thrush	*Catharus bicknelli*	S2/Special Concern	Low
Rusty blackbird	*Euphagus carolinus*	S3/Special Concern	Moderate
Wood turtle	*Clemmys insculpta*	S3/Special Concern	Moderate
Spotted turtle	*Clemmys guttata*	S1/Endangered	Low
Jefferson salamander	*Ambystoma jeffersonianum*	S2/Special Concern	Moderate
Blue-spotted salamander	*Ambystoma laterale*	S3/Special Concern	Moderate
Four-toed salamander	*Hemidactylium scutatum*	S2/Special Concern	Low
Brook floater	*Alasmidonta varicosa*	S1/Threatened	Low
Creek heelsplitter	*Lasmigona compressa*	S2	Low
Boulder-beach tiger beetle	*Cicindela ancocisconensis*	S1	Low
Monarch butterfly	*Danaus plexippus*	S5	Moderate
Yellow-banded bumblebee	*Bombus terricola*	S2S3/Threatened	Moderate

Common Name	Scientific Name	State Conservation Rank[1]/Status[2]	Likelihood of Occurrence in Project Area
West Virginia white	*Pieris virginiensis*	S3S4/Special Concern	Moderate
Harpoon clubtail	*Gomphus descriptus*	S3	Moderate
Southern pygmy clubtail	*Lanthus vernalis*	S3	Moderate

[1] Conservation ranks provide an assessment of extinction risk based on factors like abundance, distribution, population trends, and threats. State ranks are assigned by the Vermont Nongame and Natural Heritage Program to reflect the rarity of the species within the state of Vermont. For avian species, the ranks apply to breeding status only. S1 = critically imperiled; S2 = imperiled; S3 = vulnerable to extirpation or extinction; S4 = apparently secure (VNHI 2017).

[2] Vermont State Status has two categories afforded legal protection under the Vermont Endangered Species Law (10 V.S.A. Chapter 123), endangered and threatened. The additional informational category of "special concern" is not established by law, but used to track rare species (VNHI 2017).

3.2.4 Direct and Indirect Effects

3.2.4.1 Alternative A: No Action

Most changes in habitat conditions on National Forest System lands within the project area for Alternative A would take place through natural processes such as wind and ice storms, fire, beaver activity, floods, insects and disease, and natural forest succession. In the short- and long-term, effects to habitat conditions for threatened, endangered, and sensitive wildlife species, and effects to individual animals, would be negligible.

3.2.4.2 Alternative B: Proposed Action

Threatened and Endangered Species

Alternative B may affect, but would not adversely affect, the Indiana bat. Only a small proportion of the proposed activities would take place where roosts are most likely to occur, or within five miles of known Indiana bat hibernacula, where fall swarming roosts are more likely to occur. These stands include Compartment 48, Stands 1, 2, 6, 8, and 9. A number of Forest Plan standards and guidelines and project-specific design criteria are in place to minimize impacts that project activities may have on the Indiana bat within these stands. These include the retention of wildlife reserve trees, snags, and den and nest trees, as well as restrictions for harvesting near known maternity roosting areas and hibernacula (Forest Plan, pages 27 to 29; and Appendix B, Wildlife). While these measures should greatly limit the possibility of direct impacts, the potential for removing roost trees while bats are hibernating, or removing trees that would become roost trees in the future as they mature, present the potential for indirect effects. The impacts to foraging habitat would be small and may even be beneficial since the Indiana bat is known to forage over open areas.

Alternative B may affect the northern long-eared bat but would not cause prohibited take under the Final 4(d) Rule governing incidental take[2] of the species. According to the Final 4(d) Rule,

[2] As defined in the Endangered Species Act, take means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Incidental take of federally listed

incidental take of the northern long-eared bat is prohibited only under the following conditions, neither of which would apply to the ESHC Project provided adherence to the design criteria (Appendix B, Wildlife):

1. It occurs within a hibernaculum.
2. It results from tree removal activities, and
    a. the activity occurs within 0.25 mile (0.4 km) of a known hibernaculum, or
    b. the activity cuts or destroys a known, occupied maternity roost tree or other trees within a 150-foot radius from the maternity roost tree during the pup season from June 1 through July 31.

While timber harvests would not be conducted during the June to July pup season (Appendix B, Wildlife) when bats are most vulnerable, harvests may still be conducted within the earlier or later portions of the bat's active season. Therefore, any individuals roosting in trees removed during the months of April, May, August, September, or October may be taken. Furthermore, roost trees removed while northern long-eared bats are hibernating would result in a loss of habitat even though individuals would not be directly impacted. While some foraging habitat (such as interior forest) may be temporarily lost after timber harvests, this amount of lost habitat would be negligible overall. The northern long-eared bat is not limited by foraging habitat since so much of the landscape is forested and much of it is now unoccupied after the population decline resulting from white-nose syndrome.

While the Forest Service is not required to conduct field surveys to determine if any hibernacula or maternity roost trees are within the action area of a project, the agency is expected to complete due diligence to find and review any and all available data. The Forest Service has the discretion to conduct bat surveys prior to project implementation and create buffer zones around important habitat features and/or time-of-year restrictions as needed to protect populations (Appendix B, Wildlife).

Given all of this, project activities may affect the northern long-eared bat. However, any incidental take resulting from these activities is not prohibited under the Final 4(d) Rule.

Regional Forester Sensitive Species

Alternative B would have no impact on sensitive species with a low likelihood of occurrence within the project area (see Table 10). There may be an adverse impact to individual species with a moderate or high likelihood of occurrence in the analysis area, but proposed activities are not likely to cause a trend towards federal listing or loss of viability.

3.2.5 Cumulative Effects

The analysis area for cumulative effects for threatened, endangered, and sensitive wildlife species and their associated habitats includes all lands within the proclamation boundary of the Manchester Ranger District and extending out to cover normal movement areas of each species. The time frame is the same as described for the direct and indirect effects analysis area.

species is used to describe take that is unintended and not the purpose of carrying out an otherwise lawful activity. If it is determined that a project could or will result in prohibited incidental take, formal consultation with the United States Fish and Wildlife Service is required.

Past, present and future actions on National Forest System lands resulting in or potentially resulting in effects to threatened, endangered, and sensitive wildlife species and their associated habitats are primarily from management activities included in the Nordic, Dorest-Peru, South of Route 9 and Somerset integrated resource projects. This includes commercial timber management, and non-commercial vegetation management such as maintenance of permanent upland openings, apple tree release, and the treatment of non-native invasive plant species. Construction or maintenance of roads and trails could alter habitat conditions as well by fragmenting the landscape and creating barriers to wildlife movement.

Considering the minimal likelihood of measurable effects to most threatened, endangered, and sensitive wildlife species from Alternative B, and the relatively low level of impacts from other known actions within the analysis area, the addition of the proposed activities is unlikely to result in measureable cumulative impacts to the majority of species discussed in this section.

The only possible exceptions are the northern long-eared bat, little brown bat, and tri-colored bat. These bat species, although far less abundant than they were before the advent of white-nose syndrome, can be found roosting in trees throughout the effects analysis area. All timber harvests occurring during the active season of these bats (generally April through October) could impact individuals. While these species are not limited by the availability of roosting or foraging habitat, there are cumulative effects associated with the take of individual bats while they are roosting in trees.

Of all the woodland bat species, the northern long-eared bat has the highest potential for suffering cumulative impacts from timber harvests because it is widespread in forest interior habitats and roosts almost exclusively in trees. Virtually all timber harvests conducted during the species' active season could impact individuals. The U.S. Fish and Wildlife Service estimates up to 0.7 percent of the Vermont northern long-eared bat population will be disturbed and 0.1 percent of the pup population and less than 0.05 percent of the adult population will be harmed annually from the combination of timber harvest, prescribed fire, forest conversion, and wind turbine operation. Therefore, the vast majority of individuals and populations surviving white-nose syndrome will be unaffected by these activities. This degree of take is not expected to lead to population-level declines of this species (USFWS 2016). Thus, while cumulative effects to the northern long-eared bat are quantifiable, they are not anticipated to be adverse. Since adverse cumulative effects to northern long-eared bats are not likely, the same can be said of the little brown bat and tri-colored bat since, generally speaking, they share similar forested habitats.

White-nose syndrome continues to be a major concern for local, hibernating bat species, although the likelihood of Alternative B exacerbating impacts of white-nose syndrome is low. The Forest Service will continue to work collaboratively with the U.S. Fish and Wildlife Service and the Vermont Department of Fish and Wildlife for assessment and management of white-nose syndrome in Vermont.

3.3 Threatened, Endangered, and Sensitive Plants

Threatened, endangered, and sensitive plant species collectively include species federally-listed as threatened or endangered under the Endangered Species Act as well as Regional Forester Sensitive Species. Since there are no plants federally listed as threatened or endangered for the Green Mountain National Forest, there is no discussion of them in this section. Regional Forester

Sensitive Species, referred to as "sensitive" species in this section, include plant species identified by the Forest Service for which population viability is a concern.

3.3.1 Issues

Although no issues were identified for sensitive plant species, it is Forest Service policy to prevent the loss of viability for sensitive species at the Forest level (Forest Service Manual 2670).

The Biological Evaluation prepared for the ESHC Project (Deller 2018) was used to describe the affected environment and disclose the environmental effects for sensitive plant species.

3.3.2 Direct and Indirect Effects Analysis Area

Since potential effects would occur only in the physical locations of the proposed activities, the spatial extent of the direct and indirect effects analysis is the stands in which proposed activities would occur. The temporal extent of the direct and indirect effects analysis would start when management activities begin and would continue indefinitely in the case of habitat conversion.

3.3.3 Affected Environment

Based on pre-field review of stand data, the project area includes a variety of upland coniferous and deciduous forest types, plus both forested and open wetlands and maintained openings. Variable site indices indicate variable levels of site nutrient enrichment, and topographical information indicates varied elevation and varied potential for wet habitats.

Four sensitive plant species are documented to occur within the project area where work is proposed:

- *Carex aestivalis* in compartment 261, stand 65
- *Eriophorum tenellum* in compartment 44, stand 105
- *Juglans cinerea* on the border stands 4 and 9 in compartment 28
- *Panax quinquefolius* in compartment 251, stand not disclosed because of threats due to collection

Additional sensitive plants having potential habitat where work is proposed include 21 species potentially occurring in wetlands, 20 species potentially occurring in upland wooded sites (including two that could also occur in wetlands), and three species potentially occurring in upland openings.

3.3.4 Direct and Indirect Effects

Direct effects could result from activities such as equipment driving over plants, trees being felled on top of them, prescribed fire that burns them, or people trampling them. Indirect effects could result from a change in light making the habitat less suitable, a conversion of forested to open habitat, or ground disturbance and increased light facilitating invasion by non-native invasive plants.

3.3.4.1 Alternative A: No Action

No effects would be expected as a result of Alternative A. Any Sensitive plants potentially present would not be trampled, driven over, burned, or have trees felled onto them. Light would not be increased, habitat would not be converted, and the invasion of non-native invasive plants would not be facilitated.

3.3.4.2 Alternative B: Proposed Action

The four species known to occur within the analysis area can be avoided and their habitat quality can be maintained. No effects would be expected, so these species are not discussed further.

For three of the Sensitive species with potential habitat in the project area (*Galium kamtschaticum*, *Platanthera orbiculata*, and *Stellaria alsine*), the chance of direct or indirect effects to any of them is low, though not impossible. These species have broadly-defined potential habitat that is wide-spread in the project area (such as coniferous woods or seeps), and as a result, project design criteria require a sampling scheme be developed for surveying for them, rather than a complete survey (Appendix B, Sensitive Plants). It is, therefore, possible small populations would be overlooked. These could be trampled, driven over, burned, or have trees felled onto them. Light would be increased, their suitable habitat could be converted, and the invasion of non-native invasive plants could occur. Although project design criteria would limit the spread of non-native invasive plants (Appendix B, Sensitive Plants), they are unlikely to be completely effective.

For the other 43 Sensitive species with potential habitat in the project area, no effects are expected. Project design criteria require botanical field surveys prior to project implementation for these species associated with habitats where work is proposed, and also require development of protective measures for any Sensitive species found during those surveys (Appendix B, Sensitive Plants). Protection means not trampling (by people or machines), felling trees on top of, burning, or changing the habitat suitability of any Sensitive species found.

Since effects would be minimal for some species and non-existent for most, and because none of those known to occur are rare enough to be state-listed in Vermont, there is unlikely to be a trend toward federal listing for any Sensitive plant species as a result of Alternative B.

3.3.5 Cumulative Effects

The spatial extent of the cumulative effects analysis area is the entire Green Mountain National Forest, because Forest Service policy directs us to prevent loss of viability for a species at the Forest level (Forest Service Manual 2670). The temporal extent of the cumulative effects analysis is the length of the Forest Plan planning period (15 to 20 years) because species viability evaluations were completed during the 2006 Forest Plan revision, are reevaluated whenever the sensitive species list is updated (most recent update in 2017), and would be completed again the next time the Forest Plan is revised (not likely any longer than 20 years from the previous evaluation).

The three Sensitive species with more broadly defined and wide-spread potential habitat (*Galium kamtschaticum*, *Platanthera orbiculata*, and *Stellaria alsine*) are known from elsewhere on the Green Mountain National Forest (six, eight, and seven populations, respectively). Currently, there

are no known activities (past, present, or future) overlapping with any of their known occurrences causing their populations to decline. This, in combination with the limited possibility any of them would be harmed as a result of proposed project activities, suggests cumulative effects on any Sensitive species are unlikely. However, an additional factor that could affect the habitat with which each of these three species is climate change. Climate change research, summarized in part by Mattrick (2009), suggests while there is no doubt climate is changing and habitats and species may be affected by this change, the nature of the change is uncertain, is likely to vary greatly by species and geographic area, and is not likely to contribute cumulatively to a change in Sensitive species populations in these types of habitats within the analysis timeframe because plant community changes occur relatively slowly.

Since there would be no direct or indirect effects expected to habitat or project design criteria would protect known or newly discovered occurrences (Appendix B, Sensitive Plants), cumulative effects would be minimal for the species known to occur as well as the species with potential habitat within the project area.

3.4 Non-native Invasive Plants

3.4.1 Issues

Although not identified as a substantive issue, there is concern harvest and road activities will introduce non-native invasive plants to the project area. Forest Service Manual 2900 directs us to determine the risk of introducing, establishing, or spreading invasive species associated with any proposed action, and to provide measures to reduce or eliminate that risk prior to project approval. Risk assessments for stands proposed for harvest treatment or locations proposed for road construction or use containing or adjacent to infestations will follow guidance provided by *Non-native Invasive Species Framework for Plants and Animals in the U.S. Forest Service Eastern Region* (USDA Forest Service 2003). A low to moderate risk rating is considered an acceptable level of effect related to non-native invasive plants for this project.

3.4.2 Direct and Indirect Effects Analysis Area

For all non-native invasive plants, direct effects include things such as wheeled or tracked equipment moving seeds or other viable plant propagules from one location to another. Indirect effects include the potential for ground disturbance and increased light from project implementation to provide increased opportunities for non-native invasive plants to become established in new locations, plus the establishment of new pathways of dispersal along newly created roads, both permanent and temporary. Since these activities would occur at the exact location of project implementation, the area for the direct and indirect effects analysis includes all sites where proposed vegetation management and other activities would occur, including all travel corridors proposed for use in implementing the proposed activities.

3.4.3 Affected Environment

Terrestrial habitat types in the project area include a mix of uplands and wetlands, plus roads, trails, and rivers that could serve as pathways for dispersal.

Non-native invasive plants known to occur in or adjacent to stands proposed for activities include goutweed, garlic mustard, wild chervil, common barberry, spotted knapweed, cypress spurge, Morrow honeysuckle, purple loosestrife, wild parsnip, common reed, Japanese knotweed, common buckthorn, glossy buckthorn, and multiflora rose. Currently, 39 stands proposed for treatment under the ESHC Project have known infestations in them, and 42 stands have known infestations adjacent to them; many stands have both. Surveys specific to this project have not yet been completed, and so it is likely many more infestations exist than are currently known.

3.4.4 Direct and Indirect Effects

3.4.4.1 Alternative A: No Action

Non-native invasive plants would still occur in all locations where they are currently known, and would not likely be prioritized for treatment. They would still be spread by natural means, such as water, wind, and wildlife.

3.4.4.2 Alternative B: Proposed Action

All of the non-native invasive plants known to occur in the project area can outcompete native species, including some tree seedlings and saplings, and some also are human health hazards. Wherever proposed activities overlap with or are adjacent to known infestations, the ground disturbance and increased light associated with early successional habitat creation will facilitate the establishment and spread of infestations. Wherever new roads, including temporary skid roads, are established, these can serve as pathways of dispersal for non-native invasive plants. Where roads are wide enough to allow for the passage of logging trucks without contacting roadside vegetation, infestations would not be likely to be spread by these vehicles. However, these infestations still provide a seed source that could easily spread into adjacent stands proposed for harvest.

No means of non-native invasive species control is effective all of the time and available resources will always limit implementation of control methods. Small amounts of seed or other plant propagules are likely to be introduced where ground is disturbed no matter how well equipment is cleaned prior to accessing sites. Although Forest Plan standards and guidelines and project design criteria (Appendix B, Non-native Invasive Plants) are not capable of being completely effective to reduce the extent to which existing infestations expand and new infestations get established, these protective measures would still result in a low to moderate risk rating for non-native invasive plants.

3.4.5 Cumulative Effects

Since the current model for non-native invasive plants risk assessment focuses on non-native invasive plants within or immediately adjacent to the project area, the analysis area for cumulative effects is defined as such (USDA Forest Service 2003). Any activity that disturbs ground, increases the amount of light reaching the soil, or involves the movement of equipment from sites where non-native invasive plants occur to uninfested sites has the potential to increase the effect of non-native invasive plants on other resources (USDA Forest Service 2012a). Since disturbances that spread non-native invasive plants or increase the chance of infestations are ongoing, no timeframe is defined for the analysis.

Given what is known about the current level of infestations of non-native invasive plants, combined with ongoing natural and human-caused disturbances, the cumulative effect of Alternative A might be that known infestations will get worse, and other forest resources (for example, tree regeneration, rare plant viability, and wildlife habitat quality) may be increasingly negatively affected over time. It is expected this would happen quite slowly, relative to the proposed action.

The cumulative effect of Alternative B, plus any other past, present, or future activities that increase light, disturb ground, or facilitate dispersal, plus climate change, could consist of infestations growing even further beyond control and affecting other resources, such as the quality of fish and wildlife habitat, the ability of trees to regenerate, the ongoing viability of rare plant populations, soil stability, or human safety and wellness.

Design criteria have been developed to minimize these effects (Appendix B, Non-native Invasive Plants), but it should be noted none of the design criteria would entirely prevent or eliminate problems. The extent of the cumulative effect would depend on the extent to which design criteria are able to be fully implemented and the degree to which they are successful.

