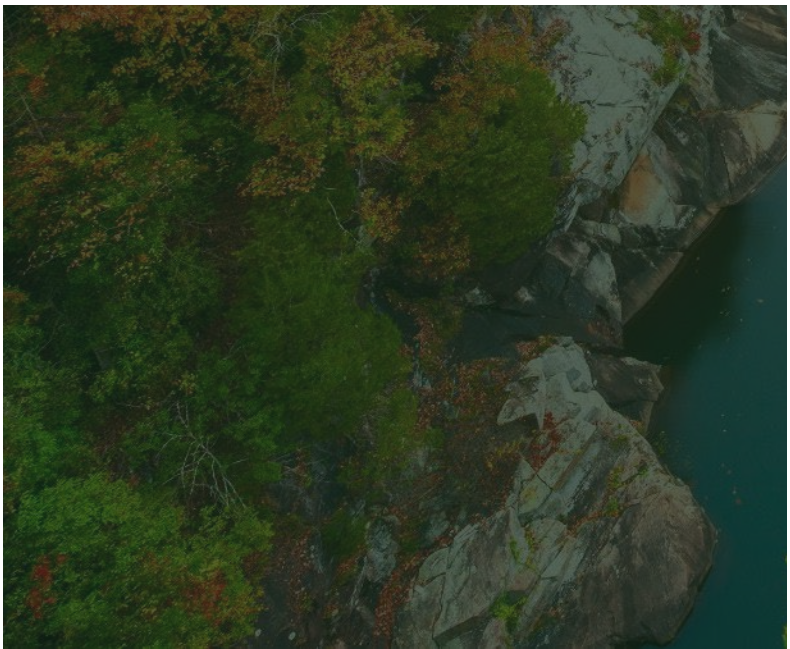
AMERICAN TREE FARM SYSTEM®

LANDSCAPE MANAGEMENT PLAN

State of Georgia



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 and geodatabase.

Natural Resource Professional Support Committee

AFF consulted regularly with staff from the Georgia Forestry Commission (GFC) to seek their input on various thematic, structural, and scientific components through multiple drafts of this LMP. Additionally, GFC 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:

- American Forest Management
- Association of Consulting Foresters
- Belle W. Baruch Foundation
- Bishop Brothers Forestry Consultants
- Boise Cascade Company
- Four W Forestry Group
- Georgia Conservancy
- Georgia Department of Natural Resources
- Georgia Farm Bureau
- Georgia Forestry Commission
- Georgia-Pacific Corporation
- Georgia Tree Farm
- Georgia Wildlife Federation
- Interfor Corporation
- International Paper Company
- Longleaf Alliance
- National Wild Turkey Federation
- Palmetto Conservation Foundation
- Pee Dee Land Trust
- Pinova Solutions
- Preservation Tree, LLC
- Quality Deer Management Association
- Southern Regional Extension Forestry
- The Nature Conservancy
- University of Georgia
- US Army – Fort Jackson
- US Fish & Wildlife Service
- USDA Farm Service Agency (FSA)
- USDA Forest Service
- USDA Natural Resources Conservation Service (NRCS)
- WestRock Company
- Weyerhaeuser Company

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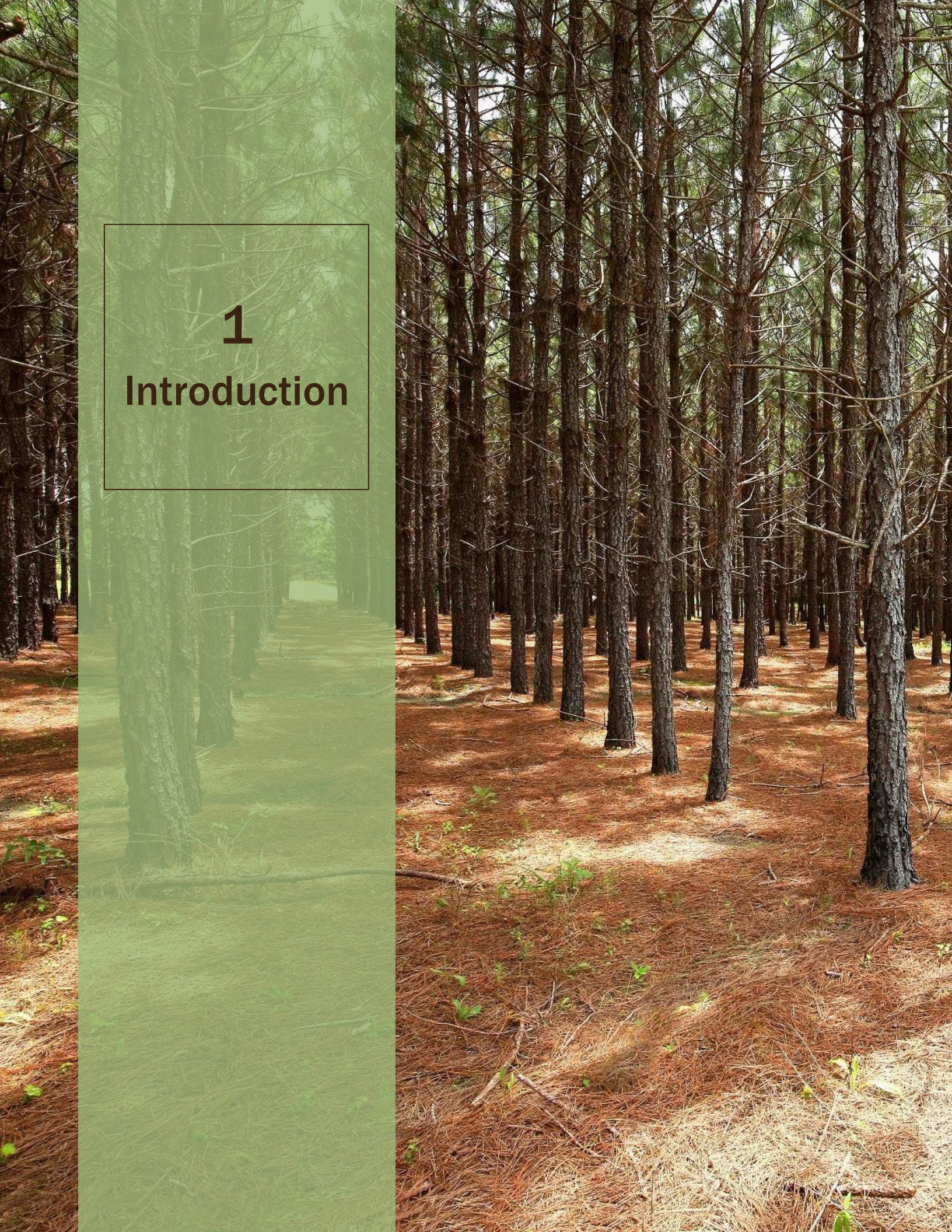


1
Introduction

1. 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 GFC State 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 Georgia 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 on 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 Georgia. 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:

- AFF 2021 Standards of Sustainability for Forest Certification (Standards)
- Forest Stewardship Program (FSP) National Standards and Guidelines (Standards)
- Georgia Forest Stewardship Program
- Georgia Statewide Forest Resources Strategy (Forest Action Plan)
- Georgia State Wildlife Action Plan
- United States Department of Agriculture (USDA) National Woodland Owner Survey (NWOS) Results and Observations (Butler et al 2016)
- Georgia Forestry Commission Best Management Practices
- National Register of Historic Places (NRHP) and the Georgia Department of Archives and History (GDAH)

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 registration boards, 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 ATFS also recognizes the importance of these forestry professionals by establishing specific eligibility requirements and recertification standards of all ATFS inspectors.

The Georgia 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. Also, landowners may make use of the excellent resources provided by the GFC, such as the Consulting Forester Directory, Forestry Services Contractors Directory, or Master Timber Harvester Directory.

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 and southern Georgia following the landfall of Hurricane Michael in 2018. An unprecedented storm for the panhandle of Florida and southern Georgia, Michael damaged an estimated 2.8 million acres of timber in Florida, 1 million acres in Georgia, and caused 95% damage to 34,000 acres within Bay, Calhoun, and Gulf counties in Florida, while the Georgia counties of Baker, Calhoun, Clay, Crisp, Decatur, Doughtery, Early, Grady, Laurens, Lee, Miller, Mitchell, Randolph, Seminole, Terrell, Thomas, Tift, Turner, and Worth all received individual federal assistance through the Federal Emergency Management Agency (FEMA); 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 investigate assistance toward their recovery efforts in the form of available cost share programs. For example, the Emergency Forest Restoration Program (EFRP) offered by the USDA's Farm Service Agency (FSA) inspects land for eligible damage and provides payments to owners of private forests to restore qualified forests damaged by disasters. One example of this occurred recently in South Carolina following Hurricane Florence; the flooding caused by the storm destroyed many recently planted pine forests and washed-out forest roads, bridges, and culverts. Available EFRP funds were used to reforest these planted stands and assist in the repair of forest infrastructure. The Georgia Department of Revenue in 2019 also began offering a Timber Tax Credit for eligible timber owners impacted by Hurricane Michael; other states offer similar programs and initiatives in the wake of natural disasters. Federal tax laws provide for casualty loss and income tax considerations/deductions as a result of natural disasters. State-specific programs should be sought to offset hurricane damage in every state affected.

Landowners must also be knowledgeable of the procedures to take following natural disasters that impact their forests. A timely salvage of the downed timber is essential to maintaining a healthy forest operation, as downed timber attracts harmful forest pests such as Southern Pine Beetle and Ips Beetle and also prevents future reforestation efforts (Natural Disaster Recovery, Georgia Forestry Commission; Assessing Hurricane and Tornado Storm Damaged Forest Stands, UGA Extension). These forest pests, if attracted by the downed timber, could rapidly spread throughout a pine stand (Gandhi et al., 2019). If the timber stand is moderately (30-50% trees blown over or broken) or heavily (>50%) damaged, it may be necessary for affected trees to be removed for salvage. Another benefit of the removal of affected timber is the decrease in the risk of out-of-control wildfires due to the accumulated downed fuel load. In some states, such as Florida following Hurricane Michael (Florida Department of Agricultural and Consumer Sciences), additional prescribed burning requirements and regulations may be instituted to monitor and protect burning on sites with a high percentage of downed timber. These additional regulations can help prevent fires from reaching too high of a temperature due to the increased fuel load on the ground, protecting surrounding areas and populations. As Georgia is squarely within the path of major Gulf or Atlantic hurricanes and has the potential for future similar levels of devastation through any number of various natural disasters, it is important for landowners to know how to manage their land in the event of such a disaster. Additional information concerning forestry cost share programs can be found below in Section 7.1.1 Conservation Incentives. There, you can receive guidance concerning evaluating damaged trees, forest health issues, tax issues/steps post-hurricane, and attempting to salvage timber already affected.

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. **2021 ATFS 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:

ⓘ 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 current forest conditions at the time of plan development, landowner's current objectives, 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.

How the LMP Covers this Section:

This LMP serves as the written management plan for all participating landowners in state of Georgia. 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 appropriately 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 Natural Resources, local Natural Resource Conservation Service office or State Forestry Commission 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** Reforestation or afforestation shall achieve adequate stocking of desired species reflecting the landowner's objectives, within five years after regeneration harvest, or an appropriate time frame for local conditions, or within a time interval as specified by applicable regulation. Native species that are well-adapted to site conditions shall be preferred. Only those introduced species, provenances or varieties shall be used whose impacts on the ecosystem and on the genetic integrity of native species and local provenances have been scientifically evaluated, and if negative impacts can be avoided or minimized.
- **Indicator 3.1.2** Landowners shall consult with a qualified resource professional to ensure that proposed afforestation does not have a negative ecological impact or degrade ecologically important non-forest ecosystems. Afforestation shall not occur if the evaluation determines that a negative impact or degradation is likely.

How the LMP Covers this Section:

- Under each of the forest types outlined in this LMP, information is provided on the different strategies to achieve success in reforestation and afforestation efforts. The state of Georgia 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 form to ensure conformance.

STANDARD 4 Air, Water and Soil Protection

Performance Measure 4.1 Landowner shall meet or exceed practices prescribed by State Forestry BMPs that are applicable to the property.

- **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). Activities in riparian zones and wetlands shall comply with applicable BMPs.

Performance Measure 4.2 Landowner shall consider a range of forest management activities to control pests, pathogens and unwanted vegetation.

- **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. Landowners or their designated representative shall document pesticide usage.

Performance Measure 4.3 When used, prescribed burns shall conform with landowner's objectives and all applicable rules, laws, and regulations.

- **Indicator 4.3.1** Prescribed burns 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 agree to meet or exceed all Georgia Best Management Practices for Forestry (GA BMPs for Forestry), even those that are voluntary, which are applicable to the property. When planning management activities that will cause any soil disturbance or require chemical application, the GA BMPs for Forestry should be consulted and applicable BMP methods should be 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.

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 other current 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.

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.

Landowners are encouraged to maintain records of forestry related activities for at least three years.

STANDARD 6 Forest Aesthetics

Performance Measure 6.1 Landowner should manage the visual impacts of forest management activities consistent with landowner objectives, 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 or designated representative shall monitor forest product harvests and other management activities (1, 2) to ensure they conform to their 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 harvest, utilization and removals, regional norms and accepted practices 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) and Georgia's Forest Stewardship Program encourage 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. 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:

ⓘ 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
- 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)
- Conservation-based estate planning / 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 ❶ Preparing to Meet the Landowner

- Use the current LMP geodatabase 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 relevant system of when follow-up should occur.
- Contact the landowner within an acceptable time frame year 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 ❶ Preparing to Meet the Forester

- Use the current LMP geodatabase (if accessible) to locate and characterize the natural features present on your property, or have these features in mind
  - 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 that you have for your land, potential landscape objectives, target forest type(s), and the geodatabase review may be applicable. Landowners should 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 one year 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

Site Specific Characterization Through Geodatabase Tools

2. SITE SPECIFIC CHARACTERIZATION THROUGH GEODATABASE TOOLS

To adequately determine the existing conditions, present on any reference site evaluated using this LMP, a GIS-based evaluation tool was developed for this process. This geodatabase represents the accumulation and organization of the most site-specific geospatial characterization tools that are publicly available within the LMP. The strategic goal of this geodatabase is to provide forest resource professionals with a geospatial tool that presents tabular data helpful in developing forest management goals and recommendations.

2.1. Instructions for Use

This geodatabase will require a geographic information system (GIS) to view, summarize and manipulate both the geospatial and tabular data included. Numerous fee-based and free shareware style geospatial applications are available and accessible for natural resource professionals, including both GFC foresters as well as consulting foresters across the state.

The geodatabase is designed to allow the user to calculate and summarize data for each geodatabase layer on the landowner's parcel of property. By selecting the landowner's tract location using publicly available county tax records, the exact location of the reference parcel can be identified. Multiple parcels can also be selected simultaneously if landowner property boundaries encompass multiple tax parcels. After identifying the referenced property, users can toggle and select between individual and/or multiple geospatial resource layers that will present summarized tabular data for the selected location. For instance, a user could determine the haul distance to specific product mills and develop detailed soil and potential hydrologic impact maps to determine harvesting operations. Likewise, users could quickly determine which potential threatened and endangered species or nearby invasive species could be present on their referenced site.

2.2. Geodatabase Layer Descriptions

The following 23 geospatial layers and aerial imagery layer comprise the LMP geodatabase used for site specific characterization of subject landowner properties. Each layer is referenced by its name within the geodatabase and information is provided about the source layers' name, location, and a brief description of the content found within the layer.

Historical Structures

- Layer Source Name: –GNIS Cultural Features - 1996, Georgia GIS Clearinghouse
- Description: This dataset contains point locations of cultural features located throughout Georgia. This data is an extract from the Geographic Names Information System (GNIS) compiled by the U.S. Geological Survey.
- Layer Source Location: https://data.georgiaspatial.org/index.asp?body=preview&dataId=11422

Cemeteries Polygon

- Layer Source Name: Cemeteries
- Description: OpenStreetMap is *open data*: you are free to use it for any purpose as long as you credit OpenStreetMap and its contributors. If you alter or build upon the data in certain ways, you may distribute the result only under the same license. See the Copyright and License page for details.

- Layer Source Location: https://mygeodata.cloud/data/download/osm/cemeteries/united-states-of-america--georgia

Wetlands

- Layer Source Name: National Wetlands Inventory 2023
- Description: This data set represents the extent, approximate location and type of wetlands and deepwater habitats in the United States and its Territories. These data delineate the areal extent of wetlands and surface waters as defined by Cowardin et al. (1979), which represents a biological definition of wetlands and deepwater habitats. There is no attempt to define the limits of proprietary jurisdiction of any Federal, State, or local government, or to establish the geographical scope of the regulatory programs of government agencies. Some wetland habitats may be under represented or excluded in certain areas because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and near shore coastal waters and also some deepwater reef communities (coral or tuberficid worm reefs). These habitats, because of their depth and water clarity, go undetected by most aerial imagery. By policy, the Service also excludes certain types of "farmed wetlands" as may be defined by the Food Security Act or that do not coincide with the Cowardin et al. definition. Contact the Service's Regional Wetland Coordinator for additional information on what types of farmed wetlands are included on wetland maps. This dataset should be used in conjunction with the Wetlands_Project_Metadata layer, which contains project boundaries, specific wetlands mapping procedures and information on dates, scales and emulsion of imagery used to map the wetlands within specific project boundaries.
- Layer Source Location: https://www.fws.gov/program/national-wetlands-inventory/download-state-wetlands-data

Hydrologic Units

- Layer Source Name: Watershed Boundary Dataset – 2023, USGS
- Description: The Watershed Boundary Dataset (WBD) is a nationally consistent watershed dataset that is subdivided into 6 levels (12-digit HUCs) and is available from the USGS and USDA-NRCS-National Cartographic and Geospatial Center's (NCGC).
- Layer Source Location: https://water.usgs.gov/GIS/huc.html

Hydrography

- Layer Source Name: National Hydrography Dataset, 2023
- Description: The NHDPlus HR is a geospatial dataset depicting the flow of water across the Nation's landscapes and through the stream network. The NHDPlus HR is built using the National Hydrography Dataset High Resolution data at 1:24,000 scale or more detailed, the 10 meter 3D Elevation Program data, and the nationally complete Watershed Boundary Dataset.

