American Forest Foundation
Landscape Management Plan

State of Virginia

Last Revised Date: 11/20/2024

Landscape Management Plan Creation

Plan Development and Composition

The American Forest Foundation (AFF), in conjunction with Southern Forestry Consultants, Inc.(SFC), developed the original components, outlines, structure, and drafts of the Landscape Management Plan (LMP) and the associated geodatabase. AFF and SFC also worked cooperatively to evaluate and incorporate edits, comments, and modifications that resulted in the final LMP.

Natural Resource Professional Support Committee

AFF consulted regularly with staff from the Virginia Department of Forestry (VDOF) to seek their input on various thematic, structural, and scientific components through multiple drafts of this LMP. Additionally, VDOF staff facilitated access to and procurement of publicly available geospatial data during the development of the geodatabase.

Additional Stakeholders

AFF also sought input from a variety of additional stakeholders with expertise in the natural resources, planning, certification, and regulatory disciplines. Like the Support Committee, these additional stakeholders did not necessarily endorse all components of the LMP, nor does AFF imply a consensus was reached. These additional stakeholders included:

- Enviva Biomass
- Franklin Lumber
- F&W Forestry
- Huber Engineered Woods
- US Fish & Wildlife Service
- USDA Forest Service
- Virginia Tech Department of Forest Resources and Environmental Conservation
- Virginia Tree Farm Program
- Virginia Department of Forestry
- Virginia Forestry Association
- WestRock Company

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1.0 Introduction

A landscape management plan (LMP) is a vital and innovative tool, offering a wide array of benefits and opportunities to landowners, foresters, and other natural resource professionals, state and federal agencies, conservation partners, and others. Specifically, this LMP can:

- Help family landowners overcome one of the biggest barriers to participating in forest certification and landowner assistance programs by eliminating the need for every landowner to develop and maintain an individual management plan.
- Support coordination of action on landscape-scale priorities across ownerships.
- Provide participating landowners with access to the benefits of the FSP and ATFS certification.
- Establish and strengthen relationships between landowners and their foresters.
- Be used by a diversity of forestry specialists, including VDOF foresters, consulting foresters, and industrial foresters.
- Be implemented adaptively across an array of conditions, landowner objectives, and ownerships. Although arranged as a single document, the chapters are designed both to support each other and to be used flexibly as forest conditions and objectives change.
- Illustrate practical silvicultural options to manage family woodlands sustainably, achieve landscape conservation goals, and conform to AFF Standards of Sustainability through a variety of strategies and approaches for forest ecosystems specific to the Virginia landscapes.
- Utilize the best available science and resources provided at the federal, state, and local levels through a program- developed and -maintained geospatial database.
- Support the efforts of foresters from across sectors to work with previously unengaged landowners and promote conservation initiatives.
- Optimize grant funding at the local, state, and national level for conservation initiatives on private land.
- Preemptively address threats to at-risk species through habitat protection.
- Provide additional access to certified materials for timber industry partners.

This LMP is designed to complement and align with federal, state, and local laws. Resources in this LMP do not override local forestry regulations that may not be addressed directly in this plan.

Forest management plans have long been a principal component of traditional family woodland owner programs in the United States. Management plans are a requirement for forest certification and landowner assistance programming and, because the individual plans are costly for both landowners and foresters to develop, they are often the biggest barrier to family landowner engagement. In addition, recent research suggests that the development of individual landowner forest management plans have only moderate to minimal impact family woodland owner behavior. Rather, it is the accompanying engagement with or receiving technical advice from a natural resource management professional that provides the motivation and support landowners need to act on the ground. Even more, individual management plans do not offer a means for inspiring, understanding and coordinating important conservation strategies across family ownerships. By setting motivating goals at the

landscape level we are creating another call to action that allows us to engage more landowners. We know that values like wildlife are important to landowners and this allows us to set aspirational goals for the landscape that line up with that motivation. The planning process remains critical to sustainable forest management. However, there is a need for a more cost-effective approach that reflects what is known about what will effectively encourage family landowner behavior and support coordinated efforts to address the critical landscape-scale conservation needs and opportunities. Drawing on emerging research, models used in Scandinavia and techniques used by some American consulting firms, the landscape plan is designed to reduce the management plan barrier that family landowners face to becoming involved in conservation activities and streamline the American Tree Farm System® (ATFS) certification process. This approach maintains the credibility required for ATFS certification while providing landowners with the essential technical support to ensure their long-term sustainable management. Finally, it also offers a mechanism for coordinating landscape scale priorities across small and family owners.

The American Forest Foundation (AFF), in conjunction with numerous natural resource partners, has therefore developed this Landscape Management Plan (LMP) to address landowner and landscape-level objectives within the state of Virginia. More specifically, this plan incorporates and supports all portions of the following site-specific and landscape level considerations that are applicable to family woodland landowners:

- American Forest Foundation 2021 Standards of Sustainability
- Forest Stewardship Program (FSP) National Standards and Guidelines (Standards)
- Virginia Forest Stewardship Program
- Virginia Forest Action Plan
- Virginia Wildlife Action Plan
- United States Department of Agriculture (USDA) National Woodland Owner Survey (NWOS) Results and Observations (Butler et al 2016)
- Virginia Department of Forestry Best Management Practices
- National Register of Historic Places (NRHP) and the Virginia Department of Historic Resources

This LMP will be revised and updated periodically to reflect changing dynamics with the specific forest resources and on the landscape broadly. Similarly, it is critical to monitor landowners' management to ensure congruence between the landscape management plan and continuity across the assemblage of landowners. This could be combined with routine monitoring, as required under certification, such as routine inspections.

1.1 Forest Resource Professionals

This LMP relies on the experience, skills, and thoughtful professionalism of foresters and other natural resource managers. The relationships they build with family woodland owners are central to the success of this LMP and to achieving the shared aims of delivering conservation impact.

As the Society of American Foresters (SAF) describes within the Preamble to its Code of Ethics:

"Service to society is the cornerstone of any profession. The profession of forestry serves society by fostering stewardship of the world's forests. Because forests provide valuable resources and perform critical ecological functions, they are vital to the wellbeing of both society and the biosphere." – SAF Code of Ethics

The role of forest resource professionals includes passing along their experience and expertise regarding the complex relationships between air, water, climate and weather, trees, flora and fauna, ecosystem processes, and anthropocentric considerations. This consultation and advice provided by forest resource professionals is commonly provided to landowners and/or their agents interested in managing their forestland. Landowners can utilize the services of a forest resource professional to manage and monitor vendors and contractors performing

silvicultural management activities on the land. Forestry resource professionals also can assist landowners with contracts and the maintenance and retention of appropriate records and documentation relating to forest management activities and certification. Furthermore, landowners can gain advice regarding taxes, estate planning, and relevant laws, regulations, and ordinances under the guidance of a forest resource professional. This LMP was developed as a resource for these professional foresters to assist in landowner engagement, identification and characterization of landowner site specific features and objectives, and the identification and management of local forest types.

Various professional organizations and certification bodies, including state forester titling laws, SAF, and the Association of Consulting Foresters (ACF), provide membership standards and requirements to ensure qualified, responsible, and ethical application of forestry principles is upheld. The ACF Code of Ethics helps govern foresters within that group. The ATFS also recognizes the importance of these forestry professionals by establishing specific eligibility requirements and recertification standards of all ATFS inspectors.

The NRCS Technical Service Provider Search Tool is a listing provided to assist landowners in finding forest management related service providers for implementation of forestry practices on their land. This database includes forest management consultants, tree seedling nurseries, and other vendors and forest product buyers.

1.2 Adaptive Management

All silvicultural options, management activities, and implementation measures provided in this LMP are predicated upon a narrow window of site, weather, time, and market conditions. Changes and variability associated with these conditions (especially weather and markets) can have significant impacts on the timing, feasibility, and success of all silvicultural implementation operations. For example, the decision of when and how to harvest timber could vary tremendously based on recent weather conditions and market conditions. A recent example of this need for adaptive management occurred in Florida following the landfall of Hurricane Michael in 2018. An unprecedented storm for the panhandle of Florida, Michael damaged an estimated 2.8 million acres of timber and caused 95% damage to 34,000 acres within Bay, Calhoun, and Gulf counties; these damages amounted to approximately $1.289 billion dollars in losses (Etters 2019). As these types of events can devastate the local timber industry, landowners may need to restructure their assets and change their revenue source from their land. Following Michael in Florida, the University of Florida's Institute of Food and Agricultural Sciences (IFAS) assisted landowners in transitioning to different crop types to offset their timber losses. As portions of Virginia are squarely within the path of major Atlantic hurricanes and have the potential for future similar levels of devastation, it is important for landowners to know how to manage their land in the event of such a disaster.

Likewise, forest landowner objectives could significantly impact both the target forest type and the silvicultural implementation methods needed to meet those goals and objectives. Inherently, silvicultural operations have some flexibility on the timing of implementation to more effectively meet the narrow window of conditions to achieve the desired result. Harvesting operations and regeneration efforts are also variable and could vary significantly when focused on meeting different landowner's objectives like maximizing revenue or conserving rare species. The tolerance to shift operations slightly increases the feasibility of meeting the established goals and objectives. Therefore, this management plan should not be viewed as an unchangeable text, but rather a living document dependent on its constant evaluation, refinement, and modification for success.

1.3 American Forest Foundation 2021 Standards of Sustainability within the LMP

The AFF's Standards promote the health and sustainability of America's family forests. These Standards are designed as a tool to help woodland owners be effective stewards of the land as they adaptively manage renewable resources; promote environmental, economic and social benefits; and work to increase public understanding of sustainable forestry. The Standards are based on international sustainability metrics and North American

guidelines for sustainable forest management and serve as the basis for the ATFS certification program. The ATFS certification program is internationally endorsed by the Programme for the Endorsement of Forest Certification (PEFC). Landowners following these Standards are recognized as ambassadors for exemplary woodland stewardship.

Each of the eight Standards of Sustainability addresses aspects of sustainable forest management. Moving from general to specific, each Standard incorporates performance measures and indicators to illustrate conformance. All components of each Standard apply to every property certified under the ATFS Standards. A standard is an overarching principle of sustainability. A performance measure refines the Standard's intent and describes considerations and pathways for conformance. An indicator identifies specific actions or activities that demonstrate conformance.

These standards, Performance Measures and indicators are presented below with links to the specific section of the LMP where they are addressed:

(NOTE: In the event an element is discussed in multiple forest types, only the location in the first forest type where the element is discussed is linked below.)

- **STANDARD 1** Commitment to Practicing Sustainable Forestry
    - **Performance Measure 1.1** Landowner shall have and implement a written forest management plan consistent with the size of the forest and the scale and intensity of the forest activities.
        - **Indicator 1.1.1** Management plan shall be active, adaptive and embody the landowner's current objectives, remain appropriate for the land certified and reflect the current state of knowledge about natural resources and sustainable forest management (1, 2, 3).
        - **Indicator 1.1.2 (a)** Management plans shall describe forest types, aesthetics, management activities aimed at achieving landowner's objectives, document a feasible strategy for activity implementation and include a map accurately depicting significant forest-related resources.
        - **Indicator 1.1.2 (b)** The forest management plan shall demonstrate consideration of the following resource elements: forest health, soil, water (1, 2, 3), wood and fiber production (1, 2, 3), threatened or endangered species (1, 2, 3, 4), special sites (1, 2, 3), invasive species (1, 2, 3), and forests of recognized importance. Where present and relevant to the property, the plan shall describe management activities related to these resource elements.
        - **Indicator 1.1.2 (c)** Where present, relevant to the property and consistent with landowner's objectives, the plan preparer should consider, describe and evaluate the following resource elements: fire, wetlands (1, 2, 3, 4), desired species, recreation (1, 2), forest aesthetics (1, 2), biomass and carbon.
        - **Indicator 1.1.3** The landowner should monitor for changes that could interfere with the management objectives as stated in the management plan. When problems are found, reasonable actions are taken.

    How the LMP Covers this Section:

    - This LMP serves as the written management plan for all participating landowners in the sections of Virginia covered by this plan. This plan provides the necessary flexibility to be active and adaptive to the variety of landowner objectives and related management activities available to the

landowners in this state, regardless of the size and scale of their property. As noted in the links included throughout this section, this LMP addresses each of the ATFS Standards.

- A secure database was developed to include all the necessary spatial information to support sustainable forest management in the area. In addition to general information of the region (soils, hydrologic information, the presence or absence of T&E species, etc.), each landowner participating in this program can have specific information to their Tree Farm stored on this database by a forester or an ATFS Inspector. Maps can be generated from this database by a forester or ATFS Inspector, or upon request by the landowner or a third-party assessor.

- **STANDARD 2** Compliance with Laws
  - **Performance Measure 2.1** Landowner shall comply with all relevant federal, state, county and municipal laws, regulations and ordinances governing forest management activities.
    - **Indicator 2.1.1** Landowner shall comply with all relevant laws, regulations and ordinances and will correct conditions that led to adverse regulatory actions, if any.
    - **Indicator 2.1.2** Landowner should obtain advice from appropriate qualified natural resource professionals or qualified contractors who are trained in, and familiar with, relevant laws, regulations and ordinances.

  How the LMP Covers this Section:

  - All landowners certified under this LMP agree to meet all federal, state, and local regulations. Understanding that while mistakes may occur in carrying out forest management activities, landowners must be committed to correcting inadvertent violations. A pattern of willful violation of relevant laws, regulations or ordinances is not acceptable. If there is evidence of past nonconformance, then the landowner must show proof of a good-faith effort to remedy the nonconformance. If the matter is tied up in court, then the landowner is only disqualified when a final adverse judgment is rendered, and the landowner refuses to comply with the ruling.
  - Compliance with all relevant (applicable) laws can be verified by a three-tiered process:
    - Step 1 – Observation of conditions on the subject property
    - Step 2 – The landowner's verbal or written claim of legal compliance
    - Step 3 – Research with the state Department of Wildlife Resources, local Natural Resource Conservation Service office or State Department of Forestry offices
    - If Step 1 and Step 2 do not raise any issues, then the qualified ATFS inspector or third-party assessor is not required to employ Step 3.

- **STANDARD 3** Reforestation and Afforestation
  - **Performance Measure 3.1** Reforestation or afforestation shall be achieved by a suitable process that ensures adequate stocking levels.

- **Indicator 3.1.1** Harvested forest land shall achieve adequate stocking of desired species reflecting the landowner's objectives, within five years after harvest, or within a time interval as specified by applicable regulation.

How the LMP Covers this Section:

- Under the silvicultural options outlined in this LMP, information is provided on the different strategies to achieve success in reforestation and afforestation efforts. The state of Virginia does not specify a specific required stocking level, post-harvest activity, so landowners operating under this LMP agree to achieve adequate stocking of desired species based on their objectives within five years after harvest. ATFS Inspectors will document these efforts within the 021 inspection form to ensure conformance.

- **STANDARD 4** Air, Water and Soil Protection
  - **Performance Measure 4.1** Landowner shall meet or exceed practices prescribed by State Water Quality BMPs.
    - **Indicator 4.1.1** Landowner shall implement specific state forestry BMPs that are applicable to the property (1, 2, 3).
    - **Indicator 4.1.2** Landowner shall minimize road construction and other disturbances within riparian zones and wetlands (1, 2, 3).
  - **Performance Measure 4.2** Landowner shall consider a range of forest management activities to forest health.
    - **Indicator 4.2.1** Landowner should evaluate alternatives to pesticides for the prevention or control of pests, pathogens and unwanted vegetation to achieve specific management objectives (1, 2, 3, 4).
    - **Indicator 4.2.2** Pesticides used shall be approved by the Environmental Protection Agency (EPA) and applied, stored and disposed of in accordance with EPA-approved labels and by persons appropriately trained, licensed and supervised.
  - **Performance Measure 4.3** When used, prescribed fire shall conform with landowner's objectives and pre-fire planning.
    - **Indicator 4.3.1** Prescribed fire shall conform with the landowner's objectives and state and local laws and regulations

How the LMP Covers this Section:

- All landowners certified under this LMP must agree to meet or exceed all Virginia Best Management Practices for Water Quality (VA BMPs for Water Quality), even though they are voluntary by law, which are applicable to the property. When planning management activities that will cause any soil disturbance or require chemical application, the VA BMPs for Water Quality should be consulted and applicable BMP methods employed. No field evidence of BMP implementation is expected where no management activity has occurred. However, if the property shows evidence of water quality impairment originating on the property that is not caused by the landowner's or designated representative's actions, the landowner is strongly encouraged

to have plans for remediation. Some BMPs, such as those that are guidelines to enhance a desired species, should only apply where relevant to the property. Activities in riparian zones and wetlands shall comply with applicable BMPs. BMP manuals are generally quite detailed on recommended practices for road construction and other disturbances of riparian zones. If there is a point of confusion, the landowner or designated representative is advised to consult with a qualified natural resource professional who is experienced in forest road design and installation. Landowners should specify with qualified contractors that BMPs must be adhered to. In all cases, the primary concern is to avoid contaminating watercourses that are adjacent to the forest activity.

- All landowners certified under this LMP shall document the use of pesticides used on the certified property.

- When conducting prescribed burns, landowners operating under this LMP shall follow all state regulations and are encouraged to work with qualified professionals. Additional information about burning based on forest type is included in the following sections.

- **STANDARD 5** Fish, Wildlife, Biodiversity and Forest Health
  - **Performance Measure 5.1** Forest management activities shall protect habitats and communities occupied by threatened or endangered species as required by law (1, 2, 3, 4, 5).
    - **Indicator 5.1.1** Landowner shall periodically confer with natural resource agencies, state natural resource heritage programs, qualified natural resource professionals or review other sources of information to determine occurrences of threatened or endangered species on the property and their habitat requirements (1, 2, 3).
    - **Indicator 5.1.2** Forest management activities shall incorporate measures to protect identified threatened or endangered species on the property (1, 2).
  - **Performance Measure 5.2** Landowner should address the desired species and/or desired forest communities when conducting forest management activities, if consistent with landowner's objectives.
    - **Indicator 5.2.1** Landowner should consult available and accessible information on management of the forest for desired species and/or forest communities and integrate it into forest management.
  - **Performance Measure 5.3** Landowner should make practical efforts to promote forest health.
    - **Indicator 5.3.1** Landowner should make practical efforts to promote forest health, including prevention, control or response to disturbances such as wildland fire, invasive species and other pests, pathogens or unwanted vegetation, to achieve specific management objectives.
  - **Performance Measure 5.4** Where present, forest management activities should maintain or enhance forests of recognized importance (FORI).
    - **Indicator 5.4.1** Appropriate to the scale and intensity of the situation, forest management activities should incorporate measures to contribute to the conservation of identified FORI.

How the LMP Covers this Section:

- The LMP database provides valuable information about the fish, wildlife, biodiversity and forest health of the program area. The database includes spatial information about where there are known occurrences of threatened and endangered species, the regional soil types, and documented areas of invasive species incursion. Foresters and ATFS Inspectors can also use the database to include information specific to a Tree Farm regarding forest health, such as additional species composition information or treatment information.
- In addition to the information available in the LMP database, landowners operating under this LMP should walk their property with a qualified natural resource professional to identify occurrences of threatened and endangered species on or near their property. Landowners are also encouraged to work with natural resource professionals to identify possible occurrences of any disease, invasive species or pest outbreak on their property and discuss the range of recommended management techniques to address these issues. This LMP also outlines the variety of native and exotic pest species that landowners may interact with in this region, as well as tactics to address these issues.
- Integrated pest management (IPM) is an excellent approach to controlling, suppressing or preventing pests and can take many forms. Preventative measures, efforts to improve forest health or, in some other way, protect the property from injurious organisms are often the most practical and effective approaches. Pesticide applications may be used when other control measures are ineffective or impractical. While landowners and designated representatives are urged to take feasible actions to address pests, pathogens and unwanted vegetation, third-party assessors are advised that, in some cases, there may be no feasible options for controlling a pest or outbreak due to severity, scale and timing of onset. When herbicides are used, landowners are required to follow EPA regulations.
- Landowners are encouraged to maintain records of forestry related activities for at least three years.
- The Virginia Tree Farm Foundation has identified FORI within Virginia as: lands in or adjacent to USFWS National Wildlife Refuges, Virginia Wildlife Management Areas, National Park Service properties, and Virginia Wild and Scenic Rivers. The FORI designations are listed in Section 6.1.6 of this document starting on page 89.

- **STANDARD 6** Forest Aesthetics
  - **Performance Measure 6.1** Landowner should manage the visual impacts of forest management activities consistent with the size of the forest, the scale and intensity of forest management activities and the location of the property.
    - **Indicator 6.1.1** Forest management activities should apply visual quality measures compatible with appropriate silvicultural practices (1, 2).

How the LMP Covers this Section:

- Forest aesthetics considerations can be incorporated into management planning with little cost to the landowner. Employing forest aesthetics considerations into the management plan can produce a much more visually appealing experience on property visits for owners, their guests and passers-

by using nearby public roads. This LMP addresses aesthetic issues relevant to each of the common forest types in the region in their respective sections.

- **STANDARD 7** Protect Special Sites
    - **Performance Measure 7.1** Forest management activities shall consider and maintain any special sites relevant on the property. (1, 2, 3)
        - **Indicator 7.1.1** Landowner shall make a reasonable effort to locate and protect special sites appropriate for the size of the forest and the scale and intensity of forest management activities. (1, 2)

How the LMP Covers this Section:

- Special sites of biological and geological significance may be identified through consultation undertaken related to the identification of FORIs and threatened or endangered species and communities (within Standard 5). In addition to publicly recognized special sites, landowners may designate sites of personal significance to them, such as a spot their grandparents cherished.
- Landowners or designated representatives shall identify special sites on management plan maps and, where appropriate, on the ground. However, some landowners may choose not to identify some special sites on a map or on the ground to protect these sites from vandalism or overuse. Landowners or designated representatives shall make efforts to protect any known special sites especially during forest management activities. These efforts may include creating a vegetation buffer, fencing the area or otherwise distinguishing it from surrounding areas. Because special sites are often in the ground, measures may be taken to control erosion and limit soil disturbance. Landowners and designated representatives are advised to review their special sites map and protection plan with qualified natural resource professionals and qualified contractors assisting in forest management activities. After harvests, landowners and designated representatives are encouraged to follow up to ensure adequate protection.

- **STANDARD 8** Forest Product Harvest and Other Activities
    - **Performance Measure 8.1** Landowner should use qualified natural resource professionals and qualified contractors when contracting for services.
        - **Indicator 8.1.1** Landowner should seek qualified natural resource professionals and qualified contractors (1, 2).
        - **Indicator 8.1.2** Landowner should engage qualified contractors who carry appropriate insurance and comply with appropriate federal, state and local safety and fair labor rules, regulations and standard practices.
        - **Indicator 8.1.3** Landowners should retain appropriate contracts or records for forest product harvests and other management activities to demonstrate conformance to the Standards
    - **Performance Measure 8.2** Landowner shall monitor forest product harvests and other management activities (1, 2) to ensure they conform to their landowner objectives.

- **Indicator 8.2.1** Harvest, utilization, removal and other management activities shall be conducted in compliance with the landowner's objectives and to maintain the potential of the property to produce forest products and other benefits sustainably (1, 2).

How the LMP Covers this Section:

- When conducting forestry activities, landowners must ensure that their actions and those taken on their behalf are in conformance with both the landowner's objectives and the ATFS Standards. To safeguard landowners from liability risks and protect their assets, landowners are encouraged to work with qualified natural resource professionals and contractors and review the Standards before planning management activities. If the landowner's objectives do not specify directives as to harvesting, utilization and removals, regional norms and accepted practices for areas covered by this LMP are expected.

- Examples of forestry activities requiring review for AFF Standards compliance:
  - Harvest operations including timber and nontimber products
  - Site preparation and reforestation
  - Forest road construction and maintenance
  - Mineral extraction
  - Hunting and fishing
  - Invasive species control
  - Pest management

- Landowners are encouraged to discuss liability issues with their insurance agent and their attorney to gain a perspective on appropriate insurance minimums that they might require of contractors. When agreeing upon the terms of the contract, landowners and designated representatives are encouraged to stipulate that contractors must follow all relevant laws and regulations and should specify that appropriate state forestry BMPs must be adhered to. A qualified natural resource professional can help with this process.

- Other contract specifications might include:
  - Protection of special sites or habitats
  - Adherence to labor laws
  - Requirements for adequate insurance
  - Protection of soil and water integrity
  - Residual tree damage
  - Forest road maintenance and restoration
  - Fence and gate protection and/or restoration
  - Litter control
  - Hazardous material spill prevention and clean-up

- Generally, landowners are encouraged to retain contracts or records for management activities for three years.

1.4 Forest Stewardship Program Standards within the LMP

The Forest Stewardship Program (FSP) encourages long-term stewardship of important state and private forest landscapes, by assisting landowners to more actively manage their forest and related resources. The program aids

owners of forest land and other lands where good stewardship, including agroforestry applications, will enhance and sustain the long-term productivity of multiple forest resources and produce healthy, resilient forest landscapes. Special attention is given to landowners in landscape areas identified by State Forest Action Plans and those new to, or in the early stages of managing their land in a way that embodies multi-resource stewardship principles. The program provides landowners with the professional planning and technical assistance they need to keep their land in a productive and healthy condition. Assistance offered through the FSP also provides landowners with enhanced access to other USDA conservation programs, forest certification programs, and forest product and ecosystem service markets. Participation in the FSP is open to any non-industrial private forest landowners who are committed to the active management and stewardship of their forested properties for at least ten years. Landowners must apply to be accepted into the program. The FSP is not a cost share program. Cost-share assistance for plan implementation may be available through other programs.

The FSP Standards were addressed and evaluated during the completion of this LMP. More specifically, in order to provide an LMP that is "multi-resource in scope and adequately comprehensive with respect to forest ecosystem management," the following plan element discussions are linked below:

(NOTE: In the event an element is discussed in multiple forest types, only the location in the first forest type where the element is discussed is linked below.)

- Soil and water (1, 2, 3)
- Biological diversity (1, 2, 3, 4)
- Range of the predominant species
- Agroforestry
- Aesthetic quality (1, 2) and desired Timber species
- Recreation (1, 2)
- Wood and fiber production (1, 2, 3)
- Fish and wildlife (1, 2)
- Threatened and endangered species (1, 2, 3, 4)
- Forest health and invasive species (1, 2, 3)
- Legacy planning information (1, 2, 3, 4)
- Archeological, cultural, and historic sites (1, 2, 3)
- Wetlands (1, 2, 3, 4)
- Fire
- Carbon Sequestration & Climate Resilience (1, 2)
- Forests of Recognized Importance (FORI) (1, 2)

1.5 A Forester's Field Guide for Using the Landscape Management Plan with Landowners

This guide is designed as a resource for foresters in using the landscape management plan to effectively provide assistance to landowners, while streamlining administrative and related elements of landowner engagement.

The landscape management plan is designed as a tool that foresters and other natural resource professionals may use to support landowners in their on-the-ground engagement that allows for economical access to programs that provide recognition of their stewardship and technical assistance and resources. While coordination with a landowner will likely be structured organically in a conversational tone and format, this field guide provides forest resource professionals a more structured approach to ensure all components of the LMP are addressed to meet certification standards. For instance, in some scenarios the initial meeting may occur anywhere (e.g. on the phone, in the office, on another landowner's property). It is important to capture as much pertinent information about

the property, its history, size and location, and the general goals and objectives of the landowner. Using the information you obtain during this initial conversation, you will be more prepared for your meeting on the landowner's property.

- Step 1: Preparing to Meet the Landowner
    - Use the current AFF-provided geodata to locate and characterize the landowner's property
        - Develop location and soils maps (NOTE: this may also be used to aid determination of applicable forest types)
        - Identify additional property characteristics (e.g. special sites, listed species potential, invasive concerns)
        - Determine current forest type(s) and acreage – may be verified during onsite consultation
    - Review Typical Landowner and Landscape Objectives for the existing forest types anticipated on the property

- Step 2: Meeting the Landowner
    - Identifying Objectives:
        - Discuss the objectives of the landowner (during initial conversation and/or during onsite follow-up)
        - Probe each objective identified by the landowner to ensure you understand the underlying motivations and goals for the property. The landowner may have multiple objectives or difficulty articulating the objectives as they are described in the LMP. A clear understanding of the landowner's objectives streamlines the options needed to meet those objectives.
        - Review and suggest other objectives and how they may also meet the landowner's underlying goals. This may initiate a re-evaluation of landowner objectives.
    - Review and discuss potential landscape objectives (if applicable) to determine if any correlations or commonalities exist with the landowner's objectives to support wider conservation goals. The landowner may be unaware or gain interest in specific landscape objectives, creating a re-evaluation of landowner objectives. Some landowners may not be interested or have objectives that share commonalities with landscape objectives. In either scenario, landowners are not required to commit to any landscape objectives or requirements.
    - Based on the review of the landowner and potential landscape objectives, and the analysis of current site conditions, determine a target forest type(s) and the forest resources available to the landowner. This forest type(s) could be different or the same as the current forest type on the property.
    - Based upon landowner objectives, potential landscape objectives, target forest type(s) and the geodatabase review, identify an actionable strategy using the silvicultural options identified in the LMP (by forest type) to meet the objectives.

- Provide advice, contacts, and technical support to the landowner of the implementation of the identified silvicultural options. Encourage or aid the landowner to document and retain records of the activities occurring on the property.

- Step 3: After the Visit
  - Contact the landowner and provide answers to any questions you were unable to answer during the visit. Additionally, prompt the landowner if they had any additional questions or comments arise following the last meeting. Provide additional support and encouragement for implementing the activities identified during the meeting. This follow-up is encouraged to occur between one week and one month following the meeting.
  - Complete and process any paperwork or certification submittals required following the meeting.
  - Using a landscape management tool makes follow-up support to landowners even more important. The LMP method depends on the relationship and engagement of the landowner and forest resource professional to meet the criteria for certification. This LMP allows landowners the flexibility to adaptively manage the property based on the results of silvicultural operations, gaining additional information (e.g. listed species), changing ecological (e.g. sea level rise) or market conditions (e.g. timber markets), and especially changing landowner (and landscape) objectives. Therefore, following up with the landowner not only promotes their engagement in active management but also allows them to modify their management strategies to meet these other dynamic conditions.
  - Make a note in the applicable landowner database or other relevant landowner-tracking system of when follow-up should occur.
  - Contact the landowner within an appropriate period of time to schedule a visit, assess activities implemented, determine if any changes have occurred to objectives, and determine if personal circumstances and/or the property have changed. This type of follow-through is strongly encouraged. Provide additional advice and technical support to the landowner, as needed. Depending on the forest type and the silvicultural options selected, a longer period between contact with the landowner may be appropriate. Optimistically, the landowner should be contacted annually to promote and foster their engagement in the active management of their property.

This guide also can be utilized for landowners with existing and/or outdated plans. The same process should be followed when replacing the existing or outdated plan, although much of the information needed for the initial step (1) may have already been completed. Additionally, the existing plan can be used during a review of the landowner's objectives, forest types and resources, and implementation activities. The additional information found in this LMP and the geodatabase will then be used to supplement and replace the existing plan.

1.6 A Landowner's Field Guide for Using the Landscape Management Plan

This guide is designed as a resource for landowners in using the landscape management plan to effectively interact with foresters, while streamlining administrative and related elements of engagement.

The landscape management plan is designed as a tool that foresters and other natural resource professionals may use to support landowners in their on-the-ground engagement that allows for economical access to programs that provide recognition of their stewardship and technical assistance and resources. While a landowner's interaction with a forester will likely be structured organically in a conversational tone and format, this field guide provides

landowners additional knowledge of the process and a more structured approach to ensure all components of the LMP are addressed to meet certification standards. For instance, in some scenarios the initial meeting may occur anywhere (e.g. on the phone, in the office, on another landowner's property). Using the information you obtain during this initial conversation, you will be more prepared for the meeting with the forester on your property.

- Step 1: Preparing to Meet the Forester
    - Use the AFF-provided geodatabase to locate and characterize the natural features present on your property
        - Identify additional property characteristics (e.g. special sites, listed species potential, invasive concerns) that may need to be discussed with the forester
        - Determine current forest type(s) and acreage
    - Review Typical Landowner and Landscape Objectives for the existing forest types anticipated on your property

- Step 2: Meeting the Forester
    - Identifying Objectives:
        - Discuss the objectives you have for the future management of your property (during initial conversation and/or during onsite follow-up)
        - Develop a method to communicate your objectives clearly to the forester. You may have multiple objectives or may need to phrase the objectives as they are described in the LMP.
    - Review and discuss potential landscape objectives with the forester (if applicable) to determine if any correlations or commonalities exist with the objectives to support wider conservation goals. The forester may suggest possible landscape objectives that would be applicable to your specific situation or the properties/location of your land.
    - Based on the review of your personal and potential landscape objectives, and the analysis of current site conditions, work with the forester to determine a target forest type(s) and the forest resources needed and available for this/these specific objectives(s). This forest type(s) could be different or the same as the current forest type on the property.
    - Based upon the objectives you have for your land, potential landscape objectives to may be applicable, target forest type(s), and the geodatabase review, work with the forester to identify an actionable strategy using the silvicultural options identified in the LMP (by forest type) to meet the objectives.

- Step 3: After the Visit
    - Contact the forester with any questions that may have been unanswered during the visit or that may have arisen since last communication with the forester. This follow-up is encouraged to occur between one week and one month following the meeting.
    - The LMP method depends on the relationship and engagement of the landowner and forest resource professional to meet the criteria for certification. This LMP allows landowners the flexibility to adaptively manage the property based on the results of silvicultural operations, gaining additional information (e.g. listed species), changing ecological (e.g. sea level rise) or market conditions (e.g. timber markets), and especially changing landowner (and landscape)

objectives. Therefore, following up with the forester resource professional not only promotes engagement in active management but also allows modification of management strategies to meet these other dynamic conditions.