3.5 Aquatic Resources

3.5.1 Issues

The substantive issue (see Chapter 1, Section 1.5), indicator for effects and acceptable effects threshold associated with this resource includes:

- The degree of proposed roadbuilding would have negative effects on water quality.

  Indicator: Parameters used to determine water quality are defined by the State Water Quality Standards (VANR 2017).

  Threshold: Noncompliance with State Water Quality Standards (Forest Plan Goal 4, page 13).

Although not identified as a substantive issue, there is also concern there would be effects from proposed activities to riparian areas, vernal pools, and state of Vermont Class A(1) surface waters. The same indicator and threshold used for effects from roadbuilding are applied.

3.5.2 Direct and Indirect Effects Analysis Area

The analysis area for the direct and indirect effects for aquatic resources (fisheries and water) consists of those locations in streams and riparian areas within the project area where water quality and fish habitat may be disturbed by forest management and road construction throughout the project area.

Specifically, this would include all stands proposed for vegetation management and associated permanent OML 1 and temporary roads, skid roads and trails, and landings along streams; and snowmobile trail and road construction/reconstruction activities crossing streams or located

within riparian areas. The timeframe for the effects analysis is 20 years, the approximate number of years expected to implement proposed project activities.

3.5.3 Affected Environment

The ESHC Project area is drained by portions of five distinct watersheds: Otter Creek, West River, Batten Kill, Deerfield River, and Hoosic River. The streams range from high-gradient channels and beaver-dominated wetland complexes in the upper elevations to low- and moderate-gradient channels as they descend in elevation. Stream bottoms consist primarily of boulder, rubble, and gravel with sand and fine sediments and silt found in moderate-gradient streams or valley-bottom reaches. Riffles and cascades are the predominate habitat types found in these streams, with pool habitat comprising only a small percentage (generally less than ten percent) of the total habitat area of each stream. Beaver impoundments exist along many of the drainages. Although transitory and temporary in nature, these ponds provide pool habitat for a variety of fish and wildlife species. The streams in the project area also have low quantities of large woody debris in their channels resulting in low habitat diversity and limited cover for fish and aquatic organisms. Fish communities are dominated by native brook trout in headwater streams with occurrences of brown trout at lower elevations. Non-game species include but are not necessarily limited to longnose dace, blacknose dace, creek chub, common shiner, and brown bullhead.

Riparian habitat along the upland (higher elevation/mountain-side) streams in the project area contain a variety of vegetation types including hardwood, mixed forest, wetland meadows, and hemlock-dominated stands. The understory vegetation contains a mix of hardwood and softwood saplings and small diameter trees and many common species of ground flora. The riparian vegetation functions to provide shade over stream channels, maintain bank stability, and filter sediment and water runoff to protect aquatic habitats for fish, amphibians, reptiles and aquatic insects, and provide good water quality.

In Vermont, surface waters are classified by the governing water quality law implemented through State rules and guided by Vermont Agency of Natural Resources policy pursuant to the Water Pollution Control Act of 1972 (Clean Water Act, or Act). Pursuant to the Act, States are required to establish and implement water pollution control programs. In particular, delegated states like Vermont must classify surface waters, designate specific uses to each classification those surface waters are managed to support, and adopt specific water quality criteria designed to protect the designated uses at the established classification level (VANR 2017).

Class A(1) surface waters are afforded the highest protection and therefore have the most restrictive water quality criteria. These waters must be maintained in a natural condition. However, this does not mean there can be no land management in the watersheds, lakeshores, or stream corridors of Class A(1) surface waters. Rather, activities must be carried out in such a way as to maintain the natural condition of streams compatible with the designated uses set forth in the Water Quality Standards.

The following streams within the project area are designated as A(1) streams for aquatic biota, aquatic habitat, and fishing:

- All streams over 2,500 feet in elevation
- All streams located within designated wilderness areas and the Robert T. Stafford White Rocks National Recreation Area

- Deerfield River and its tributaries beginning upstream of the confluence of the Rake Branch watershed, including the Castle Brook and Glastenbury River watersheds
- Mount Tabor Brook from its headwaters in the Peru Peak Wilderness and Robert T. Stafford White Rocks National Recreation area, and tributaries, downstream to its confluence with Utley Brook

The following ponds within the project area are designated as A(1) waterbodies for aquatic biota and aquatic habitat:

- Moses Pond and upstream tributaries
- Stamford Pond and upstream tributaries

3.5.4 Direct and Indirect Effects

3.5.4.1 Alternative A: No Action

There would be no disturbance to stream channels from Alternative A; no change or loss of fish habitat and riparian vegetation; no risk to other aquatic resources, including vernal pools; and no degradation of water quality. Soil stabilization on eroding trails and roads would not take place. Alternative A would result in no direct effects because no management actions would be undertaken negatively or positively impacting fish and water resources.

There would be indirect effects on the fisheries and water resources in the project area, because no management actions would be taken to reduce erosion and sedimentation currently existing from unclassified roads and trails.

3.5.4.2 Alternative B: Proposed Action

A number of activities associated with Alternative B would generally result in varying degrees of soil or vegetation disturbance potentially impacting water quality and fish habitat. The construction and use of permanent or temporary roads can potentially degrade water quality if improperly designed or placed where soil erosion and runoff would occur leading to sedimentation of streams and other waterbodies. Improper or lack of road maintenance during and following use can lead to deterioration of road surfaces, ditches, waterbars and other features. Poor design or lack of maintenance can also lead to improper water drainage especially if culverts or drainage features fail.

Proposed activities would be implemented in compliance with protective measures including Forest Plan standards and guidelines, National Best Management Practices for Water Quality (USDA Forest Service 2012b), and Vermont Acceptable Management Practices (VANR 2018). Protective filter strip standards for riparian areas (Forest Plan, page 20) direct the application of protective vegetation buffers along water sources preventing sediment delivery into streams, providing adequate shading for maintaining instream temperatures, and enhancing habitat for native fish and aquatic organisms. Buffer guidelines would also provide for future large woody debris recruitment into stream channels, creating habitat diversity and complexity within headwater streams (Forest Plan, page 21). In addition, permanent and temporary stream crossings

would maintain aquatic passage in fish bearing streams and would not create barriers to migration (Forest Plan, page 20).

Many of the existing roads (system and unclassified) and trails often have few if any water control devices such as waterbars and those containing such devices are often poorly functioning or otherwise inadequate. Culverts left in place on these roads and trails are often undersized and are easily overtopped or scoured out during high water events resulting in sediment and road gravels being delivered to streams. Alternative B would improve aquatic resources by initiating restoration of stream function and hydrology where unclassified roads and trails are currently contributing to soil loss and embeddedness within stream channels. It would also allow for the implementation of proper drainage structures and a return to hydrologic processes which have been negatively impacted by previous road construction and unauthorized use.

Overall, project activity effects on stream habitat and water quality resources would be minor because protection measures discussed above, and application of project specific design criteria (Appendix B, Aquatic Resources and Soil/Wetlands) would be effective in avoiding and/or minimizing effects. Past monitoring of projects has included the review of stream channel stability, sedimentation, turbidity, temperatures, aquatic insect viability, and fish populations. This monitoring indicates forest management activities are not violating State Water Quality Standards or negatively impacting aquatic resources in other ways (USDA Forest Service 2000, 2004, 2007a, and 2009). It follows that as long as all harvesting carried out on National Forest System lands is compliant with state and Forest Service protective measures, the activity is presumed compliant with the Water Quality Standards. In addition, the Vermont Agency of Natural Resources has worked with Forest Service staff to empirically document the protectiveness of their forest management practices (VANR 2016b, VANR 2017). Therefore, activities associated with Alternative B are not expected to exceed the threshold for adverse effects to water quality.

3.5.5 Cumulative Effects

The cumulative effects analysis area for aquatic resources includes the five major watersheds within the project area, because it encompasses activities that may spatially overlap effects from proposed activities. The timeframe for this cumulative effects analysis is ten years in the past and 20 years into the future after implementation of the final timber sale. The cumulative effects of past, present, and foreseeable future activities in the analysis area that have resulted in, or could result in, additional stream habitat and water quality effects are general ground disturbing activities, timber harvesting, road and trail construction and maintenance, and encroachment of development and agriculture into riparian areas. These activities tend to increase sedimentation and reduce riparian vegetation.

It is reasonable to assume sediment and runoff from ground disturbing activities have entered streams over the past decade although habitat surveys have indicated sediment loading is not a concern on headwater streams of the Green Mountain National Forest (McKinley 2018). However, sedimentation and runoff resulting from past projects have the potential to adversely affect hydrologic processes, stream bottom habitat, and fish populations.

Additional timber harvests are expected on National Forest Systems lands over the period of analysis (Braun 2018a). The same protective measures discussed for direct and indirect effects would apply to these harvests. Some relatively low level of harvesting is projected to be implemented on private and state lands during the period of analysis. It is assumed the Vermont

Acceptable Management Practices (VANR 2018) for protecting and maintaining instream and riparian habitats would be followed during timber harvesting on these lands, and thus would result in little or no adverse impacts.

Sediment and runoff from past ground disturbing activities has to some degree negatively affected stream bottom habitat and fish populations. The proposed ground disturbing activities and appropriate design criteria have the ability to minimize past and reasonably foreseeable activities which would not produce an overall adverse cumulative impact. In fact, it is expected Alternative B would lead to an overall positive cumulative effect by improving overall aquatic resource quality through the implementation of protective measures including project specific design criteria (Appendix B, Aquatic Resources, and Soil/Wetlands).

Encroachment into riparian areas from infrastructure and agriculture can have negative impacts on stream habitat by reducing shade or increasing sediment delivery. It is expected development would remain at low levels. There are no such developments planned on National Forest System lands and none foreseeable on private lands that would impact aquatic habitat in this way. While some Town Zoning Bylaws (Bennington, Woodford) consider protections for riparian areas, some do not. Large commercial or residential developments would require state Act 250 permits which would promote riparian area protection. Consequently, development in and near riparian areas would not have an overall negative cumulative impact on aquatic resources.

3.6 Soils and Wetlands

3.6.1 Issues

The substantive issues (see Chapter 1, Section 1.5), indicators for effects and acceptable effects thresholds associated with these resources includes:

- The degree of proposed roadbuilding would have negative effects on forest resources.

  Indictors and Thresholds: Table 11 provides the indicators and thresholds of effects for proposed ground disturbing activities associated with soils. Soil quality standards are designed to reduce soil property changes to relatively low intensities, reducing ecological risks of negatively affecting ecosystem components, functions or services to low. In one to three years following harvest or prescribed burning, negative changes to soil property change indicators would be kept below the thresholds in each stand proposed for harvest. Acres affected by road, skid road/trail and landing construction and reconstruction can also help indicate amounts and levels of detrimental soil disturbance.

Table 11. Soil property change indicator thresholds (soil quality standards)

Soil Property Change Indicator	Threshold - Percent of Harvest Stand Area
Compaction below four inches in depth	15
Erosion (sheet, rill, gully)	5
Rutting or puddling below four inches in depth	5
Mixing of surface layers	10
Topsoil displacement	15
Mineral soil exposed	5
	Threshold – Other Parameter
Litter layer loss (inches)	1 inch
Leaching	Bole-only removal, except in some conditions for aspen regeneration harvest

Source: Soil Quality Standards for Harvest Areas in the Early Successional Habitat Creation Project Area (USDA Forest Service 2018b).

- Whole tree harvesting would result in insufficient retention of coarse woody material on the forest floor, which would have negative effects on soil productivity.

  Indicator: The amount of nutrient loss.

  Threshold: The amount of nutrient loss from biomass removal impairing long-term soil productivity as defined by the Forest Plan Final Environmental Impact Statement, Chapter 3, pages 3-30 and 3-31. (USDA Forest Service 2006b).

Although not identified as substantive issues, the following concerns were identified:

- Timber harvesting activities including the construction and use of landings, and skid road and trails could negatively impact soil productivity.
- Prescribed burning and associated fire line construction could negatively impact soil productivity and wetland habitat.

  The same indicators and thresholds used for general ground disturbing activities are applied for effects from timber harvesting activities and prescribed burning/fire line construction.
- Cutting trees within wetlands does not improve its habitat and should be allowed to function naturally.

  The acceptable effect threshold is to maintain long-term wetland habitat and functions within areas treated.

3.6.2 Direct and Indirect Effects Analysis Area

The soil and wetland resource effects analysis area consists of those areas where soils or wetlands could be disturbed, as a result of any activities in the Proposed Action. For this analysis,

disturbance consists of where soils are excavated, moved, mixed, or compacted, or organic matter is lost or burned. Spatially, the affected environment consists of all stands or areas proposed for:

- Vegetation management activities including landings, skid roads and trails needed to harvest trees
- Permanent and temporary road construction, improvement, maintenance, or closure
- Site preparation to improve tree regeneration by mechanical treatments or prescribed burning
- Wetland treatment

The timeframe for the effects analysis is 20 years, which is the timeframe expected when effects from timber harvesting, road building and prescribed burning activities would be realized.

3.6.3 Affected Environment

Dominant soils in the analysis area are common in the Green Mountain National Forest and include shallow to very deep, poorly to well drained, coarse-loamy soils on 10 to 35 percent slopes (NRCS 2017). Important forest soil functions include water purification, water storage, flood mitigation, nutrient cycling, supporting biodiversity, and air quality regulation. Soil quality is generally good although it is degrading on some existing non-system road and trail segments due to compaction, loss of topsoil and erosion. There are also signs of erosion around culverts and on bare cut banks on some system roads and trails. The erosion and surface flow over these soils contributes to sediment loading in streams.

Approximately 35 percent of the soils in the proposed timber harvest stands are rated as having moderate soil erosion hazard by the Natural Resource Conservation Service, with approximately 13 percent of the soils in proposed stands rated as severe, and approximately 0.2 percent, or 34 acres, rated as very severe, due to the steepness of the slope grades (USDA Forest Service 2018c). Erosion hazard ratings indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities expose the soil surface:

- A severe erosion hazard indicates erosion is very likely without soil conservation measures (including Vermont Acceptable Management Practices, Forest Plan standards and guidelines, and project design criteria).
- A very severe erosion hazard rating indicates substantial erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Wetlands located in the project area vary in size and location. There are 175 identified wetlands equal to or greater than 0.5 acres in size in proposed harvest stands, and six vernal pools, which are potentially in or adjacent to planned harvest activities. Approximately 70 percent of these wetlands are State Class II Wetlands which have special protection under State Wetland Rules. There are multiple smaller wetlands within the project area with the majority occurring in low sloping, concave landscape positions. Wetlands are generally in good to excellent condition. They are fully vegetated and maintain their important functions and values such as providing food and habitat for wildlife, water storage and infiltration, flood protection, and nutrient filtering to improve water quality.

3.6.4 Direct and Indirect Effects

3.6.4.1 Alternative A: No Action

Alternative A proposes no soil or wetland-disturbing management activities. Existing areas of bare soil and erosion on roads would continue to erode at varying rates. The erosion and surface flow over these soils would continue contributing sediment loading in streams. On most sites, soil productivity would increase because all biomass would remain on-site. However, soil acidification, due to atmospheric deposition, may continue to deplete calcium from forest soils. Soils would not be subject to the risks of erosion and compaction inherent with activities such as tree harvesting, road construction, and prescribed burning.

Opportunities to improve soil and wetland conditions, as described in Alternative B, would be forgone. For example, existing soil quality degradation on some non-system roads and trails would not be addressed.

3.6.4.2 Alternative B: Proposed Action

Activities included in Alternative B and corresponding soil and wetland resource risks are summarized in Table 12.

Table 12: Summary of potential soil and wetland impacts from proposed management activities.

Proposed Management Activity	Amount Proposed	Relative Soil/Wetland Effects[1]	Design criteria needed?[2]
Permanent and temporary road construction	up to 25 miles	very high	yes
Timber harvest	up to 15,000 acres	moderate to high	yes
Whole-tree harvest	up to 3,410 acres	high	yes
Site preparation for natural regeneration (hand tools and mechanized equipment)	up to 15,000 acres	minimal to low	no
Site preparation for natural regeneration (prescribed fire)	up to 15,000 acres	moderate	yes
Wetland tree cutting treatments	nine acres	low	no

[1] Project Soil Quality Standards (USDA Forest Service 2018b) provide a process for estimating the ecological risk (low, moderate or high likelihood) of negatively affecting an ecosystem component, function, or service due to potential change or effects to soil properties from a specific activity.
[2] Design criteria (Appendix B, Soils and Wetlands) have been developed to mitigate changes or effects to soil properties below the acceptable thresholds when the ecological risk is moderate or high.

Forest Plan standards and guidelines for Soil, Water, and Riparian Area Protection and Restoration (Forest Plan, pages 20 to 22) including Vermont Acceptable Management Practices (VANR 2018), and design criteria (Appendix B, Soils and Wetlands) would be implemented for all pertinent proposed Alternative B activities. Meeting the ESHC Project soil quality standards would further keep soil property changes to relatively low intensities, resulting in low ecological risks of negatively affecting ecosystem components, functions or services. As a result, no

detrimental effects to soil productivity or wetland functions are anticipated with this project including proposed construction of permanent OML 1 and temporary roads, harvest activities including whole-tree harvest, prescribed fire including fireline construction, and wetland treatments.

Proposed activities with low to minimal effects are not discussed further. Activities with moderate or higher level of potential effect are discussed in the following sections.

Permanent and Temporary Road Construction

Road construction causes compaction, rutting, erosion, reduced soil productivity, and potential sediment deposition into wetlands and stream channels. Up to 25 miles of temporary and/or OML 1 permanent roads would be constructed for proposed vegetation management resulting in soil disturbance on approximately 66.7 acres assuming a road clearance of 22 feet, plus up to four feet on either side of the road for ditches and grading. About 15 miles (or 40.0 acres) of these roads would follow existing non-system roads or trails of varying conditions. The remaining 10 miles (or 26.7 acres) would be constructed where no existing road template exists.

Of the 25 miles of proposed road construction, up to 17 miles are estimated to be OML 1 roads depending on site conditions where stand access is needed (see Chapter 1, Table 6). System roads are considered a permanent commitment of forest resources and are not considered detrimental soil conditions (USDA Forest Service 2012c). Soil properties within the road prism are altered to the degree where they do not resemble native soil properties after construction, resulting in reduced surface water infiltration, and loss of overall long-term soil productivity. Where temporary roads are proposed, soil quality effects would be similar to permanent roads, but can be less depending on site conditions including type of soil, slope, number of stream crossings, and season and extent of use. Severity of effects are also tied to whether or not the road follows an existing road template, whereas the former would not be expected to result in much more impact than has already occurred.

Sixty percent of soil disturbance would be on soils with a severe erosion hazard rating, indicating erosion is very likely and slope failure is a concern on steep slopes. Slope, precipitation, and soil moisture influence soil erosion types and rates. Adding more permanent road miles in areas where the instability and erosion risks are high can cumulatively contribute to adverse negative effects to watershed health. Erosion-control measures, including operating equipment during appropriate winter conditions and revegetation of bare areas, are important to minimize soil erosion within acceptable levels (Appendix B, Soils and Wetlands).