  The NHDPlus HR framework connects the hydrologic network seamlessly across the terrain by including not only streams, but also associated catchment areas that drain to each stream segment. This association allows information about the landscape to be related to the stream network. Using tools such as the Hydrography Event Management (HEM) tool, observational data on the stream network, such as water quality samples, streamgage measurements, or fish distribution, can be linked to the framework.
- Layer Source Location: https://www.usgs.gov/national-hydrography/access-national-hydrography-products

Listed Species

- Layer Source Name: U.S. FISH AND WILDLIFE SERVICE ENVIRONMENTAL CONSERVATION ONLINE SYSTEM (ECOS) FEDERALLY LISTED SPECIES CRITICAL HABITAT-2024, USFWS
- Description: This data set represents federally listed species known to be present in each of the counties that make up Georgia within the U.S. Fish and Wildlife Service. The Environmental Conservation Online System (ECOS) is a gateway web site that provides access to data systems in the U.S. Fish and Wildlife Service (Service) and other government data sources. This central point of access assists Service personnel in managing data and information, and it provides public access to information from numerous Service databases. As of 02/13/2015 the data in this report has been updated to use a different set of information. Results are based on where the species is believed to or known to occur. The FWS feels utilizing this data set is a better representation of species occurrence. Note: there may be other federally listed species that are not currently known or expected to occur in this state but are covered by the ESA wherever they are found; Thus, if new surveys detected them in this state they are still covered by the ESA. The FWS is using the best information available on this date to generate this list. The data is not meant as a substitute for site-specific surveys. The code key below and in the User Notes, denotes the species designation. Code Key: E=Endangered, T=Threatened, PE=Proposed Endangered, PT=Proposed Threatened, C=Candidate, BGEPA=Bald and Golden Eagle Protection Act.
- Layer Source Location: https://ecos.fws.gov/ecp/report/table/critical-habitat.html

United States Fish and Wildlife Service (USFWS) Approved Acquisition Boundaries – July 2019

- Layer Source Name: FWSApproved_for_Acquisition_July_2019
- Description: This data layer depicts the external boundaries of areas approved for acquisition of lands and waters by the U.S. Fish and Wildlife Service (USFWS) in North America, U.S. Trust Territories and Possessions from willing sellers. This boundary does not represent the lands and waters administered by the USFWS. That data is found in the FWS National Realty Tracts GIS layer. The primary source for this information is the USFWS Realty program.
- Layer Source Location: https://ecos.fws.gov/ServCat/Reference/Profile/163197

Sea Level Rise

- Layer Source Name: GA_slr_0 through 10 ft
- Description: These layers show the rise of sea level from 0-10 feet.
- Layer Source Location: https://coast.noaa.gov/slrdata/

EDDMaps

- Layer Source Name: EDDMaps
- Description: Point data of invasive species collected by EDDMaps users.
- Layer Source Location: https://www.eddmaps.org/tools/

Counties

- Layer Source Name: Counties, Georgia, Atlanta Regional Commission – Jul 2021
- Description: This layer was developed by the Research & Analytics Division of the Atlanta Regional Commission and represents the counties in the entire state of Georgia.

- Layer Source Location: https://arc-garc.opendata.arcgis.com/datasets/dc20713282734a73abe990995de40497_68

Roads

- Layer Source Name: Georgia Primary and Secondary Roads State-Based Shapefile - 2023
- Description: The TIGER/Line shapefiles and related database files (.dbf) are an extract of selected geographic and cartographic information from the U.S. Census Bureau's Master Address File / Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) Database (MTDB). The MTDB represents a seamless national file with no overlaps or gaps between parts, however, each TIGER/Line shapefile is designed to stand alone as an independent data set, or they can be combined to cover the entire nation.

  Primary roads are generally divided, limited-access highways within the interstate highway system or under State management, and are distinguished by the presence of interchanges. These highways are accessible by ramps and may include some toll highways. The MAF/TIGER Feature Classification Code (MTFCC) is S1100 for primary roads. Secondary roads are main arteries, usually in the U.S. Highway, State Highway, and/or County Highway system. These roads have one or more lanes of traffic in each direction, may or may not be divided, and usually have at-grade intersections with many other roads and driveways. They usually have both a local name and a route number. The MAF/TIGER Feature Classification Code (MTFCC) is S1200 for secondary roads.

- Layer Source Location: https://catalog.data.gov/dataset/tiger-line-shapefile-2019-state-georgia-primary-and-secondary-roads-state-based-shapefile

Soil

- Layer Source Name: SSURGO_Soil_Data_GA
- Description: This dataset contains the boundaries and descriptions of soil types.
- Layer Source Location: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

ICLUS Population Projections

- Layer Source Name: ICLUS v2.1.1 Population Projections, 2023
- Description: The methodology used to produce these projections differs from ICLUS v2.0 (https://www.epa.gov/gcx/iclus-fourth-national-climate-assessment). The demographic components of change (i.e., rates of fertility and mortality) for ICLUS v2.1 were taken directly from the Wittgenstein Centre Data Explorer (http://dataexplorer.wittgensteincentre.org/wcde-v2/). These projections were produced more recently than the Census projections used in ICLUS v2.0, and incorporate more recent observations of population change. SSP2 is a “middle-of-the-road” projection, where social, economic and technological trends do not shift markedly from historical patterns, resulting in a U.S. population of 455 million people by 2100. Domestic migration trends remain largely consistent with the recent past, however the amenity value of local climate (average precipitation and temperature for summer and winter) is used in ICLUS v2.1.1 to influence migration patterns. The name of the climate model used as the source of future climate patterns is included at the end of the file name (e.g., "GISS-E2-R" or "HadGEM2-ES"). The approach for incorporating climate change into the migration model is described in the ICLUS v2.0 documentation. The SSP5 narrative describes a rapidly growing and flourishing global economy that remains heavily dependent on fossil fuels, and a U.S. population that exceeds 730 million by 2100. ICLUS v2.1 land use projections under SSP5 result in a considerably larger expansion of developed

lands relative to SSP2. The amenity value of local climate (average precipitation and temperature for summer and winter) is used in ICLUS v2.1.1 to influence migration patterns. The name of the climate model used as the source of future climate patterns is included at the end of the file name (e.g., "GISS-E2-R" or "HadGEM2-ES"). The approach for incorporating climate change into the migration model is described in the ICLUS v2.0 documentation. RCP4.5 assumes that global greenhouse gas emissions increase into the latter part of the century, before leveling off and eventually stabilizing by 2100 as a result of various climate change policies. RCP8.5 assumes that global greenhouse gas emissions increase through the year 2100.

- Layer Source Location: https://catalog.data.gov/dataset/iclus-v2-1-1-population-projections2

Projected Future Land Use, 2030

- Layer Source Name: ICLUS v2.1.1 land use projections for SSP2 and RCP4.5 pathways, 2023
- Description: The methodology used to produce these projections differs from ICLUS v2.0. The demographic components of change (i.e., rates of fertility and mortality) for ICLUS v2.1 were taken directly from the Wittgenstein Centre Data Explorer (https://dataexplorer.wittgensteincentre.org/wcde-v1/). These projections were produced more recently than the Census projections used in ICLUS v2.0, and incorporate more recent observations of population change.

  SSP2 is a "middle-of-the-road" projection of future land use, where social, economic and technological trends do not shift markedly from historical patterns, resulting in a U.S. population of 455 million people by 2100. Domestic migration trends remain consistent with the recent past. This version of the ICLUS model does not include climate change projections to dynamically update location-specific amenities when calculating migration. These projections will include the "nocc" label in the file name to indicate this difference.
- Layer Source Location: https://catalog.data.gov/dataset/iclus-v2-1-1-land-use-projections-for-ssp2-and-rcp4-5-pathways2

Imagery: World Imagery

- Layer Source Name: ESRI World Imagery, 2023
- Description: This map service presents low-resolution satellite imagery for the world and high-resolution satellite and aerial imagery, typically within 3-5 years of currency, for most of the world..
- Layer Source Location: https://hub.arcgis.com/datasets/esri::world-imagery/explore

National Conservation Easement Database (NCED) Conservation Easement Boundaries

- Layer Source Name: Complete U.S. NCED Dataset
- Description: The National Conservation Easement Database (NCED) is a collaborative venture to compile easement records (both spatial and tabular) from land trusts and public agencies throughout the United States in a single, up-to-date, sustainable, GIS compatible, online source. The goal of the NCED is to provide a comprehensive picture of the privately owned conservation easement lands, recognizing their contribution to America's natural heritage, a vibrant economy, and healthy communities. Conservation easements are legal agreements voluntarily entered into between landowners and conservation entities (agencies or land trusts) for the express purpose of protecting certain societal values such as open space or vital wildlife habitats. In some cases landowners transfer "development rights" for direct payment or for federal and state tax benefits. NCED shows a comprehensive picture of privately owned conservation easement lands in the U.S. The NCED will allow better strategic planning for conservation and development by merging data on land protection with biodiversity and resources, improving ecological and economic plans and investments. State and regional planners and

managers will appreciate this dataset as it provides critical contextual information for their work. Institutions responsible for national and international reporting will find this database full of reliable, accurate information for their purposes. The scientific and conservation community will similarly benefit from having this standardized base map to carry out their research and planning objectives.

- Layer Source Locations: https://www.conservationeasement.us/downloads/

The Nature Conservancy (TNC) Conservation Easements

- Layer Source Name: TNC Lands
- Description: This dataset includes The Nature Conservancy's properties / preserves, easements and leases (areas TNC holds a legal interest in). Boundaries are regularly collected from TNC's US State Chapters and are matched with attributes from the TNC legal database. This dataset is regularly provided to the CBI PAD-US, NCED, and USGS GAP protected area databases, but this dataset provides additional attributes & more frequent updates. Some historic data is included, but the focus is on current holdings.
- Layer Source Locations: https://geospatial.tnc.org/maps/fd71b1e571994f839bd75f149fa9bbf0/about

Lands Held by Georgia Department of Natural Resources

- Layer Source Name: Georgia Conservation Lands - 2022
- Description: Public and private conservation lands within Georgia as of 08/29/2023.
- Layer Source Locations: https://gis-gadnrwrd.opendata.arcgis.com/datasets/f90eefedbdd64a8e9b4ba87bba557685_0/explore

Mill Locations

- Layer Source Name: Mill Locations - Georgia
- Description: ArcGIS Online layer showing the wood product mills by type within the state of Georgia.
- Layer Source Locations: https://www.arcgis.com/home/item.html?id=e5d83e0576a243bab150f2e619a97e30

South Atlantic Landscape Conservation Cooperative: Southeast Conservation Blueprint

- Layer Source Name: Southeast Blueprint Version 3.0 - 2023
- Description: The Southeast Conservation Blueprint is the primary product of the Southeast Conservation Adaptation Strategy, a regional conservation partnership spanning the Southeast United States and Caribbean. It identifies the most important places for collective action by the conservation community to achieve the SECAS vision of a connected network of lands and waters. The Blueprint has evolved over time through an iterative revision process, improving its accuracy, spatial resolution, regionwide consistency, and utility to conservation professionals.

  Southeast Blueprint 2023 was released in October 2023 at the SEAFWA annual conference. For the first time, this Blueprint used a consistent approach across the entire geography and did not have to stitch together any subregional inputs. The 2023 Blueprint expanded consistent methods and indicators to Puerto Rico, the U.S. Virgin Islands, and nearshore U.S. Caribbean waters, as well as to the full extent of U.S. waters in the Atlantic Ocean and Gulf of Mexico. It also included minor refinements to the inland continental Southeast priorities and updated hubs and corridors for the full Blueprint area. The 2023 version of the Blueprint identifies priority areas based on a suite of natural and cultural resource indicators representing terrestrial, freshwater, and

marine ecosystems. A connectivity analysis identifies corridors that link coastal and inland areas and span climate gradients.

- Layer Source Locations: https://secassoutheast.org/blueprint-data-download

Georgia Land Conservation Program Projects, 2006-2013

- Layer Source Name: Georgia Land Conservation Program Projects
- Description: This dataset provides 1:24,000-scale data depicting boundaries of completed projects that were approved for funding under the Georgia Land Conservation Program. Boundaries were digitized from survey plats and lines placed on US Geological Survey 1:24,000-scale topographic maps that came from land survey plats or other maps. This dataset was developed for use in mapping at scales equal to or smaller than 1:24,000 and for county-level planning and analysis. Statewide assessments of natural resource conservation can make use of this dataset in conjunction with information on other lands managed for conservation.
- Layer Source Locations: https://data.georgiaspatial.org/index.asp?body=preview&dataId=43960

Georgia Land Trusts and Other Private Lands

- Layer Source Name: Georgia Land Trust and Other Private Lands
- Description: This dataset provides 1:24,000-scale data depicting boundaries of land parcels making up the lands managed by Land Trusts and other private organizations in Georgia. The data were collected and located by land trusts, University of Georgia NARSAL and Georgia Department of Natural Resources. Boundaries were digitized from survey plats and other information. This dataset was developed for use in mapping at scales equal to or smaller than 1:24,000 and for county-level planning and analysis. Statewide assessments of natural resource conservation can make use of this dataset in conjunction with information on other lands managed for conservation.
- Layer Source Locations: https://data.georgiaspatial.org/index.asp?body=preview&dataId=41937

Wildland Urban Interface

- Layer Source Name: Georgia Wildland Urban Interface_1990 to 2010
- Description: The wildland-urban interface (WUI) is the area where houses meet or intermingle with undeveloped wildland vegetation. This makes the WUI a focal area for human-environment conflicts such as wildland fires, habitat fragmentation, invasive species, and biodiversity decline. Using geographic information systems (GIS), we integrated U.S. Census and USGS National Land Cover Data, to map the Federal Register definition of WUI (Federal Register 66:751, 2001) for the conterminous United States from 1990-2010. These data are useful within a GIS for mapping and analysis at national, state, and local levels. Data are available as a geodatabase and include information such as housing and population densities for 1990, 2000, and 2010; wildland vegetation percentages for 1992, 2001, and 2011; as well as WUI classes in 1990, 2000, and 2010.
- Layer Source Locations: https://silvis.forest.wisc.edu/data/wui-change-2010/

Fire Boundaries 2000 - 2018

- Layer Source Name: Historic Perimeters Combined 2000-2018 GeoMAC
- Description: The Geospatial Multi-Agency Coordination Group, or GeoMAC, is an internet-based mapping tool originally designed for fire managers to access online maps of current fire locations and perimeters in the US. Perimeters are submitted to GeoMAC by field offices. The GeoMAC team attributes the perimeters using the IRWIN (Integrated Reporting of Wildland-Fire Information) system, and then posts them on the GeoMAC website

and to an HTTP site for downloading. This file contains all fire perimeters that were processed by the GeoMAC team in 2018. The projection is geographic and the datum is NAD83.

- Layer Source Locations: https://data-nifc.opendata.arcgis.com/search?tags=historic_wildlandfire_opendata%2CCategory

Fire Boundaries 2023

- Layer Source Name: Wildland Fire Incident Locations - 2023
- Description: Point Locations for all wildland fires in the United States reported to the IRWIN system.
- Layer Source Locations: https://data-nifc.opendata.arcgis.com/search?tags=historic_wildlandfire_opendata%2CCategory

3
Ecoregions (Level III)

3. 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.

Georgia contains 6 Level III and 28 Level IV ecoregions within its borders. From north to south, these Level III ecoregions and their associated Level IV ecoregions are: Southwestern Appalachians (Plateau Escarpment, Southern Table Plateaus), Ridge and Valley (Southern Limestone/Dolomite Valleys and Low Rolling Hills, Southern Shale Valleys, Southern Sandstone Ridges, Southern Dissected Ridges and Knobs), Blue Ridge (Southern Crystalline Ridges and Mountains, Southern Metasedimentary Mountains, Broad Basins), Piedmont (Southern Inner Piedmont, Southern Outer Piedmont, Carolina Slate Belt, Talladega Upland, Pine Mountain Ridges), Southeastern Plains (Sand Hills, Southern Hilly Gulf Coastal Plain, Doughtery Plain, Tifton Upland, Coastal Plain Red Uplands, Atlantic Southern Loam Plains, Tallahassee Hills/Valdosta Limesink, Southeastern Floodplains and Low Terraces), and Southern Coastal Plain (Okefenokee Plains, Sea Island Flatwoods, Okefenokee Swamp, Bacon Terraces, Floodplains and Low Terraces, Sea Islands/Coastal Marsh). It was determined that, while at times certain Level IV ecoregions may exhibit an important distinction in ecology of Georgia, 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. For additional information on the ecoregions of Georgia and their associated waterways, landforms, and land uses, consult Chapter 3 of the Georgia State Wildlife Action Plan.

While the majority of southern Georgia is composed of varying levels of plains, the northern and western portion of the state begins to transition to rolling uplands in the Piedmont and then to the foothills of the Blue Ridge mountains in the northern/northwestern corner of the state. A brief description of characteristics for each Level III ecoregion will be given below. Also, in combination with these descriptions, geospatial analysis of the geodatabase layers listed above in section 2 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.