- Expect the forester to be in contact within an appropriate period of time to schedule a follow-up visit, assess any activities implemented, determine if any changes have occurred to objectives, and determine if personal circumstances and/or the property have changed. This type of follow-through is highly value to ensuring completion of any land management goals. Ask any additional questions and bring up any new concerns to the forester, as needed. Depending on the forest type and the silvicultural options selected, a longer period between contact with the forester may be appropriate. This level of contact should occur at least annually to encourage active, thoughtful management of the property.

This guide also can be utilized for landowners with existing and/or outdated plans. The same process should be followed when replacing the existing or outdated plan, although much of the information needed for the initial step (1) may have already been completed. Additionally, the existing plan can be used during a review of the landowner's objectives, forest types and resources, and implementation activities. The additional information found in this LMP and the geodatabase will then be used to supplement and replace the existing plan.

2.0 Ecoregions (Level III)

The Environmental Protection Agency (EPA) has developed ecoregions to group the continental United States into areas where the type and quality of environmental resources, including biotic and abiotic factors, are generally similar. These resources can include patterns and similarities between geology, soils, vegetation, climate, hydrology, wildlife, and other comparative categories. This division of resources is generated from the research of Omernik (1987) as well as mapping created from collaboration between EPA regional offices, other federal agencies, and state agencies.

Ecoregions are classified into a 4-level Roman numeral scheme, with Level I being the broadest ecoregion category with 12 ecoregion divisions and Level IV being the most specific with 967 ecoregion divisions nationwide. For the purpose of this LMP, the 105 ecoregions contained in the Level III classification were deemed to be specific enough to address the management requirements across the state.

Virginia contains 7 Level III and 32 Level IV ecoregions within its borders (Figure 1). From west to east, these Level III ecoregions and their associated Level IV ecoregions are: Central Appalachians (Cumberland Mountain Thrust Block, Dissected Appalachian Plateau, Greenbriar Karst), Ridge and Valley (Southern Limestone/Dolomite Valleys and Low Rolling Hills, Southern Shale Valleys, Southern Sandstone Ridges, Southern Dissected Ridges and Knobs, Northern Shale Valleys, Northern Dissected Ridges and Knobs, Northern Limestone/Dolomite Valleys, Northern Sandstone Ridges), Blue Ridge (New River Plateau, Southern Crystalline Ridges and Mountains, Southern Sedimentary Ridges, Limestone Valleys and Coves, Northern Igneous Ridges, Northern Sedimentary and Metasedimentary Ridges), Northern Piedmont (Triassic Lowlands, Trap Rock and Conglomerate Uplands, Piedmont Uplands, Piedmont Limestone/Dolomite Lowlands), Piedmont (Northern Inner Piedmont, Northern Outer Piedmont, Carolina Slate Belt, Triassic Basins), Southeastern Plains (Rolling Coastal Plain, Chesapeake Rolling Coastal Plain), and Middle Atlantic Coastal Plain (Chesapeake-Pamlico Lowlands and Tidal Marshes, Virginian Barrier Islands and Coastal Marshes, Delmarva Uplands, Swamps and Peatlands, and Mid-Atlantic Flatwoods). It was determined that, while at times certain Level IV ecoregions may exhibit an important distinction in ecology of Virginia, the Level IV ecoregions provided too high of a degree of specificity for a LMP designed to focus on landscape-level

functions and difference; thus, the Level III ecoregions were selected as the focus of the LMP. As this LMP only covers the eastern two-thirds of the state, 5 Level II ecoregions are covered and the Central Appalachians and Ridge and Valley are omitted. For additional information on the ecoregions of Virginia and their associated waterways, landforms, and land uses, consult the Environmental Protection Agency's (EPA) Level III and IV Ecoregions of EPA Region 3.

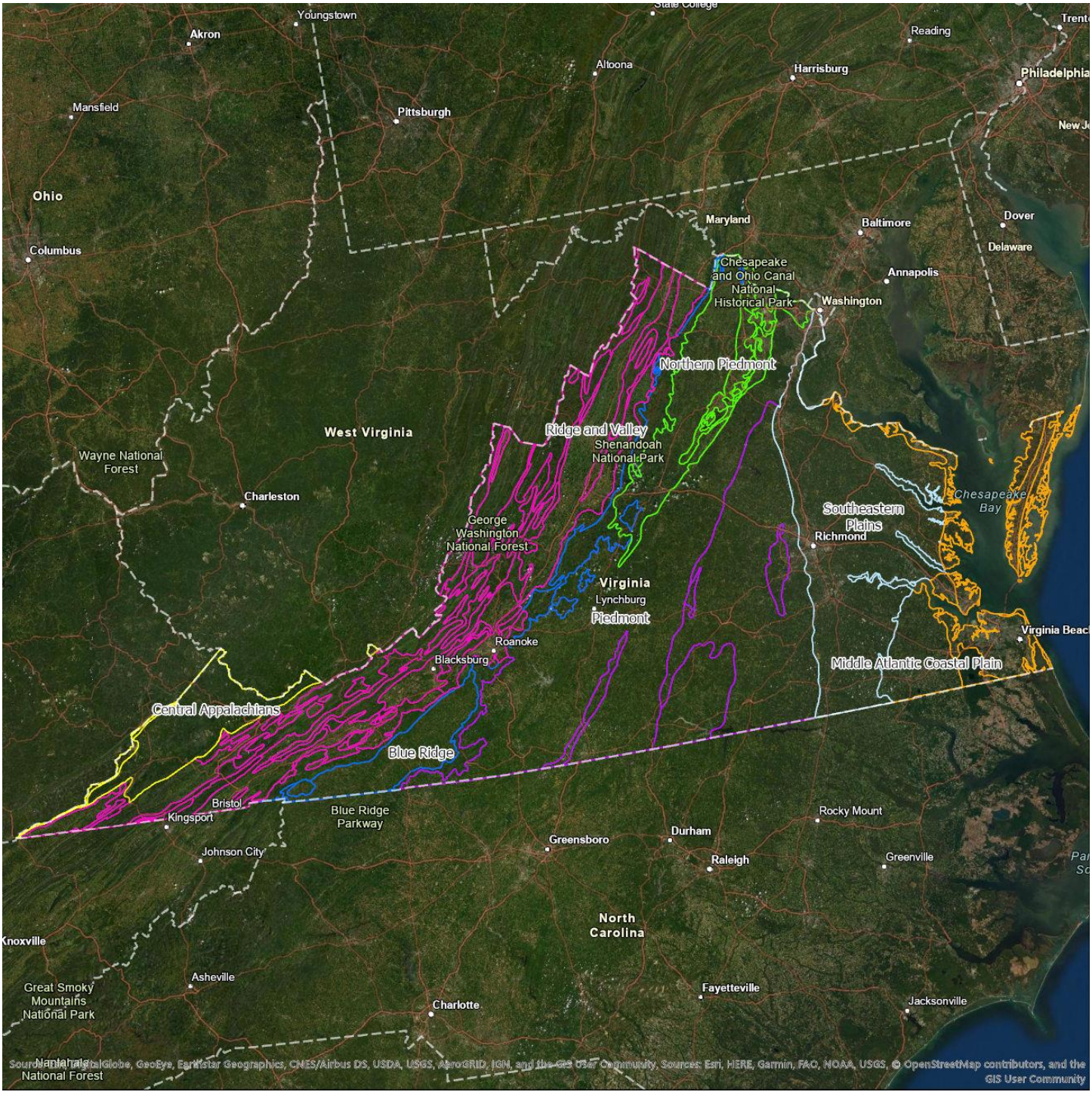


Figure 1. The 5 Level-III Ecoregions of Virginia.

While the majority of eastern Virginia is composed of varying levels of plains, the western portion of the state begins to transition to rolling uplands in the Piedmont and then to the foothills of the Blue Ridge mountains and more extreme mountainous terrain within the Blue Ridge, Ridge and Valley, and Central Appalachians ecoregions. A brief description of characteristics for each of the 5 covered Level III ecoregions will be given below. Also, in combination with these descriptions, geospatial analysis of the geodatabase layers provided by AFF will provide insight into features that are or may be present within a landowner's parcel. The boundaries of each ecoregion can be displayed with all natural/environmental features shown overlaid in order to give the landowner information about their land as well as the surrounding ecoregion. This information will alert the landowner to any potential listed species or sensitive forest features present in or around their property.

2.1 Blue Ridge

The Blue Ridge (BR; Figure 2) ecoregion is in many ways a continuation of the eastern portion of the Ridge and Valley ecoregion, which is not covered in this plan. In Virginia, the Blue Ridge is comprised of parts of Albemarle, Amherst, Augusta, Bedford, Botetourt, Buena Vista, Carroll, Clarke, Culpeper, Fauquier, Floyd, Franklin, Galax, Grayson, Greene, Loudoun, Madison, Montgomery, Nelson, Page, Patrick, Pulaski, Rappahannock, Roanoke City, Roanoke, Rockbridge, Rockingham, Smyth, Warren, Washington, Waynesboro, and Wythe counties. While being only a narrow band within Virginia, the BR provides many different species found nowhere else in the state. In fact, the southern Blue Ridge is one of the richest regions for biodiversity within the eastern United States. Most of this ecoregion is comprised of mostly forested slopes; cool, clear streams; and topographically rugged terrain. The BR is grouped into the previously mentioned "Southern Mountains" and "Northern Mountains" forest survey units, comprising the eastern edge of each that borders the adjacent "Northern Piedmont" and "Southern Piedmont" units (USDA 2016). Within these units, 66% of land is classified as timberland. The Blue Ridge substrate includes a wide range of metamorphic, acid rocks with occasional inclusions of mafic and ultramafic rocks. Within the ecoregion, tree species exhibit a wide range of diversity as well. Communities range from oak forests and northern hardwoods to spruce-fir forests and hemlock, with the topographic relief of the ecoregion providing habitat for many species found nowhere else within the Southeastern U.S. See Table 1 for the Federally-listed species present within the Blue Ridge ecoregion. Species ranges were taken from USFWS species range data through map graphics. Information regarding the forest types inhabited by these species can be found below in Section 5.2.2 Wildlife and Habitat Conservation.

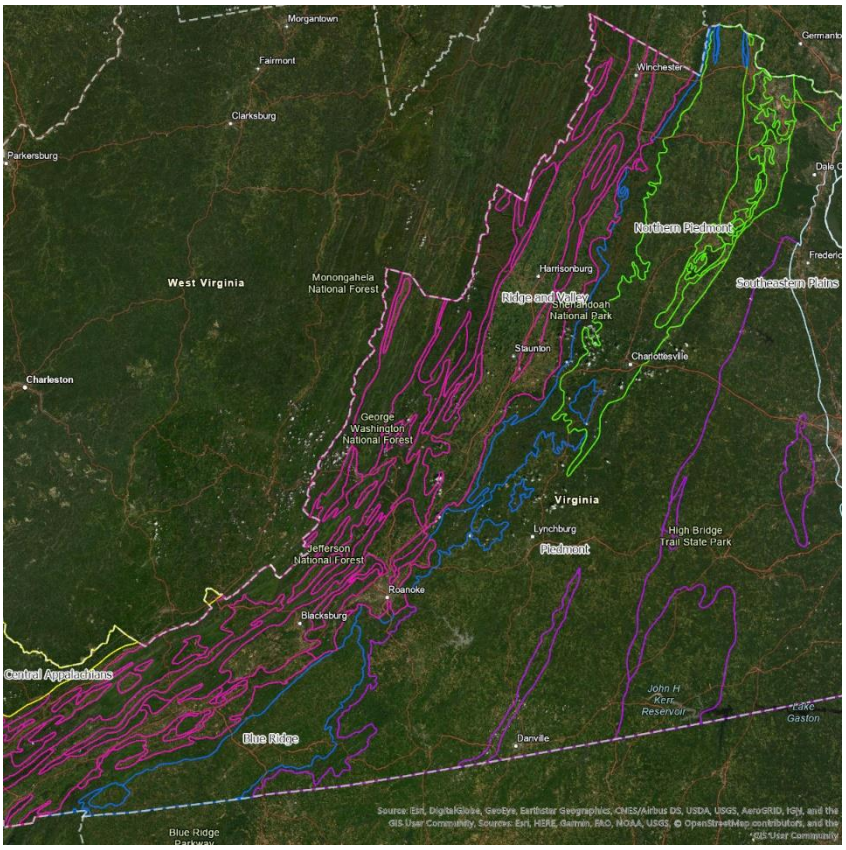


Figure 2. The Blue Ridge Level-III Ecoregion.

2.1.1 Forest Types Within Ecoregion

The Blue Ridge ecoregion is primarily recognized for its diversity in hardwood varieties. These habitats occur in association with hardwood slope forests and other topographic features, and include such forests as Southern Blue Ridge calcareous shale woodland, Southern Blue Ridge ultramafic woodland, lower Blue Ridge basic mesic forest, mountain cove forests, Appalachian oak forests, and others (Virginia Department of Conservation and Recreation (VCDR) 2017). Pine are found to a lesser extent within this ecoregion, although shortleaf pine (*Pinus echinata*) is found more in the BR than the Ridge and Valley and Central Appalachians to the west. Habitats at lower elevations within BR are similar ecologically to the adjacent Piedmont. However, as previously mentioned, upland hardwood forest types are dominant through the BR ecoregion.

2.2 Northern Piedmont

The Northern Piedmont (NP; Figure 3) ecoregion is a large landscape that stretches northeast-southwest from southern Virginia through central Maryland, southeast Pennsylvania, and central New Jersey. The NP region largely represents a landscape transition from the Blue Ridge and other mountainous ecoregions to the west to the relatively flat plains leading to the Atlantic to the east. In Virginia, the Northern Piedmont is comprised of parts of Albemarle, Arlington, Augusta, Charlottesville, Clarke, Culpeper, Fairfax, Falls Church, Fauquier, Greene, Loudoun, Madison, Manassas, Manassas Park, Nelson, Orange, Page, Prince William, Rappahannock, Rockingham, and Warren Counties. Most of the ecoregion is irregular plains with a mixture of rolling hills as forested land (56%) is a lower percentage than the mountainous ecoregions to the west. Soils in this ecoregion are generally finer-textured than the coastal plain ecoregions to the east, while there also exists a population of Precambrian and Paleozoic metamorphic and igneous rocks. While once largely cultivated, the predominant land cover of the NP is currently a mixture of urban/developed land, agriculture land, and forested land (EPA 1999).. The forested land consists of some planted pine, as well as some areas of pine that have reverted to hardwood woodlands with successional pine interspersed. See Table 1 for the Federally-listed species present within the Northern Piedmont.

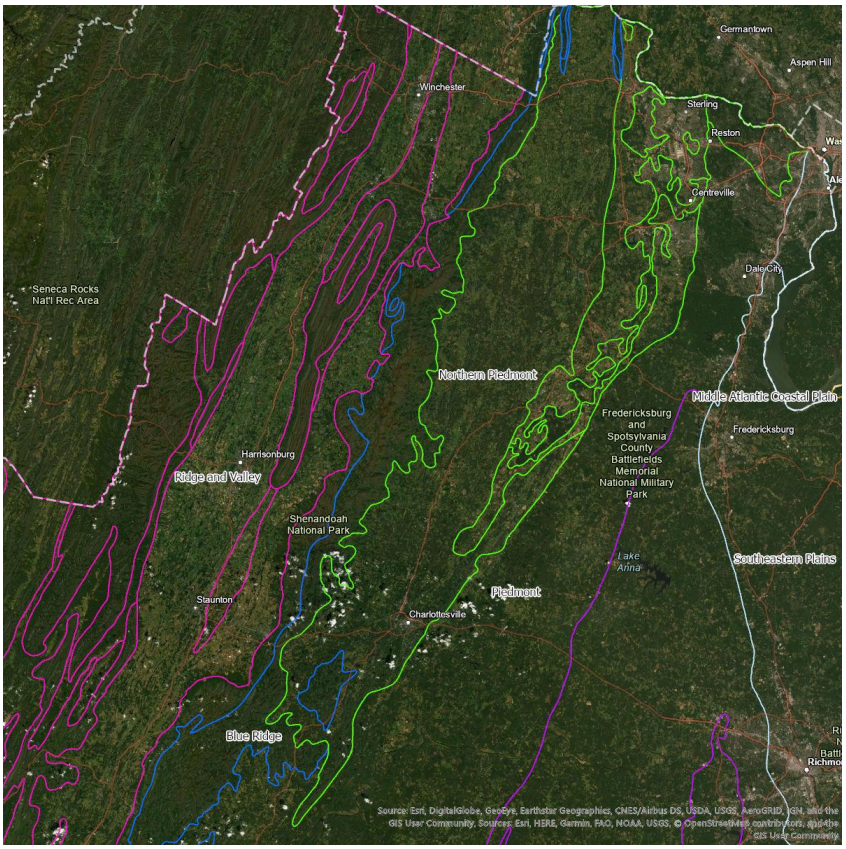


Figure 3. The Northern Piedmont Level-III Ecoregion

2.2.1 Forest Types Within Ecoregion

The Northern Piedmont is characterized mainly by its abundance of upland habitat due to its topography. Historic species commonly found in the natural pine-hardwood forests included shortleaf pine (*Pinus echinata*), Virginia pine (*Pinus virginiana*), and loblolly pine (*Pinus taeda*), while hardwood populations included white oak (*Quercus alba*), southern red oak (*Quercus falcata*), post oak (Q*uercus stellata*), and various hickory species (*Carya* spp.). All four of the pine forest types (loblolly dominated, longleaf dominated, shortleaf pine/hardwood mixed, loblolly pine/hardwood mixed) are found to varying degrees within the Piedmont. Upland hardwood forest types are also well-represented in this region. Due to the mostly upland habitat within the Piedmont, the bottomland forest types are not as present within this ecoregion; however, bottomland forest habitat may be found along the major rivers of the region.

2.3 Piedmont

The Piedmont (Figure 4) ecoregion is a large landscape that stretches northeast-southwest throughout the Carolinas and Virginia. The Piedmont region largely represents a landscape transition from the Blue Ridge and other mountainous ecoregions to the west to the relatively flat plains leading to the Atlantic to the east. In Virginia, the Piedmont is comprised of parts of Accomack, Albemarle, Alexandria, Amelia, Amherst, Appomattox, Arlington, Bedford, Brunswick, Buckingham, Campbell, Caroline, Carroll, Charlotte, Chesterfield, Culpeper, Cumberland, Danville, Dinwiddie, Fairfax City, Fairfax, Falls Church, Fauquier, Fluvanna, Franklin, Goochland, Greensville, Halifax, Hanover, Henrico, Henry, Louisa, Lunenberg, Lynchburg, Manassas, Manassas Park, Martinsville, Mecklenburg, Nelson, Nottoway, Orange, Patrick, Pittsylvania, Powhatan, Prince Edward, Prince William, Richmond City, Spotsylvania, Stafford, and Sussex Counties. Most of the ecoregion is irregular plains with a mixture of rolling hills. Soils in this ecoregion are generally finer-textured than the coastal plain ecoregions to the east, while there also exists a population of Precambrian and Paleozoic metamorphic and igneous rocks. While once largely cultivated, the predominant land cover of the Piedmont is currently planted pine and some areas of native pine, such as Virginia pine, that have reverted to hardwood woodlands with successional pine interspersed (natural and artificial forests comprise 66% of the total area of the Piedmont). See Table 1 for the Federally-listed species present within the Piedmont.

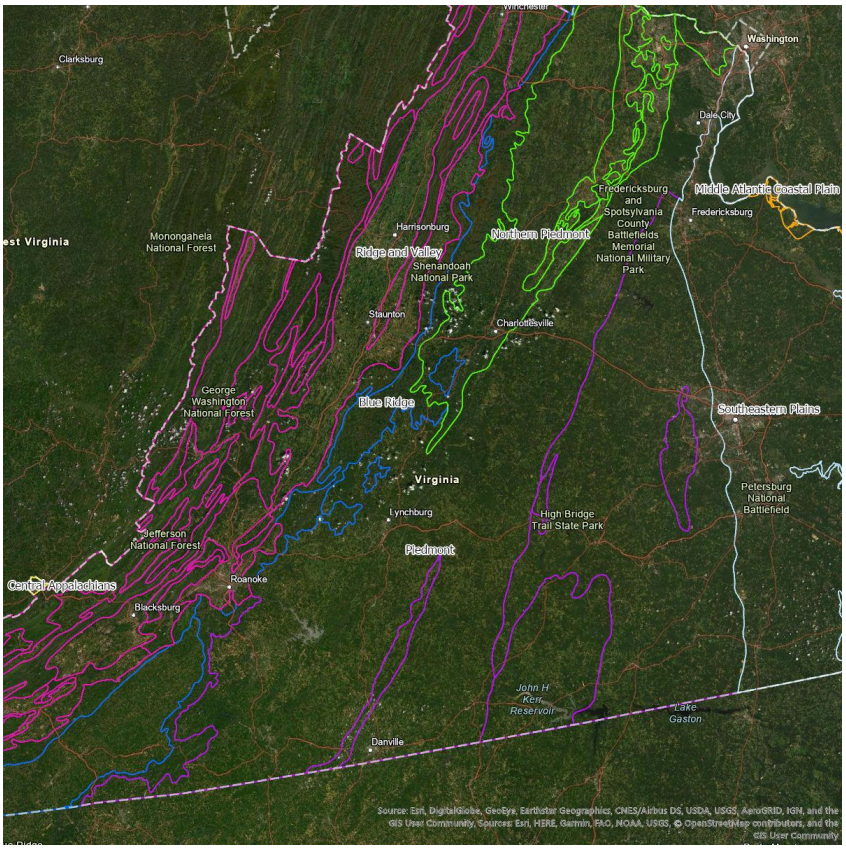


Figure 4. The Piedmont Level-III Ecoregion

2.3.1 Forest Types Within Ecoregion

The Piedmont is characterized mainly by its abundance of upland habitat due to its topography. Historic species commonly found in the natural pine-hardwood forests included shortleaf pine (*Pinus echinata*), Virginia pine, and loblolly pine (*Pinus taeda*), while hardwood populations included white oak (*Quercus alba*), southern red oak (*Quercus falcata*), post oak (Q*uercus stellata*), and various hickory species (*Carya* spp.). All four of the pine forest types (loblolly dominated, longleaf dominated, shortleaf pine/hardwood mixed, loblolly pine/hardwood mixed) are found to varying degrees within the Piedmont. Upland hardwood forest types are also well-represented in this region. Due to the mostly upland habitat within the Piedmont, the bottomland forest types are not as present within this ecoregion; however, bottomland forest habitat may be found along the major rivers of the region.

2.4 Southeastern Plains

The Southeastern Plains (SP; Figure 5) ecoregion exists between the Piedmont and Middle Atlantic Coastal Plain and consists of some irregular plains with broad interstream regions. In Virginia, the Southeastern Plains is comprised of parts of Alexandria, Arlington, Caroline, Charles City, Chesterfield, Colonial Heights, Dinwiddie, Emporia, Essex, Fairfax, Falls Church, Fredericksburg, Gloucester, Greensville, Hanover, Henrico, Hopewell, James City, King and Queen, King George, King William, Lancaster, Middlesex, New Kent, Northumberland, Petersburg, Prince George, Prince William, Richmond City, Richmond, Southampton, Spotsylvania, Stafford, Surry, Sussex, Westmoreland, Williamsburg, and York counties. The SP contains

greater elevations and relief than the Middle Atlantic Coastal Plain to the immediate east, but less than the hilly Piedmont ecoregion to the west. Streams present in this ecoregion are generally low-gradient and consist of sandy substrate. Historically, the SP was dominated by old growth natural longleaf pine, which an intermixture of hardwoods. Currently, land use within the SP is a mixture of natural forest, pine plantations, pasture, and crops. See Table 1 for the Federally-listed species present within the Southeastern Plains.

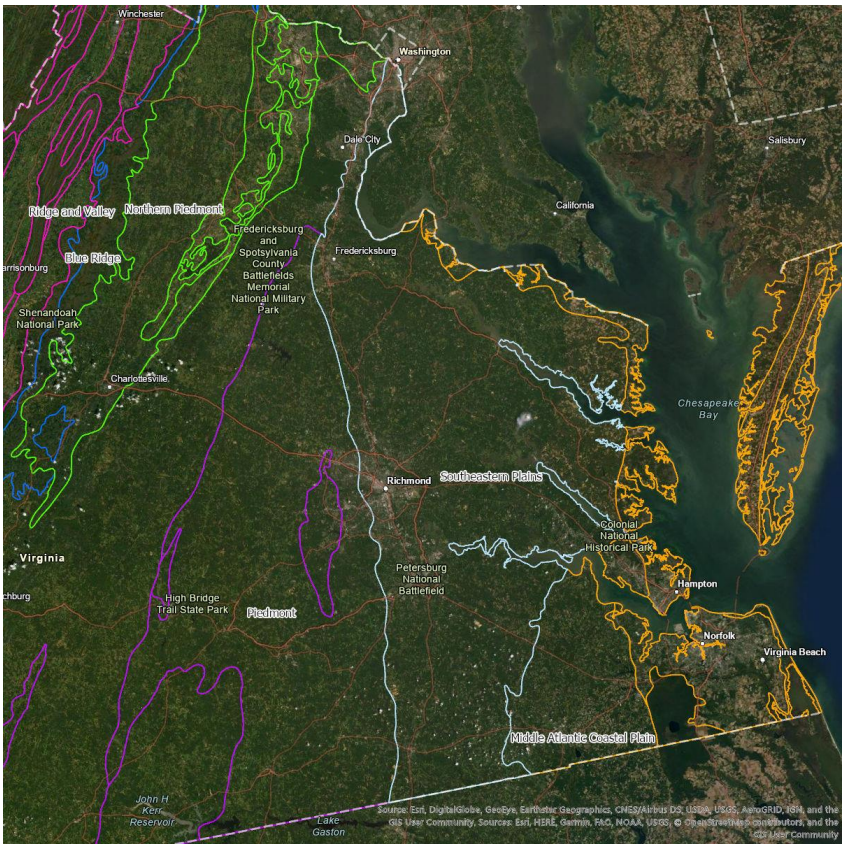


Figure 5. The Southeastern Plains Level-III Ecoregion

2.4.1 Forest Types Within Ecoregion

The SP is highly diverse in both different forest types and natural communities, as well as species richness. The many different upland habitats range from the rolling longleaf uplands to wet pine flatwoods, while wetlands range from floodplains to Carolina bays. The flat topography and fertile soils of the region make good habitat for both upland and bottomland forest types, with bottomland forests occurring in floodplains, depressional wetlands, and Carolina bays. Loblolly dominates the varying pine forest types found in SP, although longleaf can occur as well and most pine species are represented within the ecoregion.

2.5 Middle Atlantic Coastal Plain

The Middle Atlantic Coastal Plain (MACP; Figure 6) ecoregion consists of a mixture of cropland, natural woodland, and forests. In Virginia, the Middle Atlantic Coastal Plain is comprised of parts of Accomack, Chesapeake, Franklin City, Gloucester, Hampton, Isle of Wight, James City, King George, Lancaster, Mathews, Middlesex, Newport News, Norfolk, Northampton, Northumberland, Poquoson, Portsmouth, Southampton, Suffolk, Surry, Virginia Beach, Westmoreland, and York Counties. This ecoregion is predominantly comprised of flat plains, with swamps, marshes, and estuaries common through the MACP. Soils in this ecoregion are often poorly drained, and the region has both coarse and fine textured soils compared to the mostly coarse soil of the bordering Southern Coastal Plain. The MACP is a very diverse region, generating many new to science species while containing ecological communities that shift location over time. See Table 1 for the Federally-listed species present within the Middle Atlantic Coastal Plain.

Figure 6. The Middle Atlantic Coastal Plain Level-III Ecoregion.

2.5.1 Forest Types Within Ecoregion

The Middle Atlantic Coastal Plain supports a wide range of different forest types and natural communities. While longleaf pine once dominated forest types in the MACP, all pine species are present to some extent with loblolly pine having assumed the dominant role. Pine plantations for lumber and pulpwood are typical within

this ecoregion. The relatively flat topography and fertile soils of the region are suitable for both upland and bottomland forest types, with the bottomland forests occurring mainly in riparian areas. The MACP also contains a multitude of marshes, estuaries, swamps, pocosins, tupelo-cypress mixed habitats, Carolina bays, and barrier islands.

2.6 Ecoregions Application to Landscape Management Plan

Ecoregions are an important and distinct division of the landscape that takes into consideration geographical landforms, natural features (soils, vegetation, etc.), species populations, climate, and other environmental factors. It is important for landowners to realize the properties of the ecoregion in which they are located, as these features will be more or less applicable to certain landscape and/or landowner objectives and may drive the consideration of how to manage one's property.

While landowner objectives are somewhat standard across the different ecoregions, as a landowner will have similar goals independently of their location, some landscape objectives vary more greatly depending on the ecoregion. For example, if the landscape objective identified by the landowner is to support healthy forest products, the ecoregion where the landowner resides will have an effect on what types of forest products to develop on their land. While pine forest products and the mills that process them are more prevalent in the SP and MACP ecoregions, the BR ecoregion specializes more in hardwood chips and other hardwood products.

The protection of wildlife populations and species, if it is the goal of the landowner, differs by ecoregion as well. As seen in Table 1, species have a certain niche and preferred environment where they are found. For instance, a landowner interested in preserving and enhancing habitat for the red cockaded woodpecker should have land located in the MACP and SP where the landscape provides the proper pine forest needed for this species to exist; trying to provide habitat for this species within the BR would provide no benefit as it is out of their range. In addition to landowners' independent efforts to protect species and their related habitats, Conservation Initiatives have a geographic range where they are able to be applied. The National Bobwhite Conservation Initiative (NBCI) is most applicable in the central and eastern ecoregions of Virginia due to the abundance of potential bobwhite habitat.

The landscape objective of ecological restoration also varies by ecoregion. The longleaf pine and wiregrass community is a good restoration example. Many landowners in the SP and MACP ecoregions own land with deep, well-drained sandy soils that were historically populated by native longleaf pine communities. Since longleaf pine also can meet aesthetic, recreation, and revenue objectives, many landowners are interested in its restoration. Landowners in the BR or Piedmont ecoregions, however, would not have this option of longleaf restoration due to their location outside of longleaf habitat within the state. Other restoration opportunities may be available in these ecoregions, however, such as shortleaf pine initiatives. It is important to understand the restoration opportunities available to landowners within each ecoregion in the state.

Table 1. Federally threatened and endangered species present within the 5 covered Virginia Level III Ecoregions.

Species (Common Name)	Species (Scientific Name)	Blue Ridge	Northern Piedmont	Piedmont	Southeastern Plains	Middle Atlantic Coastal Plain
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*					X
Bald eagle		X	X	X	X	X
Bog turtle	*Clemmys muhlenbergii*	X				
Carolina northern flying squirrels	*Glaucomys sabrinus coloratus*	X				
Delmarva peninsula fox squirrel	*Sciurus niger cinereus*					X
Dwarf wedgemussel	*Alasmidonta heterodon*	X	X	X	X	X
Eastern prairie fringed orchid	*Platanthera leucophaea*	X				
Fluted kidneyshell	*Ptychobranchus subtentum*	X				
Gray bat	*Myotis grisescens*	X		X		
Harperella			X	X		
Indiana myotis	*Myotis sodalis*	X	X	X	X	
James spinymussel	*Pleurobema collina*	X	X	X	X	
Littlewing pearlymussel	*Pegias fabula*	X				
Madison cave isopod	*Antrolana lira*	X				
Michaux's sumac				X	X	
Mitchell's satyr	*Neonympha mitchellii*	X				
Northeastern bulrush	*Scirpus ancistrochaetus*	X				
Red-cockaded woodpecker					X	X

Species (Common Name)	Species (Scientific Name)	Blue Ridge	Northern Piedmont	Piedmont	Southeastern Plains	Middle Atlantic Coastal Plain
Roanoke logperch	*Percina rex*	X		X	X	
Sensitive joint-vetch	*Aeschynomene virginica*			X	X	X
Shenandoah salamander	*Plethodon shenandoah*	X				
Shiny pigtoe	*Fusconaia cor*	X				
Shortnose sturgeon	*Acipenser brevirostrum*				X	X
Small-anthered bittercress	*Cardamine micranthera*	X	X			
Small-whorled pogonia	*Isotria medeoloides*	X	X	X	X	
Smooth coneflower	*Echinacea laevigata*	X	X			
Spruce-fir moss spider	*Microhexura montivaga*	X				
Swamp-pink	*Helonias bullata*	X	X	X	X	
Tan riffleshell	*Epioblasma Florentina walkeri*	X				
Virginia big-eared bats	*Corynorhinus townsendii virginianus*	X				
Virginia sneezeweed	*Helenium virginicum*	X				
Virginia spiraea	*Spiraea virginiana*	X	X			

3.0 Hydrologic Categories

The United States Geological Survey (USGS) has developed the hierarchical system of Hydrologic Unit Codes (HUCs) in order to categorize and group waterbodies and watersheds of the U.S. There are 4 main levels of HUCs within the United States, ranging from the broad, 2-digit regions to the 8-digit cataloging unit, more commonly known as sub-basins. Sub-basins can then be further subdivided into 10-digit watersheds and 12-digit subwatersheds. For the purpose of this LMP, the 4-digit subregions were deemed appropriate to address the management requirements and landscape differences across the state.