Road Closure and Maintenance

The construction of OML 1 roads would become part of the Forest Service road system; as such they would be maintained as needed to meet road maintenance objectives. Improperly maintained system roads can result in erosion and sediment transport. Road closure to vehicle traffic following use, removal of drainage structures, and routine maintenance of infrastructure would minimize negative effects to soil quality to acceptable levels (Appendix B, Soils and Wetlands).

After the construction and use of temporary roads where no existing road template exists, it is difficult to revert soils in the road prisms back to functioning pre-construction conditions over the course of 20 years, without substantial effort. Improperly implemented or delayed closure and restoration can result in unacceptable erosion and sedimentation runoff degrading water quality in nearby streams. Road closure and restoration activities provided by project design criteria would

minimize these effects negating permanent impairment of soil productivity (Appendix B, Soils and Wetlands).

Temporary roads proposed to follow existing unclassified roads may contribute increased sediment loads after use, because some segments are in locations having ongoing soil degradation occurring. In addition, many non-system roads are in conditions not supporting tree growth and continue to reduce soil quality in the project area. Additional effects from vegetation removal and compaction along these roads from timber hauling activities would further compromise resources. This would be partially mitigated by the road restoration work returning the road template to pre-project use conditions. There would also be an attempt to avoid locating temporary road access along existing unclassified road segments where ongoing effects would be exacerbated (see Chapter 2, Table 6).

Whole Tree Harvest

There would be up to 20 percent of the total harvest treatment areas, or about 3,410 acres proposed for whole tree harvest[3] where site conditions warrant this method (see Chapter 1, Table 5).

Whole tree harvesting can reduce the amount of downed coarse woody material compared to other harvest treatment methods. Downed coarse woody material reduces risks of erosion by increasing water-holding capacity and reducing overland flow, and serves as a long-term nutrient source. A direct effect of timber harvest, most pronounced with clearcuts and whole-tree harvests, is the loss of site nutrients contained in the harvested biomass. A loss of biomass nutrients could decrease future soil nutrient levels. Indirect effects to soil quality from whole tree harvesting include (Hornbeck and Leak, 1992, Adams et al. 2000):

- Nutrient leaching losses following harvest as a result of accelerated decomposition of organic matter due to increased soil temperature and moisture
- Accelerated nitrification
- Short-term acidification of the soil solution
- Temporary reduction in nutrient uptake by vegetation
- Small acceleration in the chemical weathering of inorganic materials in soils and rocks

Oak trees accumulate more calcium in their foliage and, on a whole-tree harvest basis, can remove almost 100 percent more calcium than a mixed hardwood/softwood harvest. Softwood harvests, in general, remove less calcium compared to hardwood removal because they accumulate less calcium in their biomass. (Federer et al. 1989). The implementation of design criteria (Appendix B, Soils and Wetlands) would reduce risks of nutrient losses from whole tree harvesting to acceptable levels as provided by the Forest Plan Final Environmental Impact Statement, and thus long-term soil productivity would not be impaired (USDA Forest Service 2006b).

[3]Sometimes referred to as biomass removal, for purposes of this project whole tree harvesting is the commercial removal of the entire above ground tree components including the bole, top and branches from the site.

Timber Harvest Activities

Alternative B includes the construction of landings, skid roads and trails needed to harvest the stands proposed for treatment. These activities could have negative effects on soil quality due to potential high levels of compaction, rutting, erosion, and/or loss in soil productivity, and sediment deposition into waterbodies.

Landings typically between one-quarter and one-half of an acre would be constructed. Existing landings from prior vegetation management operations may be suitable for re-use in some cases. Landings require extensive soil disturbance for use. Once the overstory is cut, stumps are grubbed out and trees, stumps, and other logging debris are pushed into piles along the contour as slash barriers to trap soil transported from upslope (in this case, the log landing). During use of the landing, soil mixing of surface and subsurface horizons occurs.

Adherence to relevant Forest Plan standards and guidelines, Vermont Acceptable Management Practices, and project design criteria (Appendix B, Soils and Wetlands) would minimize effects to soils and wetlands from timber harvest activities to acceptable levels. Most of the timber harvesting area is expected to recover quickly from compaction caused by harvesting activities. The upper few inches of soil recovers quickly from light to moderate compaction (Kozlowski 1999).

Monitoring by the Forest Service on the Green Mountain National Forest has shown Forest Plan standards and guidelines and Vermont Acceptable Management Practices are successfully implemented most of the time in harvest areas, and protective measures are effective in keeping erosion, compaction, and impacts to wetlands at low levels (USDA Forest Service 2006b). One to three years after harvest, soil disturbance is expected to be similar to those found in soil disturbance monitoring in the Manchester Ranger District of the Green Mountain National Forest (Quintana 2018), which are generally below soil quality standard thresholds.

Prescribed burning

Relatively little compaction, soil displacement, litter layer loss or displacement, or nutrient loss would occur as a result of prescribed fire use including fireline construction associated with Alternative B. Some compaction and rutting may occur from limited use of off-highway vehicles for prescribed fire activity. Overall effects would be minimized by following Forest Plan standards and project design criteria (Appendix B, Soils and Wetlands).

Wetland treatments

Studies have demonstrated the importance of early successional habitat adjacent to beaver-influenced wetlands to the bird species depending on this habitat, some of which do not use early successional habitat in upland areas (Bennett 2010, Chandler et al. 2009, Schlossberg and King 2007). Bennett (2010) provides recommendations on how to manage forested stands adjacent to beaver flowages to encourage continued beaver activity and perpetuate early successional habitat in these areas. These recommendations formed the basis for this proposed treatment.

The target wildlife species (bird species requiring early successional habitat adjacent to or within wetlands) would benefit from the proposed wetlands treatments. Wildlife already occupying these areas prior to treatment, on the other hand, may be negatively impacted directly, through take of individuals, or indirectly, through loss of habitat. These effects would be short-term and would be limited to the nine acres proposed for treatment.

Wetland treatments could negatively affect important wetland functions supporting habitat quality in the short-term by decreasing ground shading, in turn raising soil and water temperatures, increasing evaporation rates, and causing the wetlands to retain less water, and retain water for a shorter period. This could negatively affect plant and animal species requiring cooler temperatures, higher water levels, or longer hydro-periods. In the long-term, wetland soil resources may improve, once trees grow enough to shade wetlands, due to an increased supply of downed woody material to feed soil organic matter.

3.6.5 Cumulative Effects

The cumulative effects analysis area for soil and wetlands is all lands within the Manchester Ranger District proclamation boundary. This analysis area was selected because soil disturbances in response to management activities such as those in the Proposed Action rarely extend much further beyond the immediate impact area. The cumulative effects of past, present, and foreseeable future soil disturbing activities within the analysis area are evaluated here using a timeframe of 20 years into the past and future.

Wetland values

Wetland values include wetland plant and animal habitats, flood storage, water purification, carbon storage, and nutrient cycling. There are no known wetland losses in extent on National Forest System lands over the past 20 years within the analysis area. If wetland extent has changed over the past two decades, it was likely due to changes in the level of beaver activity. The effects on wetlands associated with the Proposed Action would be small. In addition, we do not expect wetland losses to increase in the future.

There is no data on losses in wetland quantity or values on non-National Forest System lands over the past 20 years. Some losses have probably occurred on private lands, though they are probably small, since large wetland losses usually equate to a state or federal wetland violation. There are some limited ongoing threats to wetland values on private lands, particularity where wetlands are being used as agricultural lands, or where development is on-going. With increasing awareness of the public about the importance and values of wetlands, acreage may increase slightly due to wetland restoration efforts in the watershed.

Given this information, cumulative losses in wetland quantity or values in the analysis area in response to past, present, and future actions, is small, because actions on National Forest System lands are unlikely to result in losses in wetland quantity or values, and similar wetland losses on private lands have been, and are expected to be small due to state and federal wetland regulations.

Soil productivity

The primary activities with the potential to decrease long-term soil productivity within the analysis area are:

- Poorly implemented timber harvests, if Vermont Acceptable Management Practices (USDA Forest Service 2018) are not implemented. Erosion, compaction, and loss of soil nutrients can result in reduced soil productivity.
- Prescribed burning and associated fire line construction can reduce soil productivity and increase erosion and sedimentation.
- Development, such as residential and business construction and road building. These activities can change soil properties and reduce soil productivity.

Harvesting on National Forest System lands from past, present and future activities (Dorset – Peru, South of Route 9, and Somerset integrated resource projects) have or will follow Vermont Acceptable Management Practices, Forest Plan standards and guidelines, and each respective site-specific mitigation measures. These protective measures minimize erosion and compaction. Whole tree harvest would be limited, and long harvest rotations are typically used on the Green Mountain National Forest to minimize soil nutrient losses. Only minimal development has and would occur on National Forest System lands over the timeframe of the analysis. This would be limited to activities like a small amount of road improvement, and construction of small road-side parking areas. Again, this minimizes the effects on soil nutrient levels.

Of the 250,000 acres of land in the Manchester Ranger District, the area managed with prescribed fire is currently near 1,500 acres. This project proposes up to an additional 15,000 acres, raising the percentage of the district subject to prescribed burning over tenfold, from less than one percent to over six percent. Following the design criteria would minimize the potential for soil productivity declines.

On privately-owned lands, the amount of past and future planned harvest is low. Vermont Acceptable Management Practices are usually implemented on private lands. The amount of development on private lands has also been low, and it is reasonable to expect low levels of development will continue in the future. Agricultural practices affect soil productivity in the analysis area, but the magnitude and extent of this has not been quantified. It is likely the magnitude of agricultural effects will stay the same in the future.

To conclude, we expect cumulative losses in soil productivity to be moderate in the analysis area within the analysis timeframe because:

- On National Forest System lands, long rotations and other soil protections are used to manage stands, providing time for nutrients to accumulate in the soil following harvest.
- In the future, we foresee moderate changes in the magnitude of impacts to soil productivity due to harvesting or development (VANR 2015).

3.7 Carbon and Greenhouse Gas Emissions

3.7.1 Issues

Although not identified as a substantive issue, there is concern there would be a loss of carbon as a result of proposed harvest treatments.

Forests play a significant role in the global carbon cycle by storing about 1.4 billion metric tons every year. In addition, forests worldwide store over one trillion metric tons of carbon in plants and soil. Forestry has gained attention in recent decades because of its potential to influence the exchange of carbon with the atmosphere, either by increasing storage or releasing carbon emissions. Forests can take up and store atmospheric carbon through photosynthesis and release carbon through mortality, plant respiration, microbial decay, fire, and use of wood fiber. Forests can store carbon in soils and plant material as well as in harvested wood products storing carbon outside of the forest ecosystem. In addition, wood fiber can be used to substitute for products that are more energy-intensive to produce, such as concrete and steel, creating a substitution effect which can result in lower overall greenhouse gas emissions.

A complete and quantitative assessment of forest carbon stocks and the factors influencing carbon trends (management activities, disturbances, and environmental factors) for the Green Mountain National Forest is available in the project record (Dugan et al. 2018). This carbon assessment contains additional supporting information as well as references for this proposed action.

3.7.2 Direct and Indirect Effects Analysis Area

The effects analysis area for carbon includes forested lands on the Manchester Ranger District because this is where timber harvest and prescribed burning treatments are proposed where carbon stocks may be affected. The effects analysis for greenhouse gas emissions is the global atmosphere given the mix of atmospheric gases can have no bounds. The timeframe for the analysis is 20 years because all project activities should be completed by then.

3.7.3 Affected Environment

The carbon legacy of the Green Mountain National Forest is tied to the history of Euro-American settlement, land management, and disturbances. As the first region to be widely settled in the United States, eastern forests have had a long history of intensive harvesting and conversion of forests to agriculture. Historical disturbance dynamics, forest regrowth and recovery, and forest aging have been most responsible in driving carbon accumulation trends since 1950. Forest ecosystem carbon stocks on the Green Mountain National Forest increased 48 percent from 1990 to 2013 which provides strong evidence the Forest is maintaining a carbon sink. (USDA Forest Service 2015a).

According to satellite imagery, timber harvestings has been the dominant disturbance type on the Green Mountain National Forest from 1990 to 2011, although harvesting during this time affected no more than 0.25 percent of the forested area in any given year (USDA Forest Service, in review; Dugan et al. 2018). During this period, about 1.4 percent of the forested area experienced some level of harvest including even-aged (clearcut, seed tree, shelterwood, and thinning) and uneven-aged (individual and group selection) treatments. Carbon losses from the forest ecosystem associated with harvests have been relatively small compared to the total amount of carbon stored in the forest, with losses from 1990 to 2011 equivalent to about one percent of non-soil carbon stocks (USDA Forest Service, in review). However, these estimates represent an upper bound, because they do not account for continued storage of harvested carbon in wood products or the effect of substitution. Furthermore, the negative effects on carbon stocks caused by harvest, disturbances, and environmental conditions have been modest and exceeded by forest growth.

3.7.4 Direct, Indirect and Cumulative Effects

3.7.4.1 Alternative A: No Action

There would be no timber harvest treatments implemented under Alternative A, and thus no removal of trees from the project area. Existing carbon stocks would remain relatively stable in the short-term. However, in the absence of commercial timber harvesting on the stands where harvesting is proposed under Alternative B, the forest will thin naturally resulting in dead trees that will decay in the long-term, emitting some carbon to the atmosphere, which may or may not be offset by forest growth. A large component of the forest within the project area is over 80

years old with generally low rates of new stand establishment. If the forest continues on this aging trajectory, more stands will reach a slower growth stage in coming years and decades, potentially causing carbon accumulation to decline in the future. However, while past trends are informative, they can also be limited in their applicability given changes in climate and other pressures causing stress on forest ecosystems (Dugan et al. 2018).

3.7.4.2 Alternative B: Proposed Action

The proposed timber harvest would be conducted on approximately 15,000 acres. This scope and degree of change would be relatively minor, affecting a maximum of about six percent of forested National Forest System lands within the project area. Alternative B also proposes up to 15,000 acres of prescribed fire for site preparation following harvest. The effect of the proposed timber harvest focuses on aboveground carbon stocks stored in live woody vegetation, which comprise about 40 percent of the total ecosystem carbon stocks of the Green Mountain National Forest (USDA Forest Service 2015a). The effect of the prescribed fire focuses on the understory and forest floor, which comprises 14 percent of Forest-wide ecosystem carbon stocks. About 34 percent or more of the ecosystem carbon is in the mineral soils, a very stable and long-lived carbon pool (McKinley et al. 2011, USDA Forest Service 2015a, Domke et al. 2017).

Mineral soil is an important consideration for long-term carbon storage capacity in soils in most ecosystems. Timber harvesting generally results in a negligible amount of carbon loss from the mineral soils typically found in the United States, particularly when operations are designed in a way to minimize soil disturbance (Nave et al. 2010, McKinley et al. 2011). Although timber harvest and prescribed fire can also affect the carbon stored in the understory and forest floor organic layer consisting of debris in various stages of decomposition, the carbon loss would be negligible given it is not stable or long-lived and would be replaced with months to a few years.

Climate change is a global phenomenon, because major greenhouse gasses (GHGs)[4] mix well throughout the planet's lower atmosphere (IPCC 2013). Considering emissions of GHGs in 2010 was estimated at 13,336 ± 1,227 teragrams[5] carbon globally (IPCC 2014) and 1,881 teragrams carbon nationally (US EPA 2015), the ESHC Project makes an extremely small contribution to overall emissions. Because local GHGs emissions mix readily into the global pool of GHGs, it is difficult and highly uncertain to ascertain the indirect effects of emissions from single or multiple projects of this size on global climate. Therefore, at the global and national scales, the direct and indirect contribution from Alternative B to GHGs and climate change would be negligible. In addition, because the direct and indirect effects would be negligible, Alternative B's contribution to cumulative effects on global GHGs and climate change would also be negligible. Lastly, carbon emissions during the implementation of Alternative B would have only a momentary influence on atmospheric carbon concentrations, because carbon will be removed from the atmosphere with time as the forest regrows, further minimizing or mitigating any potential cumulative effects.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) summarized the contributions of global human activity sectors to climate change (IPCC 2014).

[4]Major greenhouse gases released as a result of human activity include carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, and perfluorocarbons.
[5]This report uses carbon mass, not carbon dioxide (CO2) mass, because carbon is a standard unit and can easily be converted to any other unit. To convert carbon mass to CO2 mass, multiply by 3.67 to account for the mass of the oxygen (O2).

From 2000 to 2009, forestry and other land uses contributed just 12 percent of the human-caused global CO_2 emissions[6]. The forestry sector's contribution to GHG emissions has declined over the last decade (IPCC 2014, Smith et al. 2014, FAOSTAT 2013). The largest source of GHG emissions in the forestry sector globally is deforestation (Pan et al. 2011, Houghton et al. 2012, IPCC 2014), which is defined as the removal of all trees to convert forested land to other land uses not supporting trees or allow trees to regrow for an indefinite period of time (IPCC 2000) (e.g., conversion of forest land to agricultural or developed landscapes). However, forest land in the United States has had a net increase since the year 2000, and this trend is expected to continue for at least another decade (Wear et al. 2013, USDA Forest Service 2015a). In addition, National Forests tend to experience low rates of land-use change, and in the Green Mountain National Forests, forested areas have actually increased since 1990.

The proposed activities in the ESHC project are not considered a major source of GHG emissions. Forested land will not be converted into a developed or agricultural condition or otherwise result in the loss of forested area. In fact, forest stands are being retained and managed to maintain a vigorous condition supporting enhanced tree growth and productivity, thus contributing to long-term carbon uptake and storage. In 2010, forests in the United States removed about 757 megatonnes[7] of CO_2 from the atmosphere after accounting for natural emissions (e.g., wildfire and decomposition) (US EPA 2015).

Some assessments suggest the effects of climate change in some United States forests may cause shifts in forest composition and productivity or prevent forests from fully recovering after severe disturbance (Anderson-Teixeira et al. 2013), thus impeding their ability to take up and store carbon[8] and retain other ecosystem functions and services. Climate change is likely already increasing the frequency and extent of droughts, fires, and insect outbreaks, which can influence forest carbon cycling (Kurz et al. 2008, Allen et al. 2010, Vose et al. 2018). In fact, reducing stand density, one of the goals of the proposed action, is consistent with adaptation practices to increase resilience of forests to climate-related environmental changes (Joyce et al. 2014, Swanston et al. 2016). Alternative B is consistent with options proposed by the IPCC for minimizing the impacts of climate change on forests, thus meeting objectives for both adapting to climate change and mitigating GHG emissions (McKinley et al. 2011).