3.1. Southwestern Appalachians

The Southwestern Appalachians (SA) ecoregion is a low mountainous landscape that stretches northwest-southeast from Kentucky to Alabama, with a minute portion of this ecoregion existing in the extreme northwest corner of Georgia. The SA largely represents a landscape transition from the gradual inclines of the Interior Plateau in Kentucky and Tennessee bordering the western portion of the SA to the more mountainous Ridge and Valley and Central

Appalachians present along the eastern and northern borders. In Georgia, the SA is comprised of parts of Chattooga, Dade, and Walker counties. Most of the ecoregion is low elevation mountains with a mixture of rolling hills. The portions of the SA that exist in Georgia, the Plateau Escarpment and Southern Table Plateaus, are mostly forested as opposed to the lower elevation cropland within these level IV ecoregions to the west. Soils in this ecoregion are generally well-drained, acidic, and underlain by limestone bedrock, providing little value for crops and agriculture. The predominant land cover of the SA is mostly hardwood forests, with mixed forested wetlands dominating deeper ravines and slopes and mixed oak-shortleaf pine stands present on summits or plateaus. See Table 1 for the Federally listed species present within the SA.

Table 1 Federally threatened and endangered species present within the Georgia Level III Ecoregions.

Species	Southwest Appalachians	Ridge and Valley	Blue Ridge	Piedmont	Southeastern Plains	Southern Coastal Plain
Alabama leather flower		X		X		
Alabama moccasinshell		X				
Altamaha Spinymussel					X	X
Amber darter						
American hart's-tongue fern	X					
American chaffseed		X	X	X		
Anthony's riversnail	X					
Black-spored quillwort			X	X		
Blue shiner		X				
Canby's dropwort				X	X	X
Cherokee darter				X		
Conasauga logperch		X	X			
Cooley's meadowrue					X	
Coosa moccasinshell	X	X				
Eastern Black rail				X		X
Eastern indigo snake					X	X
Etowah darter			X	X		
Fat threeridge					X	
Finelined pocketbook	X	X	X	X		
Florida torreya					X	
Frecklebelly madtom		X	X	X		
Fringed campion				X	X	
Frosted flatwoods salamander				X	X	X
Georgia pigtoe		X	X			
Georgia rockcress		X		X	X	
Goldline darter		X	X			
Gray bat	X	X	X			
Green pitcher-plant			X			
Gulf moccasinshell				X	X	

Species	Southwest Appalachians	Ridge and Valley	Blue Ridge	Piedmont	Southeastern Plains	Southern Coastal Plain
Hairy rattleweed						X
Harperella				X		
Indiana myotis	X	X	X			
Interrupted rocksnail	X	X				
Kral's water plantain	X					
Large-flowered skullcap	X	X				
Little amphianthus				X		
Longsolid			X			
Mat-forming quillwort				X	X	
Michaux's sumac				X	X	
Mohr's Barbara's buttons	X	X				
Morefield's leather flower	X	X				
Northern long-eared bat	X	X	X	X		
Ochlockonee moccasinshell					X	
Oval pigtoe				X	X	
Ovate clubshell			X			
Persistent trillium			X			
Pink mucket	X					
Piping plover					X	X
Pondberry				X	X	
Purple bankclimber				X	X	X
Red-cockaded woodpecker			X	X	X	X
Relict trillium				X	X	
Reticulated flatwoods salamander					X	
Rock gnome lichen			X			
Rufa red knot					X	X
Shinyrayed pocketbook				X	X	
Small whorled pogonia		X	X			
Smooth coneflower			X	X		
Southern clubshell		X	X			
Southern pigtoe		X	X			
Suwannee moccasinshell					X	X
Swamp-pink			X			
Tennessee yellow-eyed grass		X	X	X		
Triangular kidneyshell		X	X			
Trispot darter	X	X	X	X	X	X
Virginia spirea	X	X				
White fringeless orchid	X	X	X	X		

Species	Southwest Appalachians	Ridge and Valley	Blue Ridge	Piedmont	Southeastern Plains	Southern Coastal Plain
Whorled sunflower		X				
Wood stork				X	X	X

3.1.1. Forest Types Within Ecoregion

The Southwestern Appalachians is characterized mainly by its abundance of upland habitat due to its topography. Wetland environments within this ecoregion are generally limited to the bottom of slopes and stream beds. Historic species commonly found in these stream bank habitats include beech (*Fagus* spp.), tulip poplar (*Liriodendron tulipifera*), and sugar maple (*Acer saccharum*)/red maple (*Acer rubrum*), while slopes contain white oak (*Quercus alba*), chestnut oak (*Quercus montana*), and various hickory species (*Carya* spp.). The summits and plateaus of the SA are dominated by oak and mixed oak/pine, with shortleaf pine (*Pinus echinata*) as the dominant pine species. Due to the mostly upland habitat within the SA, 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.

3.2. Ridge and Valley

The Ridge and Valley (RV) ecoregion, also known as the Great Valley in Georgia, is a relatively low landscape stretching from southern New York down to central Alabama that exists between the Blue Ridge Mountains to the east and Southwestern Appalachians to the west. The RV largely represents a landscape transition from the gradual inclines of the inclines of the surrounding landscapes. In Georgia, the RV is comprised of parts of Bartow, Catoosa, Chattooga, Dade, Floyd, Gordon, Murray, Paulding, Polk, Walker, and Whitfield counties. There are roughly parallel ridges and valleys within this ecoregion that vary in widths, heights, and geologic composition (limestone, shale, dolomite, sandstone, etc.). The presence of limestone in the RV has led to the creation of numerous springs and caves. Due to this abundance of aquatic features, the RV is known for is aquatic diversity and supports multiple rare fish species. Land cover is mixed within this ecoregion, as forests comprise approximately half of the total area. See Table 1 for the Federally listed species present within the RV.

3.2.1. Forest Types Within Ecoregion

The Ridge and Valley is characterized mainly by its abundance of upland habitat due to its topography, and species composition through the RV is very similar to the SA with the exception of a greater abundance of bottomland hardwood habitats due to riverine presence (i.e. Coosa River). Wetland environments within this ecoregion are generally limited to the bottom of slopes and stream beds. Historic species commonly found in these stream bank habitats include beech, tulip poplar, and sugar maple/red maple, while slopes contain white oak, chestnut oak, and various hickory species. The summits and plateaus of the RV are dominated by oak and mixed oak/pine, with shortleaf pine as the dominant pine species. Bottomland forest types are limited to mostly major rivers within the region and can contain tree species more typical of that of a coastal plain region.

3.3. Blue Ridge

The Blue Ridge (BR) ecoregion is unique in many aspects compared to the remainder of the ecoregions within Georgia, due to it being part of the Blue Ridge mountain chain that intersects the extreme northwest part of the state. In Georgia, the Blue Ridge is comprised of parts of Bartow, Cherokee, Dawson, Fannin, Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, and White counties. While being one of the smallest

ecoregions within Georgia, 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. 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. Most of this ecoregion is comprised of mostly forested slopes; cool, clear streams; and topographically rugged terrain. 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.

3.3.1. Forest Types Within Ecoregion

The BR 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 beech gap forests, mountain cove forests, and Appalachian oak forests. Pine are found to a lesser extent within this ecoregion, although some instances of loblolly pine/hardwood and shortleaf pine/hardwood forest types can be found. 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.

3.4. **Piedmont**

The Piedmont ecoregion is a large landscape that stretches northeast-southwest throughout the Carolinas and into Georgia and Alabama. 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 Gulf of Mexico to the south. In Georgia, the Piedmont is comprised of parts of Baldwin, Banks, Barrow, Bibb, Butts, Carroll, Clarke, Clayton, Cobb, Columbia, Coweta, Crawford, Douglas, DeKalb, Elbert, Fayette, Forsyth, Franklin, Fulton, Glascock, Greene, Gwinnett, Hall, Hancock, Haralson, Harris, Hart, Heard, Henry, Jackson, Jasper, Jones, Lamar, Lincoln, Madison, McDuffie, Meriwether, Monroe, Morgan, Muscogee, Newton, Oconee, Oglethorpe, Pike, Putnam, Richmond, Rockdale, Spalding, Stephens, Talbot, Taliaferro, Taylor, Troup, Upson, Walton, Warren, and Wilkes counties. Most of the ecoregion is irregular plains with a mixture of rolling hills, as the translation of Piedmont is literally “foothills”. Soils in this ecoregion are generally finer-textured than the coastal plain ecoregions to the south, 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 pine that have reverted to hardwood woodlands with successional pine interspersed. See Table 1 for the Federally listed species present within the Piedmont.

3.4.1. 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*) and loblolly pine (*Pinus taeda*), while hardwood populations included white oak (*Quercus alba*), southern red oak (*Quercus falcata*), post oak (*Quercus 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.

3.5. **Southeastern Plains**

The Southeastern Plains (SP) ecoregion exists between the Piedmont and Southern Coastal Plain and consists of some irregular plains with broad interstream regions. In Georgia, the Southeastern Plains is comprised of parts of Appling, Atkinson, Baker, Baldwin, Ben Hill, Berrien, Bibb, Bleckley, Brooks, Bulloch, Burke, Calhoun, Candler, Chattahoochee, Clay, Coffee, Colquitt, Columbia, Cook, Crawford, Crisp, Decatur, Dodge, Dooly, Dougherty, Early, Emanuel, Evans, Glascock, Grady, Hancock, Houston, Irwin, Jeff Davis, Jefferson, Jenkins, Johnson, Jones, Laurens, Lee, Long, Lowndes, Macon, Marion, McDuffie, Miller, Mitchell, Montgomery, Muscogee, Peach, Pulaski, Quitman, Randolph, Richmond, Schley, Screven, Seminole, Stewart, Sumter, Talbot, Tattnall, Taylor, Telfair, Terrell, Thomas, Tift, Toombs, Treutlen, Turner, Twiggs, Warren, Washington, Wayne, Webster, Wheeler, Wilcox, Wilkinson, and Worth counties. The SP contains greater elevations and relief than the Southern Coastal Plain to the immediate south and east, but less than the hilly Piedmont ecoregion to the north. 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 and slash pine forest, although pine-oak and mixed hardwood forests exist to a lesser extent. 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.

3.5.1. 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. Slash dominates the varying pine forest types found in SP, although longleaf occurs frequently and most pine species are represented within the ecoregion.

3.6. **Southern Coastal Plain**

The Southern Coastal Plain (SCP) ecoregion is an extensive portion of land stretching from southern South Carolina west to eastern Louisiana, ending at the Mississippi Alluvial Plain ecoregion. In Georgia, the Southern Coastal Plain is comprised of parts of Bacon, Brantley, Bryan, Camden, Charlton, Chatham, Clinch, Echols, Effingham, Glynn, Lanier, Liberty, McIntosh, Pierce, and Ware counties. Along with the coastal plains and lowlands, this ecoregion also encompasses barrier islands, coastal lagoons, marshes, and swampy lowlands along the coast. This low, flat ecoregion supports a variety of habitats that thrive on its sandy soil, which once included longleaf pine flatwoods and savannas in addition to a variety of other pine and hardwood species tolerant of wet, sandy soils. Although longleaf pine still occurs here, current land cover in this ecoregion now mainly consists of mainly loblolly and slash pine with scattered instances of hardwood forests, bottomland hardwoods, and pastureland. See Table 1 for the Federally listed species present within the Southern Coastal Plains.

3.6.1. Forest Types Within Ecoregion

The SCP supports a wide range of different forest types and natural communities and represents a transition in forest types from the more western and northern SP. While the SCP has flat topography similar to the SP, the soils of this

ecoregion are much less fertile due to the increasingly sandy substrate closer to the Atlantic Ocean. These depleted, infertile soils are more suitable for predominantly loblolly and slash pine forest types, although the other pine forest types may be found to some degree. All of the other Georgia forest types are found within the SCP to a varying degree, with their locations dependent mostly on topography.

3.7. 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 SCP 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 frosted flatwood salamander should have land located in the SP and SCP where the landscape provides the vernal wetlands surrounded by 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 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 SCP 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, legacy planning, 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 to the same extent due to their location outside of longleaf habitat within the state, although there remain isolated, rare populations of montane longleaf in the northwestern portion of 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.

4
Hydrologic Categories

4. 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.

Georgia contains all or part of nine 4-digit subregions: 0306-Ogeechee-Savannah, 0307-Altamaha-St. Marys, 0311-Suwannee, 0312-Ochlockonee, 0313-Apalachicola, 0315-Alabama, 0601-Upper Tennessee, 0602-Middle Tennessee-Hiwassee, and 0603-Middle Tennessee-Elk. Within these 4-digit subregions, Georgia has 52 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. These 8-digit HUCs can be viewed through the geodatabase tool (see Section 2.2). Also, geospatial analysis of the geodatabase layers listed above in Section 2 will provide insight into features that are or may be present within a landowner's parcel. 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 Georgia, 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 Georgia is the Lower Savannah River Watershed Initiative. This initiative is sponsored through the Longleaf Alliance and, in conjunction with landowners in the Savannah River watershed, strives to provide technical assistance to landowners in order to increase awareness about connections between healthy forests and clean, safe drinking water. The Lower Savannah River Watershed Initiative also assists landowners in implementing BMPs beneficial for sustained water quality. Priority counties for the $3.3 million Lower Savannah River Watershed Initiative include portions of Columbia, McDuffie, Warren, Jefferson, Richmond, Burke, Screven, Effingham, and Chatham.

There also exists two other similar watershed initiatives within the state: the Upper Oconee River Basin and the Middle Chattahoochee River Basin. These initiatives are funded by the Southeastern Partnership for Forests and Water and also the Georgia Forestry Commission. These two river basins are both projected to experience significant loss of forested land to urbanization in the coming decades. The goal of these initiatives is to educate and encourage farmers to retain/properly manage their forests in order to promote the linkage with healthy water supplies.

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 Georgia, the priority watersheds for 2023 are located near the cities of Marion and Ellijay, Georgia, and include the Anderson Creek, Licklog Creek-Cartecay River, Owltown Creek-Cartecay River, Stover Creek, and Tickanetley Creek watersheds. These watersheds encompass a total of 70,900 acres in Dawson, Fannin, and Gilmer counties in northwest Georgia. These watersheds are mostly forested (from 68% to 74%), with crops comprising anywhere from 17% to 20%. Enrolling in this program provides financial assistance while also improving water quality within the state.

5
Objectives

5. 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, Rare Plant and Animal Protection, Non-native and Invasive Species Management, and in some cases Utilization of Prescribed Fire and/or Longleaf Pine Restoration.

5.1. 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 Georgia'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 Georgia. Forest type-specific landscape objectives are discussed below.

5.1.1. 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 and legacy planning are both founded upon the desire to ensure future use of a natural resource. Many landowners seek to achieve a balance between conservation and legacy planning objectives by utilizing silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests (legacy planning).

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, as herbicide use is an effective alternative to fire due to its effectiveness, value, and reduction of potential burning liability.

The retention and management of forest land within Georgia has been designated a priority through the Statewide Forest Resource Assessment and Strategy. Forests were the predominant land cover within the state of Georgia in 2011 (67% of land area, 24 million acres), with 98% of these 24.8 million forested acres being commercial timberland. In 2011, forest-related industries contributed $23.6 billion and 108,112 jobs to the state's economy, making forestry Georgia's second largest manufacturing employer (GFC Georgia Forest Facts 2011). However, Georgia continues to experience increased urbanization, with the issue of urban sprawl being recognized by stakeholders as the second most important Georgia forest resource issue in the 2010 Georgia Forest Statewide Assessment of Forest Resources and the 2015 Forest Resource Strategy. In fact, the University of Georgia's Natural Resources Spatial Analysis Laboratory (NARSAL) has estimated that approximately 54 acres of tree cover were lost each day in the Atlanta metro area each day from 1991-2001; in addition to this, 28 acres of impervious surfaces were added each day in this same time period. Urbanization has been the primary cause of deforestation in Georgia and, with the state population expected to continue growing rapidly into the future, will remain a major threat to forest land retention. In the recent past, government programs such as the Conservation Reserve Program have worked to help keep forested land in Georgia 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.

A key component in retaining forest land is to limit the amount of parcelization and its subsequent fragmentation of the forest landscape occurring within Georgia forests. As land is parcelized into smaller and smaller land holdings, the forest becomes fragmented and other land uses interrupt the forest flow. As forest land is fragmented and forested tracts are isolated from each other, wildlife are negatively impacted due to the divisions in their habitat. Also, the availability of timber, water quality, and forest manageability are likely negatively impacted by this parcelization (Georgia's Statewide Forest Resources Assessment and Strategy).

To combat the threat posed to forests by urbanization, the GFC has created multiple objectives and strategies to facilitate the retention of these forested lands. They are:

Objective 1: Increase programming to make communities aware of the benefit of increasing percent canopy cover in Georgia's metro areas from 37 percent (2005 baseline) to 40 percent by 2020.