Virginia contains all or part of three 4-digit subregions: 0206-Upper Chesapeake, 0207-Potomac, 0208-Lower Chesapeake, 0301-Chowan-Roanoke, 0304-Pee Dee, 0505-Kanawha, 0507-Big Sandy-Guyandotte, and 0601-Upper Tennessee. Within these 4-digit subregions, Virginia has 50 distinct 8-digit watersheds. These 8-digit HUCs, as mentioned above, represent too specific an area for a Landscape Management Plan due to the lack of large-scale landscape differences between these divisions. The boundaries of each HUC, 2-to-16-digit, can be displayed with all natural/environmental features shown overlaid in order to give the landowner information about their land as well as the surrounding watershed.

Within the different watersheds of Virginia, multiple watershed initiatives exist. These initiatives are largely focused on providing technical assistance to landowners to increase awareness about the connection between healthy forests and a healthy water supply as well as assisting foresters and landowners to implement sustainable and safe forest management practices. A major initiative in Virginia is the Healthy Watersheds Forest Retention program. This initiative strives to protect high-value forestland in an effort to maintain water quality of the Chesapeake Bay and prevent this forestland's conversion to land uses detrimental to the water quality of the bay. This program is supported by the Chesapeake Bay Program and their Healthy Watershed Goal Implementation Team.

The National Water Quality Initiative (NWQI) is a NRCS initiative applicable to forest lands throughout the U.S. (NRCS 2019). The NWQI program offer financial and technical assistance to forest landowners that are interested in improving water quality as well as aquatic habitats if their land falls within priority watersheds with impaired streams. A focus of the program is to provide conservation measures to landowners that will effectively control and trap nutrient and manure runoff, thereby decreasing nutrient loads to already impaired stream habitats. In Virginia, the three priority watersheds are the War Branch and Mountain Run watersheds that compose the Smith Creek Watershed in Rockingham county, as well as the Fifteenmile Creek in Washington county. While the Smith Creek watershed is mainly negatively affected by livestock in pastureland, the Fifteenmile Creek contain pockets of forestland throughout its watershed. Eligible producers (foresters and farmers) within these watersheds can receive funding to implement conservation and management practices to control nutrient and sediment runoff and thereby improve water quality within the state.

4.0 Objectives

Forest management objectives generally fall into two major levels of classification: Landowner and Landscape Objectives. Landowner objectives are those considerations important to a landowner upon which achievement measures the relative success or failure of the management in their perspective. These objectives can be used by forest resource professionals to provide, design, and implement services important to the landowner. Landowner objectives are often easily determined because they are also considered forest resources common to all forest types (e.g., aesthetics and recreation). Landscape objectives are those objectives identified on a national, state,

and/or ecoregional level that provide the greatest benefit towards forested ecosystem restoration, maintenance, and enhancement. Landowner objectives may also change or adapt after becoming aware of landscape objectives.

Generally following the determination of a landowner's objectives, forest resource professionals can identify the landscape level objectives that the landowner's objectives support. Landowner and landscape level objectives can be the same (e.g., hydrologic protection and conservation) or provide opportunities to support and enhance each other. For example, a landowner may consider their primary objectives Wildlife Management and Ecological Restoration. Through forest management activities to promote these objectives, the landowner could also be supporting landscape objectives like Wildlife Habitat Management, or Non-native and Invasive Species Management, or Forest Land Conservation and Retention.

4.1 Common Landscape Objectives

The landscape-level objectives discussed below are important to all forest types and should be considered for each landowner. They are summarized below, rather than included in the forest types discussion due to their uniform applicability across all forest types. Some of the landscape objectives were derived from Virginia's Statewide Forest Resource Assessment and Strategy, and some were taken from a stakeholder group comprised of various forest resource professionals and governmental agencies within Virginia. Forest type-specific landscape objectives are discussed below.

4.1.1 Support Healthy Forest Products Industry

This LMP promotes maintaining a healthy forest products industry in Virginia through sustainable forest management practices. This can be achieved through carefully planned timber harvests and timely site preparation and reforestation. Certification through the American Tree Farm System (ATFS) also supports sustainable forestry and adds value to timber markets. Many forest products companies need certified wood to be able to compete globally, so third-party certification through ATFS or other certifying bodies helps support these companies.

VA BMPs for Water Quality also support a healthy forest products industry through practices that protect and enhance water and soil quality. By voluntarily conducting safe, responsible, and sustainable forestry practices, over-regulation is avoided, which helps keep timber markets alive and thriving.

Another way to support the forest products industry is through the practice of regulated forestry. The concept of a "regulated" or "normal" forest is integral to forest management in Virginia. A regulated forest is at its core an ideal forest structure and is represented through a forest with an equal number of acres in each different age class. A regulated forest must have age and size classes represented in such a proportion and be growing consistently at such rates so that annual yields of products representing desired size and quality can be obtained through perpetuity (Davis and Johnson 1997).

A regulated forest will produce the maximum amount of fiber, on average, per year. Consequently, a regulated forest also produces the most money over time from the following: maintaining high average growth rates, diversification of product classes, frequency of payments, and compounding interest. Having a regulated forest also helps satisfy multiple other different landscape or landowner objectives. A regulated forest can provide net habitat for wildlife on an annual basis (Wildlife Management and Protection), always supplies sustainable products for perpetuity (Support Healthy Forest Products Industry), and can create a forest that is visually pleasing (Aesthetics) while providing a steady supply of revenue (Economic Return). Additional information concerning creating a regulated forest can be obtained through a discussion with a forest resource professional.

4.1.2 Watershed Protection and Restoration

Virginia contains several major watersheds including the Upper Chesapeake and Lower Chesapeake, Tennessee, and New River among many others. Well-managed forests help protect these watersheds and ensure clean drinking water, waterways and healthy aquatic habitats.

In order to protect these watersheds and ensure that they continue to provide high-quality water resources, the VDOF aggressively promotes adherence to VA BMPs for Water Quality. Silvicultural and agricultural BMPs are often implemented and promoted to ensure these operations do not impair water quality in the region. In many cases VA BMPs for Water Quality such as wetland harvest restrictions, road construction guidelines, and streamside management zones (SMZ's), enhance water quality, helping to restore watersheds. BMPs are voluntary yet widely followed, which helps avoid mandatory regulation on these practices while protecting water quality. Watershed restoration also involves other forest operations such as replacing and improving culverts and installing hard-surface low water crossings.

To best implement the above BMPs, the VDOF has created objectives and strategies within the Statewide Forest Action Plan's Strategy document. VDOF set a target of 90% adherence to BMPs on timber harvest operations to promote the enhancement of Virginia's waters and watersheds. Strategies set forth in an attempt to enhance the environmental and public benefits of Virginia's trees and forests are:

- Engage water quality specialists to provide more consistency to regional staff for implementation and enforcement of the water quality law.,
- Utilize comprehensive Integrated Forest Resource Information System (IFRIS) to support the water quality law enforcement program that allows for harvest operation tracking from point of notification to inspection close-out,
- Identify BMP implementation rates by individual BMP practice groups and utilize that information to target specific training programs for the SHARP Logger Program, and
- Improve statewide BMP implementation rate on timber harvesting operations by educating forest landowners on the value of BMPs and how to encourage harvesting contractors to use them where appropriate.

4.1.2.1 Riparian Buffer Establishment and Retention

A further priority established in the VDOF's Statewide Forest Action Plan's Strategy is to increase the amount of forestland protected and/or established in watersheds of Virginia, with significant watersheds receiving a priority. Protecting and establishing these riparian buffer areas along streams and rivers has received specific emphasis in the future plans for protection of Virginia's forestland. Along these lines, a goal of protecting 350 acres of protected riparian forest per year has been established. Some strategies for accomplishing these goals are:

- Work collaboratively with partners, agencies and groups to establish new buffers as outlined in the Riparian Forest Buffer Implementation Plan,
- Provide educational opportunities for the general public, SWCDs, private forestland owners, the development community and forest products manufacturers through meetings, published literature and articles. These educational opportunities will be aimed at a combination of promoting an increase in the number of riparian plantings; encouraging wider riparian plantings, when possible, and educating landowners in significant watersheds on the importance of forests to water quality,
- Use available grants and cost-share funds to increase accomplishments of buffers in rural and urban areas; fund logger BMP cost-share, and provide watershed protection through the regional grant program, and

- Make stakeholders aware of the Riparian Forest Buffer Tax Credit (RFBTC) program. VDOF foresters will actively seek and promote areas for the riparian forest buffer tax credit, including pre-harvest plans; harvest inspection process, and forest management plans.

Of special note within the above goals is the presence of the Riparian Forest Buffer Tax Credit (RFBTC). This program, in an effort to preserve bottomland forests in the riparian zone along stream and river banks, provides those compliant with its requirements the ability to earn a tax credit equaling 25% of the timber value that has been retained as a riparian buffer. To qualify for this RBTC, when conducting a timber harvest along waterways landowners (with a Stewardship Plan for the tract) must leave a buffer at least 35 feet wide and no more than 300 feet long; this buffer must remain intact for the following 15 years.

4.1.3 Wildlife Management and Protection

Virginia's forests face many threats, with changes in land-use being the leading cause of loss in forest cover. Forests, their ecosystems and natural resources can be conserved through conservation easements, sustainable forest management and habitat management.

Virginia is home to many rare species found only in this region and contains several global populations. Virginia forests provide vital habitat to many imperiled plant and animal species. Table 2 shows federally-listed species (threatened, endangered, and at-risk) found in the forested habitats of Virginia by LMP forest type. This table was created using the USFWS's Endangered and Threatened Species in Virginia. Not all listed Virginia species from the list are shown, only those with the potential to utilize some portion of forested habitat within their life cycle. Also, the Virginia Wildlife Action Plan provides a more exhaustive list of 883 "Species of Greatest Conservation Need" that can be referenced, while the VDCR provides a list of rare species and natural communities that can provide additional information on state-listed species. These habitats were then associated with each LMP forest type.

Not all of the species listed below in Table 2 are state-or-federally-listed threatened or endangered species, as some are designated as federally-listed At-Risk species. These are species currently which are currently petitioned to the USFWS to be listed as either threatened or endangered but currently do not have a designation, as the USFWS is conducting species assessments to evaluate whether listing is needed. Landowners with the potential for these At-Risk species on their property can discuss a Candidate Conservation Agreement with Assurances (CCAA) with USFWS should these species need to become listed in the future (https://www.fws.gov/service/candidate-conservation-agreements). This CCAA is a formal agreement between the USFWS and one or more landowning parties to address the conservation needs of proposed candidate species prior to them receiving a listing designation. If proper conservation actions are taken prior to listing, is it hoped that there may not be the need for future listing.

Table 2. Rare plant and animal species of Virginia by LMP forest type.

Common Name	Scientific Name	Loblolly Pine	Longleaf Pine	Shortleaf Pine/Hardwood	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland Hardwood
Amphibians								
Shenandoah salamander	*Plethodon shenandoah*			X	X		X	
Birds								
Bald eagle	*Haliaeetus leucocephalus*	X	X	X	X	X	X	X
Red-cockaded woodpecker	*Picoides borealis*	X	X	X				
Fish								
Atlantic sturgeon	*Acipenser oxyrinchus*							X
Blackside dace	*Chrosomus cumberlandensis*			X	X			
Duskytail darter	*Etheostoma percnurum*							X
Roanoke logperch	*Percina rex*			X	X			
Shortnose sturgeon	*Acipenser brevirostrum*							X
Slender chub	*Erimystax cahni*			X	X			
Spotfin chub	*Erimonax monachus*							X
Yellowfin madtom	*Noturus flavipinnis*							X
Invertebrates								
Birdwing pearlymussel	*Lemiox rimosus*				X			X
Cracking pearlymussel	*Hemistena lata*				X			X
Cumberland monkeyface	*Quadrula intermedia*				X			X
Cumberlandian combshell	*Epioblasma brevidens*				X			X
Dromedary pearlymussel	*Dromus dromas*				X			X
Dwarf wedgemussel	*Alasmidonta heterodon*							X
Fanshell	*Cyprogenia stegaria*				X			X

Common Name	Scientific Name	Loblolly Pine	Longleaf Pine	Shortleaf Pine/Hardwood	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland Hardwood
Finerayed pigtoe	*Fusconaia cuneolus*				X			X
Fluted kidneyshell	*Ptychobranchus subtentum*				X			X
Green-blossom pearly mussel	*Epioblasma torulosa gubernaculum*				X			X
James spinymussel	*Pleurobema collina*				X			X
Lee County cave isopod	*Lirceus usdagalun*				X		X	
Littlewing pearlymussel	*Pegias fabula*				X			
Madison cave isopod	*Antrolana lira*				X			
Mitchell's satyr	*Neonympha mitchellii*							X
Oyster mussel	*Epioblasma capsaeformis*				X			X
Pink mucket	*Lampsilis orbiculata*							X
Purple bean	*Villosa perpurpurea*				X			X
Rough pigtoe	*Pleurobema plenum*				X			X
Rough rabbitsfoot	*Quadrula cylindrica strigillata*				X			X
Sheepnose	*Plethobasus cyphyus*				X			X
Shiny pigtoe	*Fusconaia cor*				X			X
Slabside pearlymussel	*Lexingtonia dolabelloides*				X			X
Snuffbox	*Epioblasma triquestra*				X			X
Spectaclecase	*Cumberlandia monodonta*				X			X

Common Name	Scientific Name	Loblolly Pine	Longleaf Pine	Shortleaf Pine/Hardwood	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland Hardwood
Spruce-fir moss spider	*Microhexura montivaga*			X	X			
Tan riffleshell	*Epioblasma Florentina walkeri*				X			X
Virginia fringed mountain snail	*Polygyriscus virginicum*			X	X			
Mammals								
Carolina northern flying squirrel	*Glaucomys sabrinus coloratus*			X	X	X		
Delmarva peninsula fox squirrel	*Sciurus niger cinereus*	X	X	X				X
Gray bat	*Myotis grisescens*			X	X	X	X	X
Indiana myotis	*Myoti sodalis*	X	X	X	X	X		X
Virginia big-eared bats	*Corynorhinus townsendii virginianus*			X	X	X	X	X
Plants								
American chaffseed	*Schwalbea americana*	X	X	X				
Eastern prairie fringed orchid	*Platanthera leucophaea*					X	X	X
Harperella	*Ptilimnium nodosum*			X	X			
Michaux's sumac	*Rhus michauxii*				X	X		
Northeastern bulrush	*Scirpus ancistrochaetus*							X
Peter's Mountain mallow	*Iliamna corei*			X	X			
Rock gnome lichen	*Gymnoderma lineare*			X	X			

Common Name	Scientific Name	Loblolly Pine	Longleaf Pine	Shortleaf Pine/Hardwood	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland Hardwood
Sensitive joint-vetch	*Aeschynomene virginica*							X
Shale barren rock cress	*Boechera serotina*			X	X			
Small-anthered bittercress	*Cardamine micranthera*					X	X	X
Small-whorled pogonia	*Isotria medeoloides*				X	X	X	
Smooth coneflower	*Echinacea laevigata*			X	X			
Swamp-pink	*Helonias bullata*							X
Virginia round-leaf birch	*Betula uber*			X	X			
Virginia sneezeweed	*Helenium virginicum*				X			
Virginia spiraea	*Spiraea virginiana*			X	X			X
Reptiles								
Bog turtle	*Clemmys muhlenbergii*							X

4.1.3.1 Working Lands for Wildlife

One major initiative throughout the nation as well as the state of Virginia is the program of Working Lands for Wildlife (WLFW). Established through NRCS and funded through EQIP, this program's focus is to assist landowners in voluntary conservation efforts toward threatened species. NRCS provides financial and technical support to participants who voluntarily make certain improvements to their working lands in order to facilitate improvement of these species' habitat. This initiative has proven successful in helping conserve more than 7.1 million acres of wildlife habitat nationwide and has benefitted species such as the greater sage-grouse and New England cottontail.

In Virginia, a main target species of the WLFW program is the bobwhite quail. The program Northern Bobwhite in Working Grasslands aims to encourage landowners in the state to voluntarily establish productive warm season grass forages for their cattle to support grazing in the summer. This action helps to provide large area of habitat for the ground-nesting bobwhite quail and other wildlife. A landowner with forested land may wish to provide the same forage grasses in a silvopasture setting. NRCS funds will share the cost of conservation practices with landowners.

4.1.4 Forest Land Conservation and Retention

For this LMP, conservation is defined as the process of maintaining a natural resource (e.g. forested ecosystem) for perpetual use. This definition inherently associates conservation with the proper use of ecological processes to maintain the forested ecosystem. The term conservation is generally credited to Gifford Pinchot, who served as President Teddy Roosevelt's head of the US Forest Service in the early 20th century (Trefethen 1975). Some landowners have a conservation objective because they would like to see their forest ownership remain intact and capable of being passed down from generation to generation. Landowners with a conservation objective may utilize other consumptive use objectives like revenue generation or hunting and fishing recreation.

Conservation is founded upon the desire to ensure future use of a natural resource. Many landowners utilize silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests.

All forest types can be managed in a conservation-oriented manner. This can be accomplished using multiple-use management by balancing utilization and protection of timber, wildlife, rare plants, recreation, and hydrology. Pine forests are fire dependent and require frequent application of prescribed fire for ecological maintenance; hardwood forest types do not require these fire-related management techniques. Forest types may also be managed differently depending on the ecoregion they are located within.

The conservation and retention of forest land within Virginia has been designated a priority through the Statewide Forest Resource Assessment and Strategy. While Virginia's forests generate $27.5 billion of revenue from forest-related products and benefits annually, tens of thousands of forested acres are lost each year to conversion of forested land to other various land uses (VDOF 2010). This loss of forestland drastically reduces all of the benefits obtained from forests, such as clean air and water, habitat for wildlife, and the production of forest products; these changes negatively impact life for all Virginians. In the recent past, government programs such as the Conservation Reserve Program have worked to help keep forested land in Virginia relatively stable over time, with agricultural lands being converted to forests to offset the increasing urbanization. However, this conversion has slowed and it appears that there may soon be a net loss in forestland in the state.

In examining the recent forest land trends across the state, the VDOF realized that the primary method for slowing forestland loss is to influence the land-use decisions of not only policymakers within Virginia's Commonwealth, but also individual private landowners. A concerted effort has been made since 2010 to implement a forestland conservation program for Virginia, which included a director and division director for forestland conservation. To assist in this endeavor, a forestland conservation priority map (Figure 7) was created. This map ranks forested areas across the state by the level of potential benefits provided as well as the conservation risk faced, and is a resource in outreach efforts and ranking potential land acquisition/easement opportunities.

Following this process, the VDCR created their own Forest Conservation Value (FCV) model in 2013, which has since undergone multiple updates, most recently in 2018. This FCV aids in determining which high-priority projects that the VDCR accepts on a quarterly basis throughout the year. Six key components have been integrated into the FCV to produce better quality data: forested blocks, forest management potential, connectivity, watershed integrity, threat of conversion, and significant forest communities and diminished tree species present. The result is a model (Figure 8) that is similar to Figure 7 and furthers aids forested land retention efforts within Virginia.

Figure 7. Virginia's Forest Conservation Areas Ranked by Conservation Value (From Virginia Statewide Forest Resource Assessment)

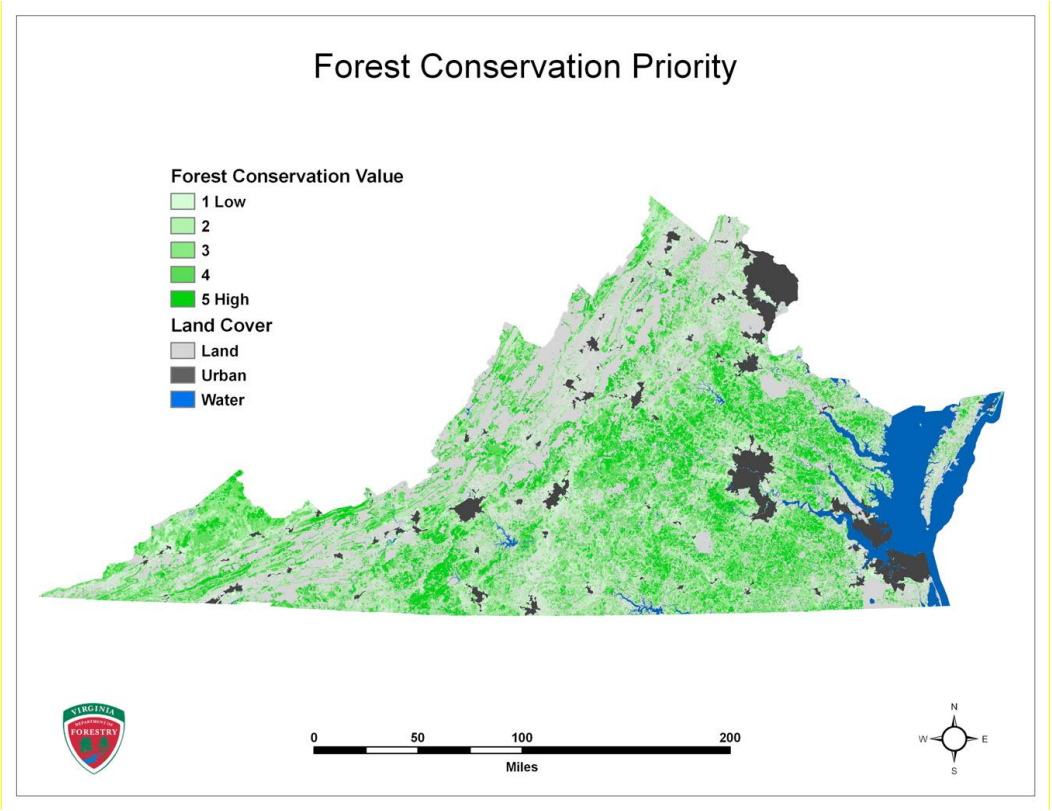
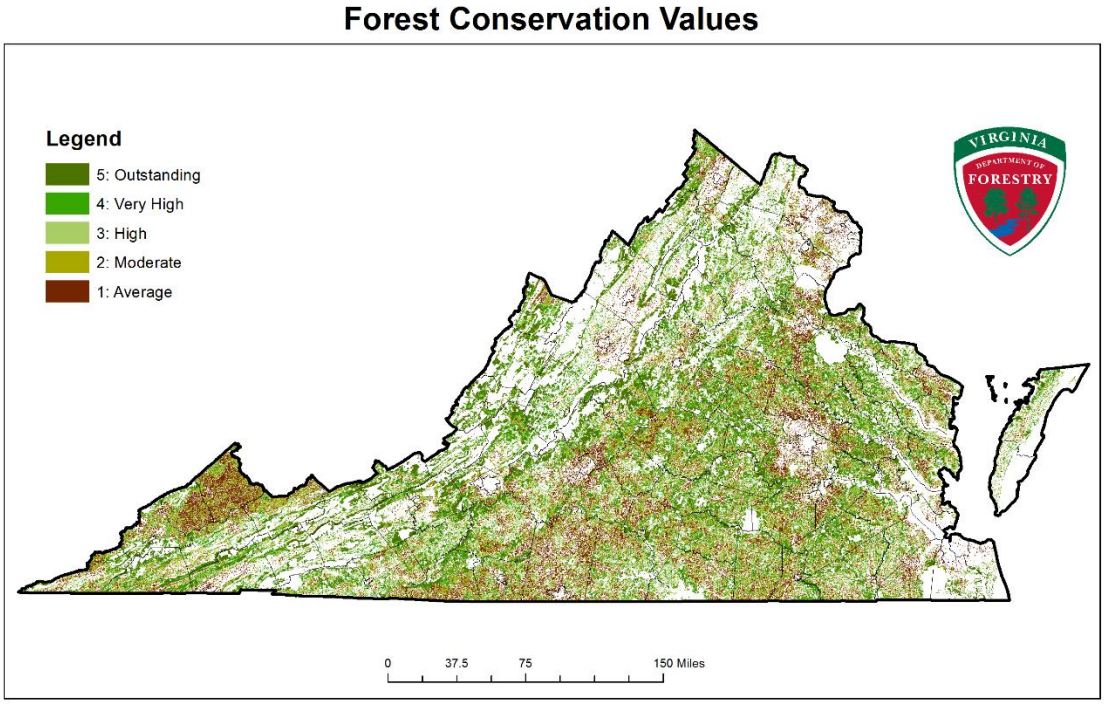


Figure 8. Virginia's Forest Conservation Areas Ranked by Conservation Value (From VDOF, 2018)



VDOF has the goal to reduce the rate of conversion of forestland to other uses; this process begins with providing the general public information on the importance of forestland and technical assistance, as well as conservation methods available. A few methods the VDOF plans to employ in the protection of forestland are to accept working forest conservation easements as well as their acquisitions, as well as promoting to the landowner benefits of legacy planning. Identifying the forestlands that provide the greatest combination of environmental and economic benefits while also being the most threatened by conversion will allow the VDOF to determine the areas in greatest conservation need (highest Forest Conservation Value). Objectives that will help guide the VDOF's efforts are as follows:

- Objective 4.1 – Increase the number of acres of forestland protected from conversion, focusing, where possible, on lands ranked as high in "Forest Conservation Value." Include expanding efforts in nonpermanent conservation.
    - Strategy 4.1.1.1 – Utilize GIS analysis to rank all forested acres in the state by priority for forest conservation based on the multiple benefits provided by that forest and the threat of conversion of that forested area.
    - Strategy 4.1.1.2 – Assist landowners in placing working forest conservation easements on forested properties, particularly for lands ranked as high in forest conservation value.
    - Strategy 4.1.1.3 – Utilize funding from federal, state and other sources when available to purchase conservation easements or fee simple interest in land, focusing on lands ranked as high in forest conservation value.
    - Strategy 4.1.1.4 – Develop and promote voluntary mitigation strategies and plans that include forest management practices to help mitigate the loss of forestland as a result of land development and land conversion.
    - Strategy 4.1.1.5 – Work with conservation partners, local governments and other authorities to identify land conservation strategies (i.e. green infrastructure) that could find wider application at the state or local level.
- Objective 4.2 – Increase awareness of the importance of and need for forestland conservation among landowners and local governments.
    - Strategy 4.2.1.1 - Work with legislators, local governments and landowners to encourage forest conservation through zoning; comprehensive plan updates, and land-use policies. Include information covering, in detail, emerging ecosystem services and markets. Forestland Conservation Division to coordinate with the Public Information Division for development of language for inclusion in county comprehensive plans. Work with regions to identify localities that are considering updating plans or ordinances and become involved in the process to advocate for forest conservation.
    - Strategy 4.2.1.2 - Develop education materials and programs and use these to raise awareness of the need for and methods available for forestland conservation. Include special promotion of the Virginia land conservation tax incentive.
- Objective 4.3 – Manage the state forestlands on a sustainable basis for research, demonstration, education, and multiple-use benefits while staying within the allowable forest harvest levels.
    - Strategy 4.3.1.1 - Develop a comprehensive annual work plan that will meet the goals of the State Forest System plan.
    - Strategy 4.3.1.2 - Develop a survey to assess the best public uses of state forestlands and the reasons the public visits the State Forests.

    - Strategy 4.3.1.3 - Define the best locations for public use on State Forests that complement forest management objectives and timber sales.
- Objective 4.4 – Promote a larger, connected forest landscape.
    - Strategy 4.4.1.1. - Assist localities, development associations and other stakeholders in understanding where key conservation priorities should be, and broadening their understanding of the importance of connecting forests across parcels. Working with partner agencies, assist localities in mapping their local green infrastructure resources.
    - Strategy 4.4.1.2 - Promote establishment of regional and statewide forest cover goals, including urban tree canopy goals, where appropriate. Encourage localities to work toward meeting these goals.
    - Strategy 4.4.1.3 – Support and promote state and local greenway initiatives, including GIS support through agency's public GIS program, when developed.

4.1.5 Non-Native and Invasive Species (NNIS) and Nuisance Species Management

There are many non-native invasive plant (NNIP) and animal (NNIA) species in the state of Virginia. Table 3 provides a list of the most common NNIS and nuisance species that impact forest management, using the Virginia Department of Conservation and Recreation's Virginia Invasive Plant Species List (2014). Additionally, there are numerous native species which can function as nuisance species when their abundance and distribution impact historic and healthy forest conditions. For example, if not kept in check bermudagrass (*Cynodon* spp.), which is not on the above-mentioned lists, can be more disruptive to a habitat than such species as bahia grass and tall fescue that are on the list. Forest resource professionals can accurately assess which native species are serving in a nuisance capacity to inhibit the achievement of landscape objectives. The Virginia Department of Wildlife Resources can also be consulted for treatment of any nuisance animals that may be present on the property. Depending on the species of nuisance animal present, permits may be required for animal control. Management and control of both NNIS and nuisance species is often most successful when it is integrative and adaptive (Miller et al 2015).

Table 3. Common Virginia non-native invasive plant species list, divided by threat category and region encountered(as listed by VDCR, 2014).

			Region		
Scientific Name	**Common Name**	**VA Invasiveness Rank**	**Mountain**	**Piedmont**	**Coastal**
HIGH THREAT					
Ailanthus altissima	Tree-of-heaven	High	●	●	●
Aldrovanda vesiculosa	Waterwheel	High			●
Alliaria petiolata	Garlic Mustard	High	●	●	●
Alternanthera philoxeroides	Alligator-weed	High			●
Ampelopsis brevipedunculata	Porcelain-berry	High		●	●
Carex kobomugi	Japanese Sand Sedge	High			●
Celastrus orbiculatus	Oriental Bittersweet	High	●	●	●

Centaurea stoebe ssp. micranthos	Spotted Knapweed	High	●	●	●
Cirsium arvense	Canada Thistle	High	●	●	●
Dioscorea polystachya	Cinnamon Vine	High	●	●	●
Eichhornia crassipes	Water Hyacinth	High			●
Elaeagnus umbellata	Autumn Olive	High	●	●	●
Euonymus alatus	Winged Euonymus	High	●	●	
Ficaria verna	Lesser Celandine	High		●	●
Hydrilla verticillata	Hydrilla	High	●	●	●
Imperata cylindrica	Cogon Grass	High			●
Iris pseudacorus	Yellow Flag	High	●	●	●
Lespedeza cuneata	Sericea Lespedeza	High	●	●	●
Ligustrum sinense	Chinese Privet	High	●	●	●
Lonicera japonica	Japanese Honeysuckle	High	●	●	●
Lonicera maackii	Amur Honeysuckle	High	●	●	●
Lonicera morrowii	Morrow's Honeysuckle	High	●	●	
Ludwigia grandiflora ssp. hexapetala	Large flower primrose willow	High	●	●	●
Lythrum salicaria	Purple Loosestrife	High	●	●	●
Microstegium vimineum	Japanese Stiltgrass	High	●	●	●
Murdannia keisak	Marsh dewflower	High	●	●	●
Myriophyllum aquaticum	Parrot Feather	High	●	●	●
Myriophyllum spicatum	Eurasian Water-milfoil	High	●	●	●
Oplismenus hirtellus ssp. undulatifolius	Wavyleaf Grass	High	●	●	
Persicaria perfoliata	Mile-a-minute	High	●	●	●
Phragmites australis ssp. australis	Common Reed	High	●	●	●
Pueraria montana var. lobata	Kudzu	High	●	●	●
Reynoutria japonica	Japanese knotweed	High	●	●	●
Rosa multiflora	Multiflora Rose	High	●	●	●
Rubus phoenicolasius	Wineberry	High	●	●	●
Sorghum halepense	Johnson Grass	High	●	●	●
Urtica dioica	European Stinging Nettle	High	●	●	●
Vitex rotundifolia	Beach Vitex	High			●
MEDIUM THREAT					

Acer platanoides	Norway Maple	Medium	●	●	●
Agrostis capillaris	Colonial bent-grass	Medium	●	●	●
Akebia quinata	Five-leaf Akebia	Medium		●	●
Albizia julibrissin	Mimosa	Medium	●	●	●
Arthraxon hispidus var. hispidus	Joint Head Grass	Medium	●	●	●
Berberis thunbergii	Japanese Barberry	Medium	●	●	●
Cirsium vulgare	Bull Thistle	Medium	●	●	●
Dipsacus fullonum	Wild Teasel	Medium	●	●	●
Egeria densa	Brazilian Waterweed	Medium	●	●	●
Euonymus fortunei	Winter Creeper	Medium	●	●	●
Glechoma hederacea	Gill-over-the-ground	Medium	●	●	●
Hedera helix	English ivy	Medium		●	●
Heracleum mantegazzianum	Giant Hogweed	Medium	●	●	
Holcus lanatus	Common Velvet Grass	Medium	●	●	●
Humulus japonicus	Japanese Hops	Medium	●	●	●
Ipomoea aquatica	Water spinach	Medium	●	●	●
Ligustrum obtusifolium var. obtusifolium	Border privet	Medium	●	●	●
Lonicera tatarica	Tartarian Honeysuckle	Medium	●	●	
Lysimachia nummularia	Moneywort	Medium	●	●	●
Miscanthus sinensis	Chinese Silvergrass	Medium	●	●	●
Najas minor	Brittle Naiad	Medium	●	●	●
Paulownia tomentosa	Royal Paulowina	Medium	●	●	●
Persicaria longiseta	Long-bristled Smartweed	Medium	●	●	●
Phyllostachys aurea	Golden Bamboo	Medium	●	●	●
Poa compressa	Flat-stemmed Bluegrass	Medium	●	●	●
Poa trivialis	Rough Bluegrass	Medium	●	●	●
Pyrus calleryana	Callery Pear	Medium	●	●	●
Rhodotypos scandens	Jetbead	Medium	●	●	●
Rumex acetosella	Sheep sorrel	Medium	●	●	●
Salvinia molesta	Giant Salvinia	Medium	●	●	●
Solanum viarum	Tropical Soda Apple	Medium		●	●
Spiraea japonica	Japanese Spiraea	Medium	●	●	
Stellaria media	Common Chickweed	Medium	●	●	●
Veronica hederifolia	Ivy-leaved Speedwell	Medium	●	●	●
Viburnum dilatatum	Linden arrow-wood	Medium		●	

Wisteria sinensis	Chinese Wisteria	Medium	●	●	●
LOW THREAT					
Commelina communis	Asiatic Dayflower	Low	●	●	●
Elaeagnus pungens	Thorny Olive	Low	●	●	●
Lespedeza bicolor	Shrubby Bushclover	Low	●	●	●
Lonicera fragrantissima	Winter Honeysuckle	Low	●	●	●
Melia azedarach	Chinaberry	Low		●	●
Morus alba	White Mulberry	Low	●	●	●
Perilla frutescens	Beefsteak Plant	Low	●	●	●
Phleum pratense	Timothy	Low	●	●	●
Populus alba	Silver Poplar	Low	●	●	●
Rumex crispus ssp. crispus	Curly dock	Low	●	●	●
Securigera varia	Crown-vetch	Low	●	●	●
Trapa natans	European Water Chestnut	Low			●
Ulmus pumila	Siberian Elm	Low	●	●	
Vinca major	Greater Periwinkle	Low	●	●	●
Vinca minor	Periwinkle	Low	●	●	●
Wisteria floribunda	Japanese Wisteria	Low		●	●

The VDCR has identified tree of heaven, waterwheel, garlic mustard, alligator-weed, porcelain-berry, Japanese sand sedge, oriental bittersweet, spotted knapweed, Canada thistle, cinnamon vine, water hyacinth, autumn-olive, winged euonymus, lesser celandine, hydrilla, cogongrass, yellow flag, sericea lespedeza, Chinese privet, Japanese honeysuckle, amur honeysuckle, Morrow's honeysuckle, large flower primrose willow, purple loosestrife, Japanese stilt grass, marsh dewflower, parrot feather, Eurasian water-milfoil, wavyleaf grass, mile-a-minute, common reed, kudzu, Japanese knotweed, multiflora rose, wineberry, Johnson grass, European stinging nettle, and beach vitex as severe invasive plant threats to natural Virginia communities. Some invasive animal species known to impact Virginia forests include the Sirex wood wasp (*Sirex noctilio*), Emerald ash borer (*Agrilus planipennis*), and feral hog (*Sus scrofa*). While all the severe species are important to recognize, cogongrass is a federally-listed noxious weed and widely regarded as the worst invasive present in the southern United States. It is an invader of both natural and disturbed habitat, where its presence disrupts natural ecosystem functions, crowds out endemic shrub and grass species, and alters fire regimes and intensity (Bryson and Carter 1993).