Forests have a "boom and bust" cycle with respect to carbon, as forests establish and grow, experience mortality with age or disturbances, and regrow over time. Forest management activities such as harvests and hazardous fuels reduction have characteristics similar to disturbances reducing stand density and promote regrowth through thinning and removal, making stands and carbon stores more resilient to environmental change (McKinley et al. 2011). The relatively small quantity of carbon released to the atmosphere and the short-term nature of the effect of Alternative B on the forest ecosystem are justified, given the overall change in condition increases the resistance to wildfire, drought, insects and disease, or a combination of disturbance types that can reduce carbon storage and alter ecosystem functions (Millar et al. 2007, D'Amato et al. 2011). Furthermore, any initial carbon emissions from Alternative B would be balanced and possibly eliminated as the stand recovers and regenerates, because the remaining trees and newly established trees typically have higher rates of growth and carbon storage (Hurteau and North 2009, Dwyer et al. 2010, McKinley et al. 2011).

[6]Fluxes from forestry and other land use (FOLU) activities are dominated by CO_2 emissions. Non-CO_2 greenhouse gas emissions from FOLU are small and mostly due to peat degradation releasing methane and were not included in this estimate.
[7]A megatonne is one million metric tons; equal to about 2.2 billion pounds.
[8]The term "carbon" is used in this context to refer to carbon dioxide.

The wood and fiber removed from the forest in Alternative B would be transferred to the wood products sector for a variety of uses, each of which has different effects on carbon (Skog et al. 2014). Carbon can be stored in wood products for a variable length of time, depending on the commodity produced. It can also be burned to produce heat or electrical energy, or converted to liquid transportation fuels and chemicals that would otherwise come from fossil fuels. In addition, a substitution effect occurs when wood products are used in place of other products emitting more GHGs in manufacturing, such as concrete and steel (Gustavasson et al. 2006, Lippke et al. 2011, McKinley et al. 2011). In fact, removing carbon from forests for human use can result in a lower net contribution of GHGs to the atmosphere than if the forest were not managed (McKinley et al. 2011, Bergman et al. 2014, Skog et al. 2014). The IPCC recognizes wood and fiber as a renewable resource can provide lasting climate-related mitigation benefits that increase over time with active management (IPCC 2000). Furthermore, by reducing stand density, Alternative B may also reduce the risk of more severe disturbances, such as insect and disease outbreak and severe wildfires, which may result in lower forest carbon stocks and greater GHG emissions.

Some tree species and forest communities within New England are well-adapted to fire and in some cases may depend on it for survival and regeneration. Historical fire suppression and harvesting practices have allowed some fire-dependent forests in the eastern U.S, to become unnaturally dense and alter species composition and structure (Nowacki and Abrams 2008, Thomas-Van Gundy 2015). Carbon emissions associated with prescribed fires from duff, litter, and dead wood comprise carbon pools that would otherwise decay quickly over time, releasing carbon to the atmosphere even in the absence of fire. By reducing vegetative competition in the understory, the proposed prescribed burning following harvest would help establish oak habitat and increase the ability of harvested areas to regenerate more quickly. This would help to support forest health in a changing climate and reducing GHG emissions over the long-term.

In summary, Alternative B affects a relatively small amount of forest land and carbon on the Green Mountain National Forest and, in the near-term, might contribute an extremely small quantity of GHG emissions relative to national and global emissions. Alternative B would not convert forest land to other non-forest uses, thus allowing any carbon initially emitted from the proposed treatments to have a temporary influence on atmospheric GHG concentrations, because carbon would be removed from the atmosphere over time as the forest regrows.

Furthermore, Alternative B would transfer carbon in the harvested wood to the product sector, where it may be stored for up to several decades and substitute for more emission intensive materials or fuels. Moreover, Alternative B is consistent with internationally recognized climate change adaptation and mitigation practices.

3.8 Recreation

3.8.1 Issues

Although not identified as substantive issues, the following concerns were identified:

- Timber harvest and road activities would impact snowmobile trail continuity during winter months and have negative effects on other trail use.
- The loss of backcountry ski and snowboard recreational opportunities from harvest activities would financially hurt local communities.

- Unauthorized off-road vehicle use would increase following the use of roads used to implement proposed timber harvest activities.

3.8.2 Direct and Indirect Effects Analysis Area

The analysis area for recreation effects is the ESHC project area, because effects of the proposed activities are not expected to extend beyond the district boundaries. The timeframe for analysis is 20 years based on the expected period for proposed actions to be implemented and the potential effects to recreation to be apparent.

3.8.3 Affected Environment

The project area offers a variety of year round recreation opportunities including both dispersed (such as trails and viewing wildlife), and developed (such as camping and day use areas). Many of the communities within and surrounding the project area benefit economically from the variety of recreation opportunities on the Manchester Ranger District and surrounding lands in southern Vermont.

The project area has been managed for multiple uses, including the coexistence of recreation and vegetation management, since its inception as a National Forest. Evidence of past vegetation management activities is apparent in the form of existing skid trails, Forest Service roads, and in the existing vegetation types and stand ages. Existing trails within the project area often lie on former town roads, skid trails, and secondary or abandoned logging roads. Past Forest Service harvesting within the analysis area has periodically facilitated and impacted recreational use; however, harvest activities were of short duration and did not cause long-term disruption to recreation opportunities.

There are approximately 500 miles of trails within the project area in addition to numerous town trails and Class 4 town roads. These trails and roads provide for multiple recreational uses, including snowmobiling, hiking, cross-country skiing, horseback riding, mountain biking, and off-road vehicle riding. Snowmobile trails on the Manchester Ranger District make up approximately 223 miles of the overall trail mileage. The District manages one backcountry ski area, Dutch Hill, which is located in Readsboro, VT. Backcountry skiing and boarding occurs in other parts of the project area as a dispersed recreational use. Hiking trails make up about 161 miles and cross-country skiing trails account for about 62 miles of trail. Both hiking and cross-country skiing also take place on trails and old roads in the project area not designed or managed specifically for these uses.

3.8.4 Direct and Indirect Effects

3.8.4.1 Alternative A: No Action

There would be no direct or indirect effects to recreation in the project area from Alternative A.

3.8.4.2 Alternative B: Proposed Action

Effects to snowmobile trail continuity in the project area would be limited in duration and scale to individual timber sales resulting from the ESHC Project. Any individual timber sale could be on-going in an area for three to five years. Design criteria have been included to maintain trail continuity as much as possible and to ensure communication is occurring between Forest Service and Vermont Association of Snow Travelers (VAST) staff regarding trail sharing, rerouting, and/or temporary closures prior to and during timber sale operations (Appendix B, Recreation).

Effects to backcountry skiing and boarding would occur over a 50 year period but would be limited to stands with existing low tree density suitable for this recreation use. An estimate of 50 years for effect duration accounts for the time it would take for vegetation to return to a low tree density with thin understory conditions. This timeframe is based on natural succession without human management promoting backcountry ski conditions (Braun 2018c). Dutch Hill, the managed backcountry skiing area within the project area, would remain unaffected. General National Forest System land is not managed for backcountry skiing and boarding, but is open for this use. Numerous opportunities outside of individual timber sale areas would still exist across the analysis area during project implementation.

It is not feasible to calculate a baseline of economic activity generated from dispersed backcountry skiing and boarding in the project area. It is anticipated there would no measurable effects to local economies, because backcountry skiing and boarding opportunities would continue to exist in the project area.

Potential effects to trails include short-term closures, reroutes, or incidental damage to trail tread with logging operation equipment. Short-term effects to trail use may include noise and/or necessary sharing of trails with logging equipment during harvest operations. Design criteria are included to reduce effects to trail tread and use, including protection during harvest operation, incidental damage repair requirements, and, when practicable, planning timber harvest and road construction activities outside of the typical season of trail use (Appendix B, Recreation).

Although old logging roads are often used by hikers and cross-country skiers, temporary roads would not be managed as trails following harvest operations apart from instances where roads and existing trails are concurrent. Temporary road construction has the potential effect of opening parts of the Forest to unauthorized off-road vehicle use following harvest activities. Design criteria includes proper closure of temporary roads to protect/restore natural resources and prevent unauthorized off-road vehicle access (Appendix B, Recreation).

3.8.5 Cumulative Effects

The analysis area for cumulative effects to recreation is the proclamation boundary surrounding the Manchester Ranger District. The area of analysis was chosen because it includes all areas on which other projects may have combined effects with ESHC proposed activities. The cumulative effects analysis takes into account activities occurring up to ten years in the past to 10 years after project implementation is complete. This time frame was chosen because it is a reasonable length of time for measuring past effects and for predicting upcoming projects.

Timber sale activities on National Forest System and non-National Forest System lands within the analysis area may have a cumulative effect on snowmobile trail continuity if hauling

operations take place over snowmobile trails during ESHC project implementation. Forest Service activities that may result in timber sales overlapping in time and space with the ESHC project include the Dorset-Peru, South of Route 9, and Somerset integrated resource projects. Design criteria or mitigation measures required for these projects along with those in the ESHC Project will reduce impacts to high-volume snowmobile trails and promote opportunities for sharing trails and continuing communication between Forest Service and VAST staff.

No additional cumulative effects to backcountry skiing/snowboarding or other recreation resources are anticipated as there are no other past, present, or future actions predicted to contribute aggregated effects.

3.9 Wilderness and Inventoried Roadless Areas

3.9.1 Issues

Although not identified as substantive issues, the following concerns were identified:

- Road construction would affect the roadless character within inventoried roadless areas evaluated during the 2006 Forest Plan revision.

  Indicators: The number of acres of regeneration cuts under even-aged management systems within an inventoried roadless area, including seed-tree, shelterwood, clearcuts, log landings (which can be up to one-half acre in size) and permanent wildlife openings (USDA Forest Service 1997). The number of miles of permanent OML 2 through OML 5 Forest system roads (USDA Forest Service 2015b, USDA Forest Service 1992).

  Thresholds: When the amount of harvest that will or has been harvested within the inventoried roadless area during a ten year period exceeds 20 percent, or the inventoried roadless area contains more than one half mile of permanent OML 2 through OML 5 Forest system road for every 1,000 acres (USDA Forest Service 1997).

- Harvest activities adjacent to wilderness boundaries would affect the wilderness character within designated wilderness.

  Indicator: Ascertaining if and how proposed actions would affect wilderness character. Wilderness character can be defined as "the combination of biophysical, experiential, and symbolic ideals that distinguish wilderness from all other lands" (USDA Forest Service 2005). Section 2(c) of the Wilderness Act further describes wilderness character by highlighting four qualities of wilderness: untrammeled, natural, undeveloped, and outstanding opportunities for solitude or a primitive and unconfined type of recreation (Wilderness Act of 1964).

  Threshold: Non-compliance with the Wilderness Act.

The project area also includes river segments eligible to be further considered for addition to the National Wild and Scenic River System. These river segments and their associated corridors are within the Eligible Wild, Scenic, and Recreational Rivers Management Area (Forest Plan, pages 105 to 109). The Eligible Wild, Scenic, and Recreational Rivers Management Area direction is to retain each river's eligibility for the stated potential classification.

3.9.2 Direct and Indirect Analysis Area

The analysis area for direct and indirect effects for wilderness includes congressionally designated wilderness areas within the project area. The analysis area for direct and indirect effects for inventoried roadless areas and eligible Wild, Scenic, and Recreational River corridors include all stands within those areas proposed for timber harvest. These areas reflect where any effects from the project proposal would be expected to occur. The timeframe for analysis is 20 years based on the expected period for proposed actions to be implemented and the potential effects to be apparent.

3.9.3 Affected Environment

Wilderness

The analysis area includes five congressionally designated wilderness areas. From north to south, they are Big Branch Wilderness (6,767 acres), Peru Peak Wilderness (7,672 acres), Lye Brook Wilderness (17,718 acres), Glastenbury Wilderness (22,425 acres) and George D. Aiken Wilderness (5,060 acres).

Inventoried Roadless Areas

An inventory of roadless areas was conducted during the revision process for the 2006 Forest Plan. Areas that met the 1992 Forest Service Handbook (FSH 1909.12 Chapter 7) inventory criteria were identified and evaluated for potential to be congressionally designated as wilderness. The Forest Plan roadless area inventory identified 37 roadless areas across the Forest totaling 124,321 acres. Although the Forest Plan Record of Decision recommended 27,473 acres to be wilderness (USDA Forest Service 2006c), there were 41,652 acres congressionally designated as wilderness with the passage of the New England Wilderness Act in 2006, increasing the Forest-wide total to 101,074 acres. Harvest treatments are proposed within eight 2006 Forest Plan revision inventoried roadless areas. The eight affected inventoried roadless areas are listed in Table 13 with corresponding acreage, acres of even-aged management from 2006 to 2018, and miles of road.

Table 13: Inventoried roadless areas containing proposed harvest treatments.

Inventoried Roadless Area	Total acres including private lands	Acres of even-aged regeneration harvest from 2006 to 2018	Miles of road as of 2006 inventory (per 1,000 acres)
Homer Stone	11,619	0	2.6 (0.22)
Old Job	1,094	0	0.7 (0.06)
Three Shanties	900	0	1.45 (1.61)
Griffith Brook	1,532	0	2.6 (1.73)
Bourn	206	0	0.4 (2.00)
Stratton	9,222	0	4.1 (0.44)
Glastenbury	43,645	0	29.5 (0.68)
Dunville Hollow	1,261	0	0 (0.00)

Eligible Wild, Scenic, and Recreational Rivers

The analysis area contains segments of rivers considered eligible for addition to the National Wild and Scenic River System. Corridor segments and one-quarter mile buffers on either side of the river are managed to protect and enhance the "outstandingly remarkable values" that led to those rivers eligibility for further consideration to the National Wild and Scenic River System. Segments of wild, scenic, and recreational eligible rivers all occur within the analysis area.

3.9.4 Direct and Indirect Effects

3.9.4.1 Alternative A: No Action

There would be no direct or indirect effects to wilderness areas, inventoried roadless areas, and eligible wild, scenic and recreational rivers segments in the project area from Alternative A.

3.9.4.2 Alternative B: Proposed Action

Wilderness

Effects to the wilderness character would be minimal in scale and time (three to five year periods based on expected timber sale activity in a given area). Wilderness areas potentially affected include Big Branch Wilderness, Peru Peak Wilderness, Lye Brook Wilderness, and Glastenbury Wilderness. It is Forest Service policy to not maintain buffer strips of undeveloped wildland to provide an informal extension of wilderness (USDA Forest Service 2007b). Design criteria have been included to ensure the involvement of recreation and survey staff in delineating boundaries where treatment units are adjacent to wilderness (Appendix B, Wilderness). No proposed activities would occur within wilderness, and no trees would be felled having the potential to fall into wilderness. Noise from timber sale operations may affect the quality of outstanding opportunities for solitude. These effects would be limited in time and scale to the area where timber sale activities occur near wilderness and to the period of operations. Opportunities for solitude would still be found in other parts of the affected wilderness and other wilderness areas on the Forest.

Inventoried Roadless Areas

Table 14 shows the proposed harvest treatment and road activities within inventoried roadless areas within the analysis area. There would be no adverse effect to roadless character within these areas with the application of design criteria that no more than 20 percent of each inventoried roadless area would be harvested with even-aged regeneration harvests in any ten-year period (Appendix B, Recreation). This design criteria is applicable to the Old Job, Three Shanties, and Bourn inventoried roadless areas. The even-aged harvest treatment acres proposed in the other inventoried roadless areas are less than 20 percent of the total areas of each respective area. The log landings and regeneration harvests would return to a forested condition and would reach the young age class during the analysis period. The areas would retain a similar appearance to their condition at the time of the 2006 roadless inventory.

Although no roads at OML 2 or higher would be constructed for Alternative B, there would be up to 9.84 miles of temporary or OML 1 road constructed in inventoried roadless areas. This level of proposed road construction is anticipated to have a minimal effect on the roadless character within these areas, because the temporary roads would return to a natural forested or trail

condition following their use, and OML 1 roads would only provide intermittent service given they are closed to vehicle traffic when not needed for management activities.

Table 14: Proposed harvest and road activities within inventoried roadless areas.

Inventoried Roadless Area	Estimated miles of new roads (OML 1 and temporary)[1]	Proposed even-aged harvest (acres)[2]	Percentage of even-aged harvest within inventoried roadless area	Proposed group selection harvest (acres)[3]
Homer Stone	1.12	550	5	138
Old Job	1.36	438	40[4]	396
Three Shanties	0.92	360	40[4]	206
Griffith Brook	0.10	50	3	12
Bourn	0.30	82	40[4]	100
Stratton	0.30	145	2	36
Glastenbury	5.56	2,726	6	682
Dunville Hollow	0.18	86	7	22

[1]The estimated OML 1 and temporary road construction is based on overall estimate of 1.67 miles of OML 1 or temporary road per 1,000 acres of treatment.

[2]An estimated 80 percent of stands proposed for treatment would use even-aged harvest methods except where noted.

[3]An estimated 20 percent of stands proposed for treatment would use uneven-aged harvest methods except where noted.

[4]With design criteria applied, even-aged harvest treatment would occur on up to 20 percent of the total inventoried roadless area for initial entry; and on an additional 20 percent after 10 years.

Eligible Wild, Scenic, and Recreational Rivers

Proposed activities would not have a detrimental effect to "outstandingly remarkable values" identified for eligible wild, scenic, and recreational rivers. No harvest treatments would take place in eligible wild river segment corridors.

Eligible scenic river segment corridors include up to 667 acres of proposed harvest treatments (see Table 15). Forest Plan guidelines allow a wide range of silvicultural practices may be conducted with an emphasis on uneven-aged management in eligible scenic river segments (Forest Plan, Guideline G-2, page 108). Proposed openings would be temporary and would make up a minimal area of the overall segment so that uneven-aged management would remain the dominant management type. It is anticipated temporary openings would return to closed-canopy conditions within 10 to 20 years after treatment.

Eligible recreational river segment corridors include up to 470 acres of proposed harvest treatments. This is consistent with the Forest Plan guidelines allowing a wide range of silvicultural practices in eligible recreational river segments since the water quality and other management objectives of the corridor would be met (Forest Plan, Guideline G-1, page 109).

Table 15: Potential treatment acres in eligible scenic river segments.

Eligible scenic river segment	Outstandingly Remarkable Values	Total eligible scenic river segment (acres)	Proposed treatment (acres)	Percentage of treatment in eligible scenic river segment
Big Branch	Heritage	1,715	391	23
West River	Recreation, Scenic	1,254	227	18
Bolles Brook	Wildlife	1,668	49	3

There are minimal effects associated with the outstandingly remarkable values identified for these rivers as a result of this project. Proposed activities within these eligible river corridors are consistent with Forest Plan direction for management of this resource (Forest Plan, pages 105 to 109). As a result, the effects from the project associated with the outstandingly remarkable values identified for these rivers are not expected to be adverse, and thus would not preclude them from future consideration for addition to the National Wild and Scenic River System.