- Strategy 1.1: Initiate updated tree canopy loss and impervious surface studies. Utilize Urban and Community Forestry funding for studies to reveal trends and provide insight on the impacts of lost forest land.
- Strategy 1.2: Prepare educational programs and training targeting urban rural interface areas. Arm counties with up-to-date information about their particular county and communities, including ways to assess and address tree loss/gain issues and values of canopy cover
- Strategy 1.3: Continue to educate the GFC staff and other state partners on values and methods for maintaining forest canopy in urban and developing areas
- Strategy 1.4: Expand urban tree planting programs through "Making the Shade" and other public tree planting programs

Objective 2: Facilitate inclusion of trees and canopy cover in stormwater management plans for 15 percent of Georgia communities by 2020

- Strategy 2.1: Provide tree and stormwater education in partnerships with GFC, water authorities and other agencies to show local communities options for managing stormwater with trees
- Strategy 2.2: Promote model stormwater/green infrastructure demonstration projects and assessment software such as iTree Hydro, the EPA's Stormwater Manual, and GFC's Green Infrastructure Planning Guidelines and Website for Coastal Georgia to communicate the positive effects that trees have on community water quantity and quality
- Strategy 2.3: Promote tree benefits specific to priority area HUCs in impaired waters

Objective 3: Demonstrate how to mitigate adverse effects of impervious surfaces through increased tree planting

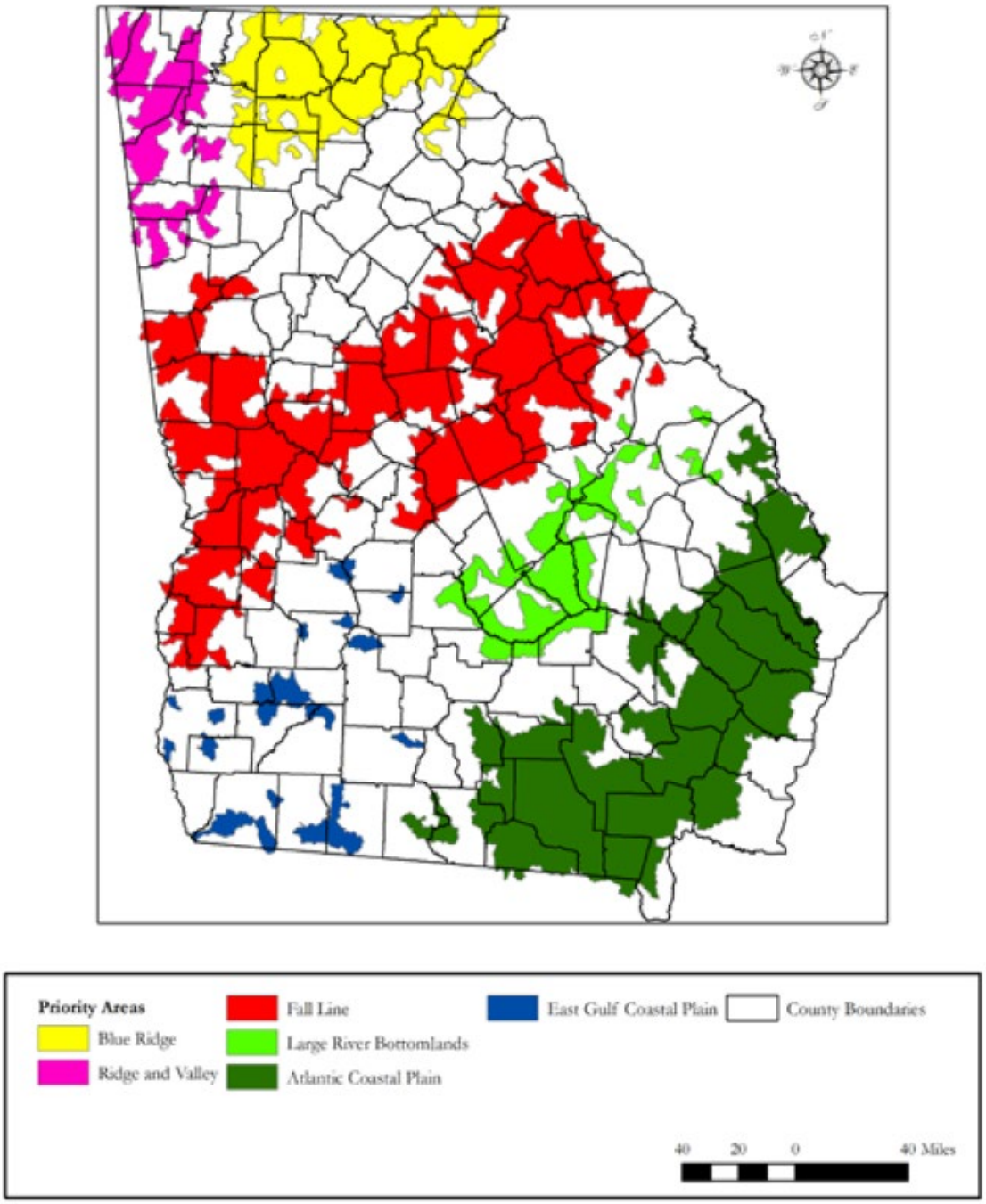
- Strategy 3.1: Develop a fact sheet that documents the effects of impervious surfaces
- Strategy 3.2: Conduct a demonstration project illustrating the benefits of shading impervious surfaces

Objective 4: Increase the number of communities that actively manage high-value forest canopy for multiple benefits from four (2009 baseline) to six by 2020

- Strategy 4.1: Facilitate local community forest assessments, tree ordinance updates, management plans and storm mitigation plans
- Strategy 4.2: Identify and promote greenscape connectivity in partnership with the Association County Commissioners of Georgia using an Integrated Green Infrastructure Management System

5.1.1.1. Priority Landscapes

The Georgia Forest Stewardship Program is also focused on conserving and retaining Georgia forest lands to combat parcelization. Through the composition of management plans by each private landowner in the GFSP program, efforts are made to meet landowner objectives as well as restore and maintain the health of Georgia's 24 million forested acres. Within the state, initial priority areas were chosen in the Georgia Statewide Assessment of Forest Resources as areas where 30 percent or greater coverage of a 12-digit HUC was composed of core area forests. These identified HUCs were then merged together to create 6 separate priority area boundaries across the state, defined as the Blue Ridge, Ridge and Valley, Fall Line, Large River Bottomlands, Atlantic Coastal Plain, and East Gulf Coastal Plain; GFSP created a similar breakdown of the state priority conservation areas through their efforts (Figures 1 and 2). Analysis suggests that forestland within these 6 areas has remained relatively stable over time, which contrasts with the non-priority areas of the state; this reinforces the essential nature of protecting these forestlands to the greatest extent possible. These priority areas signify areas of Georgia where the GFC and its partners should look first to conserve, protect, and enhance Georgia's multiple forest resources.



Source: Natural Resources Spatial Analysis Laboratory (NARSAL). 2010. University of Georgia. Athens, GA. (Unpublished data)

Figure 1 Georgia Statewide Priority Areas as Defined by the Statewide Assessment of Forest Resources, 2015.

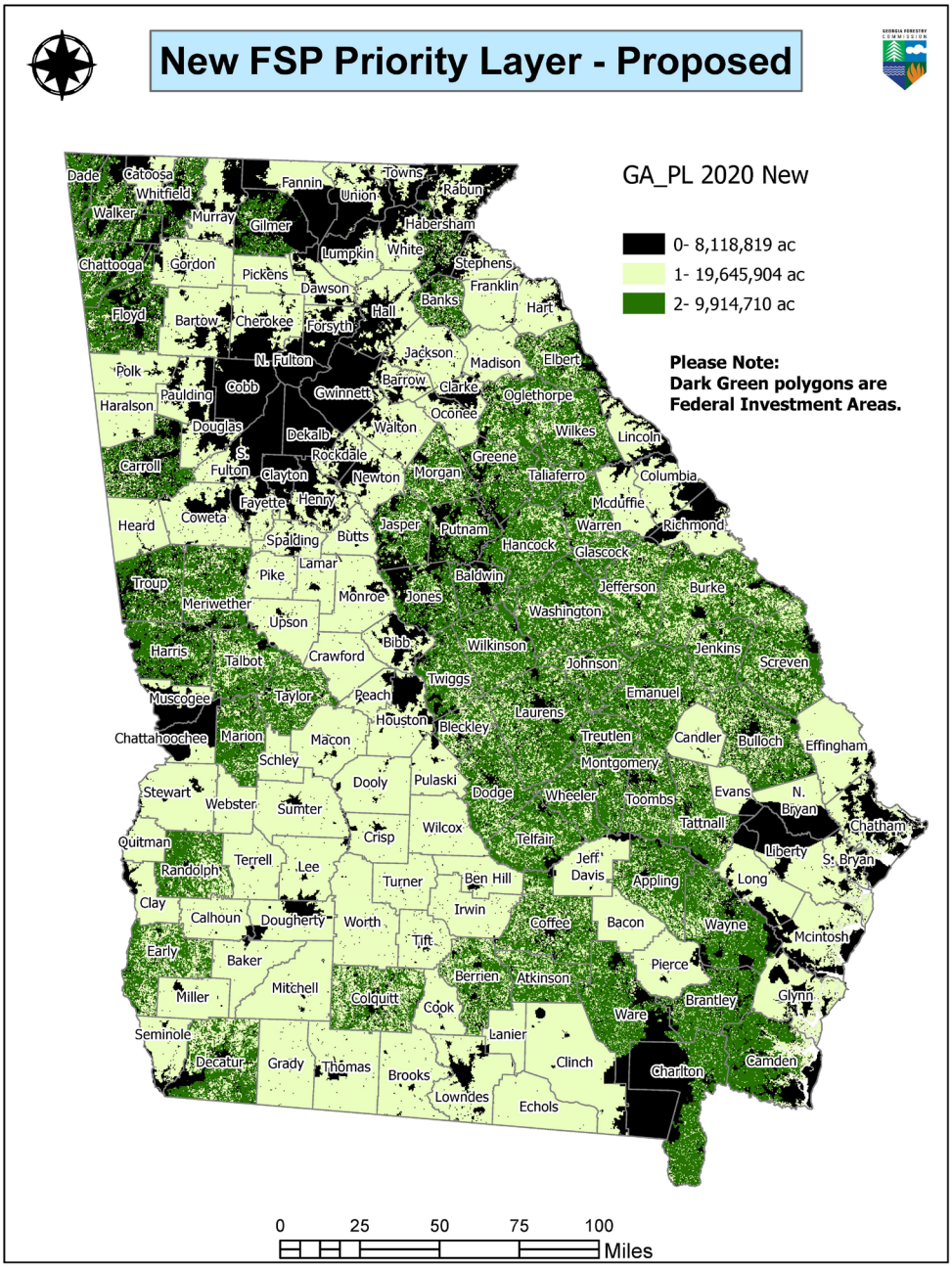


Figure 2 Georgia Statewide Priority Areas as Defined by the Georgia Forest Stewardship Program, 2020.

5.1.1.2. Urban Sprawl and Wildland Urban Interface

A certain aspect of the Forest Land Retention landscape objective that has come under focus more recently than some is managing urban sprawl and its associated wildland-urban interface. The wildland urban interface (WUI) is composed of both interface (housing present in the vicinity of wildland) and intermix (housing and wildland vegetation are continuous) communities, where housing is present at or over one structure per 40 acres. It has been determined that 25 percent of Georgia (~9 million acres) is classified as WUI.

This increasing threat of wildland urban interface in the state of Georgia can be attributed to the increased population growth statewide, especially with a large portion of the population leaving urban areas and moving into the rural frontier. This ingress into rural areas has been targeted as a factor that can affect forest sustainability soon. Below are listed some of the factors listed in the Forest Resource Assessment and Strategy plan.

5.1.1.2.1. Water

The conversion of forest land to urban use poses a threat to the sustainability of Georgia's water quality and quantity. With less forestland to effectively process rainfall, impervious, urban surfaces generate an increase in storm runoff and streamflow that can lead to increased erosion rates, overbank flooding, and sedimentation rates. An additional effect of forest loss is that pollutants and fertilizers can reach larger water bodies through flow over impervious surfaces. Also, development in rural areas tends to occur near the headwaters of streams and rivers, which may affect all of Georgia's aquatic species located downstream of development that are susceptible to pollutants and changes in water composition/temperature.

5.1.1.2.2. Biodiversity

While some species have been able to adapt over time to the gradual encroachment of urbanization into their rural habitats and the changes this has caused to the natural resources they require, others are much more susceptible to changes in or around their habitat. These species require management to help prevent further population declines due to encroachment of anthropogenic effects and their subsequent habitat loss. For example, a group of species that once populated longleaf pine savannas, such as gopher tortoise, red-cockaded woodpecker, and other species, have found their populations become threatened as their home habitat has been lost and degraded due to urban growth and development.

5.1.1.2.3. Wildfire

As the urban sprawl encroaches on natural forest habitats, the proximity of civilization to habitat that encounters frequent wildfires places more lives and properties at risk from the damages of fire. This proximity demands that safeguards and precautions are in place to ensure public safety. In Georgia, there is an average of 5,600 wildfires a year that burn approximately 46,000 acres (Georgia Forestry Commission 2010). Two major methods to accomplish this safety are man-made wildfire suppression and prescribed fire. Wildfire suppression is a reactive measure, as forestry personnel are properly trained in the logistics and strategy needed to properly contain a wildfire once it is burning.

Prescribed burning, however, is a preventative measure to proactively control fuel loads within forest habitats and help to limit the intensity that wildfire may reach when they occur. The increasing scope of the WUI presents challenges to this in the form of increased planning time needed to adequately prepare citizens for pending

prescribed burns, as well as the complexity of planning burns to limit the impacts of smoke on surrounding communities.

To combat the trend of forest land being converted to residential development, as well as the increasing reach of the WUI within the state, the GFC actively promotes the FireWise program throughout the state (National Fire Protection Association 2019). This national initiative encourages developers and homeowners to create more fire-resistant neighborhoods through less flammable landscaping, keeping lower limbs trimmed on yard trees, and removing flammable materials from roofs and under decks. Also, the GFC can conduct wildfire risk assessments which can be used to create action plans for communities. As of 2010, Georgia had 109 communities nationally recognized by FireWise.

The GFC currently has the following goals, objectives, and strategies pertaining to wildfire prevention and suppression:

Goal 1: Protect Georgia communities from wildfire.

- Objective 1: Facilitate community wildland fire planning for communities at risk within and adjacent to priority areas
  - Strategy 1.1: Continue competitive grant that introduces the community wildfire protection planning process to county leadership and will produce countywide CWPPs in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas over a three-year period.
  - Strategy 1.2: Increase number of Firewise Communities/USA in high risk communities in
  - the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.
  - Strategy 1.3: Integrate county CWPPs with GEMA county disaster hazard mitigation plans to provide coverage for a wildfire disaster in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.
  - Strategy 1.1.4 Utilize the Southern Wildfire Risk Assessment Portal (SouthWRAP) to identify high risk wildland-urban interface to focus fire prevention efforts.

Goal 2: Prevent and mitigate wildfire.

- Objective 2: Reduce the number and severity of wildfires in priority areas.
  - Strategy 2.1: Combat arson incidence through the Law Enforcement program in the Ridge and Valley and Atlantic Coastal Plain priority areas.
  - Strategy 2.2: Produce fire prevention messages and programs to educate the public on
  - preventing fires and the benefits of mitigation programs in the Blue Ridge,
  - Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.
  - Strategy 2.3: Continue to expand the computerized system to handle a larger load of
  - burning permits more efficiently and retain a comprehensive database.
  - Strategy 2.4: Provide firebreak plowing and prescribed burning services.
  - Strategy 2.5: Utilize Fire Prevention team members to provide fire prevention information to homeowners, evaluate risks to individual homes and provide assessments of their findings in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.

Goal 3: Implement the Prescribed Fire Strategic Plan

- Objective 3: Increase the number of prescribed fire acres in priority areas.
  - Strategy 3.1: Continue to implement the "One Message, Many Voices" communications and education campaign to promote the benefits of prescribed fire in cooperation with Southern Region states.
  - Strategy 3.2: Manage smoke from prescribed fire to minimize air quality and traffic impact by using technological advances to track and manage smoke in the Ridge and Valley, Fall Line and East Gulf Coastal Plain priority areas.
  - Strategy 3.3: Increase incentives to land mangers using prescribed fire by maintaining current prescribed fire incentive programs including Community Protection burns, the GOAL hazard mitigation program and NBCI in the Blue Ridge, Ridge and Valley, Fall Line, Large River Bottomlands and Atlantic Coastal Plain priority areas.
  - Strategy 3.4: Create and manage qualified agency and interagency burn teams and burn programs with adequate supplies to support more prescribed burning opportunities in the Blue Ridge, Ridge and Valley, Fall Line, Large River Bottomlands and Atlantic Coastal Plain priority areas.

5.1.2. Support Healthy Forest Products Industry

This LMP promotes maintaining a healthy forest products industry in Georgia 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.

GA BMPs for Forestry 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. Georgia BMPs for Forestry also support a healthy forest products industry through practices that protect and enhance water and soil quality. Healthy and robust timber markets are encouraged by voluntarily conducting safe, responsible, and sustainable forestry practices. Through their implementation these BMPs can also retain or increase the on-site stocks of carbon present in the forest in the medium to long term. The objectives set forth by GFC, through their retention of forestland, serve as an added benefit also help to retain or increase carbon stocks in the medium to long term. Carbon retention in forestland is directly linked to the forest retention, which is a primary priority in the utilization of BMPs to maintain forested landscapes.

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 Georgia. 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 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.

5.1.3. Watershed Protection and Restoration

Georgia contains several major watersheds including the Tennessee, Coosa, Savannah, Oconee, Chattahoochee, Suwannee, and Flint Rivers among many others. Well managed forests protect these watersheds and ensure clean drinking water, waterways, and healthy aquatic habitats. Protecting these hydrologic features, while serving as a landscape-wide objective, may also be utilized by private landowners as a landowner objective.

In the 2010 GFC public stakeholder survey, protecting, conserving, and enhancing water quality was identified as the highest-rated priority (Georgia Forest Resource Assessment 2010). Potential reasons for this issue receiving this much notoriety are the ongoing "water wars" over the Apalachicola, Chattahoochee, and Flint Rivers, where Alabama, Florida, and Georgia are all fighting for these water resources, the loss of forest land due to urbanization increasing runoff into streams, and the inadequate and insufficient protective buffers that currently exist along Georgia rivers and streams.