Currently, Virginia is not yet infected by cogongrass; however, it is on the advancing front of the infestation across the Southeast and is listed in Virginia as an early detection species. Cogongrass has been found as far north as Raleigh, North Carolina (EDD MapS). Landowners in Virginia are being made aware of the issues with cogongrass and the importance of its control.

Another major threat to natural forest communities in Virginia is the emerald ash borer (EAB). This beetle, native to Asia, is responsible for the death or decline of tens of millions of ash trees in the United States in 13 states, ranging from New York to Indiana (USDA Program Aid 769). Larvae of this beetle feed on the tissue between the bark and sapwood of the tree, which disrupts the transport of nutrients within the tree and eventually kills it.

The emerald ash borer has been detected in 44 counties within Virginia, with sighting occurring as recently as 2019(Emerald Ash Borer Information Network 2020). The USDA has attempted to prevent spread on the EAB through various methods.

The European gypsy moth (EGM; *Lymantria dispar*) is another significant threat to Virginia's forests. The EGM is most dangerous to trees in its caterpillar form, as the caterpillars have a large appetite for greater than 300 species of both trees and shrubs. Caterpillars can work to defoliate the majority of a tree, leaving the tree more susceptible to other diseases, pests, and environmental stressors (USDA APHIS 2020).

As Virginia's forests have a high proportion of hardwood species, diseases such as sudden oak death/Ramorum blight (*Phytophthora ramorum*) are of high concern to forest landowners. While the blight is not currently present in Virginia, it has decimated oaks throughout California nurseries and natural areas (where it originated in North America) as well as Oregon. If it migrated to Virginia, the blight could injure and kill oaks and other commercially important forest species (Virginia Invasive Species Working Group 2020). The Virginia Department of Agriculture and Consumer Services (VDACS) surveys nurseries in the state annually for the disease to prevent its intrusion into Virginia.

The hemlock woolly adelgid (*Adelges tsugae*) is another non-native pest known to affect Virginia and eastern hemlocks, which feeds by sucking sap from the base of foliage. Infected trees appear to have cotton on their foliage, hence the name, and usually succumb from carbohydrate loss 5-7 years post infestation. This insect has decimated the eastern hemlock of the Appalachian cove forests from Maine to Georgia. To preserve the most aesthetically/ecologically valuable trees, systemic insecticides are required to be periodically applied.

4.1.5.1 Prevention and Monitoring

Prevention is the key first step. Landowners and managers can limit the spread of NNIP's by minimizing ground disturbance activities and inspecting silvicultural and agricultural equipment for cleanliness prior to entering and departing property. Spread of NNIA's can be minimized by avoiding the transport of these species from one property to another and through fencing. Despite strong prevention measures, birds, weather and other modes of spread will occur.

Monitoring can take place during routine work or recreational activities on the property. It is important to have species identification skills and resources to aid in monitoring. Early detection through monitoring allows for rapid, aggressive treatment before infestations become established and spread throughout the property.

Some species pose an interesting dichotomy of both potentially harmful as well as helpful impacts to the environment, such as the beaver. While beaver can severely alter hydrology for the worse and harm surrounding forests with their dam building, they can also control stream bank side vegetation and enhance wetland habitats while also potentially reducing flooding downstream of the dams (BACE 2020). The aspect of monitoring is crucial for determining whether the surrounding habitat is harmed or helping by beaver occupation. Treatment options are given below in Section 4.1.5.5.

4.1.5.2 Documentation and Planning

Documentation of new and existing infestations with GPS coordinates, GIS mapping or location notes assist in the treatment and monitoring of infestations. Infestations can be marked with flagging, paint or other means. Documentation is also beneficial to insure all pesticides are approved by the Environmental Protection Agency (EPA) and applied, stored and disposed of in accordance with EPA-approved labels and by persons appropriately trained, licensed and supervised.

NNIS and nuisance species management plans can be developed to treat minor and major infestations. Integrated pest management is adaptive, aggressive and may include the following:

- Infestation occurrence and treatment documentation
    - Good record keeping
    - GIS mapping of new and existing
- Treatment plan and schedule
    - Frequency, seasonality and methods
    - Combination of treatment methods typically most effective
- Monitoring plan and schedule
    - Frequency and locations
- Adjust retreatment methods and monitoring as needed
- Repeat this cycle until control is achieved

4.1.5.3 NNIP and nuisance plant treatment methods:

- Chemical
    - Ground: broadcast or isolated treatment
        - Foliar, cut stump, hack-n-squirt, injection, basal bark, soil spot (grid)
        - Backpack and hand sprayers; ATV, farm tractor, skidder-mounted sprayers
    - Aerial: broadcast by helicopter (broadcast)
- Mechanical: broadcast or isolated
    - Hand-pull, chop, mow, mulch
- Prescribed fire (broadcast)
    - Dormant or growing season
- Additional information can be found through Miller et al 2015 and online at https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs131.pdf

4.1.5.4 NNIA treatment methods:

- Feral hogs
    - Do not transport onto property and prohibit hunting lessees from doing so
    - Property boundary fencing
    - Promote year-round aggressive hunting and trapping
        - Licensed contract trappers available

- Careful game species food plot crop selection
- Consultation and additional information through USDA Wildlife Services

4.1.5.5 Nuisance animal treatment methods:

- White-tailed deer
  - Do not transport onto property and prohibit hunting lessees from doing so
  - Modify and increase deer harvest to control population abundance and sex ratios
  - Property boundary fencing
  - Install exclusionary fencing around young plantations and/or regeneration areas
    - Licensed contract trappers available
  - Time logging activities and use uneven aged stands to provide continual availability of browse and forage options.
- Beaver
  - Do not transport onto property and prohibit hunting lessees from doing so
  - Monitor all water sources and potential impoundment locations frequently for activity
  - Promote year-round aggressive hunting and trapping
    - Licensed contract trappers available
  - Destroy any dams or impoundments in conjunction with trapping and harvesting efforts
  - Consultation and additional information through USDA APHIS Wildlife Services

4.1.5.6 Biological Control

Per the USDA Forest Service's Forest Health Technology and Enterprise Team (FHTET), a biological control is "the reduction of an organism's population density through use of its natural enemies". The FHTET recognizes biological control as being one of the most effective and cost-efficient long-term approaches for managing widespread non-native invasive species infestations. This involves utilizing natural enemies (parasites, predators, herbivores, and pathogens) to reduce the population of hosts, whose abundance influences the population levels of natural enemies (USDA-FS 2016). Biological control can be used as a component within a comprehensive Integrated Pest Management program (van Lenteren 2016). For example, some areas under this LMP have utilized rotational grazing of goats to control kudzu infestations.

In some scenarios, biological control may also be used for native vegetation management such as utilizing fenced goats as an alternative to herbicide, mechanical or prescribed fire treatments (USDA-NRCS 2015). However, the use of "prescribed grazing" in these scenarios can be less selective from a species standpoint, impacting both desirable and undesirable species (USDA-NRCS 2015). Despite good intentions and rigorous governmental regulatory environmental risk assessments along with standards and guidelines for the import, export, shipment,

evaluation and release of biological controls, it is still possible for these species themselves to become ecologically problematic in forest settings (van Lenteren 2016).

4.1.6 Forest Ecological Restoration

Ecological restoration has been defined as the intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity, and sustainability (Society of Ecological Restoration 2004). These activities are performed on ecosystems that have been degraded, damaged, transformed, or destroyed as the result of direct or indirect anthropogenic activities (Society of Ecological Restoration 2004). The enhancement and restoration of native ecosystems is often a complex and iterative process that requires adaptation and engagement. Integrated natural resource management planning, including forest management, is essential for the successful attainment of ecosystem restoration and biodiversity objectives in many Virginia ecosystems.

The longleaf pine and wiregrass community is a good restoration example. Many landowners in the Southeastern Plains and Middle Atlantic Coastal Plain ecoregions within southeastern Virginia own land with deep, well-drained sandy soils that were historically populated by native longleaf pine communities. Since longleaf pine also can meet aesthetic, recreation, and economic return objectives, many landowners are interested in its restoration. The Longleaf Alliance is working across the natural range of longleaf pine to restore the longleaf pine ecosystem. In Virginia, there is one Longleaf Implementation Team that provides leadership at the local level for this effort, The Virginia Longleaf Pine Cooperators Group. Through a combination of active forest management activities, overstory and understory conditions can be restored to natural historic levels. Through frequent and consistent application of these activities, especially prescribed fire, endemic (and often imperiled) fauna species can begin to repopulate the site. Certain species can even be translocated to recolonize a site. For example, red-cockaded woodpeckers (*Picoides borealis*) can be relocated through various federal and state programs and partnerships, through the help of natural resource professionals. Restoration tools are further discussed within silvicultural options sections within all the Common Virginia Forest Types.

The different pine species are major components in a variety of natural communities. Longleaf pine was the dominant overstory component in forests frequently fire-maintained including both wet flatwoods and sandy uplands, and shortleaf pine was once the co-dominant overstory component of the Piedmont. These pines can be replanted as a step in restoring their respective natural communities.

Restoration among hardwoods can be accomplished in a variety of ways. Natural regeneration and hydrological restoration can be conducted to assist in ecological restoration of all the upland forest types. Additionally, small-scale artificial restoration can be implemented in the restoration of mixed floodplain, tupelo-cypress mixed, and cottonwood, sycamore, and birch forest types. Large-scale artificial regeneration of these forest types is usually unnecessary and economically unviable for most Virginia landowners.

4.2 Landowner Objectives

The following common landowner objectives considered under this LMP were derived from the stakeholder group comprised of various forest resource professionals and governmental agencies within Virginia and the Virginia Forest Stewardship Program. A general description of each potential landowner objective is discussed relative to its application towards forest management. Each landowner objective is also discussed relative to its application within each forest type in the Common Virginia Forest Types Section.

4.2.1 Aesthetics

Landowners seek a certain “look and feel” from the visual appearance of their forests. Forest aesthetics spark a sense of personal landowner pride, stewardship, privacy, and even adventure. Many landowners maintain and enhance their forest aesthetics for their family, community, neighbors and passers-by to enjoy. Forest

management activities consistent with the size of the forest, the scale and intensity of forest management activities, and the location of the property tend to increase the aesthetic value. Forest resource professionals can assist landowners with implementing and managing silvicultural options in a manner that increases aesthetic value of the property.

Over the course of time, a wide range of aesthetic objectives can be accomplished with the suite of silvicultural tools within this LMP. Even though many silvicultural tools may produce immediate and temporary results that with a decreased aesthetic value, the consistent application and/or long-term results of these operations produce enhanced overall aesthetic value of the forest. For example, the short-term visual conditions produced following a prescribed fire may have minimal aesthetic value, however the resultant functional and aesthetic changes in species composition and midstory and/or nuisance species control becomes evident in just weeks following the burn. Furthermore, the aesthetic condition of consistently burned forestlands increases rapidly with each subsequent prescribed fire event. Likewise, the long-term aesthetic value gained from performing timber thinning operations far outweighs the short-term optics following harvesting operations. Landowners are rewarded with a sense of pride when their hard work and investment in management activities results in aesthetic accomplishments.

4.2.1.1 Pine Forest Aesthetics

Well-managed pine forests often meet some landowners' objective for aesthetics. Mature stands that have been prescribed burned and/or thinned have an open, park-like structure with large, well-formed pines and little to no midstory. Stands with native groundcover typically have lush green grasses, herbs and shrubs in the spring following prescribed fire and a sea of wildflowers in the fall. Some loblolly, shortleaf, or Virginia pine stands are so open you can see through these rolling forests for a mile or more. Young stands with quality groundcover managed with the LMP's appropriate silvicultural tools have the potential for the same stand structure and aesthetics with time.

Silvicultural tools can be used to maintain and enhance aesthetics. Forest operations can be planned with aesthetics in mind to ensure these objectives are met. For example, when clearcutting a pine stand, a strip of pines can be left as a buffer against adjacent high visibility areas such as roadways or neighboring homes. Or during thinning operations, logging decks can be placed within the stand interior, away from roadways. These forested strips can be managed as an even-aged forest on a cutting cycle that ensures the adjacent stand they are buffering is forested before they are clear-cut, or they can be managed as an uneven-aged forest and passively managed on the same cutting cycle as the even-aged stand they are buffering.

4.2.1.2 Hardwood Forest Aesthetics

Hardwood forests have high-quality, varying aesthetics across the different forest types that compose this category. The overstory diversity of hardwood forests provides character and variety compared to the pine-dominated forests. Most upland hardwood and mixed floodplain forest types provide opportunities in Virginia for fall foliage colors. While upland slope forests provide relatively steep topography and vegetation that are indicative of the Piedmont and Blue Ridge region of the United States, the aesthetic qualities of mixed floodplains mainly exist in the rivers, creeks, and streams that punctuate mixed floodplain forest types' overstory diversity and uneven-aged structure.

Elam/ash/cottonwood forest types have their own high-quality aesthetics, as their presence along many bottomland habitats injects wonderful colors into an already beautiful Virginia fall. The many varied hardwood species that cover the mountainous portions of the state also show their brilliance in the Fall months.

With the varying species present and the habitats which they occupy, hardwood forests in Virginia are largely natural, uneven-aged forests that possess large amounts of visual character. These aesthetic characteristics often provide landowners incentives to exclude silvicultural management in these forests, especially those presently in a desired future condition. Thus, upland hardwood forests are often solely preserved for their regional unique character and beauty. Upland forests may also be more aesthetically-pleasing through the removal of cull trees and low-quality stems.

Silvicultural tools can be used to maintain and enhance aesthetics. Forest operations should be planned with aesthetics in mind to ensure these objectives are met. For example, when clearcutting hardwood stands, a strip of hardwoods can be left as a buffer against adjacent high visibility areas such as roadways or neighboring homes. These forested strips can be managed as an even-aged forest on a cutting cycle that ensures the adjacent stand they are buffering is forested before they are clear-cut, or they can be managed as an uneven-aged forest and passively managed on the same cutting cycle as the even-aged stand they are buffering.

4.2.2 Wildlife Management and Protection

Virginia is rich in both game and non-game wildlife species. Many landowners are interested in managing, conserving and protecting these species and their habitat. Simply conserving forestland is a form of wildlife habitat protection. Some landowners wish to take a more active wildlife management role by maintaining, enhancing and restoring wildlife habitat and its components: food, cover, water and space.

Private lands in the state of Virginia provide valuable habitat to imperiled species such as red-cockaded woodpecker, gray bats, and bog turtles. Many silvicultural tools are available to maintain, enhance and restore habitat for game and non-game species including prescribed fire, timber harvests, groundcover restoration, food plots and wildlife openings.

The VA BMPs for Water Quality manual compiles strategies and considerations for managing and protecting these species and their habitat during silvicultural operations. The natural resource professional and landowner can try in the field to locate and protect any imperiled species and their habitat prior to some silvicultural activities. Although not an exhaustive list, if imperiled species and/or their habitats are located, the following protection measures can be used:

- Limited mechanical entry
- Increased management activity (prescribed fire, thinning, etc.)
- Restricted pesticide use
- Residual tree maintenance
- Buffer zone establishment and maintenance
- Hunting or fishing limitations
- Signage or marking of the habitat area
- Communicate sensitive habitat/species locations in contracts; discuss with contractors

Virginia has some of the best hunting opportunities in the Southeast in terms of acreage and game quality and quantity. Hunting and revenue from hunting leases are particularly popular landowner management objectives. White-tailed deer, wild turkey, bobwhite quail, and duck are commonly hunted and managed. Wildlife conservation practices may include managing healthy game species populations through hunting programs such

as Quality Deer Management and hunt leases. Landowners often lease their land to hunting clubs or individuals as a form of revenue. This revenue can be used to improve and protect habitat.

4.2.2.1 Pine Forest Wildlife Habitat Management and Protection

The pine forest types and their associated natural communities provide excellent wildlife habitat management and protection opportunities. Many game and imperiled species can be found within pine forests. Game species are more commonly actively managed on private lands while non-game species are managed to a lesser extent.

Hunting is a common wildlife management objective in the pine forest types, particularly for wild turkey, bob-white quail, and white-tailed deer. The first two species benefit from a frequently fire-maintained open, grassy groundcover, with low shrubs and little to no midstory; white-tailed deer prefer a bit more midstory and shrub coverage. They also prefer a relatively lower overstory density, which helps provide more sunlight to the desired groundcover. Hunting leases are used to manage healthy game populations while also generating revenue to help pay for pine management activities such as prescribed fire.

Pine habitat objectives can be met with various silvicultural options. For example, thinning planted pine stands to a lower overstory density more favorable to wildlife or creating small clearcuts for wildlife openings to diversify habitat and create edge both ensure adequate wildlife habitat. Many game and non-game species of pine forests will benefit from these activities including white-tailed deer, wild turkey, bobwhite quail, fox squirrel, and red-cockaded woodpecker.

4.2.2.2 Hardwood Forest Wildlife Habitat Management and Protection

The hardwood forest types and their associated natural communities provide excellent wildlife habitat management and protection opportunities. Many game and imperiled species utilize hardwood forest types for mast, browse, or cover throughout the year. Game species are actively managed on private lands while non-game species are managed to a lesser extent.

Hunting is a common wildlife management objective in the hardwood forest types, particularly for white-tailed deer, wild turkey, feral hogs, and gray squirrel. Hunting leases are used to manage healthy game populations while also generating revenue to help pay for management activities such as NNIS.

Hardwood habitat objectives can be met with various silvicultural options. For example, creating small group selection clearcuts for wildlife openings to diversify habitat and create edge. Many game and non-game species will benefit from these activities including white-tailed deer, wild turkey, and within more hydric environments, waterfowl and wading birds such as the great blue heron.

A more hands-off preservation approach can be used to protect non-game species in healthy, fully functioning hardwood forests. However, active management with NNIS monitoring and treatment at minimum is required to maintain this forest type and its habitat components. Additional information concerning hardwood management for certain species can be found through the following links: turkey, deer, and others.

4.2.3 Recreation

Many landowners enjoy a variety of active and passive outdoor recreation. From simply hiking their woods and wildlife viewing to hunting and off highway vehicles. Those that live onsite may recreate on their forests daily, others may live across the state or country and only visit during hunting season. A study of Virginia by the Outdoor Industry Association found that 57% of Virginia residents participate in outdoor recreation each year

(Outdoor Industry Association 2020). It was determined that the total consumer spending on Virginia recreation activities is estimated at $21.9 billion annually.

Pine forests and hardwood forests alike are popular recreational areas in Virginia, especially in the cooler, dryer months. The open, park-like stand structure of pine forests provides a scenic backdrop for a variety of recreational activities. Hardwood forests also provide similar activities, especially when the biting insects subside in cooler months. Below is a table that provides examples of these various forest-related recreational activities.

- Hunting and leases
- Bicycling
- Equestrian
- Camping
- Environmental education
- Geocaching
- Off-highway vehicles (OHV) and leases
- Wildlife viewing and birding
- Hiking
- Various Water sport activities

4.2.4 Conservation

For this LMP, conservation is defined as the process of maintaining a natural resource (e.g. forested ecosystem) for perpetual use. This definition inherently associates conservation with the proper use of ecological processes to maintain the forested ecosystem. The term conservation is generally credited to Gifford Pinchot, who served as President Teddy Roosevelt's head of the US Forest Service in the early 20th century (Trefethen 1975).

Some landowners have a conservation objective because they would like to see their forest ownership remain intact and capable of being passed down from generation to generation. Landowners with a conservation objective may also utilize other consumptive use objectives like revenue generation or hunting and fishing recreation.

Conservation is founded upon the desire to ensure future use of a natural resource. Many landowners utilize silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests.

All forest types can be managed in a conservation-oriented manner. This can be accomplished using multiple-use management by balancing utilization and protection of timber, wildlife, rare plants, recreation and hydrology. Pine forests are fire dependent and require frequent application of prescribed fire at minimum for ecological maintenance; hardwood forest types do not require these fire-related management techniques, although some may benefit from these management techniques.

4.2.5 Legacy Planning

Some landowners have a legacy planning objective. Legacy planning allows landowners to determine the destiny of their woodlands. It is the ongoing process of sharing with their heirs all that they treasure about their land and, ideally, including them in the management and planning for future generations. Legacy planning, along with traditional estate planning, can help ensure woodlands are passed on intact, in forest, and remain in the family.

Legacy planning may incorporate a variety of financial, legal, and conservation tools, with the fundamental document being a written forest management plan.

Protection of the forest from conversion to development, fragmentation, and/or degradation from alternate uses (e.g. mining) is a benefit of the legacy planning objective, and it is also a benefit of the conservation objective.

For more information on Legacy Planning, please see the Virginia Cooperative Extension Publication *Legacy Planning: A Guide for Virginia Landowners*.

4.2.5.1 Ownership

4.2.5.1.1 Filing Types

The different ownership forms in which forest property is held is important from a tax standpoint. Additionally, if the forest property is counted as a business, the type of business chosen can also affect the tax structure of the property. Nontax factors can also influence the business type chosen, such as forest management goals, the property's size, consideration of the owner's family, and the potential income needed from the property. The final decision of which ownership form a property should take is dependent on an analysis of these and other factors. Some characteristics of selected ownership types are discussed below, while an overview of the different types available can be found through the Forest Landowners Guide to the Federal Income Tax's Form of Forest Land Ownership and Business Organizations.

4.2.5.1.1.1 Basic Ownership Types

4.2.5.1.1.1.1 Sole Ownership

Sole ownership is the most basic form of timber property ownership and is composed of one owner controlling every aspect of the property management. This provides the greatest amount of control over the property. A benefit of this ownership type is profit or loss from the business endeavors can be accounted separately from the owner's other income sources.

4.2.5.1.1.1.2 Co-Ownership

Co-ownership represents the undivided ownership of property by two or more persons. This form of ownership is often used as a simpler form of more complex business arrangements, and transfer of a co-ownership at death can often be completed easily and inexpensively. A potential disadvantage to this ownership type is that business transactions must have the approval of both parties, as one owner does not have autonomy and control. The most common types of co-ownership are Tenancy in Common, Joint Tenancy, and Tenancy by the Entirety.

4.2.5.1.1.2 Business Ownership Types

4.2.5.1.1.2.1 LLC

A way that forest owners can create a preserved property to pass down through generations is the creation of a corporation (including Limited Liability Company [LLC]). Having forest land under an LLC reduces tax liability from the IRS and strives to ensure that the property is less likely to be divided by heirs in the future. There are four different mechanisms to keep properties intact and in the family for future generations: a family partnership, closely-held S-corporation, qualified trust for conservation purposes,

or, as discussed here, an LLC (McEvoy 2003). LLCs offer a level of flexibility to landowners, as the LLC can be dedicated to any purpose (investment, business, conservation, or any combination of motives). LLCs can also offer the benefits similar to the three other aforementioned mechanisms for property ownership: the liability protection of a corporation, pass-through taxation aspects of a partnership, and the ability to limit ownership in the family forest provided by a closely-held S-corporation. Also, LLCs can grow as a family does, as the founders of the LLC can set either fractional family membership, having more than one membership class, or having no limitations with regard to the number of owners.

With this ability of an LLC to set membership classes to distribute responsibility within a family, it is less likely that the property will be split by heirs over time. If a property is split once, the likelihood of it being further split and developed is much greater than if the entire property remains intact under the LLC mechanism. The LLC can allow family members to share in the receipt of both tangible and intangible forest benefits, but without the strain of any one family member feeling the burden to continue the family's property legacy. In essence, the LLC treats the family not as separate entities with one member bearing the majority of the responsibility, but as a company that leaves generations to enjoy the benefits of forests with less hassles. An LLC also provides the added benefit of qualifying for different cost-share programs that require a single Employer Identification Number (EIN) for tax purposes.

Further information for creating and registering a business in Virginia for a property can be found at the Virginia Tax website.

4.2.5.1.1.2.2 Partnerships

Partnerships are most basically an association of two or more people that conduct a business for profit as co-owners. States have developed their own legality as to what constitutes a partnership, as oral partnership agreements are not considered legally binding everywhere; therefore, it is important to have all details of the agreement in writing. The contributions of the partners to the partnership do not have to be equal. Assets that enter the partnership or are purchased within the partnership become property of the partnership. Some common considerations within partnerships are unlimited liability, minors as partners, and taxation of partnerships.

4.2.5.1.1.2.3 Corporations

A corporation is a separate legal entity that has most of the rights of an individual, while being owned by its shareholders and governed by a stakeholder-elected board of directors. The most notable feature of a corporation is the limited liability falling to the shareholders, as legal actions against a corporation are covered through the corporate assets while shareholder assets are protected. Subchapter S Corporations are a form of corporation that is restricted by various limitations, including the limiting of members to 100.

4.2.5.1.2 Forest Legacy Challenges

4.2.5.1.2.1 Estate Planning

Most nonindustrial private forest land in the United States is owned by individuals, married couples, family estates and trusts, or other types of family groups (Siegel et al. 2009). Within private forest land ownership, the estate tax structure is in a constant state of flux; this presents potential danger for estates with substantial forest land holdings. If estate planning is not conducted properly, risks such as forced liquidation of family forest landholdings or the severe fragmentation or disruption of forest land are a real possibility.

As a private forest landowner approaches retirement or faces the possibility of death, certain issues regarding the future of their land must be addressed. There are multiple costs and aspects to consider if retiring or dying with an unprepared future for forest landholdings, such as transfer costs, unexpected heirs, the continuity of forest land management, and keeping forested land from becoming liquidated or parcelized. The US Forest Service developed the publication Estate Planning for Forest Landowners: What Will Become of Your Timberland? to provide guidelines for nonindustrial private forest owners concerning the application of estate planning techniques to their forest properties.

4.2.5.1.2.2 Heirs' Property

Another potential challenge when dealing with forest legacy planning is the issue of Heirs' Property. Heirs' Property is any land or associated dwellings that are owned jointly by descendants of a deceased person whose estate proceedings were not handled in Probate Court (Watts Law Firm PA, 2019). After the Civil War in Virginia, many former slaves purchased or were deeded land throughout Virginia. When these lands were passed down through descendants, the property rights for many lands were passed down orally and no written contract was devised. Due to this ambiguity of ownership and lack of written contract, the land in question may be considered heirs' property.

An often-overlooked aspect of heirs' properties is that the land in question does not just belong to the family that resides on or pays taxes on the land, but to all heirs regardless of their location. This creates a land management challenge, as some descendants may wish to sell their particular portion of the land while others may wish to keep it their entire life. Further complicating the distinction of land ownership is the issue of each new generation further skewing the family tree; if one particular branch of the family has more descendants, they own a larger portion of the property.

The ideal solution to heirs' property issues is to have all heirs gather to discuss preferences regarding the property and come to an amenable conclusion for how to handle the land. If the lineage of the original landowner is unknown, research must be conducted to determine each heir of the property and their share. Title to the property can be cleared by one party's renunciation of property ownership or the transfer of their share to another heir. If no agreement can be reached among the heirs, litigation is an option. Once a cleared title is owned by a party, there is the freedom to build a home, mortgage the property, sell timber, or conduct other activities on the land.

For additional information regarding heirs' property, visit the Center for Heirs' Property Preservation.

4.2.6 Forest Health Management

Maintaining and promoting forest health is a major landowner concern and objective. Many unengaged landowners not actively managing their forests initially contact a forest resource professional regarding forest health issues.

Various cost share programs, grants and services aid Virginia landowners in taking preventative measures to avoid devastating outbreaks and infestations. Silvicultural options such as timber harvest, prescribed burning and non-native invasive species treatments are also available to landowners to improve forest health.

Non-native invasive species such as the emerald ash borer and feral hogs can cause major ecological and economic damage to Virginia forests. Native forest pests such as southern pine beetle are always a potential threat to our forests. Several native diseases such as fusiform rust and pitch canker among others and non-native diseases such as sudden oak death also cause damage across multiple forest types. These pests and diseases as well as other known to affect species within Virginia forests will be addressed below by species type for pines and by hardwood grouping. Additional information concerning the multiple invasive pests affecting Virginia forests can be found through the VDOF Forest Health website, while information concerning the various diseases affecting Virginia forests can be found through the Tree and Forest Health Guide available from the VDOF. While the following sections provide a short background of major issues, the two referenced sources are the best resources for additional information.

4.2.6.1 Pine Forest Health Management

The most destructive insect pests to loblolly pine are southern pine beetle (SPB), Ips, and black turpentine beetle (BTB). Loblolly is the preferred host for SPB. It is usually not a major issue in younger, well-managed stands. However, damage can be severe in overstocked and senescent stands, especially if offsite or other stressors occur (i.e. drought, lightning strikes, fire stress). Once a severe outbreak occurs, it can spread to adjacent, well-managed, younger stands. Outbreaks are cyclical and range from a few spots across a stand to hundreds of acres. Also, pine sawflies are a major defoliant of loblolly pines, capable of causing the complete loss of foliage on small trees. Ips and BTB are less aggressive and cause damage on an annual basis, usually following summer drought, and their attacks rarely exceed more than $3/10^{th}$ of an acre. SPB and Ips both contain a lethal blue stain fungus that clogs the tree's water conducting tissue, making most attacks along the trunk lethal. BTB does not have the lethal blue stain fungus and pines can survive after being attacked. Additional information on treating pines following a bark beetle outbreak can be found here: https://www.treefarmsystem.org/spbwhenyouhaveanoutbreak.

Maintaining health and vigor among your pines is the most economical way of reducing loss from bark beetles. Pines exhibiting these qualities will have plenty room and resources to grow, have 33-40 percent crowns (crown length/total length), and are free of disease along their trunks. Foresters sustain these attributes in pine plantations by removing pines that do not exhibit these qualities while retaining pines that do. Suppressing understory competition can be just as effective at increasing pine health and vigor as thinning. Foresters control this competition in pine plantations through prescribed burns, herbicides, or cutting by machine or hand. All of the above ensures most of the resources are available for the pines that can most utilize them, and these same pines will then usually have enough internal water pressure/turgor to drown attacking beetles, even during times of environmental stress.

Pitch canker and fusiform rust are fungal diseases affecting pines and are most problematic when affecting the main trunk, which disrupts the uptake of water and nutrients and causes increased susceptibility to a bark beetle attack. Pitch canker is known for its heavy resin exudation and affects all pine species throughout Virginia. Fusiform rust is known for its galls that create a weak spot along the trunk, which continues to grow with the tree

over time and produces orange spores every spring. Resistance to both diseases continues to be developed in planting stock with much success

The most detrimental disease to shortleaf pine is littleleaf disease. Infection is high on poorly drained sites, on poor soils and following root damage and drought. However, due to severe erosion resulting from past farming practices in Virginia's Piedmont, these at-risk soils are now ubiquitous. Littleleaf mostly occurs in 30-50-year-old stands and seldom in stands less than 20 years old. It can result in slow growth and high mortality. Proper shortleaf pine site selection and appropriately-timed thinning or clearcutting can reduce chances of infection with littleleaf.

Tip moths, pine saw flies, and pales and pitch-eating weevils can be problematic in young stands. Tip moths damage the terminal shoots on young pine seedlings, which can result in loss of growth and deformity of the tree if severe. Pine sawflies are a major defoliant of young pine saplings, capable of causing the complete loss of foliage on small trees. Loblolly pine sawfly also attacks shortleaf pine. Pales and pitch-eating weevils usually cause issues in newly-planted stands if planted too soon after harvest. Reforestation of stands harvested after July should not be done the next planting season or, if done, should use seedlings that have been treated with insecticides.