3.9.5 Cumulative Effects

The analysis area for cumulative effects to wilderness and inventoried roadless areas, and eligible wild, scenic, and recreational rivers is the proclamation boundary surrounding the Manchester Ranger District. The area for analysis was chosen because it includes all areas on which other projects may have combined effects with ESHC Project proposed activities. The timeframe for the cumulative effects analysis is the same as for direct and indirect effects.

Timber sale activities on National Forest System and non-system lands within the analysis area may have a cumulative effect on the quality of outstanding opportunities for solitude as it pertains to wilderness character. Timber sales associated with the Dorset-Peru Integrated Resource Project and any future timber sales on non-National Forest System lands adjacent to wilderness areas may contribute noise that could have a cumulative effect when combined with ESHC Project timber sale operations. Effects would be minimal because they would be limited in scale and time to areas where activities are occurring simultaneously. Opportunities for solitude would still exist in affected wilderness areas and other wilderness areas on the Forest.

Although there are minimal effects to the roadless character within inventoried roadless areas, there would not be any additional cumulative effects to this resource since there is no anticipated road construction or timber harvest activities affecting roadless character that would overlap with the ESHC Project. Likewise, although there would be some change to the forest canopy within eligible scenic and recreational river segment corridors, there would be no cumulative effect to their “outstandingly remarkable values” that would preclude them from future consideration for addition to the National Wild and Scenic River System since no other activities are planned to occur within these areas.

3.10 Visuals

3.10.1 Issues

Although not identified as a substantive issue, there is concern the proposed harvest treatments would degrade the visual quality from select viewsheds and along trail corridors. The threshold for visual effects is noncompliance with Visual Quality Objectives as provided in the Forest Plan (Visuals Guidance G-2, Tables 2.3.2 and 2.3.3, pages 37 to 39).

3.10.2 Direct and Indirect Effects Analysis Area

The analysis area for effects to scenery falls both within and outside the ESHC project area. The analysis area expands beyond the ESHC project area when on-site (within one-half of a mile of the proposed vegetation treatments- foreground views) and off-site views (more than one-half of a mile from the proposed vegetation treatments [middleground and background views]) fall outside of the project area. Scenery analyses would be conducted for individual timber sales at which time the boundaries of the analysis area would be further defined. The timeframe for analysis is 20 years based on the expected period for proposed actions to be implemented and the potential effects to scenery to be apparent.

3.10.3 Affected Environment

The analysis area includes a mosaic of vegetation patterns, streams, lakes, and wetlands. The Green Mountains run north/south through the area with ridges and valleys continuing to the east and west. Vegetation patterns show evidence of historic and current management activities. The complex topography creates numerous small to moderately sized viewsheds visible from major highways (such as VT Route 155 and US Route 7), popular forest roads, and key observation points or vistas along trails and roadsides. Many viewpoints are blocked by dense vegetation.

Non-National Forest System lands included in the analysis area include summits, travel corridors, and open valleys allowing for views of stands proposed for harvest treatment.

3.10.4 Direct and Indirect Effects

3.10.4.1 Alternative A: No Action

There would be no proposed vegetation treatment or related road construction that could negatively affect meeting Visual Quality Objectives from Alternative A. Any benefits to variety in scenery that could result from additional early successional forest type would not be gained.

3.10.4.2 Alternative B: Proposed Action

Effects to scenery would be short- to mid-term in scale (five to 15 years) as openings are considered temporary. Visual quality objectives would be maintained with design criteria applied by a Forest Service landscape architect or recreation specialist trained in scenery management during consultation prior to layout of each timber sale (Appendix B, Visual Quality). Visual

condition guidelines for on-site and off-site views would be applied to ensure travel corridors (vehicular and trail/recreational) would receive vegetation treatments distributed at intervals appropriate to the viewer sensitivity level and Recreation Opportunity Spectrum[9] of the corridor (Forest Plan, Section 2.3.13 Visuals, Guideline G-2). Viewsheds containing and surrounding proposed treatments would be defined and used in timber sale level scenery analyses. Consideration to viewsheds containing prominent landscape features, such as Little Stratton Mountain, would play a role in scenery analyses.

3.10.5 Cumulative Effects

The analysis area for cumulative effects to scenery is the same as the area used for direct and indirect effects analysis. The cumulative effects analysis takes into account activities occurring up to ten years in the past to 20 years after project implementation is complete. This time frame was chosen because it is a reasonable length of time for measuring past effects and for predicting upcoming projects.

Timber sale activities on National Forest System and non-system lands within viewsheds containing proposed activities may have some cumulative effects to scenery. Effects are predicted to be short to mid-term (5 to 15 years) in scale, and Visual Quality Objectives are predicted to be met. Past, present, and future Forest Service projects that may have an aggregate effect on scenery including the Nordic, Dorset-Peru, South of Route 9, and Somerset integrated resource projects. Timber sales from these projects as well as harvest activities on non-National Forest System lands have the potential to affect the scenic integrity[10] of the valued scenic character[11] (particular attributes, qualities, and traits of a landscape that give it an image and make it identifiable or unique) if they occur in areas visible from the same key observation points or travel corridors (USDA Forest Service 1995).

3.11 Heritage Resources

3.11.1 Issues

Although no issues were identified associated with heritage resources, Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effect of a project on any district, site, building, structure, or object included in, or eligible for inclusion in the National Register.

3.11.2 Direct and Indirect Effects Analysis Area

Heritage resource sites are discrete places on the landscape, and their physical integrity is completely dependent on their specific locale. With this in mind, the direct and indirect effects analysis area for a given heritage resource is generally restricted to the areas directly and

[9] A formal Forest Service classification system designed to delineate, define, and integrate outdoor recreation opportunities used to describe all recreation opportunity settings, from natural, undisturbed, and undeveloped to heavily used, modified and developed. The designations describe the kind of recreation experience one may expect to have in a given part of the National Forest.
[10] The state of naturalness or, conversely, the state of disturbance created by human activities or alteration.
[11] The particular attributes, qualities, and traits of a landscape that give it an image and make it identifiable or unique.

physically affected by a proposed project or activity. The Area of Potential Effect (APE) is the maximum total acreage proposed for project activities. This would also include any ancillary areas such as landings, access routes, or trail re-routes occurring outside of specific sites within the project area. The timeframe for the effects analysis is 20 years, which represents the number of years planned to implement any and all approved activities potentially affecting heritage resources.

3.11.3 Affected Environment

Heritage resources refer to archaeological and historic sites. Known heritage resource sites on the Green Mountain National Forest primarily consist of the remains of historic period farmsteads (such as cellar holes and barn/outbuilding foundations), mills, schools, cemeteries, stone walls, transportation corridors, and industrial sites (charcoal kilns). These are the most frequently encountered and readily discernible types of archaeological sites. Other more recent historical sites include standing structures (Forest Service buildings, fire towers, Long Trail shelters) meeting the 50-year threshold to be considered in federal undertakings. Also present are the archaeological remains of Native American resource procurement, hunting, and habitation sites.

The National Historic Preservation Act, as amended, and its implementing regulations at 36 CFR 800, state heritage resources are considered significant if they meet the criteria for inclusion to the National Register of Historic Places. These significant resources are referred to as “historic properties.” The Forest Plan specifies protection and stewardship will be provided to significant heritage resources on the Green Mountain National Forest (Forest Plan, Goal 16).

Only portions of the proposed project area have been previously surveyed for heritage resources. Because of this fact, archaeological surveys will be conducted each year, prior to implementation, as the stands for specific harvest treatments, wetland habitat enhancement, site preparation, and the locations for roads are identified along with current heritage resource survey status. The actual areas, site-specific road needs, and APE will be determined annually at the time of implementation, and may include areas not on the preliminary map (USDA Forest Service 2019a). The following discussion pertains only to the known resources within the project area.

One hundred and eighteen heritage resource sites have been recorded to some degree within the proposed treatment stands. All of them are considered to be archaeological, meaning none of them contain standing structures. The sites include two Civilian Conservation Corps (CCC) camps, a number of old logging camps, kilns, mills, two cemeteries, and numerous farmsteads. The exact location of these cultural resource sites is protected from public disclosure under the Archaeological Resources Protection Act (16 CFR 470hh).

3.11.4 Direct and Indirect Effects

This section provides a general disclosure of anticipated effects to this resource if ESHC Project activities are approved and implemented as proposed. The various activities comprising the ESHC Project, including timber harvest, wetland habitat enhancement, and road construction, have the potential to disturb archaeological remains through ground disturbing activities.

3.11.4.1 Alternative A: No Action

There would be no adverse direct effect to any heritage resource site known to occur within the APE of the ESHC Project from Alternative A, since no ground disturbing activities would be conducted.

3.11.4.2 Alternative B: Proposed Action

Proposed management activities include timber harvest and terrestrial habitat work, wetland habitat enhancements, and transportation network activities (road improvements, road construction for timber access, and creation of log landings). A number of the proposed activities have the potential to have a direct adverse effect to the condition of historic properties; however, implementation of the recommended design criteria would negate this potential (Appendix B, Heritage Resources). Forest Service staff responsible for implementing activities and the Forest Archaeologist can work to develop strategies to ensure project success while having no effect on historic properties. Additionally, some of the proposed activities would have positive effects to the condition of historic properties through site identification, protection, and stabilization.

3.11.5 Cumulative Effects

The National Historic Preservation Act includes protection of sites ("historic properties") that are significant at the local, state and national levels. Section 106 of the Act, as amended, obligates federal agencies to account for any impacts or effects to such sites. Because archaeological and historical sites are, for the most part, bounded places on the landscape, their conditions vary based on their location on the landscape. Over the last two or three decades, various projects within the ESHC project area have been carried out with little or no effect to heritage resources. An exception to this statement may be the occasional breach of a stone wall in order for people and equipment to gain access to a particular compartment or stand. With no anticipated direct or indirect effects to specific, concrete remains of sites or their historic context within the project area, there are typically no cumulative effects. Despite the number of past, present and foreseeable future actions and activities in the project area, there is no evidence to suggest there would be a cumulative effect on either a specific site or landscape comprised of numerous sites.

Chapter 4. Agencies and Persons Consulted

The following agencies, organizations and persons were consulted during the development the proposed action and environmental analysis for the ESHC Project.

Agency, Organization or Name	Level of Involvement
U. S. Fish and Wildlife Service, Susi vonOettingen	Provided guidance and information pertaining to northern long-eared bat protective measures
Vermont Natural Heritage Inventory	Provided the GIS layer of rare plant communities and the occurrence data for threatened, endangered and sensitive plant species
Vermont Fish and Wildlife Department, John Austin	Provided input regarding protection of northern long-eared bat and American marten habitat, and general discussions regarding early successional habitat
Vermont Fish and Wildlife Department, Forrest Hammond	Contacted for information regarding the potential for impacts to black bear habitat in Dover and Wardsboro
Vermont Fish and Wildlife Department, Chris Bernier and Kim Royer	Discussions to provide protection of American marten habitat
Vermont Fish and Wildlife Department, Alyssa Bennett and Scott Darling	Discussions to develop protective measures for northern long-eared bat
Vermont Fish and Wildlife Department, Eric Sorenson	Provided occurrence data of all threatened, endangered, proposed, and sensitive animal species
Vermont State Historic Preservation Office	Discussions regarding heritage resource protection
Rich Holschuh, liaison for Western Abenaki Tribes in Vermont	Discussions regarding language to include to address Abenaki tribal cultural interests
Windham Regional Commission, Chris Campany, Executive Director	Contacted for information regarding the potential for impacts to black bear habitat in Dover and Wardsboro
Mennen Environmental Foundation, Marshal T. Case	Development of the proposed action
Ruffed Grouse Society, Andy Weik	Development of the proposed action
Vermont Natural Resource Council, Jamey Fidel; and Audubon Society, Margaret Fowler	Provided concerns and input regarding early successional habitat objectives, inventoried roadless areas, wetland habitat treatment, whole tree harvesting and road construction
Backcountry Hunters and Anglers, Kyle Lapointe	Provided concerns and input regarding road construction, wetland habitat treatment, vernal pool and riparian protection, and wilderness
Vermont Association of Snow Travelers, Matt Tereault	Discussions regarding protection of snowmobile trails

Agency, Organization or Name	Level of Involvement
Jeff Nugent	Provided specific information regarding historic trail remnants associated with the Appalachian Trail/Long Trail near Stratton Mountain

The following Forest Service employees participated in the analysis and/or preparation of the environmental documents as members of the Interdisciplinary Team or provided technical assistance and/or review of the ESHC Project Environmental Assessment.

Name	Title	Area of Responsibility
David Francomb	District Ranger	Responsible Official
Brett Hillman	Wildlife Biologist	Interdisciplinary Team Leader; Wildlife including Threatened, Endangered, and Sensitive Species; Ecology
Phil Nyland	Wildlife Biologist	Wildlife including Threatened, Endangered, and Sensitive Species
Jay Strand	Forest NEPA Coordinator	NEPA; Carbon
Allan Braun	District Silviculturist	Timber; Silviculture
Jeff Tilley	Forestry Program Leader	Timber; Silviculture
Scott Wixsom	Biological Technician	Fisheries; Water
Angie Quintana	Forest Soil Scientist	Soil; Wetlands
MaryBeth Deller	Botanist	Botany including Sensitive Species and Non-Native Invasive Plants
Emily Lauderdale	Recreation Program Manager	Recreation; National Scenic Rivers; Visuals; Inventoried Roadless Areas; Wilderness
Andrew Triplett	Forest Archeologist	Heritage Resources
David DiSanto	Assistant Fire Management Officer	Fire and Fuels
Brian Austin	Forest Engineer	Transportation (roads and infrastructure)
David Donahue	Civil Engineer	Transportation (roads and infrastructure)
Diane Burbank	Geographic Information System Specialist	Spatial Analysis; Maps
Jared Serpico	Forest Surveyor	Boundary Management

Chapter 5. Literature Cited

Adams, M.B., J.A. Burger, A.B. Jenkins, and L. Zelazny. 2000. "Impact of harvesting and atmospheric pollution on nutrient depletion of eastern US hardwood forests". Forest Ecology and Management 138: 301-319.

Allen, C. D., A. K. Macalady, H. Chenchouni, D. Bachelet, N. McDowell, and M. Vennetier. 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management*, Vol. 259, No. 4. Pp. 660–684.

Anderson-Teixeira, K. J., A. D. Miller, J.E . Mohan, T. W. Hudiburg, B. D. Duval, and E. H. DeLucia. 2013. Altered dynamics of forest recovery under a changing climate. *Global Change Biology*, Vol. 19. No. 7. Pp. 2001–2021.

Bennett, Karen P., editor. 2010. "Beaver-created openings" In: *Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire* (second edition). University of New Hampshire Cooperative Extension, Durham, N.H. Pp. 132 – 134.

Bergman, R., M. E. Puettman, A. Taylor, and K. E. Skog. 2014. The carbon impacts of wood products. *Forest Products Journal*, Vol. 64. Pp. 220-231.

Braun, A. 2018a. Percent of the Manchester Ranger District National Forest System Lands in 0-9 year old age class over time: Early Successional Habitat Project. Unpublished report, Manchester, VT. 2 p. plus appendix.

Braun, A. 2018b. Email to ESHC Project Interdisciplinary Team, 17 August 2018.

Braun, A. 2018c. Conversation with Emily Lauderdale, 23 August 2018.

Burns, R. M. & Honkala, B. H., tech. cords. 1990. Silvics of North America: 1. Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington DC. Vol 2. 877 p.

Chandler, C. C., D. I. King, and R. B. Chandler. 2012. Do mature forest birds prefer early-successional habitat during the post-fledging period? *Forest Ecology and Management*, Vol. 264. Pp. 1–9.

Chandler, R. B., D. I. King, and S. DeStefano. 2009. Scrub–Shrub Bird Habitat Associations at Multiple Spatial Scales in Beaver Meadows in Massachusetts. *The Auk*, Vol. 126, No. 1. Pp. 186-197.

D'Amato, A.W., Bradford, J.B., Fraver, S., & Palik, B.J. 2011. Forest management for mitigation and adaptation to climate change: Insights from long-term silviculture experiments. Forest Ecology and Management, 262(5), 803–816. https://doi.org/10.1016/j.foreco.2011.05.014

Deller, M. 2018. Biological Evaluation for Plants. 3 August 2018. 42 p.

Domke, G.M., C.H. Perry, B.F. Walters, L.E. Nave, C.W. Woodall, and C.W. Swanston. 2017. Toward inventory-based estimates of soil organic carbon in forests of the United States. Ecological Applications 27: 1223-1235.

Dugan A., M. Janowiak, and D. McKinley. 2018. Forest carbon assessment for the Green Mountain National Forest, report on file at the Green Mountain National Forest Supervisor's Office.

Dwyer, J. M., R. Fensham, Y. M. Buckley. 2010. Restoration thinning accelerates structural development and carbon sequestration in an endangered Australian ecosystem. *Journal of Applied Ecology*, Vol. 47 Pp. 681–691.

FAOSTAT. 2013. FAOSTAT database. Food and Agriculture Organization of the United Nations. http://faostat.fao.org/

Federer, C.A., J.W. Hornbeck, L.M. Tritton, C.W. Martin, R.S. Pierce, and C.T. Smith. 1989. "Long-term depletion of calcium and other nutrients in eastern forests". Environmental Management 13 (5): 593-601.

Gustavsson, L., R. Madlener, H.-F. Hoen, G. Jungmeier, T. Karjalainen, S. KlÖhn, K. Mahapatra, J. Pohjola, B. Solberg, and H. Spelter. 2006. The Role of Wood Material for Greenhouse Gas Mitigation. *Mitigation and Adaptation Strategies for Global Change*, Vol. 11, No. 5–6. Pp. 1097–1127.

Hammond, F. 2018. Email to Brett Hillman, 9 July 2018.

Hillman, B. 2018. Biological Evaluation of the Early Successional Habitat Creation Project on federally-listed endangered and threatened species and on Regional Forester Sensitive Species. 8 August 2018.16 p.

Hornbeck, J.W., and W.B. Leak. 1992. "Ecology and management of northern hardwood forests in New England". USDA Forest Service Northeastern Forest Experiment Station General Technical Report NE-159. 43 p.

Houghton, R.A., J.I. House, J. Pongratz, G.R. van der Werf, R.S. DeFries, M.C. Hansen, et al. M.C. 2012. Carbon emissions from land use and land-cover change. Biogeosciences 9: 5125–5142. https://doi.org/10.5194/bg-9-5125-2012

Hurteau, M. and M. North. 2009. Fuel treatment effects on tree-based forest carbon storage and emissions under modeled wildfire scenarios. *Frontiers in Ecology and the Environment*, Vol. 7. Pp. 409-414.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland. 151 p. Available: http://www.ipcc.ch/report/ar5/syr/

IPCC (Intergovernmental Panel on Climate Change). 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor,

S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 1535 pp.