In order to protect these watersheds and ensure that they continue to provide high-quality water resources, the GFC is cooperating with the Watershed Protection Branch of the Georgia Environmental Protection Division, ATFS, Trout Unlimited, Riverkeeper, and other organizations to aggressively promote adherence to Georgia Water Quality Standards. Silvicultural and agricultural BMPs are often implemented and promoted to ensure these operations do not impair water quality in the region. In many cases GA BMPs for Forestry like wetland harvest guidelines, road construction guidelines, and streamside management zones (SMZs) enhance water quality, helping to restore watersheds. GA BMPs for Forestry are largely voluntary yet widely followed, which helps avoid mandatory regulation on these practices while protecting watersheds. Watershed restoration also involves other forest operations such as replacing and improving culverts and installing hard-surface low water crossings.

GFC has also identified other potential agency and organizational objectives within their Statewide Forest Resource Assessment and Strategy to enhance the role forests play in Georgia's statewide water quality and quantity. These goals are many-faceted and aim to enhance the environmental and public benefits of Georgia's trees and forests, while also ensuring that these forested lands remain so into the future. The objectives developed by GFC serve to retain and/or increase carbon stocks in the medium to long-term by this perpetuation of forest land use. They are:

- GFC will continue the state leadership role in BMP development, education, implementation and monitoring.
- Through EPA Section 319 and USFS competitive grants, GFC will continue to seek assistance in water quality education. BMP education efforts will be expanded through partnerships with Tree Farm, Trout Unlimited, Riverkeeper and other fisheries and recreation associations. Leveraging more funds with these groups and others is needed to direct more support to excellent but under-funded state programs.
- GFC will further expand BMP education by working with the Board of Registration for Foresters to support BMP education and implementation among professional foresters and with non-SFI wood mills to educate their producers about BMPs.
- GFC will work with state, federal and local government agencies to provide input and implement regional strategies identified in the Georgia Comprehensive Statewide Water Management Plan.

- As NRCS develops Rapid Watershed Assessments (Coosawattee, Ocmulgee, Upper Oconee, Satilla, Little River and Spring Creek), GFC will help identify forestry and agriculture needs for improvement to the watersheds and gain funding for cost-share assistance to landowners.
- GFC will partner with RC&Ds and county road departments to implement Better Back Road BMPs and to identify and rectify stream crossings that are a continuing source of sediment.
- GFC and DNR will provide information on high priority streams to commercial and non-profit mitigation bankers to encourage restoration and enhancement of vegetated buffers and provide financial incentives to private landowners to fence livestock out of streams.
- GFC and DNR will work with local governments and developers to ensure protection of stream buffers when development plans are considered.
- DNR will work with ATV manufacturers to develop and disseminate messages discouraging ATV use in and adjacent to streams.

The GFC currently has the following goals, objectives, and strategies pertaining to water quality and quantity:

Goal 1: Maximize positive environmental impacts of Georgia's forests on water quality and quantity in designated public drinking water supply watersheds.

- Objective 1.1: Work with local governments to implement watershed planning in designated water supply watersheds within the Blue Ridge, Ridge and Valley and Fall Line priority areas.
  - Strategy 1.1.1: Develop and implement “Smart Growth” plans consistent with Georgia Comprehensive Growth Planning.
  - Strategy 1.1.2: Ensure language in Smart Growth plans allows landowners to implement forest management practices.

Goal 2: Protect water quality during silvicultural operations in water supply watersheds and in biota and dissolved oxygen impaired watersheds especially those listed for TMDL reductions.

- Objective 2.1: Increase number of landowners and loggers trained in BMPs in priority areas.
  - Strategy 2.1.1: Deliver education programs to increase understanding of BMPs in water supply and impaired watersheds.
  - Strategy 2.1.2: Work with partners to establish field demo sites on public lands for purposes of BMP education of local stakeholders.
- Objective 2.2: Increase BMP implementation rates in priority areas.
  - Strategy 2.2.1: Determine BMP implementation baseline rates within each watershed.
  - Strategy 2.2.2: Increase monitoring of forestry practices to fill gaps through GIS analysis.
  - Strategy 2.2.3: Identify BMP implementation deficiencies by landowner type and practice.
  - Strategy 2.2.4: Review Stewardship and Tree Farm plans in priority areas to ensure adequate BMP recommendations in plans that focus on road infrastructure and stream crossings and that these recommendations are implemented as a requirement for certification.
  - Strategy 2.2.5: Continue BMP complaint resolution process.
  - Strategy 2.2.6: Continue soliciting and accepting conservation easements that require adherence to forestry BMPs.

Goal 3: Maximize water quality and quantity benefits provided by Georgia's forests.

- Objective 3.1: Increase opportunities for cost-share and other incentives for private landowners in priority areas.
  - Strategy 3.1.1: With partnerships and funding, create incentive programs for streambank restoration, riparian buffer conservation, road and stream crossing improvements and conservation easements (similar to NRCS Rapid Watershed Assessment).
  - Strategy 3.1.2: Develop ecosystem services market for private landowners to conserve their working forests.
  - Strategy 3.1.3: Promote donations of conservation easements and the receipt of associated
  - local, state and federal tax incentives for landowners.
- Objective 3.2: Increase funding for GFC to implement water quality program objectives in priority areas.
  - Strategy 3.2.1: Identify state water quality program funding needs to implement BMP education, complaint investigation, field advice and biennial statewide BMP surveys.
  - Strategy 3.2.2: Pursue federal, state and local sources of funding including local water authorities.
  - Strategy 3.2.3: Seek funding from recreationist and fisheries organizations and other nongovernmental organizations.

Goal 4: Protect, conserve and enhance ecological functions of headwater streams.

- Objective 4.1: Improve protection and enhancement of headwater streams in high priority watersheds and on public lands in priority areas.
  - Strategy 4.1.1: Identify and delineate headwater streams in high priority watersheds identified by DNR and on lands managed by public agencies.
  - Strategy 4.1.2: Develop management plans to conserve and enhance headwater streams on state lands.
  - Strategy 4.1.3: Work with private landowners to protect, conserve and enhance headwater streams in high priority watersheds identified by DNR.

Goal 5: Protect and enhance vegetated stream buffers.

- Objective 5.1: Decrease the linear measure of streams lacking intact, functional, site-appropriate forested stream buffers by 50 percent in priority areas.
  - Strategy 5.1.1: Inform landowners of vegetated stream buffer values and practices and incorporate these practices in our Stewardship Plans.
  - Strategy 5.1.2: Work with NRCS and other appropriate agencies to implement Farm Bill, USFWS Partners for Wildlife, and other programs.

5.1.4. Wildlife Management and Protection/Biodiversity

Georgia'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.

Georgia is home to many rare species found only in this region and contains several global populations. Georgia forests provide vital habitat to many imperiled plant and animal species. Table 2 shows listed species (threatened, endangered, and at-risk) found in the forested habitats of Georgia by LMP forest type. This table was created using the United States Fish and Wildlife Service's list of Threatened and Endangered Species of Georgia. Not all listed Georgia species from the list are shown, only those with the potential to utilize some portion of forested habitat within their life cycle. These habitats were then associated with each LMP forest type. Additional information on current listing status for each species can be found in the geodatabase.

Table 2 Rare animal species of Georgia by LMP forest type

Common Name	Scientific Name	Longleaf Pine	Loblolly Pine	Shortleaf Pine	Slash Pine	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwood	Mixed Floodplain	Tupelo-cypress Mixed	Elm/ Ash/ Cottonwood
Amphibians											
Frosted flatwoods salamander	*Ambystoma cingulatum*	X	X		X	X			X	X	
Reticulated flatwoods salamander	*Ambystoma bishopi*	X	X		X	X			X	X	
Birds											
Eastern black rail	*Laterallus jamaicensis*								X		
Red-cockaded woodpecker	*Picoides borealis*	X	X	X	X	X					
Wood stork	*Mycteria americana*							X	X	X	X
Fish											
Amber darter	*Percina antesella*							X	X		
Blue shiner	*Cyprinella caerulea*							X	X		
Cherokee darter	*Etheostoma scotti*							X	X		
Conasauga logperch	*Percina jenkinsi*							X	X		
Etowah darter	*Etheostoma etowahae*							X	X		
Frecklebelly madtom	*Noturus munitus*							X	X		
Goldline darter	*Percina aurolineata*							X	X		
Trispot darter	*Etheostoma trisella*							X	X		
Invertebrates											
Alabama moccasinshell	*Medionidus acutissimus*							X	X		
Altamaha Spinymussel	*Elliptio spinosa*							X	X		
Anthony's riversnail	*Athearnia anthonyi*							X	X		
Coosa moccasinshell	*Medionidus parvulus*							X	X		

Common Name	Scientific Name	Longleaf Pine	Loblolly Pine	Shortleaf Pine	Slash Pine	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwood	Mixed Floodplain	Tupelo-cypress Mixed	Elm/ Ash/ Cottonwood
Cylindrical lioplax	*Lioplax cyclostomaformis*							X	X		
Fat three-ridge	*Amblema neislerii*							X	X		
Fine-lined pocketbook	*Lampsilis altilis*							X	X		
Georgia pigtoe	*Pleurobema hanleyianum*							X	X		
Gulf moccasinshell	*Corbicula fluminea*							X	X		
Interrupted rocksnail	*Leptoxis foremani*							X	X		
Longsolid	*Fusconaia subrotunda*							X	X		
Ochlockonee moccasinshell	*Medionidus simpsonianus*							X	X		
Oval pigtoe	*Pleurobema pyriforme*							X	X		
Ovate clubshell	*Pleurobema perovatum*							X	X		
Pink mucket	*Lampsilis abrupta*							X	X		
Purple bankclimber	*Elliptoideus sloatianus*							X	X		
Shiny-rayed pocketbook	*Hamiota subangulata*							X	X		
Southern clubshell	*Pleurobema decisum*							X	X		
Southern pigtoe	*Pleurobema georgianum*							X	X		
Suwannee moccasinshell	*Medionidus walkeri*							X	X		
Triangular kidneyshell	*Ptychobranchus greenii*							X	X		
Mammals											
Gray bat	*Myotis grisescens*	X	X	X	X	X	X	X	X	X	X
Indiana myotis	*Myotis sodalis*	X	X	X	X	X	X	X	X	X	X
Northern long-eared bat	*Myotis septentrionalis*	X	X	X	X	X	X	X	X	X	X

Common Name	Scientific Name	Longleaf Pine	Loblolly Pine	Shortleaf Pine	Slash Pine	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwood	Mixed Floodplain	Tupelo-cypress Mixed	Elm/ Ash/ Cottonwood
Reptiles											
Eastern indigo snake	*Drymarchon corais couperi*	X	X	X	X	X	X	X	X	X	X

5.1.4.1. Working Lands for Wildlife

One major initiative throughout the nation as well as the state of Georgia is the program of Working Lands for Wildlife (WLfW). Established through the 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 Georgia, there are multiple target species and habitats of the WLfW program, including the gopher tortoise, golden-winged warbler, bobwhite quail (Bobwhite Quail Southern Pine Savanna Restoration Project), and various species of the Conasauga River. WLfW will assist landowners in the state to voluntarily create, restore, or enhance habitat benefitting these distinct species.

Gopher tortoise habitat conservation falls within some of the core practices of WLfW, such as Restoration and Management of Rare and Declining Habitats and Upland Wildlife Habitat Management, as well as some of the supporting practices (Prescribed Burning, Forest Stand Improvement, Tree Shrub Site Preparation). NRCS funds will share the cost of conservation practices with landowners, as more than 80% of gopher tortoise habitat in the state is within private or corporate ownership (see Figure 1). Conservation of gopher tortoise habitat also falls within the scope of the Longleaf Pine Initiative (LLPI), which aims to focus resources on increasing the amount of longleaf pine habitat, as healthy longleaf pine habitat provides some of the best gopher tortoise habitat.

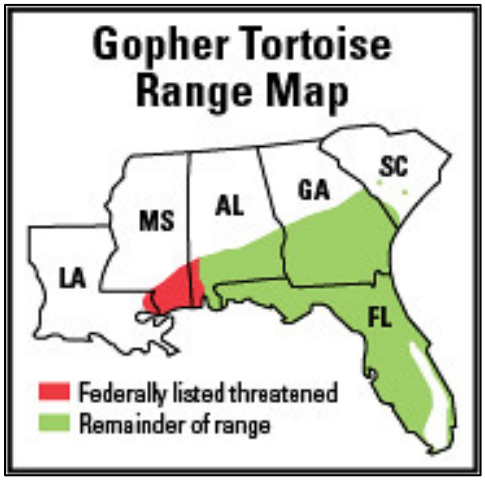


Figure 3 Historic and current gopher tortoise range, US Fish and Wildlife Service.

Another species of WLfW focus within Georgia is the northern bobwhite (*Colinus virginianus*) through the Bobwhite Quail Southern Pine Savanna Restoration Project initiative. The northern bobwhite is typically an "edge" dweller, living where woodlands and crop fields intersect and taking cover under brush. While historic land use supported this species, modern land use changes have decreased the bobwhite's population by more than 80% in the past 60 years. Now, bobwhite depend on early successional grassland, shrubby areas, and pine or oak savannas through the eastern Unites States. Research has shown that closed canopy or unburned pine stands provide poor quality habitat for bobwhites, and that forest thinning and frequent prescribed fire help to promote both savanna habitats as well as high bobwhite quail populations. Through this WLfW program, NRCS is providing technical and financial assistance for landowners to make improvements to their land to attempt to create this necessary habitat, such as establishing

field borders and buffer strips, thinning mature forests to create diverse, shrubby understory, and integrating native plants into pasture plantings. The habitat created for the northern bobwhite is also beneficial for other woodland species, including turkeys, white-tailed deer, rabbits, gopher tortoises, bog turtles, and various types of songbirds.

A third species of focus is the golden-winged warbler (*Vermivora chrysoptera*). The golden-winged warbler is a nationally identified target species of the WLfW partnership. The golden-winged warbler requires younger forest stands and shrubland for nesting, which are being increasingly replaced by aging forests or large trees within the warbler's breeding range; this shift in mature forests, largely due to a lack of fires and unsustainable forestry practices, has caused the warbler to have a 66% population loss since the 1960s. To combat this decline in numbers, land owners have voluntarily worked with the NRCS to develop and implement conservation plans targeting the creation of high-quality early successional habitat on their property, often in conjunction with programs that recognize these benefits for other species (American Bird Conservancy, Pheasants Forever, and National Turkey Federation). NRCS offers technical and financial assistance for the voluntary conservation of the golden-winged warbler through targeting the removal of trees and invasive weeds while tailoring conservation efforts to meet the structure of the landowner's property. Habitat restored for the golden-winged warbler also benefits many other songbird and game species as well.

A final WLfW program within Georgia is aimed at conservation of not just a single species but the entirety of the biodiversity located within the Consauga River, as it is known for its remarkable mussel, snail, crayfish, and fish abundance and biodiversity. In fact, the Consauga supports 10 federally listed species and 20 others listed by various states intersected by the Consauga. These species are suffering due to sediment, nutrient, and pesticide pollution in the river, and the NRCS is assisting private landowners in the Consauga watershed to implement conservation practices with the goal of reducing nutrient loading to the river through preventing the washing of nutrients, sediments, and pesticides from the surrounding landscape into the river. These conservation practices and plans are tailored to each landowner's property and may include such factors as reducing nutrient input, using cover crops to prevent nutrient runoff from the land, implementing prescribed grazing, and making improvements to the actual stream habitat.

5.1.5. 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 Georgia ecosystems. This landscape objective of ecological restoration may also serve as a private landowner objective.

The longleaf pine and wiregrass community is a good restoration example. Many landowners in the Southeastern Plains and Southern Coastal Plain 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, legacy planning, and economic return objectives, many landowners are interested in its restoration. The Georgia Forestry Commission (GFC) is among the leading organizations working to restore and manage longleaf ecosystems within the state of Georgia (GFC 2019). The GFC offers multiple longleaf ecosystem services to landowners at competitive

rates that can assist landowners with burning, plowing, or planting their land to trend toward a longleaf ecosystem. Certain national programs, such as EQIP, Working Lands for Wildlife, the Conservation Reserve Program, Partners for Fish and Wildlife, and the Southern Pine Beetle Program, can also provide services or cost share dollars toward propagating the longleaf pine ecosystem within Georgia. 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. Some of these species, like the gopher tortoise (Gopherus polyphemus) that digs deep, winding burrows that support over 350 documented animal and insect species, are considered "keystone species" in this natural community (Ashton and Ashton 2004). Restoration tools are further discussed within silvicultural options sections within all the Common Georgia Forest Types.

The different pine species are major components in a variety of natural communities. Slash and longleaf pine are the dominant overstory components 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 Georgia landowners. However, within Georgia there exists the St. Simon Land Trust, which has partnered with The Nature Conservancy and the GADNR to embark on the first organized maritime forest restoration project. This specific type of forest is found on barrier islands from Florida through North Carolina along the Atlantic coast, and Georgia has the greatest amount of intact maritime forest along the South Atlantic Coast. These forests have been impacted due to anthropogenic and natural events (hurricanes) and are now classified as globally rare ecosystems. The St. Simons Land Trust has begun to plant live oaks in these areas, with the overall objective being to comprehensively analyze the requirements for live oak plantings within these maritime forests.