Annosus root rot is a fungal disease associated with all pines growing in sandy soils that prevents the normal uptake of water and nutrients. Its spores will land on freshly cut stump surfaces, inoculate, and then spread to living pines through existing root grafts, making it an issue with recently thinned pines growing on sandy soils. Infected pines usually die from attacking beetles rather than solely from the disease, which makes Annosus largely overlooked. Peak tree loss seems to occur during 3-6 years post thinning and the disease subsides 8-10 years post thinning. Most tree loss occurs within pine stands first-thinned during the winter months located on sandy soils that were former Ag sites, pasture or field. Old ag sites with sandy, well-drained soils with a low water table and a hardpan missing, or deeper than 12", are considered high hazard sites, which placed this disease in the limelight during the early 2000s when CRP stands were being first-thinned. Prevention is the key with annosus root rot. If conducting a first thinning on high hazard sites, consider thinning during the summer months or treating the stumps within 24hrs of felling with a Borax compound. Minimizing stand entries by thinning heavier (60-70 BA) should also be considered. If pine loss occurs on sandy soils and 2-4 years post thinning, suspect annosus root rot. Once confirmed in a stand, it is generally recommended to wait until the disease has become inactive (8-10 years post thinning) before conducting the next thinning.

As previously mentioned, longleaf is the most resilient of Virginia pine species, as they are not typically affected as severely by Ips, SPB, or BTB. The most detrimental disease is brown spot needle blight which is only an issue during seedling stage in planted stands. It is not an issue once rapid vertical growth commences and can be mitigated by prescribed burning grass stage seedlings starting around the second year, post-establishment. Pitch canker and fusiform are not a major concern with longleaf and issues are localized, although the latter can cause excessive damage on old field sites.

Pales weevil, feral hogs, and livestock can cause damage to seedlings of various pine species, notably longleaf, loblolly, shortleaf, and Virginia. Lightning and subsequent southern pine beetle and Ips beetles causes severe damage in mature stands, where otherwise these are not a major concern. Southern pine beetle is not a major concern in younger, well managed pine stands. It can become a concern in offsite, overstocked and senescent stands, especially during drought conditions and following fire stress. The first year of establishment is most vulnerable for longleaf and other pines, particularly during droughts or the typically dry months of spring.

Loblolly and shortleaf pine cannot tolerate prescribed fire until the bark thickens and they reach about 10-15 feet tall (depending on fuel load). They are susceptible to crown and inner bark scorch, especially in younger stands. Longleaf is naturally fire-resistant at this early life stage.

Despite all of these potential insect and disease issues, with appropriate seedling and site selection and release and thinning regimes, pines generally have minimal issues following successful establishment.

If any of the above diseases or pests are suspected, VDOF should be contacted for a consultation. See non-native invasive species section.

4.2.6.2 Hardwood Forest Health Management

Shortleaf pine-hardwood mixed, upland hardwoods, yellow poplar, mesophytic hardwoods, and bottomland hardwood forests are generally not as intensively managed as pine forests and as such mortality caused by native diseases and insects are typically not a major concern. Common issues with hardwood forest types are insect defoliators, butt rot and heart rot fungi, and sudden oak death.

The most common defoliators are canker worms, gypsy moths and their caterpillars, and forest tent caterpillars. These occur in early spring, just after leaf formation, and generally just cause a loss of growth for that growing season. Mortality sometimes occurs on the weakest trees when defoliations have occurred in consecutive years. Canker worms are usually found with the Piedmont and rarely impact more than a few acres. Gypsy moths feed on leaves from a wide variety of different hardwood species, such as oak, hickory, beech, birch, and willow, and can eat up to 60-100% of a tree's leaves. Forest tent caterpillars are usually found in the bottomland hardwood forests located in the ecoregions east of the Piedmont and can defoliate thousands of acres.

Butt rot and heart rot fungi enter a hardwood tree from deep basal wounds caused by fire or logging. These diseases grow undetected for many years, eventually degrading the tree's use for lumber. During logging operations, it is imperative to minimize damage to residual hardwood trees, and if conducting a prescribed burn within an upland hardwood stand, understand the risks and try to minimize damage to trunks and root flares by not burning when it is too hot and dry. Prescribed burns are more likely to damage hardwoods when pine litter, which increases fire intensity, is adjacent to them, such as the case with loblolly or shortleaf pine-hardwood mixed stands.

Oak wilt is primarily a fungal disease of red oaks (especially water and willow oaks) growing on sandy soils located in the Southeastern Plains. Infected trees will eventually have their water conducting tissues blocked, causing their leaves to abruptly wilt soon after leaf formation in early spring. The fungal disease may start from a wound caused by an insect or equipment, but once started, it likely transmits from tree to tree via root grafts. Fungal mats located under the bark of infected tree are also inoculum sources used by insects to transmit the disease. Suspect oak wilt if young, healthy red oaks are suddenly dying. Sanitation and severing root grafts with a vibratory plow are two methods used for its control.

As Virginia's forests have a high proportion of hardwood species, diseases such as sudden oak death/Ramorum blight (*Phytophthora ramorum*) are of high concern to forest landowners. While the blight is not currently present in Virginia, it has decimated oaks throughout California nurseries and natural areas (where it originated in North America) as well as Oregon. If it migrated to Virginia, the blight could injure and kill oaks and other commercially important forest species (Virginia Invasive Species Working Group 2020). The Virginia Department of Agriculture and Consumer Services (VDACS) surveys nurseries in the state annually for the disease to prevent its intrusion into Virginia.

Major native insect and disease damage is species and site specific and should evaluated by a forester. For example, the ambrosia beetle-borne laurel wilt disease is decimating red bays in bottomland hardwoods forest types. It can only be slowed by actions such as limiting transport of firewood. This disease will likely eventually eliminate most red bay trees. The hemlock woolly adelgid (*Adelges tsugae*) is another pest known to affect hardwoods (hemlocks). Eastern hemlock is the most susceptible to these pests, which feed by sucking sap from these species.

If any of the above diseases or pests are suspected, contact the forester responsible for management of the property and then contact the VDOF for a consultation.

4.2.7 Economic Return

Sources of forest-based revenue in Virginia are diverse and can be derived from each forest type. Some landowners choose to balance revenue with other objectives while for others it is their primary objective and livelihood.

4.2.7.1 Timber Management

Landowners have strong, diverse timber markets in Virginia, allowing them to manage on short or long rotations for pine and hardwood products. This flexibility and economic potential in timber markets allows for restoration, revenue and investment.

Economy of scale plays a large role in timber management, and landowners must always take that in consideration when managing their forest lands. Factors affecting economies of scale are stand acreage; forest product type, size, and quality; and distance from a related forest product mill. Loggers incur costs whenever they move their equipment from one tract to the other, which makes larger tracts/stands with high value forest products closer to the mill more attractive. As a result, landowners should consider having forested stands no less than 20 acres in size, and landowners with smaller stands may need to do timber management in conjunction with another stand or with an adjacent landowner.

The above scenario becomes apparent in the upper Piedmont, where parcel sizes are generally smaller and farther away from most pulpwood mills. Landowners in this region are encouraged to plant above-average, genetically available pines on a farther spacing (9’ X 10’) than conventional (7-8’ X 10’) and conduct the first-thinning at a later date, which increases the availability of higher value product classes and the likelihood of the stand being thinned.

On the contrary, landowners located in the lower Piedmont and east of the Piedmont should consider taking advantage of available pulpwood markets and plant pines on a conventional spacing and thin as soon as they can. This is especially true for pulpwood-sized stands located on well-drained soils in the upper Southeastern Plains. During wet winters, these stands usually demand the highest pulpwood prices and are known as “all-weather-tracts.”

Timber sales can either be done as a per unit basis or as a lump sum sale. Most thinnings are sold as a per unit (ton) basis, where the contract states a price per ton for each product removed. Lump sum sales usually involve final harvests or stands where the take trees have been marked.

There are many tools available to help with timber management including thinning, clearcutting and natural and artificial regeneration. Landowners can utilize uneven-aged management with longleaf pine and hardwoods and even-aged management with other pine species and cypress. With its ease of implementation, most forest types

are managed as even-aged, with uneven-aged management usually limited to aesthetically-sensitive areas or areas facing other constraints such as threatened and endangered species.

4.2.7.2 Non-Timber Forest Products

Forestland owners have many revenue sources aside from timber products. Virginia's forests provide various non-timber forest products (NTFP). These are wide-ranging and include pine straw, honey, silvopasture, Christmas trees, holiday garlands, ginseng, and various type of mushroom sales. These markets can provide landowners with revenue between timber harvests or may be the main source of revenue generation from their forests (Chamberlain and Predny 2003).

4.2.7.3 Non-Forest Associated Land Uses

Some revenue-generating options should be considered with caution due to disadvantages associated with them. For example, the following land uses may prevent or cause loss of ATFS certification.

1. Eco-tourism through opening private land to public access for a fee.
    a. Canoe, kayak and boat rentals and tours along the many scenic waterways adjacent to Virginia's forests.
    b. Hunting leases
2. Mining for aggregate materials
    a. Sand, clay, stone, and gravel
        i. Need local permitting
        ii. Will alter local hydrology and cause ecological impacts
3. Mineral and gas leases
4. Oil, gas, and electric Right-of-Way and easement leases
    a. Can be positive or negative, depending on how the land is maintained
5. Timberland real estate
    a. May involve land development or forestry/agriculture
    b. Can conflict with ATFS and FSP Standards

4.2.7.4 Timber Tax

No matter the reason for deriving revenue from one's forest, one issue that must be faced by all landowners regarding economic return is timber taxes. The timber tax code is extensive and can be confusing for landowners whose goal is to simply manage property for periodic financial gain. These taxes are dependent on a variety of factors and situations, with some of the more frequently encountered described briefly below (Wang 2018). Additional information concerning how to interpret income tax laws can be found in the publication from the Agriculture Handbook 718, Forest Landowner's Guide to the Federal Income Tax (Haney et al. 2001).

4.2.7.4.1 Timber Property Types

In calculating timber taxes, it is first necessary to determine the type of property in question, as this governs how taxes are determined. Properties may be classified as personal-use (lands used for personal enjoyment instead of profit), investment property (lands used mainly for the generation of profit from growing timber or appreciating assets), or business property (lands that experience regular, active, and continuous timber activities to make a profit). These varying property types are impacted differently by taxes; for example, if the land is personal use and not engaged for profit, losses to trees are not tax deductible.

4.2.7.4.2 Deductions of Timber Expenses and Taxes

Timber expense and tax deductions are calculated differently depending on the property type in question. For timber on a business property, if one is materially participating in the business, expenses such as forester/accountant/attorney fees, precommercial thinning, firebreak maintenance, vegetation/competition control, insect/disease/fire control, or depreciation from equipment used are all fully deductible through Form 1040. If the property is an investment, however, starting in the 2018-2025 cycle timber expenses are no longer deductible on an annual basis and can be applied as "Carrying Charges" to the timber basis and deducted upon timber sales. State and local property taxes on these investment properties are still deductible on an annual basis using a Schedule A, or can be applied as carrying charges as well. Also, Virginia has an agricultural use tax exemption for farmers, foresters, or other agricultural land users.

4.2.7.4.3 Timber Basis and Depletion Deduction

Timber basis is the amount one paid for the timber when purchasing the property. If the property was inherited, the timber basis is the timber's fair market value on the previous owner's date of death. This original timber basis from the two above scenarios can change as capital improvements are made to the land or as depletion, amortization, or depreciation are deducted from the timber basis (Megalos et al 2016). Certain timber management and operation expenses may be capitalized as "Carrying Charges" to the timber basis and recovered upon timber sales. Depletion deductions are deductions against the timber basis upon timber sale. These deductions reflect the removal of timber from the property and provide a way to calculate the timber basis that remains on the property. Another type of depletion could be the loss of timber to a casualty event such as hurricane, fire, earthquake, tornado, etc. This type of depletion is also tax deductible and is the lesser of the following two calculations: 1) difference of the fair market value (FMV) of the timber immediately before and after the casualty, or 2) difference of the adjusted basis (less any insurance proceeds or salvage value) before and after the casualty.

4.2.7.4.4 Reforestation Costs

Reforestation costs may be tax deductible as well. Landowners can deduct up to $10,000 per year for land designated as qualified timber property (QTP). If it costs more than $10,000 per year for reforestation, the cost may be deducted over the span of 84 months (amortized). Trusts, however, are only eligible to use the amortization method. The amount deducted cannot also be expensed as a timber basis or vice versa.

4.2.7.4.5 Cost-Share Payments

Cost-share programs are of great value to many landowners, and some applications of cost-share can be excluded from your income. Part or all of a qualified cost-share payment received can be excluded from income if it was used for capital expenditure (purchases of land, timber, or equipment, expenditures for bridge or road construction, or expenses for tree planting or seeding; Jones and Jacobson 2000). Qualified federal programs that accept income inclusion are the Forest Health Protection Program, Conservation Reserve Program, Conservation Stewardship Program, and Environmental Quality Incentives Program.

4.2.7.5 Long-Term Investment

Another way to generate economic return from timberland is to use the land as a long-term investment. In the past, the economic return of treating timberland as an investment has compared favorably with stocks while providing more financial stability (King 2019). The U.S. timber investment performance is monitored by the National Council of Real Estate Investment Fiduciaries (NCREIF) Timberland Index. Returns through timber investment as monitored by this index have shown that, over the previous 20 years, timberland-generated profits are nearly equal to those gained by equity investments through the S&P 500 while encountering less than half of the volatility.

There are a few main reasons that a landowner may choose to use their timberland as an investment. First, timberland value tends to rise with inflation, thereby hedging the risk of devaluation by inflation and keeping timber prices stable relative to the index. Secondly, trees continue to grow in volume over time, as well as value, completely independent of the current economic state. Therefore, if the timber market is currently in an unfavorable state, the trees can remain in the ground to retain their value until the prices become more favorable. However, postponing the first thinning of a young pine stand can have negative effects on the stand's long-term growth and IRR. A third more intrinsic value of timberland as an investment is that the land can be enjoyed recreationally while waiting to make a profit. This "bonus" can even be as valuable to landowners as the profit they will eventually make from the timberland investment.

Regardless of the reasons for using timberland as a long-term investment, the property must be managed properly in order to produce the most and best-quality timber possible. A forester can assist in the management of timberland through a multitude of forest and silvicultural management techniques, as discussed in Section 8.

5.0 Common Virginia Forest Types

This section will discuss the common forest types and general stand conditions natural resource professionals may encounter while working with landowners in the state of Virginia. Since this LMP is forestry specific, forest type is defined here as a classification of forests by dominant overstory species or group of species (e.g. loblolly pine or mixed hardwoods). Forest type is not to be confused with the term natural community because each forest type may contain multiple natural communities. Likewise, a given natural community may be dominated by a variety of forest type species.

An example would be the mesic pine flatwoods natural community which could be dominated by longleaf pine or loblolly pine. Therefore, the mesic pine flatwoods natural community could occur in both the longleaf pine and loblolly pine forest types. Referring to The Natural Communities of Virginia distributed by the Virginia Department of Conservation and Recreation (VDCR) may be useful in helping meet landowner objectives. Detailed natural community descriptions, species lists, and other information on all the natural communities of Virginia can be found in the document as well. Virginia's natural communities associated with the LMP's Common Virginia Forest Types are discussed within each respective forest type section. Refer to Table 4 for a listing of the common, dominant overstory species by associated LMP forest type. For this table, the respective species composition for the different forest types was found within both the VDCR's Natural Communities of Virginia as well as the USDA's Virginia's Forests (2016), as each of these provided valuable information of each forest type's composite species. Multiple Communities of Virginia comprise each LMP Forest Type (i.e. the Bottomland Hardwoods Forest Type contains bald cypress-tupelo swamps, Coastal Plain/Piedmont bottomland forests, floodplain ponds and pools, Piedmont/mountain floodplain forests and swamps, Piedmont/mountain small-stream alluvial forests, and riverside prairies Community Types of Virginia).

In this section, the landscape objectives for each forest type will be discussed as well. Since some objectives are not applicable across all forest types within Virginia, they will be further discussed below the forest type they involve.

Table 4. Common tree species by LMP Forest Type.

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Pine/hardwood mixed	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland hardwoods
Florida maple	*Acer floridanum*						X	
Box elder	*Acer negundo*							X
Black maple	*Acer nigrum*						X	
Striped maple	*Acer pennsylvanicum*				X			
Red maple	*Acer rubrum*	X			X			X
Sugar maple	*Acer saccharum*				X		X	
Mountain maple	*Acer spicatum*				X			
Yellow buckeye	*Aesculus flava*				X		X	
Dwarf buckeye	*Aesculus sylvatica*						X	
Paw paw	*Asimina triloba*				X	X	X	
Yellow birch	*Betula alleghaniensis*				X		X	X
Sweet birch	*Betula lenta*						X	X
River birch	*Betula nigra*							X
American hornbeam	*Carpinus caroliniana*							X
Water hickory	*Carya aquatica*							X

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Pine/hardwood mixed	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland hardwoods
Bitternut hickory	*Carya cordiformis*				X	X	X	X
Pignut hickory	*Carya glabra*				X			
Red hickory	*Carya ovalis*				X			
Shagbark hickory	*Carya ovata*				X			X
Sand hickory	*Carya pallida*	X						
Mockernut hickory	*Carya tomentosa*			X	X			X
Hackberry	*Celtis occidentalis*							X
Atlantic white cedar	*Chamaecyparis thyoides*							X
Flowering dogwood	*Cornus florida*		X					
American beech	*Fagus grandifolia*				X		X	X
Carolina buckthorn	*Frangula caroliniana*				X			
White ash	*Fraxinus americana*			X	X	X	X	X
Carolina ash	*Fraxinus caroliniana*							X
Green ash	*Fraxinus pennsylvanica*							X
Possumhaw	*Ilex decidua*							X
Mountain holly	*Ilex montana*				X			
American holly	*Ilex opaca*				X		X	X

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Pine/hardwood mixed	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland hardwoods
Eastern black walnut	*Juglans nigra*							X
Eastern red cedar	*Juniperus virginiana*			X	X			
Mountain laurel	*Kalmia latifolia*			X	X		X	
Sweetgum	*Liquidambar styraciflua*	X						X
Tulip tree/Yellow poplar	*Liriodendron tulipifera*			X	X	X	X	X
Cucumber tree	*Magnolia acuminata*				X			
Fraser magnolia	*Magnolia fraseri*				X			
Umbrella magnolia	*Magnolia tripetala*						X	
Sweet bay	*Magnolia virginiana*							X
Wax myrtle	*Morella cerifera*	X						
Water tupelo	*Nyssa aquatica*							X
Swamp tupelo	*Nyssa biflora*							X
American hop hornbeam	*Ostrya virginiana*				X			
Sourwood	*Oxydendrum arboreum*				X			
Swamp bay	*Persea palustris*	X						X
Shortleaf pine	*Pinus echinata*			X				
Longleaf pine	*Pinus palustris*		X					

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Pine/hardwood mixed	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland hardwoods
Table mountain pine	*Pinus pungens*			X				
Pitch pine	*Pinus rigida*			X				
Eastern white pine	*Pinus strobus*			X	X		X	X
Loblolly pine	*Pinus taeda*	X	X		X			X
Virginia pine	*Pinus virginiana*			X	X			
American Sycamore	*Plantanus occidentalis*							X
Black cherry	*Prunus serotina*	X		X	X			
White oak	*Quercus alba*			X	X		X	X
Swamp white oak	*Quercus bicolor*							X
Southern red oak	*Quercus falcata*	X			X			X
Bear oak	*Quercus ilicifolia*			X				
Turkey oak	*Quercus laevis*		X					
Laurel oak	*Quercus laurifolia*							X
Overcup oak	*Quercus lyrata*							X

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Pine/hardwood mixed	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland hardwoods
Sand post oak	*Quercus margarettae*	X						
Blackjack oak	*Quercus marilandica*		X					
Swamp chestnut oak	*Quercus michauxii*						X	X
Chestnut oak	*Quercus montana*			X	X		X	
Chinkapin oak	*Quercus muehlenbergii*				X		X	
Water oak	*Quercus nigra*	X	X					
Cherrybark oak	*Quercus pagoda*							X
Pin oak	*Quercus palustris*							X
Willow oak	*Quercus phellos*							X
Northern red oak	*Quercus rubra*				X	X	X	X
Shumard oak	*Quercus shumardii*				X		X	X
Post oak	*Quercus stellata*		X	X	X			
Black oak	*Quercus velutina*			X	X			
Live oak	*Quercus virginiana*	X						

Common Name	Scientific Name	Loblolly pine dominant	Longleaf pine dominant	Pine/hardwood mixed	Upland hardwoods	Yellow Poplar	Mesophytic Hardwoods	Bottomland hardwoods
American mountain ash	*Sorbus americana*				X			
American bladdernut	*Staphylea trifolia*				X		X	
Horse-sugar	*Symplocos tinctoria*	X					X	
American basswood	*Tilia Americana*				X		X	
Cypress	*Taxodium sp.*							X
Northern white cedar	*Thuja occidentalis*				X			
Eastern hemlock	*Tsuga canadensis*						X	
Winged elm	*Ulmus alata*				X			
American elm	*Ulmus americana*							X

5.1 Loblolly Pine Dominant

Loblolly pine is a highly valuable commercial species in Virginia. It is often planted in dense, productive plantations with genetically-improved seedling stock. It is often even-aged-managed on revenue-maximizing short rotations. It can also be managed on an uneven-aged basis, although to a lesser degree than longleaf. It is generally managed on shorter rotations for pulpwood, oriented strand board and chip-n-saw. However, it can be managed on longer rotations for high-value products such as sawtimber, poles and ply logs. Refer to Table 4 for a listing of the common species comprising the loblolly pine dominant forest type.

Loblolly pine is second in the state behind longleaf pine in terms of disease, insect and fire resistance, and is not very drought tolerant. Loblolly pine is not only economically valuable but is a key ecological component in upland pine and several wetland natural communities. Revenue and conservation objectives can be balanced or achieved individually through loblolly pine management.

Loblolly pine grows in several types of wetlands and their ecotones, but thrives in productive clay uplands. It shares upland pine sites in variably mixed stands with longleaf and shortleaf pines, southern red oak (*Quercus falcata*), various other oak species, and sand hickory (*Carya pallida*) among other hardwoods, and its range includes the Piedmont, SP, and MACP ecoregions. Loblolly is found sparsely on mesic and wet flatwoods sites, particularly adjacent to wetlands. It is considered offsite on excessively well-drained sandy soils but can be found

marginally on these sites. Loblolly can also be found in savannas on these drier upland sites. Loblolly pine savannas contain a diverse assemblage of plants, along with certain rare wildlife species.

5.2 Longleaf Pine Dominant

Longleaf pine is a popular forest type due to its high regional ecological, social, cultural, and biological values. Longleaf pine is the most disease, insect and fire resistant of all the southern pine species and is very drought tolerant (Burns and Honkala 1990). Virginia longleaf pine historically grew in upland pine and upland mixed woodland natural communities ranging from the coast to inland as far as 200 miles, covering the Piedmont, SP, and MACP ecoregions. Longleaf pine is a long-lived species with relatively slower growth characteristics compared to loblolly pines, particularly for the first one to five years. Once it reaches the "rocket stage" (rapid vertical growth), growth rates are comparable to other pine species. This relatively slower growth rate and other physiological characteristics produce high quality sawtimber and pole products. It is often managed on longer rotations for these high-value products compared to shortleaf and loblolly pines. Refer to Table 4 for a listing of the common species comprising the longleaf pine dominant forest type.

Longleaf favors moderately to well drained, deep, sandy, acidic, nutrient poor soils but also thrives on rich, moderately well drained clay hills (Burns and Honkala 1990). It grows in nearly pure stands on sand hills aside scattered mixed scrub oak species and some marginal shortleaf or loblolly pine. Longleaf can also be found in savannas on these drier upland sites. Longleaf pine savannas contain some of the world's most diverse assemblages of plants, along with certain rare wildlife species. Currently, efforts are being made at The Nature Conservancy's Piney Grove Preserve to reestablish the red-cockaded woodpecker throughout pine habitats in Virginia, particularly in conjunction with longleaf restoration efforts.

In mesic and wet flatwoods, longleaf can be found in variably mixed stands, with little to no hardwood midstory in managed stands. On upland pine and upland mixed woodland sites longleaf grows alongside shortleaf pine, loblolly pine, southern red oak (*Quercus falcata*) and hickory (*Carya* spp.) among other hardwoods. Scattered natural longleaf can be found growing in wetlands and more so in their ecotones. However, longleaf is difficult to artificially establish on wetter sites, especially if regular fire disturbances have been absent for twenty years or more.

In Virginia, longleaf was pushed to the brink of extinction by 1893, as nearly 1 million acres were harvested and never replanted from Virginia; even as recently as 2014, only fewer than 200 mature trees could be found within the state (Creighton et al. 2014). There are many current economic and ecological incentives for landowners to manage for longleaf pine and restore it within the edge of its historic range. Landowners may become a valuable part of the landscape level restoration of longleaf pine**.** Longleaf is an ecologically and commercially valuable species that allows for single-use or multiple-use management.

The longleaf pine ecosystem has one of the richest species diversities of any ecosystem in the world outside of tropical rainforests (Noss 1989; Peet and Allard 1993; Jose et al 1990). Wiregrass (*Aristida stricta*) commonly dominates the diverse, pyrogenic understory of longleaf forests located along the east coast, with multiple other different varied grass and forb species present. Many endemic wildlife species of longleaf pine forests prefer its open stand structure, including fox squirrel and wild turkey. Frequent, low intensity prescribed fire is essential for maintaining and restoring this ecosystem and its diversity.

Longleaf is usually managed as an even-aged forest. However, with its open crown, sporadic seeding, and early fire resistance, longleaf is well suited for uneven-aged management, providing landowners the option of managing

for a steady, long-term income stream through single-tree selection or group selection harvests. This allows for a mix of products per harvest and meeting a mix of objectives, such as aesthetics.

For more information on the history and restoration efforts of longleaf pine forests, refer to the Longleaf Pine Restoration section.

5.3 Shortleaf Pine/Hardwood Mixed

Shortleaf pine is an important lumber species in Virginia. Shortleaf pine is most productive and common on the dry hills of the Piedmont region of the state, but is currently found within every county and ecoregion of the state (Gagnon and Johnson 2009). It is offsite on deep, excessively-drained sandy soils, or poorly-drained clay soils resulting from erosion. Refer to Table 4 for a listing of the common species comprising the shortleaf pine/hardwood mixed forest type.

Shortleaf pine commonly grows on moderately to well-drained clay soils like loblolly pine. It shares upland pine sites with longleaf, Virginia, and loblolly pines and multiple mixed hardwoods such as southern red oak, hence its grouping with these hardwood species as a forest type. The associated natural community according to The Natural Communities of Virginia is the mountain/Piedmont acidic woodlands. This section will focus on shortleaf pine on upland pine sites. It grows alongside longleaf, Virginia pine, oaks, and hickories on upland mixed woodland sites. Within dry upland hardwood forests, shortleaf can be found scattered with loblolly pine and dominant mixed hardwoods.

Shortleaf mostly occurs scattered in natural, uneven-aged, mixed hardwood-pine stands, although it can also be found occasionally in pure, even-aged stands (Gagnon and Johnson 2009). In recent years, the idea of maintaining and managing combined shortleaf and hardwood stands has gained popularity. On appropriate soils shortleaf can be planted and managed, but loblolly is generally more productive on these sites. It is generally found growing in natural stands that produce pulpwood and oriented strand board products. On the limited, better Virginia managed shortleaf sites, it can produce chip-n-saw, sawtimber and ply logs.

Due to erosion from past farming practices in the Piedmont, a significant portion of suitable sites for shortleaf have decreased while the incidence of littleleaf disease has increased. Shortleaf suffering from littleleaf disease are more susceptible to southern pine beetles (SPB), making pine stands within the Piedmont containing shortleaf more at risk to SPB. Trees should not be planted in areas where mature trees exhibit littleleaf symptoms, and those found to be suffering should be removed immediately; also, legumes could be interplanted with the pines to help increase soil nitrogen and combat the disease. Littleleaf disease, SPB, and loblolly's better growth and resistance to littleleaf are some of the main reasons most natural shortleaf and shortleaf/hardwood mixed stands in the Piedmont have been converted to loblolly. This decline in shortleaf has occurred across the Southeast and has spurred the Shortleaf Pine Initiative, a restoration effort of shortleaf pine forests across its natural range.

Other than littleleaf disease, shortleaf pine exhibits relatively good disease and insect resistance. Shortleaf seedlings and saplings readily sprout from the base following excessive fire damage, making its fire resistance more in line with longleaf than loblolly. Revenue and conservation objectives can be balanced or achieved individually through shortleaf management.

Shortleaf also allows the flexibility to grow stands out longer mainly for timber but also for aesthetic and wildlife objectives. It has been successfully uneven-aged-managed, which can be a good fit for natural stands of shortleaf on private lands.

5.4 Upland Hardwoods

Upland hardwood (UH) communities represent a mixture of hardwood tree species with little to no presence of pine species. The associated natural communities according to The Natural Communities of Virginia include: northern hardwood forests, high-elevation boulderfield forests and woodlands, high-elevation cove forests, northern red oak forests, rich cove forests, basic mesic forests, acidic cove forests, mesic mixed hardwood forests, montane dry and dry-mesic calcareous forests, coastal plain dry calcareous forests, basic oak-hickory forests, acidic oak-hickory forests, montane mixed oak and oak-hickory forests, oak/heath forests, coastal plain/Piedmont oak-beech/heath forests, Piedmont hardpan forests, low-elevation boulderfield forests, pine-oak/heath woodlands, mountain/Piedmont acidic woodlands, mountain/Piedmont basic woodlands, and oak-hickory woodlands and savannas. This forest type is variable depending on location and found throughout the entirety of the state, from the Coastal Plain flatlands in the East to the mountainous montane forests of the West. This community is similar in composition to other mesophytic and riparian forests found throughout the state. Soils within upland hardwoods are typically sub-xeric and acidic, varying from quite sandy to clayey depending on where they are found in Virginia and the surrounding habitat. See Table 4 for a listing of the common tree species for the upland hardwoods forest type.

In comparison to the pine-dominated upland forest types, upland hardwood forests usually have longer timber rotations requiring little management. Soils, productivity, and timber quality vary greatly across these hardwood sites. UH forests dominated by shade intolerant species, such as oaks, growing on productive soils are capable of producing quality sawtimber. UH forests dominated by shade tolerant species, such as red maple, growing on sub-xeric soils produce mostly low value products such as hardwood pulpwood and fuelwood. Although not usually regarded as fire tolerant/dependent, research has shown that fire applied at the beginning of an UH rotation has increased more valuable shade-intolerant species such as oaks. UH forests are important for wildlife because of the annual mast production they provide. These forests also allow the flexibility to manage for timber while also meeting aesthetic and wildlife objectives.

5.5 Yellow Poplar

The yellow poplar, or tulip poplar (*Liriodendron tulipifera*), is a very prolific and important tree within the state of Virginia. In Virginia's Forest Inventory (USDA 2016), yellow poplar is listed as having the third-highest number of live trees among singular species, while also having the 2nd highest net volume behind only the loblolly and shortleaf pine grouping. These statistics about its prominence within the state warranted its inclusion within this LMP as its own forest type.

It is a tall, fast-growing relative of the magnolias and not actually a poplar. Yellow poplar in Virginia is valued for its soft, versatile wood and usually straight, limb-free trunk. Although it is found throughout the majority of Virginia forest types, from monocultures to mixed with various other hardwoods and pine, yellow poplar prefer the best-quality sites for its growth and will not be found where water or soil nutrient availability is reduced (Virginia Tech Landowner Fact Sheets 2004).

Yellow poplar are moderately commercially important as well. Poplar wood can be used for furniture, cabinets, veneer, plywood, and pulpwood; smaller pieces can also be utilized as interior bracing for furniture. Smaller local industries may also craft both siding and shingles from yellow poplar bark (Virginia Tech Landowner Fact Sheets 2004). Yellow poplar also provide an additional NTFP in the form of honey, as they yield large quantities of nectar and produce a dark red, fairly strong honey when utilized by bees (Virtual Blue Ridge 2020). Associated Natural Communities of Virginia that include the yellow poplar are: rich cove forests, basic mesic forests, acidic cove forests, mesic mixed hardwood forests, montane dry and dry-mesic calcareous forests, coastal

plain/piedmont bottomland forests, piedmont/mountain floodplain forests and swamps, and piedmont/mountain small-stream alluvial forests.

5.6 Mesophytic Hardwoods

The mesophytic hardwood (MH) forest grouping is quite diverse, including multiple species of broad-leafed deciduous trees. This forest type is composed of predominantly hardwood forests that are typically found on deep lowland soils or protected landscapes such as lower mountain slopes or coves (The Nature Conservancy 2020). This forest type within Virginia is found in the greatest abundance within the southwest corner of the state and along the West Virginia border. MH forests are characterized by high biodiversity in both the plant and animal species that they are known to support, with up to 30 different canopy species supported (Hinkle et al. 1993).

Soils of MH habitats in southwestern Virginia reflect the underlying parent rock material of the surrounding landscape, and are mostly composed of Inceptisols and Ultisols. Forests that are located near the bottom of rocky slopes may contain loose stony material consisting of sandstone, siltstone, and/or limestone depending on local bedrock and the slope's steepness; these deep rock materials give rise to some of the richest and most productive MH forests. The vegetation of these MH forests varies depending on the region and surrounding topography, as the climax community for slopes may be different from those at the base of slopes (Hinkle et al. 1993). Regardless of location, the dominant species are typically comprised of a mixture of oaks, tulip poplar, chestnut, maples, and beech.