IPCC (Intergovernmental Panel on Climate Change). 2000. Special Report on Land Use, Land Use Change and Forestry, Summary for Policy Makers, 2000. IPCC, Geneva, Switzerland. 20 p. Available: http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=0

Joyce, L.A., Running, S.W., Breshears, D.D., Dale, V.H., Malmsheimer, R.W., Sampson, R.N., Sohngen, B., Woodall, C.W. 2014. Chapter 7: Forests. In: Melillo, Jerry; Richmond, Terese (T.C.); Yohe, Gary, eds. Climate change impacts in the United States: The third national climate assessment. U.S. Global Change Research Program: 176–194. http://nca2014.globalchange.gov/report/sectors/forests

Kozlowski, T.T. (1999) Soil Compaction and Growth of Woody Plants. Scandinavian Journal of Forest Research, 14:6, 596-619, DOI: 10.1080/02827589908540825

Kurz, W.A., C. C. Dymond, G. Stinson, G. J. Rampley, E. T. Neilson, and A. L. Carroll. 2008. Mountain pine beetle and forest carbon feedback to climate change. *Nature*, Vol. 452. Pp. 987–990.

Leak, W. B., Yamasaki, M., and Holleran, R. 2014. Silvicultural guide for northern hardwoods in the Northeast (Gen. Tech. Rep. NRS-132). Newtown Square, PA, US Department of Agriculture, Forest Service, Northern Research Station. 46 p.

Lippke, B., E. O'Neil, R. Harrison, K. Skog, L. Gustavsson, and R. Sathre. 2011. Life cycle impacts of forest management and wood utilization on carbon mitigation: knowns and unknowns. *Carbon Management*, Vol. 2, No. 3. Pp. 303-333.

Lorimer, C. G. and A. S. White. 2003. Scale and frequency of natural disturbances in the Northeastern U.S.: implications for early successional forest habitats and regional age distributions. *Forest Ecology and Management*, Vol. 185. Pp. 41-64.

Lorimer, C. G., S. E. Dahir, and E. V. Nordheim. 2001. Tree mortality rates and longevity in mature and old-growth hemlock-hardwood forests. *Journal of Ecology*, Vol. 89, No. 6. Pp. 960-971.

Mattrick, C. 2009. "Climate change and botanical resources on the White Mountain National Forest" in Literature Reviews: Effects of Climate Change on Resources. White Mountain National Forest, USDA Forest Service, Campton, NH. November 2010. Pp. 52-62

McCullough, R. 2018. Email to Allan Braun, 20 August 2018.

McKinley, D. 2018. Email to Brett Hillman, 28 August 2018.

McKinley, D. C., M. G. Ryan, R. A. Birdsey, C. P. Giardina, M. E. Harmon, L. S. Heath, R. A. Houghton, R. B. Jackson, J. F. Morrison, B. C. Murray, D. E. Pataki, and K. E. Skog. 2011. A synthesis of current knowledge on forests and carbon storage in the United States. *Ecological Applications*, Vol. 21, No. 6. Pp. 1902-1924.

Millar, C. I., N. L. Stephenson, and S. L. Stephens. 2007. Climate change and forests of the future: Managing in the face of uncertainty. *Ecological Applications*, Vol. 17, No. 8. Pp. 2145-2151.

Nave, Lucas E., Eric D. Vance, Christopher W. Swanston, and Peter S. Curtis. 2010. Harvest impacts on soil carbon storage in temperate forests. Forest Ecology and Management 259 (2010) 857–866.

NRCS (Natural Resources Conservation Service). 2017. Web Soil Survey. Available: https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Nowacki, G.J & Abrams, M. D. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. Bioscience; Feb 2008; 58, 2; ProQuest Natural Science Collection pg. 123.
The Demise of Fire and "Mesophication" of Forests in the Eastern United States
Pan, Y., R. A. Birdsey, J. Fang, R. Houghton, P. E. Kauppi, W. A. Kurz, O. L. Phillips, A. Shvidenko, S. L. Lewis, J. G. Canadell, P. Ciais, R. B. Jackson, S. W. Pacala, A. D. McGuire, S. Piao, A. Rautiainen, S. Sitch, and D. Hayes. 2011. A large and persistent carbon sink in the world's forests. *Science*, Vol. 333. Pp. 988–993.

Quintana, A. 2018. Soil Disturbance Monitoring Report (2015-2018), Green Mountain National Forest.

Raymond, P., S. Bedard, V. Roy, C. Larouche, and S. Tremblay. 2009. The irregular shelterwood system: review, classification, and potential application to forests affected by partial disturbances. *Journal of Forestry,* Vol. 107, No. 8. Pp. 405-413.

Sabetto, Alyssa. 2018, email to Brett Hillman, 16 August 2018.

Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski, Jr, K. L. Pardieck, J. E. Fallon, and W. A. Link. 2017. The North American Breeding Bird Survey, Results and Analysis 1966 - 2015. Version 2.07.2017, USGS Patuxent Wildlife Research Center, Laurel, MD. Available: https://www.mbr-pwrc.usgs.gov/bbs/

Schlossberg, S., King, D. I. 2007. Ecology and management of scrub-shrub birds in New England: A comprehensive review. Report submitted to Natural Resources Conservation Service, Resource Inventory and Assessment Division, Beltsville, Maryland.

Schneski, Sam. 2018. Email to Allan Braun, 15 August 2018.

Seymour, R.S. 2018. 2018. Silviculture Institute - spruce-fir [PowerPoint slides]. 52 p.

Seymour, R.S. 1995. "The Northeastern Region" In: *Regional Silviculture of the United States*, *Ed. 3*. Ed. Barrett, J. W. Wiley and Sons, New York, NY. 643 pgs. Pp. 31-79.

Seymour, R.S. 1992. "The red spruce-balsam fir forest of Maine: Evolution of silvicultural practice in response to stand development patterns and disturbances" In: *The Ecology and Silviculture of Mixed Species Forests*. Eds. Kelty, M. J., B. C. Larson, and C. D. Oliver. Kluwer Publishers, Norwell, MA. Pp. 217-244.

Skog, K. E., D. C. McKinley, R. A. Birdsey, S. J. Hines, C. W. Woodall, E. D. Reinhardt, J. M. Vose. 2014. "Chapter 7: Managing Carbon" In: *Climate Change and United States Forests, Advances in Global Change Research* , Vol. 57. Pp. 151-182.

Smith P., M. Bustamante, H. Ahammad, H. Clark, H. Dong, E. A. Elsiddig, H. Haberl, R. Harper, J. House, M. Jafari, O. Masera, C. Mbow, N. H. Ravindranath, C. W. Rice, C. Robledo Abad, A. Romanovskaya, F. Sperling, and F. Tubiello, 2014. Agriculture, Forestry and Other Land Use (AFOLU). In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 121 pp.
http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter11.pdf

Sorenson, E. and J. Osborne. 2014. Vermont habitat blocks and habitat connectivity: an analysis using geographic information systems. Vermont Department of Fish and Wildlife. 48 pp. Available:
http://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Vermont_Forests/Library/VFWD%20Habitat%20Block%20Report-April%202014.pdf

Sorenson, E. and R. Zaino. 2018. Vermont Conservation Design: summary report for landscapes, natural communities, habitats, and species. Vermont Agency of Natural Resources. February 2018. 38 pp. Available:
http://anr.vermont.gov/sites/anr/files/maps/biofinder/Vermont%20Conservation%20Design%20-%20Summary%20Report%20-%20February%202018.pdf

Swanston, C.W., M.K Janowiak, L.A. Brandt, P.R. Butler, S.D. Handler, P.D. Shannon, A.D. Lewis, K. Hall, R.T. Fahey, L. Scott, A. Kerber, L.R. Parker, and M. St. Pierre. 2016. Forest adaptation resources: climate change tools and approaches for land managers. Gen. Tech. Rep. NRS-GTR-87-2. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station. 161 p.

Thomas-Van Gundy, M.A., G.J. Nowacki and C.V. Cogbill. 2015. Mapping pyrophilic percentages across the northeastern United States using witness trees, with focus on four national forests. General Technical Report NRS-145. Newtown Square, PA: United States Department of Agriculture, Forest Service, Northern Research Station. 26 p.

Thornton, L. 2018. Email to Allan Braun, 20 August 2018.

US EPA (Environmental Protection Agency). 2015. US inventory of greenhouse gas emissions and sinks: 1990 – 2013. Executive Summary. EPA 430-R15-004, United States Environmental Protection Agency. Washington, D.C. 27 pp.

USDA Forest Service. In review. Assessment of the influence of disturbance, management activities, and environmental factors on carbon stocks, Eastern Region. 90 pp.

USDA Forest Service. 2019a. Early Successional Habitat Creation Project Implementation Guide. February 2019. 10 pp.

USDA Forest Service. 2019b. Early Successional Habitat Creation Project Scoping Comments - Content Analysis and Response to Comments. February 2019. 15 pp.

USDA Forest Service. 2018a. Early Successional Habitat Creation Project: Notice of Proposed Action and Opportunity to Comment. May 2018. 31 pp.

USDA Forest Service. 2018b. Soil Quality Standards for Harvest Areas in the Early Successional Habitat Creation Project Area. November 2018. 4 pp.

USDA Forest Service. 2018c. Early Successional Habitat Creation Project - Erosion Hazard Rating Map. 23 November 2018.

USDA Forest Service. 2016. Future of America's Forests and Rangelands: Update to the 2010 Resources Planning Act Assessment. General Technical Report WO-GTR-94. Washington, DC 250 p.

USDA Forest Service. 2015a. Baseline estimates of carbon stocks in forests and harvested wood products for National Forest System Units, Eastern Region. 43 pp. Available: https://www.fs.fed.us/climatechange/documents/EasternRegionCarbonAssessmentTwoBaselines.pdf

USDA Forest Service. 2015b. Forest Service Handbook FSH 1909.12 Land Management Planning Handbook, Chapter 70, Wilderness. WO Amendment 12-2015-1. 15 p.

USDA Forest Service. 2012a. Non-native invasive species best management practices: guidelines for the U.S. Forest Service Eastern Region. 288 p. Available: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5412822.pdf

USDA Forest Service. 2012b. National Best Management Practices Program for Water Quality Management on National Forest System Lands. Volume 1: National Core BMP Technical Guide. FS-990a. 177 pp. Available: https://www.fs.fed.us/naturalresources/watershed/pubs/FS_National_Core_BMPs_April2012.pdf

USDA Forest Service. 2012c. Forest Service Manual, Supplement R9 RO 2550-2012-1. Soil Management.

USDA Forest Service. 2010. Forest-Wide Non-Native Invasive Plant Control Project Decision Notice and Finding of No Significant Impact. 19 October 2010.

USDA Forest Service. 2009. Green Mountain National Forest annual monitoring and evaluation report: fiscal year 2008. 107 p.

USDA Forest Service. 2007a. Annual Monitoring and Evaluation Report: Green Mountain National Forest. 76 p.

USDA Forest Service. 2007b. Forest Service Manual 2320.3 Wilderness Management. WO Amendment 2300-90-2. 55 p.

USDA Forest Service. 2006a. Green Mountain National Forest Land and Resource Management Plan (Forest Plan). Eastern Region, Milwaukee, Wisconsin. February 2006. 164 p. plus appendices.

USDA Forest Service. 2006b. Final Environmental Impact Statement, Green Mountain National Forest Land and Resource Management Plan (Forest Plan). February 2006. 390 p. plus appendices.

USDA Forest Service. 2006c. Record of Decision. Final Environmental Impact Statement, Green Mountain National Forest Land and Resource Management Plan (Forest Plan). 10 February 2006. 54 pp.

USDA Forest Service. 2004. Green Mountain National Forest, Forest Plan monitoring and evaluation report: 2004. 11 p.

USDA Forest Service. 2003. Non-native invasive species framework for plants and animals in the U.S. Forest Service Eastern Region. 20 p. Available: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_054493.pdf

USDA Forest Service. 2000. Green Mountain National Forest Plan monitoring and evaluation report: 2000. 70 p.

USDA Forest Service. 1997. Guidelines for completing roadless area inventories during Forest Plan revision. August 1997. 12 p.

USDA Forest Service (USDA FS). 1995. Agriculture Handbook 701. Landscape Aesthetics: A Handbook for Scenery Management.

USDA Forest Service. 1992. Forest Service Handbook FSH 1909.12 Land and Resource Management Planning Handbook, Chapter 70, Wilderness Evaluation.

USFWS (U.S. Fish and Wildlife Service). 2016. Programmatic Biological Opinion on Final 4(d) Rule for the northern long-eared bat and activities excepted from take prohibitions. 5 January 2016. 109 pp.

VANR (Vermont Agency of Natural Resources). 2018. Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont. Effective 11 August 2018. 13 p. Available: https://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Forest_Management/Library/AMP%20final%20version%207-17-18.pdf

VANR (Vermont Agency of Natural Resources). 2017. Vermont Water Quality Standards: Environmental Protection Rule Chapter 29A. Effective 15 January 2017. 108 p. Available: http://dec.vermont.gov/sites/dec/files/documents/wsmd_water_quality_standards_2016.pdf

VANR (Vermont Agency of Natural Resources). 2016a. BioFinder 2.0 component abstract: Interior Forest Blocks. Available: https://anrmaps.vermont.gov/websites/biofinder2016/Documents/ComponentAbstracts/InteriorForestComponentAbstract.PDF

VANR (Vermont Agency of Natural Resources). 2016b. Proposal - Reclassification of Certain Vermont Surface Waters in the Green Mountain National Forest to Class A(1) Pursuant to the Vermont Water Quality Standards. Vermont Department of Environmental Conservation. 3 June 2016. 20 pp.

VANR (Vermont Agency of Natural Resources). 2016c. Forest Management Guidance for State Lands - Northern Long-eared Bats. Vermont Agency of Natural Resources. March 2016. 21 pp.

VANR (Vermont Agency of Natural Resources). 2015. Vermont Forest Fragmentation Report presented to the Vermont Legislature submitted in April 2015. 62 p. Available: https://fpr.vermont.gov/sites/fpr/files/About_the_Department/News/Library/FOREST%20FRAGMENTATION_FINAL_rev06-03-15.pdf.

VDHP (Vermont Division of Historic Preservation). 2017. Guidelines for Conducting Archaeology in Vermont. 74 pp. Available: https://accd.vermont.gov/sites/accdnew/files/documents/HP/ARCHEO%20GUIDELINES%20Final.pdf

VNHI (Vermont Natural Heritage Inventory). 2017. Rare and uncommon animals of Vermont. 22 March 2017. Available: https://vtfishandwildlife.hosted.civiclive.com/common/pages/DisplayFile.aspx?itemId=229831

Vose, J.M., D.L. Peterson, G.M. Domke, C.J. Fettig, L.A. Joyce, R.E. Keane, C.H. Luce, J.P. Prestemon, L.E. Band, J.S. Clark, N.E. Cooley, A. D'Amato, and J.E. Halofsky, 2018: Forests. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA.

Wear, D.N., Huggett, R., Li, R., Perryman, B. & Liu, S. 2013. Forecasts of forest conditions in regions of the United States under future scenarios: A technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-170 (US Department of Agriculture, Forest Service, 2013.

Wilderness Act of 1964, Pub. L. No. 88-577 (16 U.S. C. 1131-1136).

WRC (Windham Regional Commission). 2014. Windham Regional Plan. Adopted September 30, 2014. 257 p. Available: http://www.windhamregional.org/publications

Appendix A: Proposed Harvest Treatments

Compartment	Stand	Area (acres)	Management Area[1]	Compartment	Stand	Area (acres)	Management Area[1]
1	1	10	GME	52	8	44	DFU
1	2	17	NRA	52	9	44	DFU
2	4	15	NRA	52	10	76	DFU
3	1	23	NRA	53	1	19	DFU
3	4	69	NRA	53	3	52	DFU
3	6	23	NRA	53	6	35	DFU
3	7	17	NRA	53	8	36	DFU
3	8	19	NRA	53	9	140	DFU
3	9	20	NRA	53	11	44	DFU
3	10	27	NRA	53	12	72	DFU
3	13	18	NRA	53	13	108	DFU
3	15	17	NRA	53	14	103	DFU
3	18	11	NRA	53	16	23	DFU
3	22	14	NRA	53	22	5	DFU
3	24	18	NRA	53	29	22	DFU
3	26	18	NRA	89	2	4	DBC
3	31	55	NRA	89	12	35	DBC
3	32	12	NRA	89	46	1	DBC
3	33	17	NRA	89	46	6	DBC
3	35	14	NRA	91	1	38	DBC
3	36	60	NRA	91	4	7	DBC
3	39	34	NRA	91	6	57	DBC
3	40	46	NRA	91	14	18	DBC
4	1	10	DFU	91	17	61	DBC
4	3	9	DFU	91	18	39	DBC
4	4	95	DFU	91	20	45	DBC
4	6	21	NRA	91	21	20	DBC
4	10	26	DFU	91	22	26	DBC
4	11	14	DFU	91	24	3	DBC
4	12	23	DFU	91	25	16	DBC
4	13	21	DFU	91	26	12	DBC
4	14	60	DFU	91	26	6	DBC
4	15	90	DFU	91	32	58	DBC
4	17	89	DFU	91	33	33	DBC
4	18	57	DFU	91	34	22	DBC
4	19	14	DFU	91	36	28	DBC
4	20	55	DFU	91	38	49	DBC
4	22	17	DFU	91	39	31	DBC
5	1	13	DFU	91	40	13	DBC
5	2	44	DFU	91	41	54	DBC
5	3	22	DFU	91	42	27	DBC
5	4	16	DFU	91	44	26	DBC
5	5	12	DFU	91	48	36	DBC

Compartment	Stand	Area (acres)	Management Area[1]	Compartment	Stand	Area (acres)	Management Area[1]
5	6	14	DFU	92	26	17	DBC
5	7	30	DFU	92	27	47	DBC
5	8	16	DFU	92	28	31	DBC
5	9	27	DFU	92	29	10	DBC
5	11	7	DFU	92	31	146	DBC
5	12	39	DFU	92	44	6	DBC
5	13	10	DFU	92	46	5	DBC
5	14	16	DFU	92	47	70	DBC
5	15	17	DFU	92	48	31	DBC
5	16	30	DFU	92	49	10	DBC
5	18	10	DFU	92	51	32	DBC
5	19	17	DFU	94	8	3	DBC
5	21	9	DFU	94	10	20	DBC
6	27	37	GME	94	12	8	DBC
6	29	11	DFU	94	15	203	DBC
9	1	9	GME	117	6	3	DFU
9	4	11	DFU	122	2	59	DFU
9	4	6	DFU	122	16	30	DFU
9	5	8	DFU	122	41	68	DFU
9	6	30	DFU	122	43	77	DFU
9	7	23	DFU	128	56	134	DBC
9	8	32	DFU	129	1	96	DBC
9	9	15	DFU	129	15	56	DFU
9	10	39	DFU	129	16	89	DFU
9	11	16	DFU	129	24	23	DFU
9	12	15	DFU	129	26	31	DFU
9	13	16	DFU	129	27	46	DFU
9	19	15	DFU	129	32	34	DFU
9	20	6	DFU	129	44	69	DFU
9	21	8	DFU	129	49	42	DBC
9	22	22	DFU	129	54	36	DBC
9	23	27	DFU	129	56	47	DBC
9	24	13	DFU	129	57	73	DBC
9	25	32	DFU	129	60	37	DBC
10	1	43	NRA	129	60	13	DBC
10	6	18	NRA	129	63	85	DBC
10	7	25	NRA	129	70	19	DBC
10	42	32	NRA	129	71	56	DBC
10	45	82	NRA	129	75	14	DFU
10	46	78	NRA	133	2	11	DBC
12	54	5	NRA	133	6	28	DBC
13	1	3	DFU	134	5	51	DFU
14	1	9	DFU	134	8	54	DFU
14	2	22	DFU	134	9	11	DFU
14	3	22	DFU	134	15	38	DFU
14	5	33	DFU	134	26	31	DFU