5.1.6. Non-Native and Invasive Species (NNIS) and Nuisance Species Management

There are many non-native invasive plant (NNIP) and non-native animal (NNIA) species in the state of Georgia. Table 3 provides a list of the most common NNIS and nuisance species that impact forest management, using the Georgia Exotic Pest Plant Council's (GA-EPPC) Terrestrial Exotic Invasive 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, the absence of historic wildfires and the lack of prescribed burning in some areas develops conditions where fetterbush (Lyonia lucida) and Chinese tallow tree (Triadica sebifera) limit forest regeneration, increase wildfire risk, and reduce biodiversity. Additionally, 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. A landowner likely will not be able to, but forest resource professionals can accurately assess which native species are serving in a nuisance capacity to inhibit the achievement of landscape objectives. Management and control of both NNIS and nuisance species is often most successful when it is integrative and adaptive (Miller et al 2015).

The GA-EPPC has identified tree of heaven (*Alianthus altissima*), mimosa (*Albizia julibrissin*), alligatorweed (*Alternanthera philoxeroides*), common water hyacinth (*Eichhornia crassipes*), Scotch broom (*Cytisus scoparius*), thorny-olive (*Elaeagnus pungens*), autumn-olive (*Elaeagnus umbellate*), English ivy (*Hedera helix*), hydrilla (*Hydrilla verticillata*), shrubby lespedeza (*Lespedeza bicolor*), sericea lespedeza (*Lespedeza cuneate*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), Japanese climbing fern (*Lygodium japonicum*), chinaberry (*Melia azedarach*), Japanese stilt grass (*Microstegium vimineum*), marsh dayflower (Murdannia keisak), princess tree (*Paulownia tomentosa*), kudzu (*Pueraria montana*), multiflora rose (*Rosa multiflora*), Chinese tallow tree (*Triadica sebifera*), and Chinese wisteria (*Wisteria sinensis*) as Category 1 severe invasive threats to natural Georgia communities. In addition to the Category 1 species, there are Category 1 Alert species such as cogongrass that are federally listed noxious weeds and represent a potential future threat to Georgia natural communities if not controlled in the present.

While not yet drastically infected by cogongrass, Georgia is on the advancing front on the infestation across the Southeast. Currently, cogongrass can be found surrounding Georgia to the West and South, as there are multiple infestations just west of Columbus and just south of Thomasville, with some of these southern occurrences moving into the state. For the most part, the Chattahoochee River provides a barrier to the western part of the state. Landowners in the vicinity of these cogongrass infestations are being made aware of the issues with cogongrass and the importance of its control; communication with the GFC is essential if cogongrass is noticed within a landowner's property. A cogongrass task force formed within the GFC in 2004 is currently working to search for and eliminate this species.

Another major threat to natural communities within Georgia 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 was detected in Georgia in 2013 and in the surrounding state of South Carolina in 2017 (EDDMaps 2019). The USDA has attempted to prevent spread on the EAB by quarantining areas where it is known to exist.

The ambrosia beetle-borne laurel wilt disease targets the *Lauraceae* family (red bay, sassafras, pond spice) and is decimating red bays in slash pine dominated as well as tupelo-cypress mixed forest types and can only be slowed by actions such as limiting transport of firewood. This insect/disease complex will likely eventually eliminate most red bay trees.

The hemlock woolly adelgid (*Adelges tsugae*) is another non-native pest known to affect carolina 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.

5.1.6.1. Prevention and Monitoring

Prevention is the key first step. Landowners and managers can limit the spread of NNIPs by minimizing ground disturbance activities and inspecting silvicultural and agricultural equipment for cleanliness prior to entering and departing property. Spread of NNIAs can be minimized by avoiding the transport of these species from one property to another and fencing. Even through 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.

5.1.6.2. 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

5.1.6.3. 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.invasivespeciesinfo.gov/subject/control-mechanismsNNIA 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

5.1.6.4. 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 Wildlife Services

Table 3 Common Georgia non-native invasive plant (upland) species, divided by threat category and species type

Scientific Name	Common Name
Category 1	
Ailanthus altissima	tree-of-heaven
Albizia julibrissin	mimosa
Alternanthera philoxeroides	alligatorweed
Eichhornia crassipes	common water hyacinth
Elaeagnus umbellata	autumn olive
Hedera helix	English ivy
Hydrilla verticillata	hydrilla
Lespedeza bicolor	shrubby lespedeza
Lespedeza cuneata	sericea lespedeza
Ligustrum sinense	Chinese privet
Lonicera japonica	Japanese honeysuckle
Lygodium japonicum	Japanese climbing fern
Melia azedarach	chinaberry
Microstegium vimineum	Japanese stiltgrass
Murdannia keisak	marsh dayflower
Paulownia tomentosa	princesstree
Pueraria montana var. lobata	kudzu
Rosa multiflora	multiflora rose
Triadica sebifera	Chinese tallowtree
Wisteria sinensis	Chinese wisteria
Category 1 Alert	
Achyranthes japonica	Japanese chaff flower
Alliaria petiolata	garlic mustard
Arthraxon hispidus	small carpetgrass, joint-head grass
Celastrus orbiculatus	oriental bittersweet
Fallopia japonica	Japanese knotweed
Imperata cylindrica	cogongrass
Paederia foetida	skunk-vine
Salvinia molesta	giant salvinia
Category 2	
Ardisia crenata	coral ardisia
Cinnamomum camphora	camphortree
Cynodon dactylon	bermudagrass
Dioscorea polystachya	Chinese yam
Egeria densa	Brazilian waterweed
Elaeagnus pungens	thorny olive
Leucanthemum vulgare	oxeye daisy
Ligustrum japonicum	Japanese privet
Lonicera maackii	Amur honeysuckle
Miscanthus sinensis	Chinese silvergrass
Myriophyllum aquaticum	parrotfeather
Nandina domestica	sacred bamboo
Nasturtium officinale	watercress
Paspalum notatum	bahiagrass
Phyllostachys aurea	golden bamboo
Sesbania herbacea	bigpod sesbania
Sesbania punicea	red sesbania
Spiraea japonica	Japanese spiraea
Tamarix gallica	French tamarisk
Vinca major	big periwinkle
Vinca minor	common periwinkle
Category 3	
Alternanthera sessilis	sessile joyweed
Ampelopsis brevipedunculata	porcelain-berry
Anthoxanthum odoratum	sweet vernalgrass
Arundo donax	giant reed
Berberis thunbergii	Japanese barberry
Broussonetia papyrifera	paper-mulberry
Carduus nutans	musk thistle
Centaurea cyanus	cornflower
Clematis terniflora	sweet autumn virginsbower
Colocasia esculenta	coco yam, wild taro
Daucus carota	Queen Anne's lace, wild carrot
Dioscorea alata	winged yam
Dioscorea bulbifera	air-potato
Eragrostis curvula	weeping lovegrass
Eragrostis curvula	weeping lovegrass
Euonymus fortunei	winter creeper
Festuca arundinacea	tall fescue

Scientific Name	Common Name
Hemerocallis fulva	tawny daylily
Hibiscus syriacus	rose of Sharon
Lantana camara	largeleaf lantana
Lespedeza thunbergii	Thunberg lespedeza
Ligustrum lucidum	glossy privet
Limnophila sessiliflora	limnophila
Liriope muscari	monkeygrass
Liriope spicata	creeping liriope
Lonicera fragrantissima	sweet breath of spring
Mahonia bealei	leatherleaf mahonia
Marsilea minuta	dwarf waterclover
Melilotus albus	white sweetclover
Melinis repens	natalgrass
Menthax piperita	peppermint
Morus alba	white mulberry
Mosla dianthera	miniature beefsteakplant
Myriophyllum spicatum	Eurasian water-milfoil
Panicum repens	torpedograss
Paspalum urvillei	vaseygrass
Persicaria maculosa	ladysthumb
Phragmites australis	common reed
Poa annua	annual bluegrass
Poncirus trifoliata	Trifoliate orange
Potamogeton crispus	curly-leaved pondweed
Pyrus calleryana	callery pear (bradford pear)
Rottboellia cochinchinensis	itchgrass
Rubus armeniacus	Himalayan blackberry
Securigera varia	purple crown-vetch
Sesbania vesicaria	bagpod
Solanum viarum	tropical soda apple
Sorghum halepense	johnsongrass
Stachys floridana	Florida betony
Vernicia fordii	tungoil tree
Category 4	
Akebia quinata	chocolate vine
Allium vineale	wild garlic
Alysicarpus vaginalis	alyceclover

Scientific Name	Common Name
Artemisia vulgaris	mugwort
Bidens bipinnata	spanishneedles
Bidens pilosa	hairy beggarticks
Bromus secalinus	rye brome
Bromus tectorum	cheatgrass
Cirsium vulgare	bull thistle
Commelina benghalensis	Benghal dayflower
Cytisus scoparius	Scotch broom
Euonymus alatus	winged burning bush
Fallopia sachalinensis	giant knotweed
Fatoua villosa	mulberryweed
Firmiana simplex	Chinese parasoltree
Ilex cornuta	Chinese holly
Ilex crenata	Japanese holly
Ipomoea coccinea	red morning-glory
Ipomoea cordatotriloba var. cordatotriloba	tievine
Ipomoea purpurea	tall morning-glory
Jacquemontia tamnifolia	smallflower morningglory
Kummerowia stipulacea	Korean lespedeza
Kummerowia striata	Japanese clover
Najas minor	brittleleaf naiad
Orobanche minor	small broomrape
Paspalum quadrifarium	tussock paspalum
Persicaria longiseta	Oriental lady's thumb
Pyracantha coccinea	scarlet firethorn
Quercus acutissima	sawtooth oak
Rosa laevigata	Cherokee rose
Rubus phoenicolasius	wine raspberry
Setaria faberi	giant foxtail
Setaria pumila	yellow foxtail
Setaria viridis var. viridis	green bristlegrass
Sonchus asper	spiny sowthistle
Sonchus oleraceus	annual sowthistle
Torilis arvensis	spreading hedgeparsley
Verbascum thapsus	common mullein
Verbena bonariensis	tall vervain
Verbena incompta	Brazilian vervain

5.1.6.5. 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 2012). 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 2012).

5.1.7. Supporting Military Bases Through REPI and Sentinel Landscapes

5.1.7.1. REPI

A key component to ecosystem conservation within Georgia, especially with the military installations of Fort Benning, Fort Stewart, and Moody Air Force Base present within the state, is the Readiness and Environmental Protection Integration (REPI) program instituted through the Department of Defense (DoD). The REPI is a key tool for combating developmental encroachment that can hamper or restrict military training, testing, and operations. These actions are protected through the REPI program by helping remove or avoid land-use conflicts affecting military bases and appropriately addressing regulatory restrictions.

Encroachment is a factor that limits military readiness and can come in the forms of competition for land, airspace, or waterfront access, as well as the development of nearby land. Development near military bases can decrease their capacity for readiness through a variety of factors, such as light pollution affecting night vision training, complaints from nearby residents affecting the timing of military exercises, or development of land near bases causing endangered species to move onto military land, resulting in increased training/operation restrictions. A main tool of the REPI Program to combat encroachment is to use buffer partnerships among military services, private conservation groups, and state and local governments. These partnerships benefit both entities through sharing the cost of easement acquisitions or working to preserve compatible land uses and natural habitats located near military installations or ranges.

The REPI Program can also help to benefit the environment through its actions. Some of these beneficial methods include conservation of land near military bases and ranges, protecting working lands (farms, forests, ranches, etc.), preserving aquatic habitat, and protecting endangered species.

5.1.7.2. Sentinel Landscapes

Sentinel landscapes are made up of the lands surrounding military installations and ranges. The Federal Coordinating Committee first designates locations as sentinel landscapes and then works to connect private landowners with assistance. The military, through the Sentinel Landscapes Partnership (2013), has created a coalition of federal agencies, state/local governments, and non-governmental organizations that work with private landowners to promote and advance sustainable land management practices in these areas surrounding military installations. These sentinel lands can be used to promote land use compatible with the national defense, give landowners access to programs aimed at sustainable management practices, preserve sensitive natural resource features, support agricultural production, and increase the access and availability to certain outdoor recreational activities (hunting, fishing, hiking, etc.).

Within Georgia, the Georgia Sentinel Landscape was developed in 2017 and contains approximately 1.3 million acres within south Georgia that are critical to natural resources, working economies, and military readiness (The Nature Conservancy 2019). The Georgia Sentinel Landscape brings together greater than 20 partners at the federal, state, and local tiers of government to protect species habitat, support and sustain local farm and forest land uses, and promote land use consistent with the military's mission at nine military installations and ranges. Within this landscape is conservation lands containing some of Georgia's most valuable remaining longleaf pine stands, a habitat which in turn fosters habitat for listed species such as the gopher tortoise. The Nature Conservancy, through the Georgia Sentinel Landscape, has the goal to protect 20 additional gopher tortoise populations in the state over the next 5 years.

To promote the adoption of sentinel landscape practices, the Sentinel Landscape Partnership has introduced the Interactive Landowner Resources Tool. This allows landowners to search for voluntary assistance programs useful for managing their land sustainably, and also provides additional information concerning each of the program alternatives.

5.1.8. Air Quality

Along with the many other benefits provided by forests, such as water quality/quantity services, recreation, aesthetics, flood control, wildlife habitat, etc., forest habitat can also provide the important climatic benefit of carbon sequestration. Forests can also improve air quality by removing pollutants and reducing energy usage, which can further reduce the amount of carbon pollution coming from utility companies. As climate change continues to impact our world, giving a monetary value to forest carbon through private landowner participation in the sequestration market provides the opportunity of landowners getting paid while also providing a societal benefit. As a majority of the land within Georgia in particular and the South as a whole is privately owned, there is the potential for private forest owners to create a sizeable impact through their actions. If landowners can be financially compensated by retaining forests on their property, they will be more likely to resist their lands succumbing to further development in the future (Georgia Forest Resource Strategy 2015).

To promote the benefits provided by forests in regard to current and future air quality, the GFC has created multiple objectives and strategies to facilitate the retention of these forested lands and minimize the loss of trees while maximizing their benefits to carbon sequestration. They are:

Goal 1: Develop and enhance value-capture activity for carbon sequestration in forests.

- Objective 1.1: Increase the amount of forest land involved with carbon sequestration offset projects at some market or value-capture level in priority areas.
  - Strategy 1.1.1: Educate forest landowners and landowner agents to enable their participation in carbon sequestration projects.
  - Strategy 1.1.2: Develop the GFC carbon protocol/registry revision or merge with new compliance protocols. The stages of development will include the following components:
    - Monitor the development of climate legislation and designated standards for forestry offsets in the compliance market.
    - Develop a plan to modify or merge the Georgia Carbon Sequestration Registry (GCSR) to support the new compliance market.
    - Identify funding for GCSR modification.
    - Initiate GCSR changes.
    - Conduct stakeholder review of proposed changes.
    - Complete GCSR revision and associated realignment of GFC carbon sequestration assistance program.
    - Develop new partnerships with private transaction/marketing platform(s).

Goal 2: Enhance air quality in Georgia.

- Objective 2.1: Increase canopy cover in Urban and Interface priority areas.
  - Strategy 2.1.1: Assist communities in setting tree canopy goals.
  - Strategy 2.1.2: Utilize grant and corporate funds to plant trees in communities.
- Objective 2.2: Increase public understanding of the role of trees and forests in air quality in Urban and Interface priority areas.
  - Strategy 2.2.1: Partner with utilities to educate homeowners about the energy benefits of strategically planted trees.
  - Strategy 2.2.2: Identify air quality benefits of community forests related to public health.

Goal 3: Monitor air quality on the Chattahoochee National Forest to meet the goals of the federal Clean Air Act and applicable Georgia air quality regulations to evaluate air pollution impacts to forest resources.

- Objective 3.1: Monitor air quality in the Ridge and Valley priority area in the vicinity of the Cohutta Wilderness Area in Fannin and Murray Counties, Georgia, designated as Class I by the U.S. Congress.
  - Strategy 3.1.1: Work with EPD to monitor visibility impairment, ozone impacts and pollutants affecting forest resources in the Cohutta Wilderness as an indicator of air quality.

5.1.9. Fire Management

As with any forest habitat, especially in the South due to the frequent lightning strikes in the summer, Georgia forests are susceptible to wildfires. Georgia averages approximately 5,600 wildfires per year, which collectively burn greater than 46,000 acres of forestland (Georgia Forest Resource Strategy 2015). In addition to this destruction of land, Georgia loses approximately 115 homes collectively valued at $4.2 million and 180 buildings collectively valued at

$1.3 million each year to wildfire. One of the Georgia Forestry Commission's founding missions was the protection of forest resources from wildfire, and today approximately 24.8 million acres is protected by the GFC. The GFC Fire Management program, through direct fire suppression efforts, is able to save approximately 1800 structures each year, which equates to approximately $162 million.

Recently, certain factors have increased both the threat of wildfire within Georgia forests as well as their potential severity. Urbanization of previously forested land, the increasing levels of forest fuels, and certain restrictions that reduce the use of prescribed burning all contribute to wildfires having an even greater potential to negatively impact Georgia forests. While the GFC does everything in its power to suppress wildfires, suppression is not enough; fires must be preemptively mitigated through fuel reduction programs. The 2008 Southern Wildfire Risk Assessment (SWRA) determined that 25 percent of Georgia (9 million acres) is designated Urban Interface (Andreu and Hermansen-Baez 2008). Also, the SWRA has classified 5,000 of Georgia's communities as "high" or "very high" risk for wildfires.

The GFC has made it a priority to provide more public education on the risk of wildfires, as well as attempting to prevent them from occurring and further suppressing them if they occur. To aid in these endeavors, the GFC has created various goals, objectives, and strategies, listed below.

Goal 1: Protect Georgia communities from wildfire.