If MH forests are left undisturbed, they can grow to great heights and be a very productive source of hardwood timber. Various different hardwood forest products can be produced from the MH forest type, and these forests can also harbor various important NTFP's such as ginseng. Associated Natural Communities of Virginia that comprise the MH forests are: rich cove forests, basic mesic forests, acidic cove forests, mesic mixed hardwood forests, Eastern hemlock/hardwood forests, montane dry and dry-mesic calcareous forests, basic oak/hickory forests, acidic oak/hickory forests, montane mixed oak and oak/hickory forests, coastal plain/piedmont oak-beech/heath forests, low elevation boulderfield forests, pine-oak/heath woodlands, mountain/piedmont acidic woodlands, mountain/piedmont basic woodlands, limestone/dolostone woodlands and barrens, and oak-hickory woodlands and savannas.

5.7 Bottomland Hardwoods

Bottomland hardwood (BH) forests are typically river swamps and lowlands found along streams and rivers throughout the southeast and south-central United States. These habitats are generally lacking in slope due to their presence within the broad, flat floodplains of their associated hydrologic feature, while the width of these forests depends on the size of the stream or river and local topography. BH communities within the Piedmont and Appalachian regions of Virginia usually exhibit higher ranges of topography, resulting in a more narrow floodplain. Due to their presence in floodplains, BH soils typically consist of alluvial sediment ranging from clay to sand depending on the features (size, water velocity, etc.) of the nearby stream or river. All species within BH communities are dependent on occasional flooding, with the flooding regime determining which species are best adapted for each habitat.

In Virginia, Bottomland Hardwoods can be found along black river floodplains and red river floodplains. Black rivers drain smaller watersheds, originate within the coastal plain region, and can either empty into larger red rivers or into the Atlantic Ocean. Red rivers drain larger watersheds, originate within the Piedmont and BR ecoregions, and flow through the MACP ecoregion before emptying into the Atlantic Ocean (North Carolina Forestry Library 2009). Black rivers are named because of their nutrient-poor, high organic content found in the coastal plain, and red rivers are named because of their nutrient-rich, high clay and mineral content found

throughout the Piedmont and BR. Red river floodplains are usually larger and more productive than black river floodplains (Messina and Conner, 1998). In the SP and MACP ecoregions, BH forests of both rivers are composed largely of oaks (cherrybark, swamp chestnut, laurel, and willow), while other hardwoods present include bitternut hickory, green ash, and sweetgum (USFWS 2014). Where little topography relief exists, cypress and tupelo become more prevalent in both rivers, with pond cypress being more prevalent along black rivers and bald cypress along red rivers. BH forests along red rivers in the Piedmont are usually smaller in area due to the higher gradients and topography changes, and consist of the oaks and hickories found within the SP but also a larger population of red maple, American elm, sycamore, and river birch (North Carolina Wildlife Resources Commission 2019).

In comparison to the pine-dominated upland forest types, bottomland hardwood forests have limited access and generally are not actively managed. On shorter rotations, BH forests produce mostly low value products such as hardwood pulpwood and fuelwood, but on longer rotations, BH forests, especially along red rivers, can produce high value sawtimber and veneer products. Harvests should maintain natural water-flow patterns and take into account of the regeneration of the next forest, from seed, seedling or stump sprouts. BH forests exist from small-and-large- scale disturbances, and ones dominated with shade tolerant hardwoods have usually been high-graded over time (Messina and Conner, 1998). BH allows the flexibility to manage for timber while also meeting aesthetic and wildlife objectives.

The associated natural communities within the BH designation according to The Natural Communities of Virginia include: bald cypress-tupelo swamp, coastal plain/piedmont bottomland forests, piedmont/mountain floodplain forests and swamps, and piedmont/mountain small-stream alluvial forests. After conferring with a group of natural resource professionals from Virginia, however, it was determined that for the purpose of landscape management within this plan, the only two distinct subdivisions under the BH designation aside from the general BH category that warrant further discussion are the elm/ash/cottonwood forest types.

5.7.1 Elm/Ash/Cottonwood

Elm, ash, and cottonwood (EAC) is a community located in still water depressions or lowlands and may be associated with rivers or creeks. This is an uneven-aged, natural forested wetland with a varying hydroperiod. EAC communities are not fire tolerant/dependent and they have a closed canopy. Cottonwoods are usually a pioneer species of this community, where they are eventually outcompeted and replaced by various elm, ash, and birch species (Myers and Buchman 1984). EAC's typically have dense over/mid/understories and are sometimes impenetrable. Up to 50 species with some type of commercial importance are associated with the EAC complex. Natural as well as anthropogenic factors such as site, timber harvesting, flooding, insects, disease, and natural succession can alter EAC species composition. See Table 4 for a listing of the common, dominant overstory tree species for the elm, ash, and cottonwood forest type.

In comparison to the pine-dominated upland forest types, these wetlands have relatively low timber productivity. This is due to slower growth rates and their harvest windows being limited by longer hydroperiods. However, they can be sustainably managed by using Virginia's BMPs for Forestry. The associated natural communities within the EAC designation according to The Natural Communities of Virginia include: coastal plain/piedmont floodplain swamp (green ash-red maple type) and piedmont/central Appalachian floodplain swamp (silver maple-green ash type).

6.0 Forest Resources

The forest resources discussed below are applicable resources from all forest types in the LMP and may be considered for each landowner. They are summarized below, rather than included in the forest types discussion due to their relative uniform applicability across all forest types. The forest resources particular to each forest type are given in Section 6.2.

6.1 Common Forest Resources

6.1.1 Conservation Incentives

There are several programs and markets available to landowners that can reward them and provide incentives for their conservation efforts. The most widely used programs are cost-shares. A list of some of the major incentives available within Virginia by providing agency is given below. Additional minor initiatives that may be applicable in certain circumstances are given in Section 7.1.1.1.2.

Providing Agency	Program Title
USDA Natural Resource Conservation Service (NRCS)/Farm Service Agency/National Initiatives	Conservation Reserve Program
	Conservation Reserve Enhancement Program
	Emergency Watershed Protection Program
	Healthy Forests Reserve Program
	Emergency Conservation Program
	Environmental Quality Incentives Program
	Conservation Stewardship Program
	National Water Quality Initiative
	Longleaf Pine Initiative
	Regional Conservation Partnership Program
	Shortleaf Pine Initiative
	Working Lands for Wildlife
	Agricultural Conservation Easement Program
	National Bobwhite Conservation Initiative
	Wetland Reserve Program
	Partners for Fish and Wildlife Program
Virginia Regional Initiatives	Water Quality Improvement Fund
	Forests to Faucets Program
	Nutrient Management Equipment Tax Credit Program
	Forest Legacy Program

	Virginia Agricultural Best Management Practices (BMP) Cost-Share Program
	Scenic Rivers Program
	Forestry Quail Habitat Recovery Program
	Northern Bobwhite Quail Action Plan for Virginia
	Agricultural BMP Cost-Share Program
	Agricultural BMP Loan Program
	Virginia BMP Tax Credit Program
	Piedmont Prairie Partnership
Virginia Department of Forestry Programs	
	Logging Best Management Practices (BMP) Cost-Share Programs
	Alliance for the Chesapeake Bay and Chesapeake Forest Fund Tree Planting Program
	Pine Bark Beetle Prevention Program
	Emerald Ash Borer Program
	Reforestation of Timberlands
	Riparian Forest Buffer Tax Credit Program
	Southern Pine Beetle Prevention Program

Some landowners, as well as groups such as the Virginia Outdoors Foundation, can sign conservation easements to ensure this long-term protection. Landowners can enter their property into a conservation easement agreement through various national entities such as The Nature Conservancy or local entities such as the VDOF's Working Forest Conservation Easement Program. Conservation servitudes vary, but most ensure the land is never developed while allowing the landowner to continue management activities such as timber harvests, and in return they receive a property tax break. This option also allows many landowners a strategy during the estate planning process. The VDOF requires that before entering a property into their conservation easement program: a written forest stewardship management plan (by either a VDOF forester or private consulting forester) is prepared for the direction of all future forest management activities; a written pre-harvest plan is in place before any timber harvesting occurs; and BMPs must be implemented with any timber harvesting that occurs. VDOF also requires that properties applying for the program be over 50 acres in size and greater than 75% forested (VDOF 2012). Some landowners may also be able to earn credits on private mitigation banking markets through the enhancement or restoration of wetlands and/or threatened and endangered species habitat.

6.1.1.1 Conservation Incentives Within Ecoregions

Conservation is essential to maintain the abundant natural resources found in Virginia. There are multiple Conservation Initiatives (CI) at work in the state that are working to protect these resources. This report will focus on those with components that involve or affect forested habitat or species located within these habitats. It should be noted, though, that this section may not be an entirely comprehensive list of all conservation incentives available to landowners within Virginia. Research should be personally conducted in conjunction with a forester consultation in order to discern whether other CIs may be available to landowners, as others may be available depending on the time or location.

6.1.1.1.1 National Conservation Initiatives and Programs

The United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) administers the Environmental Quality Incentives Program (EQIP) to "provide financial and technical assistance to forestry producers to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation, and improved or created wildlife habitat." Through this program, NRCS provides guidance and financial resources to implement environmental improvements. EQIP is available throughout all ecoregions in Virginia; depending on where your land is located, any number of 200 different forest and farm-focused land improvement practices may be available. Some of these various EQIP practices can be found in subsequent sections of the LMP.

The USDA Farm Service Agency (FSA) administers the Conservation Reserve Enhancement Program (CREP), an enhancement to the Conservation Reserve Program established in 1985;since that time, CREP has been the largest private-lands conservation program in the United States. Through this program, farmers agree to accept a yearly rental payment and participate in cost-share of up to 50% and in return remove lands deemed environmentally sensitive from their normal production and instead plant species to improve environmental quality and health. The contract length for lands enrolled in CRP vary from 10 to 15 years, with the long-term goal of re-establishing valuable land cover to improve water quality, prevent soil erosion, and reduce wildlife habitat loss. The CREP has two regions within Virginia, the Chesapeake Bay CREP and the Southern Rivers CREP. There are multiple initiatives that landowners can choose to participate in, ranging from the Duck Habitat Initiative to the Bottomland Hardwoods Initiative, which is applicable in the Virginia wetland forested habitats. All of Virginia, except for a few portions of HUCs in Dickenson County, are CREP-eligible. Additional information concerning the CREP in Virginia can be found through the VDCR.

An aquatic initiative active within Virginia is the National Water Quality Initiative (NWQI). Through this program, the NRCS provides both financial and technical assistance to landowners interested in improving the quality and habitat structure of impaired streams. In Virginia, the watersheds meeting the criteria to be classified as "priority watersheds" are the War Branch, Mountain Run, and Fifteenmile Creek watersheds. The War Branch and Mountain Run watersheds comprise the Smith Creek watershed, which the Fifteenmile Creek is a tributary to the South Fork Holston Lake. Possible sources of contamination within this watershed are cattle watering in creeks, due to the prevalence of pastureland in the watershed boundaries. A main method of improving these watersheds is the control of nutrient and manure runoff into the water bodies. This control may be accomplished through assistance installing cover crops, filter strips, and tailwater recovery systems, which will aid landowners in protecting natural resources voluntarily while also receiving a profit.

A forest-based restoration initiative that is present throughout multiple southeastern states is the Longleaf Pine Initiative (LLPI) through NRCS. This initiative seeks to improve the sustainability and profitability of longleaf ecosystems and forests. Through the Farm Bill, landowners in Virginia receive technical and financial assistance in propagating the spread and protection of these longleaf pine habitats. Under the LLPI, landowners participate in a variety of forestry practices, such as site preparation, forest stand improvement, and prescribed burning to create an optimal habitat for longleaf pine. Benefits of the LLPI include improved soil and water quality, better

wildlife habitat and diversity, improved carbon sequestration, and enhanced recreational opportunities and aesthetics. The boundaries of the LLPI in Virginia cover portions of the MACP and SP, areas that are historic longleaf habitat.

The Shortleaf Pine Initiative (SPI) is a program designed to address the multiple threats facing the increasingly imperiled shortleaf pine forest (Shortleaf Pine Restoration Plan, 2016). Recently, factors such as pine beetle outbreaks, changes in timber management practices, altered fire regimes, and land use changes have contributed to the decline of this specific ecosystem. In 2013, the SPI was formed to address these issues through policy formed by key federal and state agencies from the 22 states affected by the shortleaf pine decline. Shortleaf pine restoration depends on site-specific efforts by regional practitioners and partners to educate landowners interested in restoration on their lands. These efforts include the demonstration of shortleaf pine restoration practices, the sharing of technical information, and the promotion of site-based conservation. This initiative is available throughout all Virginia ecoregions.

A wildlife-focused conservation initiative within Virginia is the National Bobwhite Conservation Initiative (NBCI 2015). The NBCI is a 25-state effort to restore bobwhite quail to the whole of America's landscape. The NBCI is focused on developing an ever-evolving strategy to approach bobwhite revival on a landscape scale as opposed to a small-scale, individual farm-based approach as previously utilized. Through the NBCI Technical Committee, representatives from the 25 states can lend their biological, scientific research, and private conservation expertise to the protection and restoration of bobwhite quail. Methods for promoting the reestablishment of bobwhite quail include advancing the establishment of native grasses and flowers along cropland and rural land edges to promote habitat connectivity, converting up to one-third of existing pasture to native grasses beneficial to both cattle and bobwhite, and managing pine and other forests to promote forest habitat connectivity. The NBCI is available to landowners with appropriate acreage and suitable habitat that are deemed to qualify for a NBCI Focal Area, and area where quail populations can be studied more in depth. NBCI provides coordination, design, training, data management, reporting tools, and nationwide outreach. All ecoregions within Virginia can qualify under the NBCI.

6.1.1.1.2 State Conservation Initiatives and Programs

The VDOF is a major source of the conservation initiatives and programs available within Virginia to aid in the preservation of species or natural forested resources. The VDOF provides an index of programs available nationally and through Virginia organizations such as VDOF, VDCR, Virginia Association of Soil and Water Conservation Districts (VSWCD), and the Virginia Department of Environmental Quality (VDEQ). Of these state wildlife initiatives, there are multiple programs focused on forestry or wildlife programs. These include the CREP, the VDEQ's Water Quality Improvement Fund (WQIF), the Riparian Forest Buffer Tax Credit (RFBTC) Program, the Virginia BMP Tax Credit Program, the Virginia Hardwood Initiative Tax Credit Program, the Virginia Agricultural BMP Cost-Share Program/Virginia Agricultural BMP Loan Program, the Logging BMP Cost-Share Program, the Forestry Quail Habitat Recovery Program, the Pine Bark Beetle Prevention Program (PBBPP), the Emerald Ash Borer Program, and the Reforestation of Timberlands Program. These programs should be consulted through the above links to determine whether they apply in each location and circumstance. A few of them will be discussed below, but landowners should take the time to explore each of the initiatives to determine potential cost-share opportunities.

The Forests to Faucets Program was designed to promote the maintenance of existing forestland as well as the planting of new forests in an effort to create enhanced water quality within the targeted Rivanna River watershed. Within Virginia, this watershed covers the counties of Albemarle, Fluvanna, Greene, and Louisa. The VDOF uses

this program to provide grant incentives for landowners placing their land into a conservation easement, in addition to the existing tax benefits of donating a conservation easement. Up to $15,000 could be available through Forests to Faucets for landowners who wish to create/enhance conservation easements within the Rivanna River watershed. The eligibility to join this program is a minimum of 50 acres, of which 75% is forestland, as well as an easement to permanently protect at least 75% of that forestland.

Another VDOF program, the Riparian Forest Buffer Tax Credit, was designed to provide landowners statewide with an incentive to preserve riparian (river) buffers along waterways during a timber harvest operation. The incentive through this program is in the form of a tax credit and is equal to 25% of the value of any timber left as a buffer along the stream or river, up to a specified limit. It is required that the buffer be at least 35 and not more than 300 feet wide, and it must be kept intact for 15 years. All applicants hoping to qualify for this incentive must also have a Stewardship Plan for their tract in question.

The VDOF also funds the Alliance for the Chesapeake Bay and Chesapeake Forest Fund Tree Planting Program. This program's goal is to provide cost-share assistance to landowners for the process of pine reforestation. Planting pine trees is a useful strategy that helps to achieve better water quality, air quality, and other varied natural resource goals. The Chesapeake Forest Fund provides full funding to institute open land (no trees for the past 10 years) tree plantings, as well as maintain those plantings, on those counties in Virginia that border the Chesapeake Bay. While priority is given to lands with conservation easements, lands adjacent to existing forest, and lands proximal to streams/rivers, all landowners with greater than one acre and who agree to maintain the project for 15 years may apply.

The VDOF offers state cost-share programs to those who qualify. One of these programs also offers the Reforestation of Timberlands program (RT)), which is a strictly state-administered program that is funded through the forest industry in Virginia as well as through matching funds from the Commonwealth of Virginia's General Fund. The goal of RT is to promote the planting of pine forests by landowners, with the VDOF reimbursing landowners for a portion of the costs associated with installing pine plantings. Examples of the projects/practices eligible for funding through RT include planting pine, mechanical and chemical site preparation, herbicide use, and others. All counties/ecoregions within the state are eligible for RT.

The Pine Bark Beetle Prevention Program (PBBPP) is designed to mitigate future forest loss from Southern Pine Beetles and other various pine beetles for non-industrial private forest landowners through management of pine density using prevention and restoration practices. The financial incentives in this program provide payment for conducting pine thinnings and/or pine restoration. Approved projects under the PBBPP can receive the incentive payment of 60% of the direct project cost for pre-commercial thinnings, not to exceed $105/acre or $10,000 in a fiscal year. The goal of these practices is to ensure a pine stand will reach merchantable size prior to the stress of being overly dense develops. As landowners receive financial benefits and vigorous stand growth through these thinning practices, they are incentivized to keep stand density low enough to reduce potential loss from SPB. Different requirements of each property to qualify for the PBBPP include: parcel must be at least 5 acres; pine species must be loblolly, shortleaf, longleaf, pond, Virginia, pitch, or white pine; trees must be <15 years old and no more than 4 inches average diameter at breast height; pre-thinning tree density must be at least 800 stems per acre, and post-thinning densities must be from 300-500 stems per acre; and the parcel must not be in public or forest ownership, or managed by a Timber Investment Management Organization (TIMO) or Real Estate Investment Trust (REIT).All counties/ecoregions are eligible for the prevention practices, and all counties/ecoregions are eligible for the restoration practices.

The Emerald Ash Borer Program is another pest treatment program run by the VDOF, in addition to the PBBPP. In this program, eligible landowners will receive a 50/50 cost-share allotment from VDOF for the treatment of ash trees threatened by the EAB. Both private landowners as well as organizations can qualify for this program,

and to qualify the land must have: ash trees at least 12 inches in diameter and not displaying >30% canopy loss; a detailed Ash Prevention Strategy; and a need for protecting the genetic, ecological, historical, or public value of ash trees.

Within the America's Longleaf Restoration Initiative, one Implementation Team exists across the state of Virginia: the Longleaf Cooperators of Virginia. This partnership has the goals of stakeholder"restoring the ecological, economic, cultural, historical, and recreational values of the native longleaf pine forests of southeastern Virginia, as well as providing technical expertise to help landowners achieve their longleaf restoration success". Participating in the various land management activities promoted by this individual Cooperators group may qualify the landowner for cost-share benefits. Additional information regarding the partnership can be found at the above link.

The three Virginia BMP Programs (Logging Best Management Practices (BMP) Cost-Share Programs, Agricultural BMP Loan Program, and Virginia BMP Tax Credit Program) all provide various levels of incentives for adhering to state BMPs. The individual programs should be researched for further information on potential available incentives.

6.1.2 Ecosystem Services

Forests provide ecosystem services to society that are wide ranging and difficult to value. These ecosystem services include clean air and water, carbon sequestration, aquifer recharge, climate resilience, and biodiversity. There are currently few significant markets for these services in Virginia, but they may develop in coming years. One notable exception is the Healthy Watersheds Forest Retention Program described in Section 4.0. However, lack of financial incentives does not discount the crucial services ecosystems provide us, making ecological maintenance and restoration an important objective for many landowners.

6.1.3 Historical and Cultural Sites

Many private lands contain various historical and cultural resources, also known through ATFS as "special sites." Therefore, forest management activities are often developed to consider and maintain special sites on the property. Landowners may be aware of these sites or their locations may be documented and mapped with federal, state or local agencies and organizations. Forest resource professionals could discuss known sites with landowners. If the landowner is unaware of any sites or the land is newly acquired, there are many resources available to review potential recorded sites such as the National Register of Historic Places (NRHP) or the State Historic Preservation Office (SHPO) through the Virginia Department of Historic Resources (VDHR) and local historical societies and museums.

In addition, the property can be reviewed on the ground through visual reconnaissance by the landowner or forest resource professional, within a reasonable scale relative to property acreage and accessibility. The VDHR and local historical organizations have limited resources, but may be able to assist with locating or interpreting potential significant sites and local preservation laws. Sites listed by these organizations reflect a determination of a site's significance to the history of a community, state or nation and should be protected as required by federal, state or local laws. Non-listed sites of personal significance to the landowner may also be protected.

Landowners and their forest resource professionals are encouraged to make reasonable efforts to locate and protect special sites appropriate for the size of the forest and the scale and intensity of forest management activities. Protection of historical and cultural sites during land management activities can be considered during planning, contract development, monitoring and follow-up inspections. These sites can be designated on the

ground with vegetative buffers, flagged/blazed trees, fencing, or signage and communicated to contractors and sub-contractors.

Landowner considerations for determining whether to designate an unlisted site may include:

- **Significance**:
    - Site has made a significant contribution to the broad patterns of our history;
    - Associated with the lives of significant persons of the past;
    - Embody distinctive characteristics of a type, period or method of construction, or represent the work of a master, or possess high artistic values, or represent a distinguishable entity whose components may lack individual distinction;
    - Yielded or likely to yield information important in history or pre-history
- **Age**: Minimum 50 years-old
- **Integrity**:
    - Site must retain its historical physical integrity with its character-defining features still present.
    - Building, structure or landscape feature must be relatively unchanged.
    - Archeological site must be relatively undisturbed, with its patterns and layers of artifacts relatively intact.
    - Traditional cultural site must be recognizable to today's affiliated cultural group, evidenced through tradition and still used or revered today.
- **Personal Significance**: such as a location, structure or artifact with a family importance or meaning.

Special sites of biological and geological significance and sensitivity may be identified through consultation undertaken related to the identification of threatened or endangered species and natural communities. Cultural and historical resources can be mapped and marked on the ground to aid general protection, documentation and monitoring efforts. However, some landowners may wish to keep these sites unmarked and unmapped to avoid attracting attention that could lead to vandalism, theft or degradation.

Historic, cultural, and special sites may include:

- Native American burial grounds, camps, middens, mounds etc.
- Historic dwellings, structures, foundations, barns, wells, cattle dipping vats, ruins, cemeteries, bridges
- Geological formations, sinkholes, limestone bluffs or outcroppings, caves/entrances, spring heads, springs, etc.
- Rare plant populations, pitcher plant bogs, champion trees, bear dens, etc.

6.1.4 Recreation

Virginia's geography and variability of different habitats within the state, ranging from the coastal plains to the Central Appalachians, lend itself to providing a wide range of recreation opportunities through its natural areas. Virginia's forests are popular places to recreate due to their unique topography, biological diversity and the wide range of potential activities. Landowners can enjoy personal and family recreational use or lease their land as a means of revenue generation. If leasing land for hunting, it is important to purchase liability insurance for the property to protect your liability in the event of an accident. Potential recreation activities include:

- Hunting and leases
- Fishing and leases
- Off-highway vehicles (OHV) and leases
- Eco-tourism and leases
- Wildlife viewing and birding
- Hiking
- Bicycling
- Equestrian
- Camping
- Environmental education
- Geocaching
- Paddling

6.1.5 Aesthetics

From a towering pine stand with a sea of grasses to a lush, mixed bottomland hardwood forest to the rocky peaks of the Blue Ridge, the wide range of forest types, topography and aquatic features throughout Virginia provide unique forest aesthetic values. The forests themselves vary from open, pine-dominated rolling hills to dense cypress ponds. The western and northern Virginia borders contain dense forests composed of many northern species, providing a different aesthetic than the southeastern Virginia lowlands, where the cypress lined rivers and ponds have their own prehistoric beauty.

Virginia is quite diverse in its topography due to its stretching from coastal lowlands to the Appalachian mountains. It has rolling sand and clay hills in the Piedmont, steep-head spring ravines, slope forests and high river bluffs. These features allow for exceptional forest views. Various aquatic features such as forested wetlands, lakes, ponds, rivers, streams, springs, and pocosins are major visual highlights of the state's forests. These are present naturally throughout the region and add character to a property; so much so that many landowners choose to enhance their property's aesthetics by creating man made ponds and waterbodies. These forest aesthetic considerations not only provide beautiful views but also a sense of privacy, adventure, and landowner pride.

6.1.6 Forests of Recognized Importance (FORI)

Forests of recognized importance (FORI) represent globally, regionally, and nationally significant large landscape areas of exceptional ecological, social, cultural, or biological values. These forests are evaluated at the landscape level, rather than at the stand level, and are recognized for a combination of unique values, rather than a single attribute. FORIs may include landscapes with exceptionally high concentrations of one or more of the following:

• Protected, rare, sensitive, or representative forest ecosystems such as riparian areas and wetland biotopes.

• Areas containing endemic species and critical habitats of multiple threatened or endangered plant and animal species, as identified under the Endangered Species Act (ESA) or other recognized listings.

• Recognized large-scale cultural or archeological sites including sites of human habitation, cities, burial grounds, and *in situ* artifacts.

• Areas containing identified and protected water resources upon which large metropolitan populations are dependent.

• Areas containing identified unique or geologic features including geysers, waterfalls, lava beds, caves, or craters.

While landowners are encouraged to contribute to or support the values that led to the FORI designation of the area, the FORI designation does not compel the landowner to take any actions.

6.1.6.1 FORI Designation within Region

In the United States, because of their significance, FORIs have generally been identified and protected by federal or state governments or are under conservation easement by an environmental nonprofit organization. There is currently no state or federal agency that regulates FORIs on private forestlands in the United States. Several conservation organizations have identified areas that they believe are of exceptional status, yet there remains no single central clearinghouse of information regarding such forested landscapes.

To support and facilitate identification of these resources within this project, AFF worked with the Support Committee to develop a list of FORIs within the state while consulting the Virginia's Forest Action Plan and area conservation priorities. The following forest landscapes were identified for the LMP, by these stakeholders, based on the combination of their unique attributes, consistent with the definition of FORI under ATFS.

6.1.6.1.1 Select Public Lands

Due to their recognized conservation priorities for protecting habitat, biodiversity, water resources, cultural sites, and unique geologic features, certain federal and state protected public lands are considered FORIs within this LMP. FORIs defined in this way in Virginia include areas within or contiguous to: USFWS National Wildlife Refuges, Virginia Wildlife Management Areas, and lands managed by the National Park Service. This designation includes national forests, national parks, wildlife management areas, and wildlife refuges. The goal of recognizing these specific designations as FORI is to protect areas with potential ecological or cultural significance to the state of Virginia.

6.1.6.1.2 Rivers Enrolled in the Virginia Scenic Rivers Program

The Virginia Scenic Rivers Program's intent is to identify, designate and help protect rivers and streams that possess outstanding scenic, recreational, historic and natural characteristics of statewide significance for future generations. This program is managed by the state and should not be confused with the federal Department of the Interior's Wild and Scenic Rivers Program. This program is focused on both recognizing and conserving scenic rivers and their corridors. State and federal agencies review projects and programs within the state to determine how they may affect these designated rivers.

6.1.6.1.1.2 Landowner Actions to Protect FORIs

For family landowners, a likely scenario is that their property is adjacent to a state or federally protected area or recognized scenic river and identified as a FORI at a landscape scale. Landowners should consider the impact to a neighboring FORI and opportunities to support consideration of specific values or attributes when planning and implementing activities on their forest property. Given the size and scale of family ownerships eligible for ATFS certification, landowners may be limited in their abilities to significantly impact FORI presence and quality through management at the small scale.

Management activities on or adjacent to an identified FORI should seek to contribute to or support the values that led to the designation of the area. While landowners are encouraged to contribute to or support the values that led to the FORI designation of the area, the FORI designation does not compel the landowner to take any actions.

During the ATFS inspection process, an ATFS Inspecting Forester shall confirm the presence or absence of a FORI on the property. The ATFS Inspecting Forester should also identify any efforts the landowner is making to support the values of the identified FORI within the 021 Form.

6.2 Forest Type-Specific Forest Resources

6.2.1 Fish & Wildlife

The forests and associated aquatic ecosystems of Virginia provide habitat for a wide array of game and non-game fish and wildlife, including several imperiled species (Table 2). These forests can be managed in a way that enhances, restores and protects the valuable habitats these species call home. These species may be managed for various objectives such as conservation, legacy planning or recreation. Present listed species can be documented, mapped and monitored.

The VA BMPs for Water Quality compile strategies and considerations for managing and protecting these species and their habitat during silvicultural operations. For example, marking a rare plant or animal area with flagging, paint or signage to protect during harvest operations, regular active monitoring and following up with post-harvest inspection(s). The BMP manual also considers fish and wildlife conservation in relation to silvicultural activities.

Pine forests provide habitat to hundreds of game and non-game species including bobwhite quail, wild turkey and deer. They are also home to several rare species including: bald eagle, Indiana bat, and red-cockaded woodpecker (Table 2). Hardwood forests also provide habitat for their own collection of game and non-game species.

6.2.2 Timber Products

The merchantability of a stand of trees, whether planted or natural, pine or hardwood, will depend on acreage and volume, local timber markets and mill product specifications. Mills in Virginia and surrounding states purchase these products from Virginia landowners.

The value of timber trees is based on the value of the products that can be made from them. This is dictated by size (height and diameter), species, and quality of the trees. Markets near Virginia currently include these products:

- Pulpwood:

    - Pine and Hardwood
        - Tree-length and clean chips
- Oriented strand board (OSB): pine
    - Similar price as pulpwood
- Chip-n-saw: pine
- Sawtimber: pine and hardwood
- Poles and pilings: pine
- Mulch: hardwood and cypress
- Fuelwood:
    - Pine, hardwood and large woody shrub species
        - Chips/Pellets for energy production
    - Hardwood
        - Firewood
- Other hardwood products: Pallets, mats, small diameter saw timber for furniture, horse bedding (pine shavings or hardwood pellets), veneer

Timber, like any other commodity, experiences price fluctuation according to the laws of supply and demand; prices may vary significantly from one part of the state to another. The price paid for any product class also varies according to quality.

Landowners may rightfully wish to advertise that their lumber or non-timber forest products are produced in Virginia. The VDOF has a limited number of promotional items designed to inform and educate consumers concerning the benefits of buying local wood products and other manufactured forest products. Also, the Virginia Grown Forest Products logo is available for free (www.dof.virginia.gov) online so that landowners can advertise their goods as being from Virginia.

Pine forest products

Timber is considered pre-merchantable if it is not marketable as one of the products above. All the major timber product groups can be harvested from all the different pine forest types including pulpwood, chip-n-saw, sawtimber and poles. These pine forests also allow for fuelwood harvests, especially utilizing natural regeneration and hardwood reduction treatments. With its fast, early growth, loblolly pine is sometimes managed for lower value, short rotation products such as pulpwood. Each pine species can generally be managed for longer rotation products such as sawtimber, poles, and pilings/veneer. All the major timber product groups can be harvested from pine-hardwood mixed forests.

Hardwood forest products

All the major timber product groups can be harvested from Shortleaf Pine-Hardwood Mixed, Upland Hardwood, and Bottomland Hardwoods forest types including pulpwood, chip-n-saw, sawtimber and fuelwood. Forest age

and site quality have a strong effect on which products can be produced, with older forests growing on good soils having the most potential of producing the most valuable products. Bottomland Hardwood forests are sometimes managed for hardwood pulpwood, especially if hardwood pulpwood prices are high. Mature Pine-Hardwoods Mixed forests, where hardwood makes up the understory, will produce hardwood pulpwood along with pine sawtimber

6.2.3 Non-Timber Forest Products

Non-timber forest products can generally be grouped into for general categories: edibles (mushrooms, etc.), medicinal and dietary supplements (ginseng, gingko, etc.), floral products (moss, garlands, etc.), and specialty wood products (carving and containers). Many non-timber forest products (NTFP) opportunities exist within pine forests, including pine straw (longleaf pine) silvopasture (all pine forests), and bee-keeping (all pine forests). NTFPs exist to a certain scale within hardwood forests as well. Pine-hardwood mixed, upland hardwood, and elm, ash, cottonwood all provide opportunities for bee-keeping and fruit harvests, while mesophytic hardwoods can provide ginseng.

Pine-specific forest types

Silvopasture

All pine habitat is conducive to silvopasture. Silvopasture is an agroforestry practice combining livestock, forage and timber management within the same land management unit (Hamilton 2008). This system provides landowners various combinations of options to manage forage (hay, etc.), livestock (cattle, etc.) and pine straw for short-term revenues while managing their timber for high-value products (poles and sawtimber) on longer rotations. Properly managed silvopasture systems also allow farms to be more profitable by diversifying revenue sources and cutting feed costs. However, landowners should be willing and able to actively manage the forage, livestock and timber components.