Compartment	Stand	Area (acres)	Management Area[1]	Compartment	Stand	Area (acres)	Management Area[1]
14	15	26	DFU	141	2	51	DBC
14	21	29	DFU	141	3	32	DBC
14	22	56	DFU	141	6	55	DBC
14	23	126	DFU	141	9	20	DBC
14	24	40	DFU	141	10	18	DBC
15	2	23	DFU	141	12	30	DBC
15	3	57	DFU	141	14	81	DBC
15	4	13	DFU	141	25	64	DBC
15	5	7	DFU	141	102	1	DBC
15	6	11	DFU	142	4	28	DFU
15	18	27	DFU	142	9	7	DFU
15	19	33	DFU	142	13	41	DFU
15	20	4	DFU	144	2	47	GME
15	21	23	DFU	144	3	56	GME
15	22	7	DFU	144	7	76	GME
15	23	18	DFU	144	8	37	GME
15	25	6	DFU	144	9	56	GME
15	26	8	DFU	144	11	25	DBC
15	27	10	DFU	144	12	51	DBC
15	32	96	DFU	144	14	63	GME
19	1	74	NRA	144	15	26	GME
19	2	125	NRA	144	16	16	GME
19	5	18	NRA	144	17	21	GME
19	6	44	NRA	144	18	28	GME
19	7	414	NRA	144	19	62	DBC
19	8	41	NRA	144	20	41	DBC
19	10	12	NRA	144	21	8	GME
19	11	42	NRA	144	22	19	GME
19	12	26	NRA	144	23	37	DBC
19	13	7	NRA	144	27	11	GME
19	14	14	NRA	144	27	16	GME
19	15	23	NRA	144	28	9	GME
19	16	12	NRA	144	29	4	GME
19	17	8	NRA	144	30	30	GME
19	19	50	NRA	144	31	54	GME
19	20	38	NRA	145	11	24	GME
19	28	92	NRA	145	14	25	GME
19	29	147	NRA	145	15	84	GME
19	31	126	NRA	145	16	17	GME
19	32	9	NRA	145	17	15	GME
19	36	120	NRA	145	18	51	GME
19	39	12	NRA	145	19	8	GME
19	40	12	NRA	145	22	9	GME
19	42	30	NRA	145	24	25	GME
23	8	48	NRA	145	26	45	GME
23	11	12	NRA	145	27	10	GME

Compartment	Stand	Area (acres)	Management Area[1]	Compartment	Stand	Area (acres)	Management Area[1]
23	20	67	NRA	145	28	8	GME
23	21	15	NRA	145	29	44	GME
23	37	23	NRA	145	30	55	GME
23	38	10	NRA	145	32	44	GME
23	39	4	NRA	145	33	9	GME
23	40	16	NRA	145	103	5	GME
25	16	72	RWH	149	6	34	RWH
27	28	8	DFU	149	7	9	RWH
28	3	70	DFU	149	8	17	RWH
28	4	41	DFU	149	11	11	RWH
28	5	15	DFU	149	14	15	RWH
28	6	17	DFU	156	16	17	DFU
28	7	7	DFU	156	17	62	DFU
28	8	14	DFU	156	18	40	DFU
28	9	17	DFU	172	2	36	GME
28	10	13	DFU	172	3	28	DBC
28	11	41	DFU	172	4	33	DBC
28	12	29	DFU	172	10	57	DBC
28	13	14	DFU	172	11	25	DBC
28	14	22	DFU	172	12	99	DBC
28	15	31	DFU	172	13	6	DBC
28	20	5	DFU	172	14	35	DBC
30	6	86	DFU	172	15	25	DBC
30	8	21	DFU	172	18	36	DBC
30	12	10	DFU	172	20	221	DBC
30	13	7	DFU	172	22	39	DBC
30	14	174	DFU	172	23	5	DBC
30	16	23	DFU	172	24	20	DBC
30	17	7	DFU	172	25	82	DBC
30	18	6	DFU	174	3	19	DFU
30	20	29	DFU	174	4	10	DFU
31	1	6	DFU	174	6	15	DFU
31	2	17	DFU	174	7	4	DFU
31	4	28	DFU	174	8	51	DFU
31	5	19	DFU	174	9	44	DFU
31	8	49	DFU	174	19	62	DFU
31	10	77	DFU	174	20	15	DFU
31	12	29	DFU	174	21	27	DFU
31	13	52	DFU	174	22	10	DFU
31	14	9	DFU	174	23	21	DFU
31	15	25	DFU	174	24	58	RWH
31	16	46	DFU	174	25	46	RWH
31	17	23	DFU	179	9	53	RWH
31	18	4	DFU	179	11	9	RWH
31	19	5	DFU	181	2	22	RWH
31	20	8	DFU	181	3	62	RWH

Compartment	Stand	Area (acres)	Management Area[1]	Compartment	Stand	Area (acres)	Management Area[1]
31	23	7	DFU	181	4	41	RWH
31	25	15	DFU	181	14	17	RWH
38	7	8	GME	181	15	16	RWH
38	15	19	DFU	181	16	31	RWH
38	16	4	DFU	181	17	7	RWH
38	21	19	GME	181	18	5	RWH
38	22	3	GME	181	19	29	RWH
39	4	26	DFU	181	31	16	RWH
43	7	50	RWH	184	7	17	DBC
43	15	21	RWH	184	14	20	DBC
43	22	14	RWH	184	15	38	DBC
43	23	7	RWH	184	16	33	DBC
43	26	35	RWH	184	17	15	DBC
43	31	30	RWH	184	19	2	DBC
43	64	16	RWH	186	2	45	DFU
44	2	37	DFU	186	999	895	RWH
44	4	3	DFU	192	1	33	DFU
44	5	14	DFU	192	5	22	DFU
44	8	6	DFU	192	6	49	DFU
44	10	12	DFU	192	7	18	DFU
44	13	55	DFU	192	8	33	DFU
44	14	6	DFU	192	9	57	DFU
44	15	5	DFU	192	11	48	DFU
44	16	1	DFU	192	17	33	DFU
44	19	26	DFU	192	18	34	DFU
44	20	11	DFU	192	20	35	DFU
44	21	15	DFU	192	21	47	DFU
44	22	22	DFU	192	22	5	DFU
44	23	28	DFU	192	23	4	DFU
44	24	6	DFU	242	3	182	DFU
44	25	20	DFU	242	4	93	DFU
44	41	8	DFU	242	5	170	DFU
44	113	3	DFU	242	6	85	DFU
45	3	14	DFU	251	36	8	DFU
45	6	6	DFU	251	47	9	DFU
45	8	32	DFU	251	48	8	DFU
45	10	13	DFU	251	49	13	DFU
45	12	49	DFU	251	50	39	DFU
45	13	16	DFU	251	51	19	DFU
45	18	4	DFU	251	53	27	DFU
45	30	5	DFU	251	56	8	DFU
45	31	17	DFU	251	60	44	DFU
45	32	5	DFU	251	61	18	DFU
45	33	24	DFU	251	64	53	DFU
45	37	5	DFU	251	65	201	DFU
47	12	14	RWH	251	66	201	DFU

Compartment	Stand	Area (acres)	Management Area[1]	Compartment	Stand	Area (acres)	Management Area[1]
48	1	29	DFU	251	67	135	DFU
48	2	1	DFU				
48	6	44	DFU				
48	8	17	DFU				
48	9	37	DFU				
51	999	759	RWH				
52	7	31	DFU				

[1]GME = Green Mountain Escarpment
DBC = Diverse Backcountry
DFU = Diverse Forest Use
NRA = Robert T. Stafford White Rocks National Recreation Area
RWH = Remote Wildlife Habitat

Appendix B: Design Criteria

Wildlife

1. Before each timber harvest and associated road construction may commence, consultation with the U.S. Fish and Wildlife Service must be completed if activities may affect a federally-listed species.
2. In order to protect both nesting birds (in particular neo-tropical migrant passerines) and bats, tree felling and clearing activities shall not be conducted from May 1 through July 31.
3. Potential Indiana bat roost trees (defined as any tree greater than or equal to eight inches diameter at breast height with exfoliating bark, cavities, or crevices) located under 1,100 feet in elevation west of the spine of the Green Mountains and/or within five miles of a known Indiana bat hibernaculum shall not be removed unless one of the following measures are taken:
    a. Trees are surveyed for emerging bats
    b. Trees are cut outside of the Indiana bat active season, including the fall swarming season (April 1 to November 15)
    c. Trees are deemed as hazards that are likely to fall in the immediate future and could cause injury or death to people
4. When working in stands that are important black bear habitat as evidenced by high densities of black bears and/or the presence of bear-clawed beech trees, including all stands considered for treatment within Compartments 52, 122, 149, 181, 184, and 186, consult with Vermont Agency of Natural Resources staff to minimize impacts to bears and, when practicable, enhance bear habitat.
5. To minimize the potential fragmentation effects in the highest priority Connectivity Block and the regionally significant bear travel corridor located in Dover and Wardsboro, work closely with Vermont Agency of Natural Resources staff when planning project activities in Compartments 51, 52, 53, and 186.
6. If threatened, endangered, or Regional Forester Sensitive Species (RFSS) are previously documented, located in surveys, or newly discovered, staff would recommend buffer zones and/or time-of-year restrictions as needed to protect the populations. Populations and protection measures would be reviewed on a case-by-case basis to determine the appropriate action. Guidelines in approved recovery plans, current conservation approaches including *Vermont Agency of Natural Resources - Forest Management Guidance for State Lands: Northern Long-eared Bats* (VANR 2016c, or current version if superseded by an updated document), other scientific literature, the 2006 Forest Plan, and professional judgment would be followed to protect these populations. The Responsible Official would make a final decision on protection measures.
7. To provide for American marten movements within core areas, preclude harvest within 100 feet along both sides of the South Fork of the Roaring Branch and its headwater tributary located near the end of the MacIntyre Road (Forest Road 85).

Sensitive Natural Communities

1. When planning work around rare and sensitive natural communities (as mapped by the Vermont Natural Heritage Inventory program) with a State Rank of S1 (critically imperiled) through S3 (vulnerable), do not conduct timber harvests or create roads or skid trails within 100 feet of the mapped communities.

Sensitive Plants

1. Site-specific botanical field surveys will be conducted prior to project implementation for habitats within the project area based on the Likelihood of Occurrence Table (see project file). If any plant listed as a Regional Forester Sensitive Species (RFSS) is found, specific measures to protect these plants would be developed by the Forest botanist so that the population does not lose viability, and the species does not trend toward federal listing. "Protect" means do not trample, fell trees on top of, or change the habitats of RFSS plants. Examples include winter logging to avoid trampling, marking rare plants with GPS and flagging to avoid trampling or felling trees on top of them, and excluding areas to avoid altering habitats.
2. An individual RFSS needs to be searched for only in the sites that, based on pre-field review, are likely to provide the species-specific habitat requirements (such as liminess, certain elevation, topography, etc.).
3. Where trees will be felled near wetlands, protect *Sphagnum pulchrum*, which occurs in wetlands.
4. If eastern dwarf mistletoe (*Arceuthobium pusillum*) is found in a wetland, do not cut the tree upon which it grows.
5. Search for and protect all plant RFSS listed as possible to occur in rich woodlands (including sugar maple/beech/yellow birch, sugar maple, and old field northern hardwoods forest types with a site index greater than 60).
6. Search for and protect leathery grapefern (*Botrychium multifidum*) and hay sedge (*Carex argyrantha*) in the one likely dry opening in the project area (Compartment 141, Stand 102).
7. Search for and protect all plant RFSS listed as possible to occur in dry woods (dry red maple/beech, beech, and red oak forest types) in western Vermont.
8. Protect rough cotton grass (*Eriophorum tenellum*) which is known to occur in Compartment 44, Stand 105.
9. Where work will occur along streams, protect plant RFSS listed as possible in seeps or along streams: boreal bedstraw (*Galium kamtschaticum*) and bog chickweed (*Stellaria alsine*). Given the extensive potential habitat, develop a sampling scheme and implement it, rather than searching all seeps or stream sides.
10. Where coniferous woods or mixed woods occur (red spruce/balsam fir and maple/beech/birch/spruce forest types), search for and protect round-leaved orchis (*Platanthera orbiculata*) and lesser wintergreen (*Pyrola minor*). Given the abundance of this type of habitat, and the very limited likelihood of locating either species (one tends to occur in very small populations that are easily overlooked and the other is very small in size), develop a sampling scheme and implement it, rather than searching all such stands.

11. Do not cut healthy butternut (*Juglans cinerea*) trees where they occur.

Non-native Invasive Plants

1. For stands that occur along roadsides, inventory for non-native invasive plants at least 500 feet in both directions on both sides of the road, and if landowner permission can be obtained (or it is National Forest System land next to a Forest Service road), treat any non-native invasive plants found prior to project implementation, using methods in keeping with the Forest-wide Non-native Invasive Species Control Environmental Assessment and associated Decision Notice (USDA Forest Service 2010). Treat any non-native invasive plant infestations found from monitoring newly created early successional habitat stands after implementation activities are complete.
2. Based on results of any pre-field review, plus any botanical inventory that occurs, implement relevant best management practices as determined by the Forest Botanist, using the "Non-native Invasive Species Best Management Practices Guidelines for the U.S. Forest Service Eastern Region" (USDA Forest Service 2012a).
3. Perform risk assessments for stands that contain or are adjacent to infestations by using the "Non-native Invasive Species Framework for Plants and Animals in the U.S. Forest Service Eastern Region" (USDA Forest Service 2003), and incorporate the results of the risk assessments into project implementation.
4. When seeding bare, disturbed soil resulting from project activities, use a Forest Service approved local, native plant mix. If unavailable, use a non-invasive seed mix approved by the Forest botanist.

Aquatic Resources

1. As necessary to attain stabilization of roadbed and fill slopes of temporary roads, measures will be employed such as out-sloping, drainage dips, and water-spreading ditches.
2. Once temporary roads have served their purpose, restore roadbeds to the original landscape contour and remove all bridges and culverts. Eliminate ditches, out-slope roadbed, remove ruts and berms, effectively block the road to normal vehicular traffic where feasible under existing terrain conditions, and build necessary cross ditches and water bars.
3. When bridges and culverts are removed, associated fills shall also be removed to the extent necessary to permit normal maximum flow of water as well as normal floodplain and wetland functions.
4. Where permanent roads will be created, or where existing and/or unclassified roads will be improved, permanent stream crossing structures proposed for installation (new or replacement) on fish bearing streams shall allow for the passage of aquatic organisms, sediment, and wood.
5. Reshape streambank to preconstruction/natural shape to restore stream hydrology.

Soils and Wetlands

1. Planning and implementation of all proposed activities would comply with the National

Best Management Practices Program for Water Quality Management on National Forest System Lands (USDA Forest Service 2012b).

2. The following design criteria are applicable to ground disturbing vegetation management activities, such as commercial timber harvests and non-commercial vegetation treatments. These are in addition to timber sale contract provisions for protection of soil and water quality:

    a. Bole-only harvest would be done in all stands except those with aspen present where clearcuts are planned for aspen regeneration, where long-term soil productivity is expected to be maintained. This measure limits nutrient removal associated with harvesting.

        i. Woody material other than boles would not be removed (i.e., no whole tree harvest) on sandy or other low water-holding capacity soils, nutrient-poor soils, soils that are shallow to bedrock, are poorly drained, soils above 2,500 foot elevation, soils with ratings of severe erosion hazard or poor harvest equipment operability, or where forest critical load nitrogen exceedance is above 9.8 kilograms/hectare/year (maps available in the project planning record).

        ii. The potential for more rapid depletion of calcium when harvesting oak stands would be considered during review of potential whole tree harvest units.

    b. Do not remove stumps, roots, or other below-ground biomass. Do not remove litter.

    c. Do not re-enter stands for whole tree harvest to avoid repeated soil compaction.

    d. Where whole tree harvest is utilized (on unrestricted soils):

        i. Harvest with sufficient snow cover (at least one foot) or frozen soil, to minimize soil disturbance and to ensure leaves and their associated nutrients remain onsite.

        ii. Retain at least one third of tops and limbs, scattered throughout harvested stands, to reduce risks of nutrient depletion.

        iii. Retain fine woody material present before harvest except on roads, skid trails, and landings; retain fine woody material resulting from incidental breakage of tops and limbs in the general harvest area. Disperse residues throughout the site.

    e. Leave tops and limbs used to stabilize soil on roads or skid trails in place following harvest operations. Tops and limbs may be used to cross small wet drainages, but must be removed from drainages prior to sale close-out and scattered throughout harvested stands.

    f. Do not operate heavy machinery or harvest within 100 feet of wetlands, except when wetlands must be crossed for timber management because there are no reasonable alternatives. Maintain cross drainage during and after the project is completed, and place easily removable materials such as mats, small pipe bundles, corduroy (log stringers), or similar structures to minimize damage due to fill removal; and only log when soils are frozen or sufficiently covered with snow to protect soil resources (generally at least a foot). Flag wetlands with a 100 foot buffer within units as equipment exclusion areas.

g. Sale area layout would exclude all mapped slopes greater than 45 percent. Equipment operations would be prohibited on all slopes greater than 35 percent except in special situations where equipment operations on a very short slope would greatly facilitate timber sale operations and/or reduce impacts to soils in other areas, and where erosion and sedimentation will be minor, with soil/land stability maintaining intact. All proposed equipment operations would be approved by sale administration personnel in consultation with a soil scientist on a case by case basis. Equipment operations on slopes between 25 and 35 percent will be evaluated on a case by case basis by Forest Service personnel in consultation with a forest soil scientist. Sale area layout may exclude these slopes within cutting units or areas would not be marked to avoid soil resource damage.

h. To address soil productivity concerns within harvested stands, maintain even slash distribution throughout the stand. Retaining a few brush piles for wildlife purposes is acceptable.

i. Sale area layout would exclude all wetlands, poorly drained soils, or very poorly drained soils, and all shallow soils greater than one-quarter of an acre in area (less than 20 inches deep over bedrock). Sale area layout would also exclude all areas with a very severe erosion hazard.

j. Do not harvest on elevations greater than 2,500 feet, except in some stands on a case-by-case basis with soil scientist review, considering site-specific soil-affecting parameters (like acid deposition, acid deposition critical load exceedance, aspect, plant communities, and wildlife habitat needs). Do not harvest if sensitive soil parameters are present (slopes greater than 35 percent, soils with a severe or very severe erosion hazard rating, shallow soils, or somewhat poorly drained soils). If no sensitive soil parameters are present, use lower harvest intensities and avoid even-aged regeneration methods, such as clearcutting and seed tree prescriptions.

k. Stands would generally be harvested with sufficient snow cover (at least one foot) or frozen soil, to minimize soil disturbance. Some stands may be suitable for summer harvest under the following conditions:

    i. When soils are sufficiently dry, typically between early August and late September.

    ii. When stands are below 2,500 foot elevation, with moderately well-drained soils or drier, with moderately deep or deeper soils, erosion hazard ratings of slight or moderate, harvest equipment operability ratings other than poor, and no wetlands that would be crossed during logging operations.

    iii. When specific stands for summer harvest are identified during annual soil scientist input in response to proposed vegetation management. A small number of additional stands may be identified afterward by the soil scientist as suited to summer harvest, if for example special harvest equipment is used, there is an unusually dry summer, or tactics such as mats and slash beds are used to minimize disturbance, provided skid roads and landings are located outside of stream protective strips prescribed in the Forest Plan.