- Objective 1.1: Facilitate community wildland fire planning for communities at risk within and adjacent to priority areas.
  - Strategy 1.1.1: Continue competitive grant that introduces the community wildfire protection planning process to county leadership and will produce countywide CWPPs in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas over a three-year period.
  - Strategy 1.1.2: Increase number of Firewise Communities/USA in high risk communities in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.
  - Strategy 1.1.3: Integrate county CWPPs with GEMA county disaster hazard mitigation plans to provide coverage for a wildfire disaster in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.
  - Strategy 1.1.4 Utilize the Southern Wildfire Risk Assessment Portal (SouthWRAP) to identify high risk wildland-urban interface to focus fire prevention efforts.

Goal 2: Prevent and mitigate wildfire.

- Objective 2.1: Reduce the number and severity of wildfires in priority areas.
  - Strategy 2.1.1: Combat arson incidence through the Law Enforcement program in the Ridge and Valley and Atlantic Coastal Plain priority areas.
  - Strategy 2.1.2: Produce fire prevention messages and programs to educate the public on preventing fires and the benefits of mitigation programs in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.
  - Strategy 2.1.3: Continue to expand the computerized system to handle a larger load of burning permits more efficiently and retain a comprehensive database.
  - Strategy 2.1.4: Provide firebreak plowing and prescribed burning services.

- Strategy 2.1.5: Utilize Fire Prevention team members to provide fire prevention information to homeowners, evaluate risks to individual homes and provide assessments of their findings in the Blue Ridge, Ridge and Valley, Fall Line and Atlantic Coastal Plain priority areas.

Goal 3: Implement the Prescribed Fire Strategic Plan.

- Objective 3.1: Increase the number of prescribed fire acres in priority areas.
  - Strategy 3.1.1: Continue to implement the "One Message, Many Voices" communications and education campaign to promote the benefits of prescribed fire in cooperation with Southern Region states.
  - Strategy 3.1.2: Manage smoke from prescribed fire to minimize air quality and traffic impact by using technological advances to track and manage smoke in the Ridge and Valley, Fall Line and East Gulf Coastal Plain priority areas.
  - Strategy 3.1.3: Increase incentives to land mangers using prescribed fire by maintaining current prescribed fire incentive programs including Community Protection burns, the GOAL hazard mitigation program and NBCI in the Blue Ridge, Ridge and Valley, Fall Line, Large River Bottomlands and Atlantic Coastal Plain priority areas.
  - Strategy 3.1.4: Create and manage qualified agency and interagency burn teams and burn programs with adequate supplies to support more prescribed burning opportunities in the Blue Ridge, Ridge and Valley, Fall Line, Large River Bottomlands and Atlantic Coastal Plain priority areas.

5.2. 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 Georgia and the Georgia 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 Georgia Forest Types Section.

5.2.1. 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 Georgia 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 cogon grass and feral hogs can cause major ecological and economic damage to Georgia 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 oak and laurel wilt also cause damage across multiple forest types. These pests and diseases as well as others known to affect species within Georgia forests will be addressed below by species type for pines and by hardwood grouping. Additional information concerning the multiple invasive pests affecting Georgia forests can be found through the GFC Insects and Disease webpage. While the following sections provide a short background of major issues, the referenced source is the best resource for additional information.

5.2.1.1. 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 3/10th 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.

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 of room and resources to grow, have 33-40 percent live crowns (crown length/total tree 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 Georgia. 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. This rust also increases the tree's susceptibility to wind damage. 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 nutrient-poor soils, and following root damage and drought. However, due to severe erosion resulting from past farming practices in Georgia'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.

Heterobasidium (Annosum) 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 the disease largely overlooked. Peak tree loss seems to occur 3-6 years post thinning and the disease subsides 8-10 years post thinning. The disease is least active in Georgia during the summer months, June-August, and 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 heterobasidium 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 within 2-4 years post thinning, suspect 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 Georgia pine species, as they are not typically affected as severely by Ips, SPB, or BTB, but if not thinned or stressed from excessive straw raking can be just as susceptible. 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 longleaf pine. 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 longleaf 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, particularly during droughts or the typically dry months of spring.

Loblolly, slash, and shortleaf pine cannot tolerate prescribed fire until the bark thickens and they reach about 10-15 feet tall (depending on fuel load). Slash and loblolly pine forests may be prescribed burned every two to four 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. 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, site selection, release, and thinning regimes, pines generally have minimal issues following successful establishment.

If any of the above diseases or pests are suspected, GFC should be contacted for a consultation. See the non-native invasive species section for additional information about threats to Georgia forests.

5.2.1.2. Hardwood Forest Health Management

Pine/hardwood mixed, upland hardwoods, tupelo-cypress mixed, mixed floodplain, and elm/ash/cottonwood 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, laurel wilt disease, and sudden oak death.

The most common defoliators are canker worms and forest tent caterpillars. Both 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 within the Piedmont and rarely impact more than a few acres. Forest tent caterpillars are usually found in the bottomland hardwood forests located in the ecoregions southeast of the Piedmont and can defoliate thousands of acres.

Laurel wilt is primarily a fungal disease of the laurel family (*Lauraceae*), which includes such Georgia species as redbay (*Persea borbonia*), swampbay (*Persea palustris*), sassafras (*Sassafras albidum*), pondspice (*Litsea aestivalis*), and pondberry (*Lindera melissifolia*). Infected trees will eventually have their water conducting tissues blocked, causing their leaves to abruptly wilt soon after leaf formation in early spring. It can only be slowed by actions such as limiting transport of firewood. This disease will likely eventually eliminate most red bay trees. 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, a similar disease that affects oaks instead of the laurel family, if young, healthy red oaks are suddenly dying. Sanitation and severing root grafts with a vibratory plow are two methods used for its control.

Sudden oak death (SOD) is a fairly new disease in Georgia, as it was first reported in California in 1995 and was spread to Georgia through the transport of certain camelias in the Fall of 2004. Out of a total of 59,000 potentially-infected plants that were shipped to Georgia, 49,000 were sold before Georgia was aware of the disease's presence (GFC 2019). Due to this shipment, SOD has now been positively identified in 17 nurseries throughout Georgia. SOD is a fungus, *Phytophthora ramorum*, that causes a bleeding canker on the tree's side which continues to grow until eventually girdling the tree. This girdling eliminates the tree's ability to transport water from the roots to the crown, which can cause leaf spot and twig dieback. Of the oaks present in Georgia, it has been shown that red oak and pin oak are particularly susceptible to the fungus. GFC is continuing to sample native vegetation surrounding suspected nursery sites, and no native plants have yet to be infected within Georgia.

If any of the above diseases or pests are suspected, contact the GFC for a consultation.

5.2.1.2.1. Degraded Hardwood Restoration

In Georgia, some forests encountered mainly in north Georgia are comprised of hardwoods that over time have become degraded in some manner or fashion. A major factor in this hardwood forest degradation is the historically limited market for small, low-value trees; larger trees have been "high-graded" out of the stand selectively, with the incorrect assumption that the small trees remaining in the stand will replace the larger trees removed as the next round of merchantable timber. In reality, the remaining trees were likely the same age as those harvested and will now never reach that level of quality due to a lack of competition producing smaller crowns and overall weaker trees. Further, measures are not taken toward stand improvement in the interim following the harvest. Degraded hardwood stands may also be due to the result of fire, insect, or disease damage, or a poor choice of site for the stand, not just anthropogenic mismanagement. A cycle of mismanagement has produced degraded hardwood stands that are a

mixture of degraded remnants of previous harvests, a certain amount of desirable species regrowth, and a large contingent of smaller shade-tolerant trees that are not desirable for timber production and crowd out young target tree species (Clatterbuck 2006).

In the wake of this silvicultural mismanagement, degraded forest stands can be found throughout much of north Georgia. The effort and cost required to restore these stands can be great, and, depending on the current market for degraded wood products such as pallets, ties, chips, and pulpwood, may be entirely cost prohibitive for an agency or landowner. However, this issue of degraded stands is becoming more widely recognized and their product market is becoming stronger, so degraded hardwood stands are becoming more of a focal point as of late in the Georgia forestry community.

Depending on the condition of the specific site and the objective of the landowner, there are three options for the management of degraded stands: rehabilitation, regeneration, or no action. Rehabilitation refers to the improvement of an existing stand to the point where it no longer exists in a degraded condition, while regeneration involves the creation of an entirely new stand that will have the opportunity to grow into a balanced stand. The key factor in deciding whether to rehabilitate or regenerate a hardwood stand is whether acceptable growing stock (AGS; trees of commercial value that are capable of reproducing) exists within the current stand. If so, the stand could be a candidate for rehabilitation; if not, regeneration of the site is the best route moving forward (Clatterbuck 2006).

McGee (1982) provides a helpful checklist for first evaluating and then prescribing a treatment plan for a degraded hardwood timber stand. Depending on the option chosen, various different silvicultural options from the ones present below in Sections 8.1-Section 8.4 may or may not be applicable. As degraded hardwood restoration is at the forefront of timber management in Tennessee, each section and subsection below within the Silvicultural Options section describe how that particular practice could be used within the framework of either rehabilitation or regeneration.

5.2.2. 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 and legacy planning are both founded upon the desire to ensure future use of a natural resource. Many landowners seek to achieve a balance between conservation and legacy planning objectives by utilizing silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests (legacy planning).

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, or an herbicidal treatment, for ecological maintenance; hardwood forest types do not require these fire-related management techniques, although some may benefit from these management techniques.

Sites within the forest being managed that demonstrate a high conservation value (like FORIs or critical habitat), as well as representative areas of the forest types that are found in the forest management unit, should be identified, protected, and, where possible, enhanced. The sites may contain one or more of the following values: diversity of species, ecosystems and habitats, ecosystem services, ecosystems at landscape level, and cultural values. Conservation of the particular type(s) of forest areas found within the forest management unit is essential in protecting the forest's natural resources for this and future generations. Locating these high conservation value sites is aided through utilization of the LMP Geodatabase and the NatureServe Explorer (explorer.natureserve.org), a GIS-based tool that provides locations of rare and protected plants, animals, and ecosystems of the United States.

Once a high conservation value or representative forest area are determined to occur within a landowner's property, strategies and actions to maintain these areas should meet the existing local and national laws and legislations. One component of active management may be the periodic monitoring or evaluation of the landowner strategies effectiveness. Although landowners are encouraged to conduct their own periodic monitoring of the high conservation areas on their property, their assessments as a whole are not authoritative or effective in determining the efficacy of such measures. As the scale of monitoring high value conservation areas is quite large, the applicable local, regional, or federal entities hold ultimate responsibility for this task.

5.2.3. Economic Return

Sources of forest-based revenue in Georgia 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.

5.2.3.1. Timber Management

Landowners have strong, diverse timber markets in Georgia, allowing them to manage on short or long rotations for pine, hardwood, and cypress products. In fact, Georgia is consistently ranked as the top forestry state in the nation. Paper, lumber, and over 5,000 different timber-based life-sustaining products are produced through Georgia timber markets (Georgia Forestry Association 2020). This flexibility and economic potential in timber markets allows for restoration, revenue, and investment. A current timber price report by quarter is available through the Timber Update (https://timberupdate.com/timber-prices/georgia-prices/).

Economy of scale plays a large role in timber management, and landowners must always take that in consideration when managing their forest lands. Forest landowners often retain portions of their land in natural ecosystems and habitats, where regulatory considerations, economies of scale, and silvicultural options indicate this is the best management approach. For instance, adherence to BMP standards encourage the retention of mixed forested wetland overstory along existing stream channels.

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 than conventional 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. Also, native species are preferred in the management of wood plantations in Georgia due to multiple factors, including: evolutionary adaptations to endemic soils, climate, and threats, their comprising the vast majority of the nursery stock of Georgia, the requirement of various cost-share programs to utilize only native species, and the preference of local markets and mills to process native species as opposed to exotics.

5.2.3.2. Non-Timber Forest Products

Forestland owners have many revenue sources aside from timber products. Georgia's forests provide various non-timber forest products (NTFP). These are wide-ranging and include pine straw, honey, silvopasture, saw palmetto drupes, ginseng, and cypress knee 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).

5.2.3.3. Non-Forest Associated Land Uses

Some revenue-generating options should be considered with caution due to disadvantages associated with them. Forests should remain classified as forests to ensure that certification is met. 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 Georgia'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

6. Conversion of the forested land from a forested state (natural or plantation-style plantings) to an unnatural tree plantation containing non-native or exotic tree types.

Some instances of forests being converted to non-forested land uses are acceptable under various standards. These circumstances consist of:

- The area concerned is small (the total area to be converted to a non-forested land use is no more than 5% of the total forest management unit
- This conversion clearly benefits long-term nature conservation advantages
- This conversion causes no damage or threat of damage to high conservation-value areas

5.2.3.4. 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).

5.2.3.4.1. 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.

5.2.3.4.2. 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 Form or can be applied as carrying charges as well. Also, Georgia has an agricultural use tax exemption for farmers, foresters, or other agricultural land users.

5.2.3.4.3. 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, calculated by the difference of the fair market value (FMV) of the timber immediately before and after the casualty.

5.2.3.4.4. 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.

5.2.3.4.5. 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, Healthy Forests Reserve Program, Conservation Reserve Program, Conservation Stewardship Program, Partners for Fish and Wildlife Program, Wildlife Incentives for Nongame and Game Species, and Environmental Quality Incentives Program. There are also multiple state programs that qualify for exclusion, depending on the state. GFC’s Forest Renewal Program (FRP) and Southern Pine Beetle Program (SPB) both qualify for this exclusion. The excludable amount is calculated as the present value of which is greater: $2.50 per acre or 10 percent of the average annual income from affected areas over the previous 3 years. The excluded amount cannot also be deducted from income or expensed as a timber basis; e.g., if the total costs were $10,000 and the excluded cost share payments were $4,000, the amount deducted from income or expensed as a timber basis should be $6,000.

5.2.3.5. 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.

5.2.4. Wildlife Management and Protection

Georgia 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 Georgia provide valuable habitat to imperiled species such as red-cockaded woodpecker, Northern long-eared bat, gopher tortoise, and frosted flatwoods salamander. 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 GA BMPs for Forestry 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. The LMP Geodatabase and associated resources can be used to locate any known imperiled species occurrences on a property. 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

In addition to the above-mentioned protection measures, the landowner may also choose to enhance habitat where the species is known and visibly apparent. This may include removing nuisance and invasive species or, depending on the species preferred habitat, participating in ecological restoration efforts. State and federally listed plant species are not legally required for protection unless there is a federal funding nexus on the site or additional landowner objectives require. While it is recognized that protection of endangered or threatened plants may not be legally required, many landowners actively choose to do so as a part of their land management, or some standards may ask landowners to take measures to protect any T&E species. Also, foresters that assist the landowners make note of these T & E species as a standard practice.

The natural resource professional and landowner should plan and implement silvicultural activities with regard to known and visibly apparent species and their habitats. Additionally, guidelines for the protection of certain USFWS Threatened and Endangered (T&E) species can be found through the Environmental Protection Agency's (EPA) threatened and endangered pesticide use guidelines, as well as the USFWS's Landowner Tools site. The LMP Geodatabase and associated resources can be used to locate any known imperiled species occurrences on a property. Although not an exhaustive list, if imperiled species and/or their habitats are located, the following protection measures can be used:

- Conservation zones (or protected areas). Size and location of the conservation zones conform to national and local legislation and are sufficient to guarantee the continuing presence of the identified species. Conservation zones have been identified and marked on maps and, where necessary, on the ground in a way that is visible when entering the zone; and
- Reduced harvesting methods to protect nesting and breeding sites.

Georgia 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, duck and feral hog are commonly hunted and managed. Wildlife conservation practices may include managing healthy game species populations through hunting programs such as National Deer Association 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.

5.2.4.1. 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. These species benefit from a frequently fire-maintained open, grassy groundcover, with low shrubs and little to no midstory. 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 or paying for annual land taxes.

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, gopher tortoise, fox squirrel, and red cockaded woodpecker.

Wildlife habitat protection objectives can be met through legacy planning practices. The more hands-off preservation approach can be used to protect non-game species in healthy, fully functioning pine forests. However, active management with prescribed fire at minimum is required to maintain this forest type and its habitat components.

5.2.4.2. 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 tools. 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.

Wildlife habitat protection objectives can be met through legacy planning practices. The 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.

5.2.5. 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.

Pine forests and hardwood forests alike are popular recreational areas in Georgia, 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

5.2.6. 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 decrease 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.

5.2.6.1. 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 or, often in longleaf pine stands, wiregrass in the Fall. Some loblolly, shortleaf, slash, or longleaf 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.

5.2.6.2. 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. While upland slope forests provide relatively steep topography and vegetation that are indicative of the Piedmont 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.

Tupelo-cypress mixed forests have their own high-quality aesthetics, with both having a unique form with buttress-based stems and cypress extending knees from their roots. They are often draped with Spanish moss. This gives them a pleasantly eerie and prehistoric look that is quite unique across the landscape. Cypress is one of the few deciduous conifers in the world and turns a stunning auburn in the Fall before dropping its' needles. Swamp tupelo also changes to red, providing some color in a relatively bland Georgia Fall.

Most uplands in Georgia are pine dominated and even-aged, and provide their own type of beauty, but hardwood forests are less common, natural, uneven-aged and possess a lot of 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.

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.

5.2.7. Legacy Planning

Some landowners have a legacy planning objective because they would like to see their forest ownership remain intact and capable of being passed down between generations. The protection of the forested ecosystem from conversion to development, fragmentation, and/or degradation from alternate uses (e.g. mining) is a benefit of the legacy planning objective, yet it could also be a benefit of the conservation objective.