The open forage areas within the management unit allow for biodiversity, enhancing cool season grasses, while also allowing for warm season grass production. The areas with timber provide shade to livestock. This open, relatively low density stand structure enhances aesthetics, property values and recreational opportunities. This system also promotes wildlife populations and provides habitat for wild turkey and quail. The combination of timber and quality forage also prevents erosion and improves water quality and hydroperiod.

Silvopasture provides economic security by reducing risk through diversification of products. However, prior to establishing a new silvopasture system, local land-use, cost share and tax regulations should be reviewed. Forestry and agriculture may have different land use and zoning regulations which may be tied to separate tax structures. Some states, including Virginia, consider silvopasture cost sharable through Environmental Quality Incentives Program (EQIP).

Silvopasture is generally easier to establish in existing timber stands, which already have trees with good form that can be thinned or clearcut to provide corridors of adequate width that support forage production. Converting existing pastures can be difficult when having to exclude existing livestock from the developing stand. Silvopasture supports less livestock than pasture, since it is simultaneously supporting viable timber and livestock production.

Visit Silvopasture: Establishment & management principles for pine forests in the Southeastern United States" for more information (Hamilton 2008).

Hardwood-specific forest types

Ginseng

American ginseng (*Panax quinquefolius*) is a commercially important plant native to deciduous regions of the United States, notably the Appalachian and Ozark Mountains. It is highly prized for its medicinal purposes, and most ginseng harvested domestically now is sent to Asia for the Asian market's consumption (FWS 2020). Ginseng is usually found in mesophytic hardwoods forests, located in the bottom of slopes.

Due to the high demand for ginseng, especially in its overseas market, the Virginia Department of Agriculture and Consumer Services is responsible for issuing ginseng harvesting requirements in an attempt to ensure its future sustainability. Wild ginseng is listed under Virginia's Endangered Plant and Insect Species Act, and thus measures have been taken to protect it. The Board of VDACS adopted the Regulation of the Harvest and Purchase of Wild Ginseng; this document outlines requirements for harvest, sale, and resale/export of ginseng.

Pine and hardwood forest types

Honey

Beekeeping and honey production are common within pine forests. Honey production can provide annual short-term revenues. Landowners can produce and sell honey themselves, sell their honey to larger producers and distributors, lease their lands to honey producers, or conduct beekeeping as a hobby for personal consumption. Properties with a diverse stand composition, in terms of overstory and understory species and uplands and wetlands, can potentially generate honey revenue nearly year-round. Upland and wetland forests are marketable for apiary leases; however, this is not particularly lucrative and often done by bartering honey for leased land.

Beekeeping and honey production, especially the introduction of bees into the state, is covered by the Virginia Honey and Labeling Laws (https://www.virginiabeekeepers.org/Honey-and-Labeling). The VDACS also has Best Management Practices for Maintaining European Honey Bee Colonies in Virginia. In order to protect this industry from pests and unwanted species of honey bees, VDACS also requires inspections of new colonies. Additional resources and professional association affiliation can be found through the Virginia State Beekeepers Association.

Fruits

Hawthorn (*Crataegus* spp.) can be collected from bottomland hardwoods and upland forests as a group and is often made into a jelly and sold commercially. Blueberry, blackberry and other native fruits grow in several forest types, but are not commercially harvested from forest settings. However, landowners may enjoy harvesting small quantities from their land for personal use. Other Non-Timber Forest Products are given below:

Other Current and Potential NTFP Markets

- **Medicinal Native Plants**
    - St. John's Wort
    - Goldenseal
    - Cohosh
- **Other Edible Products**

  - Nuts
  - Mushrooms
- **Ornamental Products**
  - Pine Tips for Garlands
  - Pine Cones
  - Grapevines
  - Burl and Crooked Wood
- **Landscape Products**
  - Pine Bark Mulches

7.0 Silvicultural Options

7.1 Timber Harvest

The following silvicultural and land management tools are available to Virginia forest resource professionals to meet various landowner objectives and utilize forest resources. These are the common methods used in this region but there may be others available. One or a combination of these tools may be used to meet single or multiple objectives. Landowner objectives and budget ultimately determine which tools may be utilized. Local contractor availability, timber and NTFP markets, project scale, local regulations, site conditions, local climate, the degree of planning and scheduling and other factors also influence the forester and landowner decision making process when determining which tools to utilize to efficiently and effectively meet landowner objectives. Before conducting a timber harvest, it's imperative to have the timber basis established so that capital gain taxes only apply to the net gains, not the gross timber sale.

The VA BMPs for Water Quality compile voluntary guidelines, strategies and considerations for managing, enhancing and protecting: timber and NTFP resources, rare plant and animal species/habitat, aquatic ecosystems and air and water quality, during silvicultural operations. VA BMPs for Water Quality apply to: timber harvest, site preparation, reforestation and forest operations (roads, water control structures, etc.) activities. Historical and cultural resource protection and recreation management are also considered during planning and active silvicultural operations.

An important step prior to beginning a harvesting operation is the process of pre-harvest planning, as recommended by VDOF. This planning involves proper harvest preparation through: reviewing maps of the harvest area, walking the area and flagging skid trails and roads to familiarize yourself with on-the-ground conditions, planning out any stream management zone boundaries and how these streams will be crossed (if necessary), and generally noting any conditions that may pose a problem to logging operations. Virginia law requires that the VDOF be notified prior to beginning a logging operation, and that personnel conduct a harvest inspection of the site.

The general descriptions of each specific Virginia forest type provide information related to their specific harvest and profitability information. Each forest type is examined for its preferred management method (i.e. even-aged), length of growth rotation, site suitability for commercial species, and further options beyond commercial harvesting (i.e. aesthetics, wildlife). Below are descriptions of each type of silvicultural activity and how each activity is applicable to the different forest types within Virginia. In instances where there is no difference between

multiple different forest types in respect to the silvicultural practice, only the forest types that differ will be further explained.

7.1.1 Thinning

Pine Forest Types

Thinning is a primary land management tool used in Virginia to meet various objectives such as revenue, aesthetics, wildlife and restoration. The type and timing of thinning are dependent on several factors including landowner objectives, market conditions and stand and site conditions. This is a stand-specific determination that can be made by a forester. There are also site-specific VA BMPs for Water Quality related to thinning harvests, particularly in wetlands and streamside management zones.

Several types of merchantable thinnings are utilized in pine stands in Virginia. These partial harvests may involve row thinning, single tree selection, or a combination of both. Due to a lack of equipment mobility, individual rows must be removed during first thinnings to allow equipment access. The most common row thinning method for first thinnings is a third row thinning. Single-tree selection via logger-selection or a logger-select thinning, also known as "operator select," of the residual rows is also common during first thinnings. The most common used method for first thinnings is a combination of both, the "fifth row and select" method, in which the fifth row is removed to provide access to logging equipment, and then the lower quality trees in the leave rows are removed in order to reach the target stand density.

Some first thinnings in planted pine, and most thereafter, are thinned through marked selection or marked-select thinning by a forester. Foresters also mark 1+ acre demonstration areas on logger-selection first thinnings to walk through and discuss with logging crews how the stand will be thinned.

Single-tree selection in combination with row thinning is preferred over straight row thinnings without selection. Whether marked or logger-selection, single-tree selection improves forest health, aesthetics and promotes higher net growth. A straight row thinning reduces competition for the trees adjacent to take row but leaves inferior cull trees throughout stand.

If wildlife, aesthetics, or biodiversity are primary objectives, stands are thinned to a lower density. If timber and revenue are primary objectives, a higher density is maintained. If managing for multiple-uses, a moderate density can be used. The crown density of remaining trees should be considered when evaluating the effectiveness of a thinning procedure.

Natural pine stands are typically thinned using marked selection by a forester. Marking natural stands allows for more control over thinning density and quality due to their variable nature. If a natural stand is relatively uniform, with mostly lower value pulpwood or has a dense understory, it may be more efficient to use logger-selection and close supervision. Due to lack of row access, first thinnings in natural stands may call for a slightly lower density to improve logger operability.

Following two to three thinnings, planted stands appear more natural and have improved aesthetics. Prior to each thinning, landowner objectives are revisited. Eventually, a decision must be made on final harvest or conducting a natural regeneration cut. Natural regeneration and under-planting harvests utilize thinning and will be discussed in reforestation.

On productive sites, planted pine generally requires first thinning around age 15-20. On less productive sites, it may be pre-merchantable or not have enough volume per acre to market until around age 20 in which case stand replacement should be strongly considered. This stipulation applies mainly to loblolly

pine stands, as poor growth in these species usually indicates a poor match of the species to the soil type present.

First thinnings in planted pine stands involve row-thinning, preferably with marked-selection or operator-selection thinning. Natural stands are thinned using marked-selection. Subsequent thinnings will generally take place every five to ten years in planted and natural stands.

Pre-merchantable 20+ year-old planted pine stands or those overstocked with natural regeneration may require a pre-merchantable thinning or fuelwood chipping harvest.

Many landowners may choose not to thin mature even-aged and two-aged pine stands as their desired future condition has been met. They enjoy the benefits of this mature stand structure such as high-quality wildlife habitat, aesthetics and recreational opportunities. Other landowners may choose to occasionally lightly thin their mature pine for revenue, forest health and maintaining overstory composition. See the forest health section for the risks associated with managing mature pine.

Natural regeneration harvests are discussed in the reforestation section.

Shortleaf Pine/Hardwood Mixed

Thinning shortleaf pine/hardwood mixed and loblolly pine/hardwood mixedforests is not as commonly practiced in Virginia. However, thinning can be conducted in these mixed forest types.

Thinning from above can be used as a natural regeneration method.

Thinning is a primary land management tool used to meet various objectives such as revenue, aesthetics, wildlife and restoration. The type and timing of thinning are dependent on several factors including landowner objectives, market conditions and stand and site conditions. This is a stand-specific determination that should be made by a forester. There are also site-specific VA BMPs for Water Quality related to thinning harvests, particularly in wetlands and streamside management zones.

Shortleaf pine/hardwood mixed stands can be thinned using **marked selection** by a forester. Marking these stands allows for more control over thinning density and quality due to their variable nature. Desired residual species ratio should be considered during planning. Logger operability should be considered during marking.

Thinning from below, utilizing a hardwood pulpwood or fuelwood chipping harvest, is sometimes done in pine/hardwood mixed forests, since the hardwoods are primarily in the understory. Many landowners may choose not to thin pine/hardwood mixed forests as their stands are already in desired future condition. They enjoy the benefits of this forest type's structure such as high-quality wildlife habitat, aesthetics and recreational opportunities. Other landowners may choose to occasionally lightly thin their stands for revenue, forest health and maintaining overstory composition.

Natural regeneration harvests are discussed in the reforestation section.

Upland Hardwoods Forest Types (Upland Hardwoods, Yellow Poplar, Mesophytic Hardwoods)

Thinning upland hardwood forests is not commonly practiced in Virginia, but certain high-quality hardwood stands such as desirable oak can be selectively-thinned. Thinning these stands should be done

cautiously, since exposing trunks to high levels of sunlight from thinning may cause epicormic sprouting, degrading the value of these trees for sawtimber.

Bottomland Hardwoods Forest Types (Elm/Ash/Cottonwood)

Thinning bottomland hardwood is not commonly practiced in Virginia. They produce low value products and it is not economically viable to manage these forests through thinning.

7.1.1.1 Edge Feathering

Edge feathering is a technique used within thinning to create forest edges that gradually transition from forest to the surrounding habitat, especially if the adjacent land is managed land such as cropland or pasture. Within this practice, three different zones are created with each containing increased levels of thinning (75% thinned, 50% thinned, 25% thinned) moving from the forest edge into the forest (Habitat How-To's 2019). This method of thinning creates a gradual transition from larger trees in the forest to smaller grassy vegetation, while creating habitat for various wildlife species that need brushy cover for nesting. This method is best applied to edges with a southern or western aspect that receive direct sunlight. A broader edge between forest and pasture/cropland gives more room for these species to establish a home and is a major technique utilized in bird-friendly forestry.

7.1.2 Clearcut

Clearcutting is a standard silvicultural practice in managing shade intolerant pine as well as hardwoods for timber and other objectives. In most Virginia timber markets, on most soils, timber revenue is maximized through long-rotation, even-aged management for pulpwood and sawtimber production. Uneven-aged management is used mainly in longleaf pine stands and hardwoods, or stands that are in aesthetically-sensitive areas. Clearcuts are utilized in planted or natural stands of pine, hardwood and cypress. When clearcutting, hardwoods coppice (regenerate from the stump) and should be cut above the stem mean water mark to allow for successful regeneration.

Another primary use of clearcutting is for salvage harvests which are discussed in that section.

A clearcut can also be utilized for species conversion within a timber stand to meet various objectives or may reflect a change in objectives. Many pine-hardwood mixed forests were historically dominated by longleaf, shortleaf, or loblolly pine. Clearcutting can be used to remove offsite pine-hardwood mixed stands and replant with the appropriate pine species. The common Virginia example is converting off-site pine and hardwood species back to longleaf pine. Another may be clearcutting longleaf and reforesting with a more productive species like loblolly pine on certain spodic soils or loblolly on certain clay soils.

There are site-specific VA BMPs for Water Quality, when using clearcuts, particularly in wetlands and SMZs. The size and shape of clearcuts should be considered if wildlife and aesthetics are also objectives. Also, timing and seasonality are crucial when considering clearcutting in wetlands or wet upland sites. Mat logging is a technique utilized to minimize soil and hydrological impacts in these hydric forest types (Bottomland Hardwoods). Non-clearcut buffers or "beauty strips" can be used along roads and highways to reduce negative aesthetics associated with clearcuts. Timing and seasonality are crucial in wetlands and wet upland sites.

7.1.2.1 Patch Cuts

Patch cuts are a form of clearcutting that cuts groups (patches) of trees in an individual stand (USDA Reforestation Glossary 2019). This method can help to create varying habitat within a forest stand while promoting natural

regeneration within the small openings in canopy cover (Zielke and Bancroft 1999). All these small patch cuts will then be managed as individual stand units.

7.1.3 Chipping/Pellets

Another form of timber harvest in Virginia is chipping. Material is felled and skidded conventionally, then inserted into an industrial chipping machine at the loading deck, with chips being hauled to the mill rather than tree-length. Both pre-merchantable and merchantable pine, hardwood and shrub materials can be chipped. The maximum diameter of the material to be chipped varies by chipping machine and species.

Hardwood and pine tree-length pulpwood can be hauled as clean chips, which often have a higher stumpage price than pulpwood. Clean chips are derived from nearly pure, living wood that has already been debarked and contains very little vegetation and debris mixed in. Hardwood and pine clean chip loads must be sorted. Young merchantable pine clearcuts can be clean-chipped.

Fuelwood chips can be derived from the same size and species of material as clean chips but include dead and living vegetation such as needles, leaves and limbs. A load of fuelwood chips can contain a mix of hardwood, pine and shrub materials. Fuelwood chips are burned at mills and biomass energy plants to generate electricity and are the lowest value timber product in Virginia markets. They are also processed into pellets and shipped to European markets and burned for energy production. Young merchantable pine clearcuts can be clean-chipped as fuelwood chips

Fuelwood chipping is commonly used in low-value hardwood, clearcuts, land clearing operations, or other situations where it is not feasible to conduct a traditional timber harvest. These operations may break-even or generate a small amount of revenue from fuelwood, but more importantly, they can meet other landowner objectives, such as hardwood reduction and removal or site clearing. Chipping can also be used in place of a pre-merchantable thinning to reduce natural pine regeneration or tree density in overly stocked planted pine stands. This avoids pre-merchantable thinning costs and will generate revenue or break-even. Fuelwood or clean-chipping can be used where a very debris-free post-harvest site is required. For example, fuelwood chipping can be used as part of site preparation for groundcover restoration projects.

Pine and hardwood stands present opportunities for fuelwood chipping operations such as reducing overstocked natural regeneration in mature, two-aged stands, decreasing woody understory competition to desirable overstory species (i.e. pines), or hardwood reduction/adjusting hardwood ratios. Within the hydric Bottomland Hardwoods forest type, fuelwood chipping operations may serve as an alternative to hauling tree-length logs from the site.

7.1.4 Salvage

Salvage harvests are valuable tools that help make the most of difficult circumstances. They are commonly utilized to harvest timber following varying degrees of catastrophic natural disasters. These include wildfires, climatic events such as hurricanes, and forest health issues such as pine beetle or other types of pest outbreaks.

The primary purpose of a salvage harvest is to utilize as much of the damaged timber resource as possible prior to mortality and a complete loss of merchantability. Salvage is also used to maintain or enhance forest health and aesthetics. Sometimes secondary objectives become primary or attainable following a catastrophic event. For example, restoration and recreation goals may get realigned, allowing for good management accomplishments to arise out of what appears to be a completely bad situation at the time.

Salvage operations typically involve clearcuts, but that is not always the case. A salvage operation can entail evaluating an impacted stand and thinning the damaged timber using marked-selection, while maintaining the relatively healthy trees. There is always a forest health risk involved in the determination to clearcut or thin

damaged timber. This determination is situation and site-specific and should be made following careful evaluation.

Salvage harvest operations can be used in pine stands as well as hardwoods. A variety of natural and anthropogenic factors could cause the need for a salvage harvest. For example, a hurricane may wind-throw an entire stand that would need to be salvaged, southern pine beetle outbreaks may require a clearcut for salvage, or an improper prescribed burn may cause mortality.

7.2 Reforestation

Reforestation is a core tool of sustainable forestry. The goal is to successfully establish a species appropriate for the site, while meeting landowner objectives. This process involves careful planning and selection of: artificial or natural regeneration, species, seedlings, density, site preparation**,** planting method and release. Each of these elements of reforestation are dictated by: landowner objectives, site conditions, current and forecasted timber markets, budget and other factors.

The Upland Hardwoods and Bottomland Hardwoods forest types are not artificially regenerated in Virginia at a significant scale worth discussion.

7.2.1 Artificial vs. Natural Regeneration

A selection between artificial and natural regeneration must be made during the stand and property-level silvicultural planning process. This selection is driven by landowner objectives and site-specific circumstances. However, there are pros and cons to each reforestation strategy (Table 5).

Table 5. Comparison summary of artificial and natural regeneration methods of reforestation.

	Pros	**Cons**
Artificial	More productive timber management	More expensive: seedling and planting costs
	Better stand development: form, growth	Rows may decrease aesthetics during early rotation
	More control over seedling quality through improved genetics: growth rate, disease resistance, form	More heavy equipment entry required (soil compaction, rare plants)
	Control over planting density and spacing	
	More conducive to high production management	
	Less likely to require pre-merchantable thinning (cost)	
	Can use for species conversion i.e. underplant longleaf pine	

	Pros	Cons
	Less fire exclusion time due to faster growth	
Natural	Less expensive: no seedling and planting costs	Less productive timber management
	More conducive to conservation-oriented management: uneven-aged	Poorer stand development: form, growth
	Less heavy equipment entry (soil compaction, rare plants)	Less control over seedling quality: only single tree selection thinning (seed trees)
	Lack of rows may increase aesthetics	Less control over seedling density and spacing
	Even-aged pine stands can be converted to two-aged, then uneven-aged structures	Cannot control cone/seed production
	More fire exclusion time due to slower growth (slash, loblolly, shortleaf)	May require single or multiple premerchantable release thinnings (cost)

8.2.2 Site Preparation

Adequate site preparation is required to achieve high survival rates and successfully establish a new stand of timber. The following methods can be used in various forest types for natural or artificial regeneration. Site conditions, landowner objectives and budget drive this selection. Target vegetation includes herbaceous, grasses, non-crop pines, woody shrubs and hardwood species. Site preparation is broken into three categories: chemical, mechanical and prescribed fire. These methods can be used individually or in combination. Site preparation treatments generally take place in the spring and summer months prior to winter planting.

Vegetative competition varies across sites and the appropriate site preparation technique(s) should be selected to adequately control it. Vegetative competition control *prior* to planting increases the stand establishment success. With adequate site preparation, loblolly and shortleaf pine will initiate fast, early vertical growth. For longleaf pine, adequate site preparation is essential for seedling survival.

7.2.2.1 Chemical Site preparation

The use of herbicides over mechanical treatments in site preparation has increased in the last couple decades for a variety of reasons, including increased machinery and fuel costs, increased chemical specificity, the ability of herbicides to kill the entire root of unwanted hardwoods, and the minimal impact of herbicides on soils (VDOF Pine Management 2020). Herbicide is applied based on the recommended site preparation label rate for the target and crop species and site conditions. The appropriate herbicide and chemical site preparation technique is selected to effectively target the primary woody and herbaceous vegetative competition. Site preparation herbicide is typically applied aerially by helicopter or through ground application using the broadcast or banded techniques**.**

There are site-specific VA BMPs for Water Quality related to site preparation, particularly in wetlands and streamside management zones.

The use of herbicides in chemical site preparation offers some noticeable benefits, but also have noticeable shortcomings. Herbicides can effectively provide longer-lived control of competing vegetation, which leads to an increased economic return for the landowner. Their application does not affect the soil of a site, meaning that soil compaction does not occur and the soil is protected. They can also control exotic or invasive species relatively effectively. However, there are disadvantages as well to choosing chemical site preparation, with chief among them being the cost depending on the brand used. Herbicides may also prevent a problem if used without caution, as surface runoff or spills can have potentially unintended effects on surrounding vegetation.

Each herbicide used has different characteristics that allow it to be used in specific situations and to target specific forms of vegetation. The active ingredient present within the herbicide has the greatest influence on the effectiveness of the herbicide, as it is the portion of the herbicide that negatively affects the desired vegetation (Osiecka et al. 2005). A listing of common active ingredients, along with the species targeted by the herbicide, the species resistant to the herbicide, and the proper application period can be found through the NC State 2017 Quick Guide to Forestry Herbicides Used for Softwood and Hardwood Site Preparation and Release. It is important to consult a professional forester prior to herbicide use in order to ensure correct application and usage.

Chemical site preparation techniques and application methods are varied, depending on the species present and the desired outcome of the chemical application. Herbicide labels give the types of application methods registered for each herbicide. Factors such as tract size, stand density and structure, the needed application rate, and the proper application timing are also essential to determine before selecting the proper herbicide (Osiecka et al. 2005). Below are common techniques for the application of herbicides; also, Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forests provides details concerning the chemical composition of and application methods for various herbicides.

7.2.2.1.1 All Herbicide Types

7.2.2.1.1.1 Broadcast

Broadcast applications involve herbicide being spread out over an entire area. This method of treatment is accomplished either through the air (usually by helicopter or more rarely aircraft) or on the ground through the use of machine-mounted or hand-held equipment. This is the general method utilized for site preparation, but may also be utilized for conifer release or weed control.

7.2.2.1.1.2 Band

Band applications are similar to broadcast treatments in their general application method, but are applied in strips or along rows of planted trees with ground-based equipment. This method is as effective as using broadcast for herbaceous weed control in young pine plantations, and may also provide a significant cost decrease if used properly. Annual weeds are usually more effectively controlled by this method compared to perennial weeds.

7.2.2.1.1.3 Spot

Spot applications are applied as needed to smaller areas or even individual stems, typically with hand-held spraying devices to ensure greater accuracy. If the proper species are targeted with this method, the reduction of unwanted species can be obtained at a far cheaper cost. However, these types of treatments are typically very labor intensive and can only be justified as a treatment method within areas containing a small number of problem spots needing treatment.

7.2.2.1.1.3.1 Directed Spray

Directed spray is a form of spot treatment used primarily for conifer release and occasionally weed control. The spray from hand-held spray units can be effectively directed only to the foliage being targeted while avoiding crop/plantation trees. In addition to spraying, herbicide can be applied through this method by wiping directly onto the target species with a wick applicator.

7.2.2.1.1.3.2 Basal Bark Spray

The basal bark application method involves spraying intact bark with a particular herbicide. This application type is best utilized with ester formulations with an oil carrier. With basal bark spraying, small stems can be treated by thinline spraying (herbicide applied in a narrow band 6-24 inches above stem base) or full basal (spray-to-wet) spraying (spraying the entire lower 12-20 inches of the plant to the point of runoff). Basal bark spraying can be done throughout the year as long as the bark is dry.

7.2.2.1.1.3.3 Hack and Squirt

The hack and squirt application method involves cutting or drilling into the sapwood of the tree and immediately applying herbicide to the interior of this cut. This application method is most effectively for treating large-diameter trees and requires the herbicide to be water soluble and not in an ester formulation. Hack and squirt can be done most of the year, but it is less effective before and during the Spring flush.

7.2.2.1.1.3.4 Injection

The injection method is similar to hack and squirt, except it does not involve cutting into the tree prior to application. Herbicide in this method is injected directly into the tree's interior through use of a special device. The application timing for this method is similar to hack and squirt.

7.2.2.1.1.3.5 Cut Stump

The cut stump application method involves application of a herbicide to the outer edge of a freshly-cut stump. This method is most effective on woody species that are known to resprout following being cut down.

7.2.2.1.1.3.6 Grid Application

The grid application method involves using a grid pattern when applying soil-active herbicide to an entire area. The grid pattern selected as well as the rate of herbicide application is dependent on the soils texture and woody species composition of the site. This method can be used for conifer release as well as site preparation, particularly on sites with a high density of unwanted woody vegetation.

7.2.2.1.1.3.7 Spot-Around

The spot-around application method involves the application of granular soil-active herbicide to an area around the trunks of the trees wanted to be kept. Herbicide application within this method can be in the form of small spots or a small area. This method prevents woody and herbaceous vegetation from overcrowding the target tree species.

7.2.2.1.1.3.8 Individual Stem

The individual stem (basal soil) application method involves the application of specific herbicides to the soil directly adjacent to the stems of targeted woody species.

7.2.2.2 Mechanical Site preparation

There are many mechanical site preparation methods to choose from. Some can be used on various sites, while others have very site-specific applications. All the following methods can be used with establishing all the pine forest types.

7.2.2.2.1 **Bedding**

Bedding is used on flat, wet sites to elevate the roots of seedlings and promote respiration and growth. There are various bedding machines that create beds of different heights, depending on is the moisture level of the site. Some wet sites are difficult or impossible to successfully, artificially regenerate without beds. Bedding is appropriate for timber management objectives but can have long-term negative impacts on desirable groundcover, aesthetics and hydrology. Bedding should be oriented so surface water drainage is not blocked. Bedding machines are pulled behind farm tractors, bull dozers, or more commonly, skidding machines, depending on horsepower requirements and site conditions. Bedding is typically done during the driest months of the year, September and October. For more information on bedding, go to: https://www.ncforestservice.gov/publications/Forestry%20Leaflets/FM06c.pdf

7.2.2.2.2 Roller drum chopping

Roller drum chopping is used on various pine flatwoods sites to reduce woody and herbaceous competition, but they are mostly used to help facilitate planting access on sites with thick competing cover resulting from 3-5 growing seasons. Chemical site preparation in conjunction with roller drum copping will deliver the best results when compared to roller drum chopping alone. There are various sizes of roller drum choppers with various lengths of blades. The appropriate equipment is selected based on site conditions (i.e. soil moisture, topography, etc.) and vegetation size and density. Many chopping machines can be filled with varying levels of water to achieve different degrees of vegetative impacts. For example, a site with light, herbaceous vegetation may not require the chopper to be filled, while it may be appropriate to chop a heavy gallberry site with a full drum. Choppers are pulled behind farm tractors, bull dozers, or more commonly, skidding machines, depending on horsepower requirements and site conditions. The VDOF may rent roller drum choppers as a fee under landowner services, so landowners should check before conducting these land management activities.

7.*2.2.2.3* **Scalping** and **ripping/subsoiling**

Scalping and ripping/subsoiling usually only take place on old field and pasture sites during afforestation. Scalping peels back thick, matted turf grass, creating a vegetation-free strip to plant seedlings in. Ripping or subsoiling is used in compacted soils like those found in pastures and old field sites, particularly those on clay soils.

7.*2.2.2.4* **Root raking and piling**

Root raking and piling, with an optional pile burn is a common site preparation method used to reduce debris for mechanical planting. Usually only large surface material is raked for silvicultural use, not stumps and roots as is the case during land clearing operations. The piles may be left or

burned, depending on objectives, budget, and burning regulations. Often in Virginia pile burns are discouraged due to potential smoke problems, and alternatives are provided through the VDOF. If a pile burn is absolutely necessary, it is imperative that care and research of burning regulations should be undertaken prior to a pile burn.

7.2.2.2.5 **Mowing and mulching**

Mowing and mulching can be effective mechanical site preparation in stands to be naturally regenerated, especially those with heavy fuel loads and lack of prescribed fire history. Mowing can reduce the fuel load and allow for safer, more effective site preparation burns.

7.2.2.2.6 **Harrowing/disking**

Harrowing/disking can be used on relatively clean sites or those that have been raked or burned, to create vegetation-free strips to plant seedlings in.

7.2.2.2.7 **Shearing**

Shearing involves a heavy bulldozer equipped with an oversized V-blade that shears off stumps and other vegetation and debris. This material is then piled with root rakes and typically burned. This creates a very clean planting site, ideal for establishing a pine straw stand. Shearing is most often used with bedding. If the tractor is large enough, it can shear and bed at the same time, but most often it takes two tractors, one shearing in the front and one bedding in the rear. Shearing can also be used during groundcover restoration; converting clearcut timber to pasture or crops; or shearing strips within thick competing cover to allow planting access.

7.2.2.2.8 **Logging**

Logging impacts to understory vegetation can be utilized as part of a broader site preparation plan, especially when carefully timed. In heavy fuels and understory, logging acts as an initial fuel reduction treatment that can be followed up by chemical, mechanical and/or prescribed fire site preparation.

7.2.2.2.9 **Anchor chain/dragging**

Anchor chain/dragging is an efficient way to remove dense stands of trees and shrubs (Boerr et al 1986). This method involves pulling a heavy anchor chain (~7000 lbs.) 100-500 feet between 2 bulldozers in a V-or-J-shaped loop. Steel bars may be welded to individual chain links in order to increase scarification within the soil. Dragging requires high-power machinery, and is not as effective on young, supple plants. This method is less commonly used in Virginia.

7.2.2.3 Prescribed Site Preparation Burn

Prescribed fire can be used solely or in combination with other site preparation methods. It is becoming less and less common to prescribe site preparation burns following mechanical and chemical site preparation in Virginia, although in certain circumstances the practice may be helpful. Site preparation burns typically take place in the late summer, early fall once fuels have cured, and prior to winter planting.

If timber management is not an objective, a winter site preparation burn alone and prior to planting may be adequate to establish a loblolly stand. Survival rates will likely be lower compared to more intensively prepped sites.

7.2.3 Artificial Regeneration

Artificial regeneration generally occurs after clearcutting and site preparation during the following winter months between December and March. If site preparation includes chemicals, it is best not to plant too soon after application. This is especially the case for longleaf which is known to be more sensitive to Imazapyr, the base herbicide in most chemical site preps. Referring to " VDOF's Chemical Herbicide Site Preparation" section will help ensure one is not planting too soon after chemical site prep. Planting too soon after bedding or scalping can have negative consequences as well since seedlings are more likely to be buried. Waiting after 2-4 inches of rainfall will allow soil settlement prior to planting. Table 6 provides a summary of the advantages and disadvantages of artificial and natural regeneration.

Artificial regeneration generally involves planting seedlings in rows that are spaced at a desired density. A spacing of 6' X 10' says that the seedlings are 6' apart within 10' rows. However, a random or natural pattern can be established as well using hand planting. High survival rates depend on selecting appropriate species for the site, adequate site preparation, suitable planting method, proper care of quality seedlings and natural factors such as climate and pests. A seedling survival check should be conducted following the first growing season to determine if the stand was successfully established, to document initial stocking and decide if supplemental planting is required to achieve desired stocking.

Planting density is an important consideration and is dependent on landowner objectives, available markets, budget, site conditions, cost share requirements, and other factors. The soil productivity, hydrology and natural community should be accurately evaluated during artificial regeneration planning. A density is selected that meets primary objectives such as timber, wildlife, aesthetics, and recreation. If timber management is an objective, a relatively higher density may be selected. Available pulpwood markets should have an effect on density as well. Landowners in good pulpwood markets should consider taking advantage of them by planting at a density that ensures the earliest merchantable first-thinning. Spacings of 6' X 10', 6' X 12' or 7' X 10' are common under this scenario. Other landowners, or landowners with small stands, may want to consider planting fewer trees that postpones the first-thinning, but the trees will likely be more merchantable with larger diameters and more height. Spacings of 8' X 12' or 9' X 10' are common under this scenario.

If timber management is not an objective, lower planting densities may also help meet wildlife, rare plant, and aesthetic objectives. However, due to tree biology and physiology, planting at too low of a density will result in aesthetic tradeoffs and a stand of short, shrub-like trees with excessive limbs. They will never develop into tall, straight, well-formed trees as most landowners aesthetically desire and envision their forest. A medium, balanced density that meets multiple objectives can also be considered.

Successful artificial regeneration with longleaf pine has been historically challenging, especially on wetter sites. However, in recent decades, an increase in research has led to higher quality seedling stock and more effective site preparation and reforestation techniques. This progress has resulted in higher survival rates, increasing seedling demand and more nurseries growing quality longleaf seedlings (Brockway et al.2006).

Longleaf is a good alternative to loblolly pine on less productive, sandy soils for landowners interested in managing for multiple uses. The dichotomy between managing loblolly and longleaf on flatwoods sites can be reviewed with the landowner prior to species selection. Flatwoods sites with long-term fire exclusion will be the hardest to get longleaf established and will also require longer suppression of competing shrubs such as blueberry or huckleberry. This decision is driven by the typical species selection considerations, but landowner objectives will ultimately determine the appropriate species to plant.