3. The following design criteria are applicable to the siting and use of log landings:

    a. Do not locate landings on somewhat poorly or poorly drained soils. Locate

landings where slope directs sediment away from water bodies, including seasonal ponds.

b. Locate landings at least 100 feet from all wetlands, including seasonal ponds, and design and manage them to not contribute sediment to any water body.

c. Reduce logging debris (such as chips and bark) at landings to less than 12 inches so as to not severely restrict vegetative growth in the area.

d. Scatter tops and limbs on landings and skid trails during logging operations where needed to reduce compaction and erosion, and return all other tops and limbs and scatter throughout harvested stands to retain soil nutrients.

4. The following design criteria are required to maintain soil stability and control erosion. They apply to all newly constructed Operational Maintenance Level (OML) 1 permanent and temporary road segments:

    a. Seed and mulch bare soils to a depth of at least one inch in the road corridor off the driving surface (such as fillslopes and cutbanks). However, if construction occurs when seeding is not recommended (such as the dormant season), mulch to a depth of at least three inches or use natural fiber erosion control blankets to prevent adverse soil erosion.

    b. Place geotextile fabric, jute netting, or other erosion control matting to hold the soil and seed in place until vegetation is established on cutbanks and exposed steep slopes in excess of 35 percent.

    c. Establish closer crossdrain spacing than required by Vermont Acceptable Management Practices (VANR 2018) on new road sections where needed to help reduce soil erosion.

    d. Remove drainage structures across streams and wetlands and all fills associated with drainages and wetlands following harvest, to permit normal maximum water flows, which includes some floodplain area and normal wetland function.

    e. Where existing system roads are damaging resources due to poor location, they may be reconstructed in a more appropriate nearby location. In this case, the existing system road would be decommissioned and closed.

    f. Following use of new temporary roads constructed or rerouted where no existing road template exists, restore roadbeds to the original landscape contour where needed to maintain natural stream hydrology, and stabilize soil to ensure long-term soil productivity is not compromised. This includes, but is not limited to, the outsloping of roadbeds, elimination of ditches, and reshaping streambanks to pre-use conditions.

5. Design skid trails to direct water flow outside of riparian corridors as quickly as possible, to avoid steep terrain (slopes above 35 percent), maximize the distance between the road and water-bodies, minimize the number of water body crossings, and minimize the total miles of skid road.

6. The following design criteria apply to prescribed burning and associated activities:

    a. Prescribed burning will be done only when overall mineral soil heating is low, and no more than an average loss of one inch or one-half of the sum of organic

horizons will be consumed during burns. Burns will have mixed-severity burn patterns at each unit, and uneven, mosaic forest floor consumption, with no more than 10 percent of the area having mineral soil exposed immediately after the burn. This minimizes soil erosion and nutrient losses. In addition, burning will not be done in areas dominated by outcrops and soils less than 12 inches deep over bedrock.

b. While burning piles, minimize the number of piles at each pile burning site, with a maximum of 10 percent of the area of each unit occupied by piles. Previous pile burning sites shall be reused as much as possible. This would minimize soil nutrient losses.

c. Use hand lines for fire line creation whenever hand line can be safely used, to minimize potential for compaction, rutting, erosion, and sedimentation.

d. No excavator equipment will be used to create fire line within the protective strips of streams, wetlands, or ponds, or on slopes in excess of 35 percent.

e. Mulch all exposed mineral soil within fire lines with nearby duff material after burning to minimize erosion and sedimentation.

f. On slopes in excess of 35 percent, install waterbars during fire line construction (i.e. before burning).

g. On slopes in excess of 20 percent, install waterbars along the fire line after burning to minimize erosion.

h. Excavator equipment will only be used once in each stand over the life of the project for the creation of fire lines.

i. When equipment is used for fire line creation, only remove the upper layers of organic matter, leaving the most decomposed organic matter layer intact, to minimize erosion and sedimentation. To correct unintended soil disturbance and removal, mulch with nearby duff material or straw and install water bars.

j. To maintain existing wetland wildlife habitat and to maintain soil organic carbon levels, do not conduct prescribed burns within wetlands or their buffers.

Recreation

Roads

1. Temporary traffic controls shall be used to provide road users with adequate warning of hazardous or potentially hazardous conditions associated with timber harvesting operations. The timber sale purchasers and the Forest Service shall agree to a specific traffic control plan for each individual project prior to commencing operations to address safety concerns associated with recreation traffic.
2. Upon completion of harvest activities, road closure devices shall be installed to prevent unauthorized motorized use in accordance with the following:
    a. The selection of a road closure device and closure procedures shall follow the road access management guidelines for roads on the Green Mountain National Forest. Road closures can be conducted using berms, boulders, gates, or

transplanting trees and shrubs from nearby or adjacent sites into the road surface area. This is to discourage unauthorized use and subsequent aquatic and soil resource impacts. Closure devices on roads used for recreation and other access shall allow for openings to meet those uses.

b. Wherever practical, a closure device should be placed at the entrance of a network of roads rather than closing each individual segment.

Trails

1. The following design criteria shall be implemented to protect the trails, including continued safe use of the existing trail system.

    a. No trail shall require permanent re-routing as a result of this vegetation management prior to or after project implementation. Temporary rerouting or trail closures may be an option selected when necessary for safety and when other options are not viable.

    b. A recreation specialist shall be included in the planning of individual sale layout activities to ensure there is minimal disruption to existing and future designated trails within the project area.

    c. Existing trails shall be protected during harvest operations. Any damage to trails incidental to logging activities will be repaired in a timely manner. This includes repairing damage to waterbars, removal of slash and debris, smoothing of ruts in trails and removal of overhead hazards.

    d. Skid road crossings on trails shall be perpendicular to the trail tread and have a sight distance safe enough to allow visibility for recreation users.

    e. Skid roads that cross system trails shall be disguised with retained organic material produced by logging activities. Prior to the completion of harvest activities, tree branches with diameters of six inches or less shall be placed in a random, natural appearing pattern along the width of the road where it intersects the trail to a height of two to three feet and a depth of six to eight feet.

    f. Where feasible, trees shall be felled away from the trail prism to reduce retained organic material accumulation immediately adjacent to the trail.

    g. When practicable, plan timber harvests and road construction activities outside of the typical season of use of any trails or other recreation sites that may be impacted.

    h. If harvest activities occur along or within trails, logging activity signs shall be posted and the trails shall be evaluated for temporary closure to ensure safety of forest visitors.

    i. Hauling activities impacting high-use snowmobile trails shall not take place on weekends or federal holidays unless snow conditions do not allow snowmobiling to occur. Recreation and timber staff shall consult with local snowmobile clubs during sale layout planning to determine use levels on trails and appropriate weekend haul restrictions.

    j. If harvest activities using snowmobile trails for skidding or hauling are required by prescription to operate during the snowmobile season (December 16 to April 15), attempts to accommodate both activities shall be made. If conditions allow,

adequate snow pack at a width that would allow snowmobile passage shall be left on one side of the trail and safety signs shall be posted. If simultaneous use of the trails is not possible, temporary reroutes of the snowmobile trails shall be attempted. Coordination between timber and recreation shall occur before the snowmobile season to allow time for the responsible clubs to designate alternative routes with Vermont Association of Snow Travelers, or complete closure of the route to mitigate safety concerns.

Developed Recreation

1. No harvest activities would occur within developed recreation sites, such as Wallingford Pond Trailhead or any other developed recreation sites identified in pre-implementation surveys.
2. If harvest activities occur adjacent to developed recreation areas, logging activity signs shall be posted and sites shall be evaluated for temporary closure to ensure safety of forest visitors.

Inventoried Roadless Areas

1. No more than 20 percent of each inventoried roadless area shall be harvested with even-aged regeneration harvests in any ten-year period.

Congressionally Designated Areas

1. Treatment units adjacent to Wilderness shall have boundaries marked and delineated to a degree of accuracy agreed upon by recreation and survey staff. No trees shall be felled that can fall into Wilderness.
2. Questions regarding the location of any wilderness area boundaries shall be directed to the Forest Land Surveyor. No determinations shall be made based on assumptions or previous answers to similar questions.

Visual Quality

1. A Forest Service landscape architect or recreation specialist trained in scenery management shall conduct a scenery analysis to determine appropriate site-specific design criteria prior to layout of each timber sale.
2. Treatment units visible from state highways, well-traveled Forest Roads, and key observation points at recreation sites or along trails shall be limited in size and shape. Mitigation techniques such as paralleling harvest edges with existing contours, feathering harvest areas and avoiding creation of unnatural hard straight lines and shapes on the landscape shall be used to reduce visual contrast from the valued scenic character. Specific mitigations shall be selected prior to layout in order to best meet scenic integrity objectives of the site.
3. Screen log landings from view of Forest recreation users on trails, roads, and at developed recreation sites by using an angled road or leaving a vegetative screen. When possible, landings shall be located out of sight from roads or public viewing locations.
4. Retained organic material that results from timber harvests shall be managed according to the following restrictions:

a. Where retained organic material is created adjacent to developed recreation sites, it shall be lopped and scattered no higher than two feet from the ground within 50 feet from the recreation site.

b. Where timber harvest takes place adjacent to recreation trails and/or maintained residential areas, lop and scatter any remaining retained organic material that falls within 25 feet of the residential boundary or each side of recreation trails to no higher than two feet from the ground.

c. Where timber harvest takes place adjacent to major travel corridors, such as VT Route 155, Forest Road 10, and other significant travel ways and recreation access routes, pull back retained organic material from the road edge a minimum of 15 feet, then lop and scatter to within two feet of the ground so as not to create an unnatural edge.

Heritage Resources

1. A draft Programmatic Agreement between the Green Mountain National Forest, the Vermont State Historic Preservation Office, and the Advisory Council on Historic Places, is currently undergoing review and revision. It is the desire of all who are entering into this agreement to streamline procedural requirements, and emphasize the common goal of protecting historic properties within National Forest System lands in Vermont. When the Programmatic Agreement is finalized and signed by all signatories, the following mitigation measures may be modified, based on the final version of the Programmatic Agreement.
2. Until the Programmatic Agreement is finalized, all project-related fieldwork and reports shall meet the standards set forth in the Vermont Division for Historic Preservation's *Guidelines for Conducting Archaeology in Vermont* (VDHP 2017). Therefore, for each years' proposed activities the Green Mountain National Forest shall submit archaeological survey reports for review to the Vermont State Historic Preservation Office and consulted tribes. These reports will document the Forests' findings that the activities may not affect or may not adversely affect historic properties. Concurrence for these survey reports must occur prior to implementation of any project activity.
3. Historic period archaeological sites will have a buffer zone to protect the site from physical disturbance. This buffer zone may be customized to reflect the kind of site; its associated features, location, and/or level of prior use and disturbance; and the nature of the proposed activity. In the absence of a customized buffer (or the inadvertent discovery of a site during project layout or implementation), the Vermont Division for Historic Preservation has determined that the default buffer is 200 feet in every direction. Alternately, customization may be implemented to harvest activities within the site area under circumstances that minimize disturbance and maximize benefit to the overall condition of the site. These types of measures are agreed to by the Forest Service Archaeologist and project proponent or Timber Sale Administrator.
4. A standard mitigation measure for stone walls/fences generally states that there will be no disturbance. However, with the Forest Archeologists' approval, exceptions may be made when there is a clear need to breach a wall (for example, to move between timber sale units). The location and manner in which this will be done will be determined by the Forest Service Archaeologist in conjunction with the activity project proponent/program manager or Timber Sale Administrator for harvest activities. In cases in which the origin

of the stone walls/fences is potentially of Native American origin, the Western Abenaki groups of Vermont will be notified and included in any relevant decisions.

5. General mitigation measures for areas sensitive for the location of prehistoric Native American sites will be applied to ensure that disturbance to the subsurface soil horizon in which these sites do, or may, exist is avoided or minimized. These measures include: avoidance of the area altogether, operating over-snow (eight to 12 inches), or on frozen ground conditions, and the use of alternative harvest technologies such as tracked feller-bunchers or helicopters. In the project area, many of the stands and areas where proposed activities will take place may require this treatment, but specific measures will be determined by the Forest Service Archaeologist as needed prior to and during implementation. Post-harvest monitoring will occur in areas in which over-snow, frozen ground, and tracked feller-bunchers harvest techniques were used to determine if these mitigation measures were adequate. Modifications to this mitigation may occur, based on these findings.
6. The specific locations of newly proposed temporary haul roads and skid roads that require disturbance below the ground surface, such as clearing and grading, will be coordinated with the Forest Service Archaeologist prior to implementation to ensure heritage resources are avoided. A map showing the buffered area for protected heritage resources in these areas will be provided to appropriate personnel prior to any approved project implementation.
7. All known and newly identified heritage sites in the project area will be incorporated into the Natural Resource Manager Heritage Application and the Green Mountain National Forest GIS database.
8. All archaeological and historic sites that are eligible for the National Register of Historic Places (NRHP), or whose NRHP statues remains unevaluated, will be protected from any ground disturbance. These sites will be avoided by all project activities, and will be protected by a buffer zone of up to 30 meters (100 feet) beyond the site boundary. No vegetation removal or other activities will be allowed within this zone.
9. Forest Service staff and contractors must immediately stop work if any unexpected artifacts, archaeological sites, or human remains are encountered; and the location shall be reported to the Forest Archaeologist.
10. Provide a 50 foot wide protective buffer on both sides of the old Stratton Mountain Trail leading to the historic Stratton Mountain tower to prevent disturbance from harvest activities. Exceptions may be made when there is a clear need to cross the trail to facilitate timber sale activities. Consultation between the Forest Service Archeologist and the Vermont State Historic Preservation Office will be necessary to determine the location and manner in which this will be done.

Property Boundaries and Easements

1. The Forest Land Surveyor shall be consulted prior to any ground disturbing activity within one-quarter of a mile of any exterior National Forest property boundary, or Special Designated Area boundary, or within any easements of unknown location or extent.
2. All National Forest System property boundaries and Special Designated Area boundary lines within 500 feet of a treatment area must be surveyed and marked or

maintained prior to commencing activity, unless an exemption is provided by the Forest Land Surveyor for a specified area.

3. Boundary buffers or setbacks shall not be used for purposes of avoiding the boundary marking requirement. Whenever possible, treatment areas that are not coincident with the exterior National Forest System or Special Designated Area boundaries, but are within one-quarter of a mile of the same, shall be defined by non-linear boundaries in order to reduce the likelihood of misinterpretation as evidence of the legal boundary.
4. The Forest Land Surveyor shall be consulted prior to the removal of any bearing trees, trees marked for boundary, line posts, or other boundary markings. Sufficient time shall be allotted for the Forest Land Surveyor to coordinate the perpetuation of boundary corners and lines in the field so that marked boundaries are not lost during the management activity.
5. Geographic Information System (GIS)-based coordinates for survey lines, parcel boundaries, controlling corners, and parcel corners shall not be used as authoritative indicators of legal boundary lines and property corners. In addition, fence lines, fence corners, and other alleged physical evidence of the lines and corners are not to be used as indicators of boundary lines unless their locations have been validated by the Forest Land Surveyor.
6. All suspected trespasses or encroachments, whether appearing to have been committed against or by the Forest Service, shall be reported to the Forest Land Surveyor. In severe cases, or where planned Forest activities may contaminate evidence or interfere with investigation of such cases, Forest Service staff and contractors must immediately stop work and report the location and issue to the Forest Land Surveyor and Law Enforcement.
7. All claims of title or disagreements regarding boundary location or land use rights, received verbally or in writing, shall be reported to the Forest Land Surveyor.
8. Interpretation of deeds, legal descriptions, and other written documents that define the ownership and location of land title and land boundaries is the responsibility of the Forest Land Surveyor.
9. Legal access to National Forest land, across other lands, shall not be assumed. Proposed access routes and known easements or rights-of-way shall be discussed with the Forest Land Surveyor prior to project implementation.
10. Rights to timber removed from easements or rights-of-way across non-National Forest System lands should be discussed with the Forest Land Surveyor prior to project implementation.

Appendix C: Operational Maintenance Level Descriptions for Roads

The following are Operational Maintenance Level descriptions for National Forest System roads (Forest Service Handbook 7709.59 Chapter 60).

Maintenance Level 1 (OML 1)
Assigned to intermittent service roads during the time they are closed to vehicular traffic. The closure period must exceed 1 year. Basic custodial maintenance is performed to keep damage to adjacent resources to an acceptable level and to perpetuate the road to facilitate future management activities. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level.

Appropriate traffic management strategies are "prohibit" and "eliminate." Roads receiving level 1 maintenance may be of any type, class, or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic, but may be open and suitable for non-motorized uses.

Maintenance Level 2 (OML 2)
Assigned to roads open for use by high clearance vehicles. Passenger car traffic is not a consideration. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level. Appropriate traffic management strategies are either to (1) discourage or prohibit passenger cars, or (2) accept or discourage high clearance vehicles.

Maintenance Level 3 (OML 3)
Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. Roads in this maintenance level are typically low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users.

Maintenance Level 4 (OML 4)
Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. The most appropriate traffic management strategy is “encourage.” However, the “prohibit” strategy may apply to specific classes of vehicles or users at certain times.

Maintenance Level 5 (OML 5)
Assigned to roads that provide a high degree of user comfort and convenience. These roads are normally double lane and paved. Some may be aggregate surfaced and dust abated. The appropriate traffic management strategy is “encourage.”

Appendix D: Project Maps

See enclosure