Although the state of Virginia has no regulation regarding survival standards, attaining 90+% survival rates with pine species can be achieved with careful reforestation planning and execution. Landowners should establish their own standard for survival prior to planting, given the site conditions. Planting a few extra seedlings for "insurance" towards a desired stocking density may also be worthwhile.

7.2.3.1 Hand Planting Vs. Machine Planting

7.2.3.1.1 Hand planting

Hand planting entails crews planting seedlings by hand. Simple equipment is needed for this method, with a planting bag to hold seedlings and a planting bar (or hoedad) to create the holes necessary for planting. Refer to Table 6 for more information on this method and a comparison with machine planting.

7.2.3.1.2 Machine planting

Machine planting involves two main methods (flatwoods planting (rubber-tired tractor) or V-blade planting). Flatwoods planting requires a cleaner site, hence more mechanical site preparation. This is due to limitations of the planting machine itself and the rubber-tired farm tractor commonly used to pull it. V-blade machine planting generally uses the same planting machine, but is pulled behind a bull-dozer with a large heavy duty "V"-shaped blade that clears large debris and creates a vegetation-free strip that seedlings are planted in. V-blade planting can handle rougher sites, and therefore does not require as much mechanical site preparation. V-blade is essentially planting and site preparation in-one, but costs more than flatwoods planting. On wetter sites, V-blade planting can result in planting seedlings in a trench, which can lead to high mortality and poor growth of the surviving seedlings. V-blade planting is particularly useful on large acreages, on acreages where planting access is difficult, or where chemical site preparation methods conflict with landowner objectives. Specific planting machines are not recommended because of variation of conditions throughout Virginia. Fortunately, a number of good machines with specialized features are available from the Department of Forestry for private rental (VDOF 2020). Refer to Table 6 or more information on machine planting. Any of these planting methods can be used to plant pine species.

Table 6. Comparison summary of hand and machine planting methods of artificial regeneration.

	Pros	**Cons**
Hand Planting	Less expensive than machine planting	More potential for human-caused error i.e. J or L rooting, seedling depth and packing issues, etc.
	Can plant rough sites without raking	Inexperienced crews require more supervision
	Experienced, supervised crews have similar quality and consistency to machine planting	

	Less groundcover impact and soil compaction	
	Easier to plant any pattern for natural look (no rows)	
	Can use for under-planting thinned stands	
	Can plant any pine or cypress species; bare root or containerized seedlings	
	Can be used on hills and steep topography	
Machine Planting (Flatwoods & V-Blade)	Less human-caused error i.e. J or L rooting, seedling depth and packing issues	More expensive than hand planting
	Generally, more consistent than hand planting	Flatwoods requires cleaner site/more mechanical site preparation
	Requires less supervision	More groundcover and soil impacts, especially V-blade
	Can plant any pine species, bare root or containerized seedlings	Harder to plant natural pattern
	V-blade requires less site preparation	Cannot under-plant thinned stands
	Ensures straighter rows for easier management	Harder to plant hills and steep topography

7.2.3.2 Under-Planting

Under-planting longleaf pine in heavily thinned loblolly stands can be used as an alternative to clearcutting for species conversion. This method fits stands where aesthetics, wildlife, and rare plants are more desired than timber management. The advantages to this method are better quality post-planting prescribed burns due to retained needlecast and better aesthetics by avoiding clearcuts. Trees with large crowns should be retained for optimal needle-cast. These overstory trees can be removed during the first longleaf thinning or retained for a multi-aged look. The disadvantage is slowed timber growth due to shading, and seedling competition originating from the overstory trees.

7.2.3.3 Seedlings

This section will focus primarily on artificial regeneration methods with pine seedlings. Large-scale artificial reforestation with hardwood species is less common than with pine species throughout Virginia. Seedling cost and management considerations often lead many landowners to use natural regeneration practices (over artificial regeneration) for large-scale hardwood regeneration efforts. However, hardwood and cypress seedlings are available in local nursery markets, mainly in containerized form. Pond and bald cypress are available in traditional, "cell" containerized form, while hardwood seedlings generally start in larger 1-3 gallon containers for landscaping markets. Hardwoods are more commonly planted on a smaller-scale, focusing on wildlife management; for example, planting white oaks adjacent to food plots for enhancing hunting programs. Cypress is often planted near pond edges for wildlife or aesthetics and small-scale wetland restoration.

7.2.3.3.1 Containerized Vs. Bare Root

7.2.3.3.1.1 Containerized seedlings

Containerized seedlings are considered higher quality and average higher survival rates but are more expensive. Containerized seedlings are more resilient during transport and storage and can be kept longer once lifted if properly stored in a refrigerated trailer (i.e., refer). Shortleaf, longleaf, and loblolly pine seedlings are available with various genetic *improvements*, such as growth rate, form and disease resistance. Improved, containerized pine seedlings are more expensive than bare root and are preferred if planting budget allows. Orders can be placed early summer to ensure needs are met and to avoid delays in planting. The ideal planting window for Virginia is from December to March in the Coastal Plain and February to early April in the mountains.

7.2.3.3.1.2 Bare root seedlings

Bare root seedlings, in comparison, generally average lower survival rates, require immediate planting once lifted, and are very vulnerable during transport and storage, yet are less expensive. Bare root seedlings are very sensitive to warmer temperatures, dry air, and direct sunlight. Bare root can have comparable survival to containerized with proper planting technique (depth, angle and packing), adequate site preparation, storage and handling.

Both seedling types' survivability increases exponentially if planted as soon as possible after lifting, stored in a refrigerated cooler (i.e., "reefer"), and/or kept under seedling tarps in the shade prior to planting. Hand, flatwoods and V-blade planting methods can be used to plant all the Virginia pine species, bare root or containerized.

7.2.3.4 Afforestation

Virginia has a long history of agricultural production such as tobacco, cotton, corn, and peanuts. These industries have remained a major income source for Virginia in recent decades, but other land uses such as resulting in land-use conversions o timber and cattle production have recently emerged. Many landowners plant various pine species on old field and pasture sites within the state.

Many of these sites were heavily fertilized or grazed and still contain high nutrient loads, especially those with heavy clay soils. This causes many pine stands to develop poor form, excessive limbs and forks and a high occurrence of fusiform rust. This effect tends to be localized and more severe on heavy soils and where cattle were fed. Landowners managing their pine for timber products generally are not concerned

with these issues. If nutrient loads are not excessive, this can have a positive fertilization-like effect on growth rates and timber production.

Old field and pasture sites will require scalping and/or ripping (subsoiling) prior to beginning the afforestation process as discussed in the site preparation section.

7.2.4 Natural Regeneration

Pine, hardwood and cypress stands can be naturally regenerated to meet various objectives, including uneven-aged management. This section will examine both hardwood and pine natural regeneration site preparation processes, although commercial hardwood management activities are far less common within Virginia. Large-scale artificial regeneration of cypress and hardwood is generally not economically feasible for most private landowners. These species can coppice and are generally clearcut and regenerated in this manner. High-graded hardwood and cypress stands (timber capable of producing the most high-value products) can be clearcut and naturally regenerated to improve timber quality and aesthetics. Reference Table 5 for general information on pine natural regeneration and a comparison between this method and artificial regeneration.

Premerchantable thinning is often required in natural pine regeneration management regimes and is discussed in the release treatment section.

Existing loblolly pine stands can be naturally regenerated to meet various objectives, including two-aged management and aesthetics. Due to the growth characteristics and product markets, this pine species is not usually managed uneven-aged, although shortleaf and longleaf stands may be. Some natural pine stands encountered may have been historically high-graded and a decision must be made on whether to clearcut and start over by planting higher quality genetics or naturally regenerate and hope for the best.

The different pine species have different annual windows of seed production. Loblolly pine produces seed annually which usually peaks in October. Longleaf seed production usually peaks in October, but only produces bumper crops every 7-10 years, while shortleaf peaks in October as well but produces bumper crops every 3-6 years. Planning for natural regeneration of pine entails evaluating the cone crop the prior Spring and carefully timed site preparation prior to fall. seed catch. Natural regeneration of pine species requires careful planning and coordination.

7.2.4.1 Site preparation

7.2.4.1.1 Pine forest types

Site preparation options are the same between pine natural regeneration methods and are like artificial regeneration site preparation. A natural regeneration harvest itself can serve as a form of site preparation. On sites with a history of prescribed fire or light fuel loads, site preparation may simply entail a carefully timed prescribed burn. Prescribed burning in spring to early summer will prepare the seed bed by scarifying the soil, promoting seed catch. Conducting prescribed burns near seed dispersal should be avoided, as seed predation will be greater due to less groundcover. Some understory regrowth is desirable, so the seeds are not completely exposed to predators. In stands with heavy fuel loads, a single site preparation burn will likely not be adequate. Establishing a fire regime and reducing fuel loads over time can allow for a successful site preparation burn in the future, or a combination of site preparation methods can be used with prescribed fire to achieve natural regeneration sooner.

Seed trees should be considered and protected as needed when conducting site preparation activities for natural regeneration.

7.2.4.1.2 Hardwood forest types

For Shortleaf Pine/Hardwood Mixed and Upland Hardwood forest types, timing of site preparation activities such as a prescribed burn has an effect on the overall survival of natural recruitment. Different forms of site preparation are recommended for hardwood forests, such as a natural regeneration harvest or clearcut. A carefully timed natural regeneration harvest typically serves as site preparation when attempting to naturally regenerate hardwood stands, while coppice can also be utilized to reforest a clearcut. The seedbank present in the soil of forests can also serve as an important source for regeneration. Following disturbance through the loss of surrounding trees or fire, seeds present in this seedbank are able to sprout and help to naturally regenerate the forest. Research has shown that fire applied at the beginning of an Upland Hardwood rotation can increase more valuable shade-intolerant species such as oaks. Other forms of site preparation previously discussed may also be utilized.

The Bottomland Hardwoods forest type can be naturally regenerated to meet various objectives, including uneven-aged timber management, timber stand improvement, wildlife and aesthetics. Mixed bottomland hardwood species can coppice and are generally clearcut and regenerated in this manner. High-graded mixed bottomlands can be clearcut and naturally regenerated to essentially start over by improving timber quality and aesthetics.

Thinning from above, shelterwood, seed tree and group selection natural regeneration harvests may also be utilized in mixed bottomlands but this is less common in Virginia.

7.2.4.2 Shelterwood

Shelterwood is generally the most effective method of natural regeneration across Virginia pine species. This entails thinning a stand to approximately 30-40 square feet per acre of basal area or about 20-50 trees per acre. Shelterwood allows for a more uniform coverage of natural regeneration across a stand. It also allows for a uniform application of prescribed fire across the site by maintaining adequate needlecast. Younger age classes are sheltered by a higher density of seed trees. Seed trees should be the highest quality in terms of crown size, form and health/vigor. Seedling growth may be slightly lower compared to seed tree method if seed trees are retained, which is optional, following successful stand establishment.

This strategy may also be utilized within Shortleaf Pine/Hardwood Mixed and Upland Hardwood forest types.

7.2.4.3 Seed Tree

The seed tree method is used throughout the varied pine and hardwood forest types. The seed tree method is like shelterwood except stands are thinned to a slightly lower basal area of approximately 10-30 square feet per acre or about 10-20 trees per acre. A good cone crop is important using this method to ensure adequate seed catch at this lower density. Seed trees should be the highest quality in terms of crown size, form and health/vigor. Seedling growth may be slightly higher compared to shelterwood if seed trees are retained, which is optional following successful stand establishment.

7.2.4.4 Group Selection

The final method of natural regeneration is group selection, which is less commonly used to naturally regenerate pine and upland hardwood forest types. These are small 0.25 - 0.5-acre clearcuts interspersed

throughout a stand. The size is critical to ensure adequate seed coverage. If they are too large, the interior portions may not regenerate adequately. Consequently, these understocked areas tend not to burn consistently due to lack of needlecast, leading to thickets of woody vegetation. Group selections can be conducted independently, but more commonly made in combination with a stand-wide thinning. Group selections can be beneficial to wildlife since they create edge and a juxtaposition of habitat.

7.2.4.5 Thinning from Above

This method of thinning can be used to release existing natural regeneration in Shortleaf Pine/Hardwood Mixed and Upland Hardwood forest types. This entails removing all or part of the dominant overstory trees, releasing the suppressed natural regeneration already in place within the midstory. This requires carefully planned logging operations so as to not destroy the desired trees being released during overstory harvest.

7.3 Release

Early and mid-rotation release treatments are common in pine management and less common in Shortleaf Pine/Hardwood Mixed forest types within Virginia. Chemical, mechanical and prescribed fire are the three primary types of treatments used to release pines from vegetative competition and promote timber production through increased vertical and diameter growth and good form. For Shortleaf Pine-Hardwood Mixed, only chemical and mechanical treatment types are utilized, as prescribed fire is not a viable tool within these forests. Target vegetation includes herbaceous, grasses, non-crop pines, woody shrubs and hardwood species. These treatments may take place in planted or natural pine stands. Merchantable thinning harvest is another form of release and discussed in the timber harvest section.

7.3.1 Chemical

Early and mid-rotation herbicide release treatments targeting vegetative competition are utilized where additional competition control is required. This is sometimes due to insufficient site preparation. Herbicide is applied based on the recommended release label rate for the target and crop species and site conditions. The appropriate herbicide and chemical release method are selected to effectively target the primary herbaceous and woody vegetative competition.

These early and mid-rotation methods include:

- Ground
  - Broadcast or banded
    - Skidder, farm tractor or All-terrain vehicle ATV-mounted sprayers
  - Spot (grid)
    - ATV or backpack sprayers
- Aerial
  - Broadcast
    - Helicopter

7.3.1.1 Herbaceous Weed Control

Herbaceous weed control is mostly utilized in recently planted pine forests that were site prepped using the bedding or V-blading technique. In the spring just after planting, herbicides are applied over the top using the band spray technique, which is the name it is also referred to as. Proper herbicides, rates and timing suppresses herbaceous weed growth, while increasing pine growth and survival.

7.3.1.2 Woody Stems/Understory

Understory trees, woody brush, and herbaceous weeds may also be suppressed using a chemical herbicide application and treatment. This treatment type is usually completed in pine forests after the first thinning using a skidder, but can involve spot treatment techniques when competition is less intense.

7.3.2 Mechanical

Early and mid-rotation mechanical release treatments targeting vegetative competition are utilized where additional competition control is required. This is sometimes due to insufficient site preparation. These treatments are like site preparation and include: mowing, chopping, mulching, and the utilization of hand tools. All four can be used for early-rotation release but caution should be used to avoid damaging young pines. Chopping may damage feeder roots in mature pines and should be avoided mid-rotation.

7.3.3 Prescribed Fire

Prescribed fire can be used as an early rotation release in shortleaf pine stands after year two, since they readily resprout after fire. Prescribed fire is an effective competitive management tool in longleaf stands beginning at year two. Broadcast prescribed burning serves as a mid-rotation release in loblolly stands.

7.3.4 Premerchantable Thinning

Pre-merchantable thinnings are common in overstocked, naturally-regenerated pine stands. These treatments reduce competition and promote proper stand development. They can also be used to improve aesthetics, wildlife habitat, and forest health. Pre-merchantable thinning is a cost, but the VDOF's PBBPP Program offers cost-share assistance for this practice. If there is enough material per acre, a fuelwood chipping operation can substitute and generate revenue or break-even. Merchantable thinning is a release treatment in older stands and discussed in the timber harvest section.

7.4 Prescribed Fire

Pine forest types

Virginia's natural communities, especially along the coastal plain region, were shaped for centuries through fires started by lightning, Native Americans and settlers. Early European settlers documented vast, open, park-like longleaf pine forests maintained with fire. Prescribed fire is a key land management tool used to maintain and restore the fire dependent natural communities of Virginia by mimicking historical, natural fire regimes and resetting succession. Prescribed fire is safely and responsibly applied to ecosystems to achieve various land management objectives such as aesthetics, wildlife habitat and biodiversity.

Prescribed fire plays a critical ecological maintenance and restoration role in pine forests, mimicking historic natural fires. Without fire, pine forests would succeed to hardwood forests in most cases.

Shortleaf and loblolly pine are fire tolerant once the bark thickens and they reach about 10-15 feet tall (depending on fuel load). Longleaf is the most fire tolerant species of all the southern pines; it can withstand fire once it is approximately one full year-old following planting. Once longleaf reaches three

to five feet in height, fire-caused mortality increases. Above six feet, longleaf is more tolerant of fire. Longleaf, loblolly, and shortleaf pine should all be burned every one-to-three years to maintain and restore the natural communities in which it is dominant and to enhance wildlife habitat, improve aesthetics, reduce vegetative competition, reduce fuel loads and stimulate rare plants.

Hardwood forest types

Aside from the previously discussed upland pine natural community (longleaf, loblolly and shortleaf pines), Shortleaf Pine/Hardwood Mixed forests are not fire dependent and rarely burn. However, their ecotones generally burn along with their adjacent fire dependent uplands. Burning these ecotones is crucial for the many rare species found there. Mixed forests with an adequate pine component will carry fire. Pure hardwood stands only entirely burn within narrow fire weather conditions.

Research, however, has shown that certain hardwood types, particularly oak-dominated communities as seen in the Piedmont and mountainous regions of Virginia, can benefit from prescribed burning although they are not necessarily fire-dependent (Van Lear et al. 1999). As fire was gradually removed from oak-dominated and other upland hardwood communities, shade-tolerant species began to dominate the understory and then the overstory as disturbance allowed them access to sunlight. On better quality sites, frequent burning has been seen to create oak-favorable environments by removing shade-tolerant understory species. This creates a bare forest floor that promotes oak regeneration through squirrel and blue jay acorn burying and also reduces soil moisture, keeping oaks at an advantage over mesophytic shade-tolerant species such as birch, maple, or hickory.

Certain factors must be considered when burning in oak-dominated Upland Hardwood of Mesophytic Hardwood forests. Oaks can tolerate high-intensity burns than shade-tolerant species due to their sprouts originating deeper in the soil and greater energy for sprouting stored in their roots (Brose and Van Lear 1998); therefore, a high-intensity burn at the beginning of a stand's origination will help to favor oak regeneration. Oaks have the greatest amount of energy storage in the roots during the dormant season, making this a favorable time to conduct burns to promote oaks.

As prescribed burning within hardwood forests is dependent on a variety of factors, it is essential to consult a resource professional prior to attempting a burn. This consultation can provide further information on how and when the burn will be the most effective for a specific purpose.

Bottomland Hardwoods forest types are not fire dependent and burn infrequently, with cypress dominated ponds slightly more frequent than gum-dominated. However, their ecotones generally burn along with the fire dependent uplands they are embedded within. Burning these ecotones is crucial for the many rare species found there. The interior portions of the BH forests generally contain thick duff and muck layers, which rarely burn. If it is an objective to reduce the understory or midstory of one of these ponds with fire, the soil needs to be moist as to avoid a peat fire. Peat fires can burn for months during droughts and cause serious smoke management and safety issues

7.4.1 Advantages of Prescribed Fire

There are many benefits to using prescribed fire to meet land management objectives. This practice reduces fuel loads, which directly lowers the risks and hazards associated with catastrophic wildfires. If a

wildfire occurs in an area with a history of prescribed fire, the intensity and severity of that wildfire will be substantially less compared to areas without.

Prescribed fire opens the mid and understories by consuming overgrown vegetation and dead fuels. This stimulates many species of grasses, forbs and herbs. The result is an open, lush, scenic understory that is aesthetically pleasing. Stands maintained with prescribed fire have more plant and wildlife biodiversity compared to fire suppressed stands. Even old field sites planted with pines develop a more diverse understory compared to those without fire. This diverse, open understory is also beneficial to many species of wildlife, including several rare species such as the red cockaded woodpecker, which requires this fire-maintained structure. Likewise, allowing fire to burn through isolated and ephemeral wetlands within forest stands is beneficial for diversity in those natural communities.

Prescribed fire increases the nutrient content of forage species and the mast productivity of species such as blueberry (*Vaccinium* spp.). Wildlife prefer this nutrient and mast-rich understory. Pines and other plant species receive a post-burn flush of nutrients through increased nutrient cycling.

Landowners also enjoy this fire-maintained understory for the improved access and beautiful, open views it provides. This enhances recreational activities such as hunting, wildlife viewing and hiking. Prescribed fire also reduces many forest pests. This also improves outdoor recreational experiences and helps reduce the spread of tick-borne illnesses such as Lyme disease and rocky mountain spotted fever.

7.4.2 Disadvantages of Prescribed Fire and Ways to Mitigate

Inappropriately applied prescribed fire can reduce growth rates and lead to mortality in pine stands. Excessive heat can scorch crowns and cause damage to feeder roots and inner bark. Excessive scorch alone may just slow growth and cause isolated mortality. When excessive scorch is combined with other stress factors such as poor soil quality, offsite species, overstocking and drought, widespread mortality may occur (FDACS 2012-2019). Southern pine beetle *(Dendroctonus frontalis*), ips beetle (*Ips* spp.), or black turpentine beetle (*Dendroctonus terebans*) outbreaks are more likely to occur following excessive scorch.

There are ways to mitigate these negative impacts. Cool, dormant season burns can be utilized initially until fuel loads are reduced, especially in long-unburned stands. Thick duff layers can be reduced slowly over time by only burning following precipitation to avoid damaging feeder roots. Appropriate firing techniques should be selected considering overstory species, stand structure, burn objectives, desired fire intensity and severity, fuels (type, loading, structure) and weather conditions.

Fire is inherently dangerous, so a certain level of risk comes along with conducting prescribed burns. Tied to that risk is the liability if a burn does not go as planned which causes many landowners to avoid prescribed burning. Landowners have the option to transfer that liability by hiring a state or private contractor to conduct their burning. Virginia has strong prescribed fire statutes which protect safe, responsible prescribed burn managers (Code of Virginia Certified Prescribed Burning Manager Program 1998). Much of prescribed burning revolves around the weather and even with careful planning and forecasting, the weather can change. Most other preparation and implementation factors can be controlled. Burn planning is crucial and may include:

- Thorough burn prescription development
- Weather forecasting and observations
- Smoke management and screening
- Gathering resources

- Notification of neighbors, the public and local emergency responders
- Having a contingency plan in place

Documentation and record keeping of prescribed fire planning and activities is encouraged.

7.4.3 Methods of Prescribed Fire

7.4.3.1 Broadcast Burning

The act of burning acreage to meet various objectives is referred to as broadcast burning. Broadcast burning includes burning uplands or wetlands. It is the most common type of prescribed fire. Broadcast burning is used to meet various objectives including: fuel reduction, ecological maintenance and restoration, wildlife habitat management, aesthetics and imperiled species management.

7.4.3.2 Site Preparation Burns

Site preparation burning is a form of broadcast burning that prepares sites for artificial or natural regeneration. Site preparation burns reduce vegetative competition, improve access and operability for planting and scarify the soil for seed catch. They also meet some of the same objectives as broadcast burning.

7.4.3.3 Pile Burns

Pile burning is a form of site preparation burning. Large post-harvest debris within clearcuts are raked into scattered piles and burned. The objective is reducing logging to improve access and operability for machine planting. Pile burning is not used to reduce vegetative competition. A site preparation burn may incorporate pile burning. Often in Virginia pile burns are discouraged due to potential smoke problems, and alternatives are provided through the VDOF. If a pile burn is absolutely necessary, it is imperative that care and research of burning regulations should be undertaken prior to a pile burn. When pile burning it is essential to manage the smoke production adequately in order to prevent adverse smoke effects.

7.4.4 Fire Return Intervals

Fire return interval is the frequency at which a burn unit will be burned. This is site-specific and primarily dependent on landowner objectives, budget, forest type, fuel conditions and fire history. Determining the appropriate fire return interval at the burn unit level is vital to a successful burn program.

Loblolly, shortleaf, and longleaf pine should all have prescribed fire every-one-to-three years. This can be adjusted based on the factors listed in the previous paragraph.

7.4.5 Seasonality

Seasonality plays an important role in a prescribed fire program and should be carefully considered to help meet specific objectives. Seasonality should be varied over time, avoiding burning the same stands, during the same season.

Historically, in Virginia, most natural fires were caused by lightning and occurred mainly during the early growing season (March-May) when storms, high winds, and low relative humidity were the most common. Many plant species adapted to this seasonality and require fire in the spring or summer months to

reproduce. For example, wiregrass produces optimal seed when burned in the Spring. Growing season prescribed fire promotes a higher density of grasses, forbs and herbs and lower density of woody species such as blueberry, huckleberry, and hardwoods. Growing season burns also reduce fuel loads quicker and result in delayed woody regrowth. If wildlife management is the focus, growing season burns often result in excellent habitat. If isolated wetlands such as cypress ponds or depression marshes need woody species reduction, a Spring burn would be ideal.

However, growing season burns are challenging due to increased potential for scorch caused by higher ambient temperatures. Growing season prescribed burns are ideal for sites with lighter fuel loads or those with a history of prescribed fire. Additionally, not all historic fires occurred during the growing season. The southern pine beetle's main dispersal is in the Spring when trees are already drought stressed. Adding additional stress caused by a hot prescribed burn may lead to an outbreak. Pines are also susceptible to mortality caused by crown scorch during Spring due to bud elongation.

Dormant season burns generally occur between December and February, as the name implies, which promotes more woody species stems per acre and less grass, forb and herbaceous ground cover. However, more legumes respond to dormant season fires than growing season fires. Dormant season burns safely and slowly lighten fuel loads, but post-burn woody regrowth occurs faster, since they have the whole growing season to recover. Dormant season burns are generally easier to conduct due to cooler temperatures, less intense fire behavior, consistent winds and higher fuel and soil moisture. Pine trees are in dormancy during the winter months so impacts from scorch are not as dramatic but should still be kept to a minimum. There are generally more available burn days in dormant season. There is less potential for dormant season burns to stress pines or lead to mortality issues.

Dormant season burns are ideal for sites with heavier fuel loads or those little to no burn history. For example, reintroducing fire to a dense pine plantation with a thirty-year rough (i.e. time since the last burn) would be most successful using a dormant season burn. If desired, burning can be transitioned to the growing season after one to two initial dormant burns. If wildlife management, groundcover and biodiversity are not objectives, but timber management is, dormant season prescribed fire is a better fit. A dormant season burn can substitute for a scheduled growing season burn if winter conditions are more favorable, avoiding missing an entire year.

Young, developing longleaf pine stands are typically burned during this season before terminal bud elongation. A general rule of thumb is burn to using the Dot Fire technique within these weather conditions: RH 35-70%, Temps 45-65F, and winds 5-10MPH. These conditions are usually found in the morning hours before 2:00PM. The dot fire technique involves placing a backfire on the downwind side before placing dots (spots) of fire upwind on a 2 chain X 2 chain grid.

Fall burns are typically not conducted under pines since they are transitioning into dormancy and very susceptible to mortality during this time. If excessive scorch occurs, pines may not have adequate needles to survive until spring. Fall tends to be the driest or second driest time of year in Virginia and there is a Fall southern pine beetle dispersal, so adding another stressor is risky. If maintaining quality groundcover is an objective, Fall burns are generally avoided since many grasses and herbaceous species flower and seed in the fall. However, if pine dormancy has begun early, the fuel load is light and appropriate lighting techniques are used, it is possible to successfully conduct a Fall burn. This may be beneficial where hardwood reduction is an objective as they are also vulnerable in the Fall. Burning in the fall also allows an early start to long burn seasons with ambitious acreage goals.

7.4.6 Fire Weather

One of the most important considerations in planning and conducting a prescribed burn is fire weather. Burn prescriptions contain a section with desired, forecasted and actual fire weather for a burn unit. The United States Forest Service's (USFS) "A Guide for Prescribed Fire in Southern Forests" is an excellent resource for burn managers in the region and contains recommendations and detailed descriptions of the following fire weather factors (Wade and Lunsford 1989). For a Virginia-specific resource on fire weather and related resources within the state, the VDOF provides a multitude of links to various sources describing the impacts of weather on fire and fire safety.

Relative humidity (RH) is the amount of moisture in the air in relation to the air temperature. RH is the main factor affecting spotting potential and also affects fire intensity and fuel availability. Various fuel sizes are affected differently by RH. Fine fuels like grasses and leaves are more responsive to RH. They absorb and release moisture much faster compared to the slower responses of heavier fuels like branches and logs. Relative humidity is a factor in whether a fuel will burn and how well it will burn. This is important within the burn unit, but also when using natural firebreaks such as hardwoods. Temperature is a major factor in RH, fire intensity, scorch potential, and live fuel moisture. Wind speed and direction affects fire intensity, rate of spread, smoke management and spotting potential. Dispersion index is essentially a measure of atmospheric stability which is directly related to smoke and heat lift. It also affects scorch potential. Live fuel moisture is a measure of the amount of moisture in live vegetation. This affects fuel volatility, availability and fire intensity. Days since last rain affects live fuel moisture, fire intensity, drought indices, and the ability of natural firebreaks such as hardwood stands or wetlands to hold fire. The Keetch-Byram Drought Index (KBDI) is an indicator of drought severity and may help determine if a prescribed burn can take place. It measures soil and duff layer moisture assuming there are eight inches of moisture available to vegetation in a saturated soil. During burn planning, KBDI can help indicate how wet duff layers and wetlands might be.

7.4.7 Prescribed Burning Regulations

Prescribed burning in Virginia must be carried out according to the state rules and regulations. In the VA Code of Laws, Article 6.1, Section 10.1-1150.4 Prescribed Burn Elements requires persons doing outdoor burning to (1) have a prescribed burn manager and (2) for this manager to ensure that the prescribed burn is conducted in accordance with the predetermined prescription.. Go to https://law.lis.virginia.gov/vacode/title10.1/chapter11/section10.1-1150.4/ for the complete wording of this law. Also, the VDOF forbids burning between 10 AM and 4 PM from February 15 until April 30.

Article 6.1 Section 10.1-1150.5 provides information on limited liability protection for persons who have been certified as Prescribed Fire Managers. To be become a Certified Prescribed Fire Manager, an individual must successfully complete a training program which includes a written exam. The course is geared toward persons with considerable fire management experience. They must also provide documentation of practical experience in prescribed burning. In addition, they must agree to conduct all burning in compliance with all applicable laws and ordinances.

The VDOF also presents guidelines for controlling prescribed burns and their smoke output in their "Voluntary Smoke Management Guidelines for Virginia" within the Guide to Prescribed Fire in Virginia.

7.5 Fertilization

Fertilization can be utilized on nutrient poor soils in Virginia. Loblolly pine on flatwoods sites responds to fertilization. Fertilization uptake is dependent on soil composition (i.e. sand versus clay, drainage) among other factors. Bedding on some poorly-drained flatwood sites will sometimes make more nutrients available, reducing

the need to fertilize. Excessive fertilization may cause fusiform rust issues and trees to retain limbs longer, both contributing to the degradation of their form. Fertilizer label rates, material safety data sheets and (Moorehead 1998) provide additional guidance on application procedures and rates.

8.0 Acronymic Key

Abbreviation	**Name**
021 Form	ATFS Inspection Form
ACF	Association of Consulting Foresters
AFF Standards	AFF Standards of Sustainability
ALRI	America's Longleaf Restoration Initiative
ATFS	American Tree Farm System
ATV	All-Terrain Vehicle
BH	Bottomland Hardwoods
BMP	Best Management Practice
BR	Blue Ridge ecoregion
BTB	Black Turpentine Beetle
CCAA	Candidate Conservation Agreement with Assurances
CI	Conservation Initiative
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
EAB	Emerald Ash Borer
ECOS	Environmental Conservation Online System
EGM	European Gypsy Moth
EIN	Employee Identification Number
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FCV	Forest Conservation Value
FHTET	Forest Health Technology and Enterprise Team
FMV	Fair Market Value
FORI	Forests of Recognized Importance

FSA	Farm Service Agency
FSP	Forest Stewardship Program
FSP Standards	FSP National Guidelines and Standards
GIS	Geographic Information System
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IOBC	International Organization for Biological Control
IPM	Integrated Pest Management
KBDI	Keetch-Byram Drought Index
LLC	Limited Liability Company
LLPI	Longleaf Pine Initiative
LMP	Landscape Management Plan
MACP	Middle Atlantic Coastal Plain ecoregion
NBCI	National Bobwhite Conservation Initiative
NCREIF	National Council of Real Estate Investment Fiduciaries
NNIA	Non-Native Invasive Animal
NNIP	Non-Native Invasive Plant
NNIS	Non-Native Invasive Species
NP	Northern Piedmont
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NTFP	Non-Timber Forest Product
NWF	National Wildlife Federation
NWOS	National Woodland Owner Survey
NWQI	National Water Quality Initiative
OHV	Off-Highway Vehicle
OSB	Oriented Strand Board
PEFC	Programme for the Endorsement of Forest Certification
PBBPP	Pine Bark Beetle Prevention Program
QTP	Qualified Timber Property

RFBTC	Riparian Forest Buffer Tax Credit program
RCW	Red-cockaded Woodpecker
REIT	Real Estate Investment Trust
RH	Relative Humidity
RT	Reforestation of Timberlands
SAF	Society of American Foresters
SFC	Southern Forestry Consultants
SMZ	Streamside Management Zone
SP	Southeastern Plains ecoregion
SPB	Southern Pine Beetle
SPI	Shortleaf Pine Initiative
Support Committee	Landscape Management Plan Development Support Committee
T&E	Threatened and Endangered Species
TIMO	Timber Investment Management Organization
UH	Upland Hardwoods
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VDACS	Virginia Department of Agriculture and Consumer Services
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDHR	Virginia Department of Historic Resources
VDOF	Virginia Department of Forestry
VSWCD	Virginia Association of Soil and Water Conservation Districts
WQIF	Water Quality Improvement Fund
WBD	Water Boundary Dataset
WLFW	Working Lands for Wildlife
WUI	Wildland Urban Interface

9.0 References

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