Landowners that treat their forestland as an untouched "preserve" and do not actively manage their forest may observe changes in forest type composition more quickly sue to succession of other species. However, many of Georgia's forest types (i.e. pine) are fire dependent and at a minimum require active management with prescribed fire (or equivalent successional and fuel reduction measures) for ecological maintenance.

Conservation and legacy planning are both founded upon the desire to ensure future use of a natural resource. Many landowners seek to achieve a balance between conservation and legacy planning objectives by utilizing silvicultural tools to mimic ecological processes (conservation) and restricting human activities outside their interests (legacy planning).

Pine forests are fire dependent and require frequent application of prescribed fire at minimum for ecological maintenance. These forests are not conducive to legacy planning-oriented, single-use management. Preservation of pine forests will result in long-term succession to hardwood forest due to lack of prescribed fire application.

Some hardwood forest types are more conducive to legacy planning-oriented, single-use management than upland pine and other fire-dependent forest types. However, without active management and landowner engagement this may cause ATFS de-certification.

5.2.7.1. Legacy

5.2.7.1.1. 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. Non-tax 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.

Basic Ownership Types

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.

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.

Business Ownership Types

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 Georgia for a property can be found at the Georgia Secretary of State website.

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.

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.

5.2.7.1.2. Forest Legacy Challenges

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.

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 (Georgia Heirs Property Law Center, 2024). After the Civil War in Georgia, many former slaves purchased or were deeded land throughout Georgia. 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.

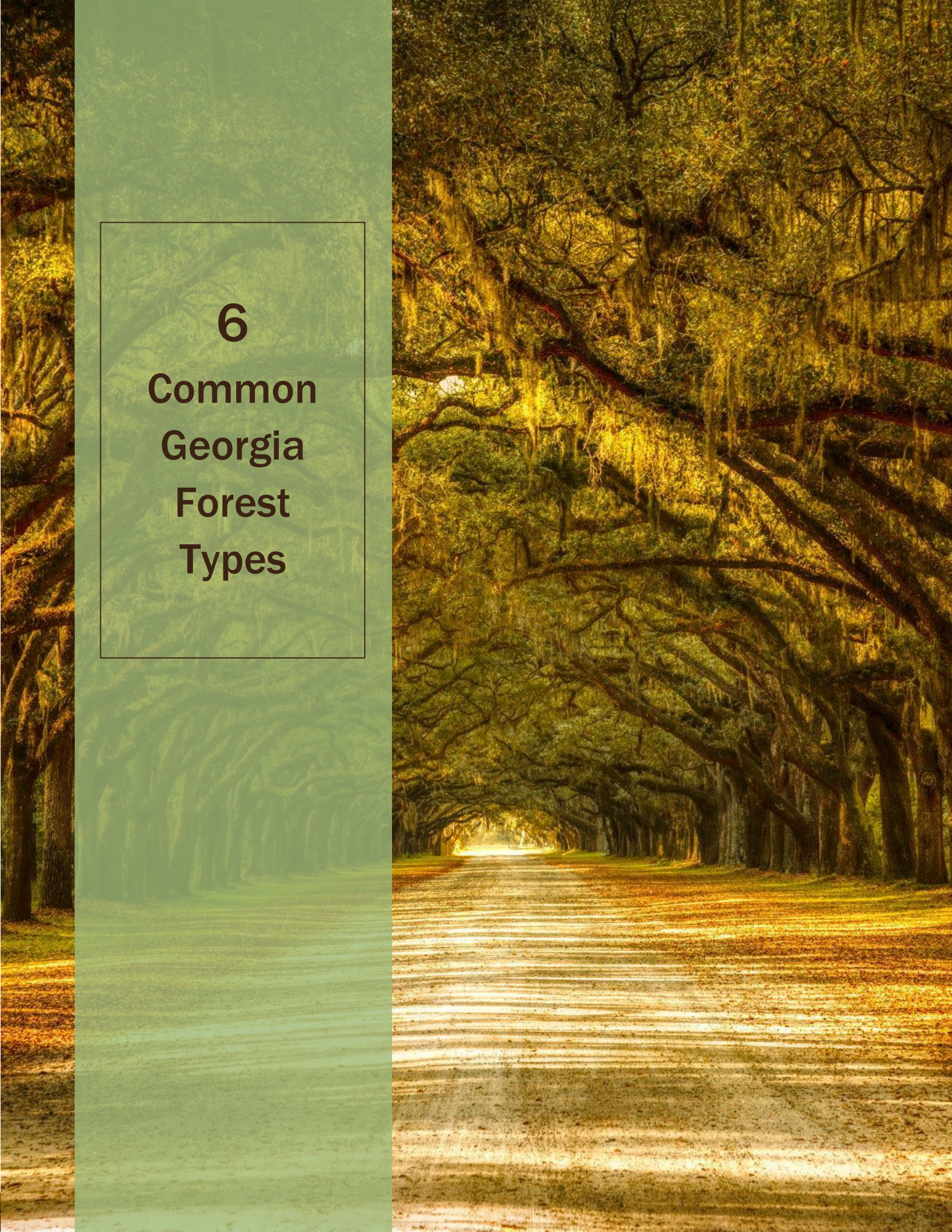
An often-overlooked aspect of heirs' properties is that the land in question does not just belong to the family that resides on or pays taxes on the land, but to all heirs regardless of their location. This creates a land management challenge, as some descendants may wish to sell their particular portion 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 Georgia Heirs Property Law Center.

6 Common Georgia Forest Types



6. COMMON GEORGIA 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 Georgia. 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. slash 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 slash pine forest types. Referring to The Natural Communities of Georgia distributed by the University of Georgia Press may be useful in helping meet landowner objectives. Detailed natural community descriptions, species lists, and other information on all the natural communities of Georgia can be found in the online resource or the accompanying book (Ambrose et al. 2013). Georgia natural communities associated with the LMP's Common Georgia 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 the University of Georgia's publication, Guide to the Natural Communities of Georgia. Multiple Communities of Georgia comprise each LMP Forest Type (i.e. Bottomland Hardwoods Forest Type contains Piedmont seepage forest, mesic forests, and wet meadows Communities of Georgia). Also, if a species is present in both Upland Hardwoods and Bottomland Hardwoods, it is likely found in the moderate Mesic Forests community type that is not specifically discussed as a major forest type of Georgia.

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 Georgia, 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	Shortleaf Pine Dominant	Slash Pine Dominant	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwoods
Southern sugar maple	*Acer floridanum*							X
Box elder	*Acer negundo*							X
Striped maple	*Acer pensylvanica*						X	
Red maple	*Acer rubrum*	X		X	X	X	X	X
Sugar maple	*Acer saccharum*						X	X
Mountain maple	*Acer spicatum*						X	
Yellowbuckeye	*Aesculus flava*						X	X
Downy serviceberry	*Amelanchier arborea*					X		
Yellow birch	*Betula alleghaniensis*						X	
Black (sweet) birch	*Betula lenta*						X	
River birch	*Betula nigra*							X
American hornbeam	*Carpinus caroliniana*				X		X	X
Water hickory	*Carya aquatica*							X
Bitternut hickory	*Carya cordiformis*						X	X
Pignut hickory	*Carya glabra*					X	X	
Red hickory	*Carya ovalis*					X	X	X
Shagbark hickory	*Carya ovata*					X	X	X
Pale hickory	*Carya pallida*					X		
Mockernut hickory	*Carya tomentosa*					X	X	X
Sugarberry	*Celtis laevigata*				X			X
Redbud	*Cercis canadensis*				X	X	X	
Atlantic white cedar	*Chamaecyparis thyoides*							X

Common Name	Scientific Name	Loblolly Pine Dominant	Longleaf Pine Dominant	Shortleaf Pine Dominant	Slash Pine Dominant	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwoods
Black titi	*Cliftonia monophylla*		X					X
Flowering dogwood	*Cornus florida*	X	X	X	X	X	X	X
Swamp dogwood	*Cornus foemina*							X
Swamp titi	*Cyrilla racemiflora*		X		X			X
Persimmon	*Diospyros virginiana*				X			X
American beech	*Fagus grandifolia*	X		X	X		X	X
White ash	*Fraxinus americana*						X	X
Carolina ash	*Fraxinus caroliniana*							X
Green ash	*Fraxinus pennsylvanica*							X
Loblolly bay	*Gordonia lasianthus*				X			X
Common silverbell	*Halesia tetraptera*						X	X
American holly	*Ilex opaca*				X			X
Yaupon holly	*Ilex vomitoria*	X	X			X		
Black walnut	*Juglans nigra*							X
Eastern red cedar	*Juniperus virginiana*					X	X	
Mountain laurel	*Kalmia latifolia*			X			X	X
Sweetgum	*Liquidambar styraciflua*	X		X	X	X	X	X
Tulip tree	*Liriodendron tulipifera*				X		X	X
Cucumber magnolia	*Magnolia acuminata*						X	X
Fraser magnolia	*Magnolia fraseri*						X	X
Magnolia	*Magnolia grandiflora*	X	X		X	X		X
Sweet bay	*Magnolia virginiana*				X			X
Wax myrtle	*Morella cerifera*	X	X		X			
Red mulberry	*Morus rubra*				X			X

Common Name	Scientific Name	Loblolly Pine Dominant	Longleaf Pine Dominant	Shortleaf Pine Dominant	Slash Pine Dominant	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwoods
Black tupelo	*Nyssa sylvatica*	X	X	X		X	X	X
American hop hornbeam	*Ostrya virginiana*					X	X	X
Sourwood	*Oxydendrum arboreum*					X	X	
Red bay	*Persea borbonia*				X	X		X
Swamp bay	*Persea palustris*							X
Shortleaf pine	*Pinus echinata*		X	X		X	X	
Slash pine	*Pinus elliotti*	X	X		X	X		
Spruce pine	*Pinus glabra*	X	X	X		X	X	
Longleaf pine	*Pinus palustris*		X			X		
Table Mountain pine	*Pinus pungens*					X		
Pitch pine	*Pinus rigida*					X		
Pond pine	*Pinus serotina*	X	X					X
Eastern white pine	*Pinus strobus*					X	X	
Loblolly pine	*Pinus taeda*	X	X			X	X	X
Virginia pine	*Pinus virginiana*					X	X	
American Sycamore	*Plantanus occidentalis*							X
Eastern cottonwood	*Populus deltoides*					X	X	
Pin cherry	*Prunus pensylvanica*						X	
Black cherry	*Prunus serotina*	X	X	X	X	X	X	X
White oak	*Quercus alba*	X				X	X	X
Scarlet oak	*Quercus coccinea*		X	X		X	X	
Southern red oak	*Quercus falcata*	X	X	X		X	X	X
Bluejack oak	*Quercus incana*		X			X	X	
Turkey oak	*Quercus laevis*		X			X	X	

Common Name	Scientific Name	Loblolly Pine Dominant	Longleaf Pine Dominant	Shortleaf Pine Dominant	Slash Pine Dominant	Pine/ Hardwood Mixed	Upland Hardwoods	Bottomland Hardwoods
Laurel oak	*Quercus laurifolia*	X	X		X	X	X	
Overcup oak	*Quercus lyrata*							X
Blackjack oak	*Quercus marilandica*		X			X	X	
Swamp chestnut oak	*Quercus michauxii*							X
Chestnut oak	*Quercus montana*		X			X		
Water oak	*Quercus nigra*	X	X		X	X	X	X
Cherrybark oak	*Quercus pagoda*							X
Willow oak	*Quercus phellos*						X	X
Northern red oak	*Quercus rubra*						X	X
Shumard oak	*Quercus shumardii*							X
Post oak	*Quercus stellata*		X			X	X	
Black oak	*Quercus velutina*		X			X	X	
Live oak	*Quercus virginiana*					X	X	
Black locust	*Robinia pseudoaccacia*					X	X	
Black willow	*Salix nigra*							X
Sassafras	*Sassafras albidum*						X	X
Mountain-ash	*Sorbus americana*						X	
Cypress	*Taxodium sp.*							X
White basswood	*Tilia americana*						X	X
Eastern hemlock	*Tsuga canadensis*					X	X	
Winged elm	*Ulmus alata*							X
American elm	*Ulmus americana*							X

6.1. Loblolly Pine Dominant

Loblolly pine is a highly valuable commercial species in Georgia. It is often planted in dense, productive plantations with genetically improved seedling stock. It is often even-aged-managed on revenue-maximizing short rotations, although 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*) and hickory (*Carya* spp.) among other hardwoods. Loblolly is found sparsely on mesic and wet flatwoods sites, particularly adjacent to wetlands. It is considered offsite on excessively well-drained sandy soils of the coastal areas, 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. As previously mentioned, a Working Lands for Wildlife Program for Georgia is working toward the reestablishment of bobwhite in this pine savanna habitat.

6.2. 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). Georgia longleaf pine historically grew in mesic savannahs or mesic/wet/scrubby flatwoods, upland pine, and upland mixed woodland natural communities ranging from the coast to inland as far as 200 miles. Longleaf pine is a long-lived species with relatively slower growth characteristics compared to loblolly or slash 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, slash, and loblolly pines. Sand pine can be a threat to longleaf pine if stands are not properly managed. 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 slash 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. As previously mentioned, the Working Lands for Wildlife Program for Georgia is working toward the reestablishment of bobwhite in this pine savanna habitat.

In mesic and wet flatwoods, it 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.

There are many economic and ecological incentives for landowners to manage for longleaf pine. 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 in the southern portion of southern and western Georgia. Many endemic wildlife species of longleaf pine forests prefer its open stand structure, including gopher tortoise, 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 Forest Ecological Restoration section.

6.3. **Shortleaf Pine Dominant**

Shortleaf pine is an important lumber species in Georgia. Shortleaf pine is most productive and common in the Piedmont region of the state and mountains, but is currently found within every county and ecoregion of the state (Georgia Forestry Commission Native Trees of Georgia). 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 and loblolly pines and mixed hardwoods such as southern red oak. This section will focus on shortleaf pine on upland pine sites. It grows alongside longleaf, 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. 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 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. Littleleaf, 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. Shortleaf pine may also fall victim to red heart disease, and mature trees with this affliction prove to be favored nesting sites for the red-cockaded woodpecker (RCW).

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. Shortleaf is an ecological component in upland pine (loblolly mixed), upland mixed woodland, and dry upland hardwood forest natural communities. Revenue and conservation objectives can be balanced or achieved individually through shortleaf management.

Shortleaf pine is shade intolerant and is best suited for even-aged management, providing landowners the option of managing intensively and maximizing revenue with short rotations. 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.

6.4. **Slash Pine Dominant**

Slash pine is a highly valuable commercial species in Georgia, especially South Georgia. It is often planted in dense, productive plantations with genetically improved seedling stock. It is often managed even-aged on revenue-maximizing short rotations. Slash is not as long-lived as longleaf pine and is unsuitable for uneven-aged management. 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 saw timber, poles and ply logs.

Slash pine is second only to longleaf pine in terms of disease, insect and fire resistance, but only moderately drought tolerant. Slash pine is not only economically valuable but is a key ecological component in pine flatwoods natural communities. Revenue and conservation objectives can be balanced or achieved individually through slash pine management.

Slash pine can be found scattered throughout various wetlands and their ecotones, but thrives in the sandy, acidic spodic soils of mesic and wet flatwoods. It shares these flatwoods sites in variably mixed stands with longleaf pine, with little to no hardwood in managed stands. Slash grows marginally along scrubby flatwoods sites with sand pine, longleaf pine and mixed scrub oaks. It is considered offsite on sandhills and clay soils but can be found marginally on these sites.

6.5. **Pine/Hardwood Mixed**

Pine/hardwood mixed forest type is a combination of uneven-aged, natural forest types which includes multiple upland natural communities. The associated natural communities according to The Natural Communities of Georgia (Ambrose et al. 2013) include: pine-oak woodlands, oak-pine-hickory, acidic oak-pine forests, and pine-oak woodlands. Refer to Table 4 for a listing of the common, dominant overstory species comprising the pine/hardwood mixed forest type.

The natural communities within pine/hardwood mixed are each similar in silvicultural operability to other xeric sites in Georgia. This forest type is found state-wide within the uplands of Georgia, and species composition within this forest type varies based on hydrology and elevation from site to site. These forests usually result from long-term fire

exclusion but are usually found within the ecotone where bottomland forests and upland pine forests meet. Upland pine has been collectively represented and covered within the loblolly pine and shortleaf pine forest type sections.

Pine/hardwood mixed forests have lower timber productivity than loblolly stands due to the interspersed hardwood species and generally are not actively managed, aside from upland pine. They are not fire tolerant/dependent, aside from upland pine and upland mixed woodland. Soils, productivity, and timber quality vary greatly across these sites. Pine/hardwood mixed forests produce pine products similar to loblolly pine dominated forests and also low value products such as hardwood pulpwood and fuelwood. These forests usually have understories dominated by shade tolerant hardwoods which are best suited for uneven-aged management. Pine/hardwood mixed forest types allow the flexibility to manage for timber while also meeting aesthetic and wildlife objectives.

6.6. 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 Georgia (Ambrose et al. 2013) include: northern hardwoods, oak forests, montane oak forests, dry calcareous forests, and mesic forests, to a degree. This forest type is variable depending on location and found throughout the state. 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 Georgia 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, UH 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.

6.7. Bottomland Hardwoods

Bottomland hardwood (BH) communities are river swamps generally found along streams and rivers throughout the southeast and south-central United States, although sometimes they can be found in depressions such as Carolina bays or pocosins. These habitats are generally lacking in slope due to their presence within the broad, flat floodplains of their associated hydrologic feature; also, BH communities within the Piedmont and Appalachian regions of Georgia 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.

Within Georgia, 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 Blue Ridge regions,

and flow through the Coastal Plain region 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 Blue Ridge. Red river floodplains are usually larger and more productive than black river floodplains (Messina and Conner, 1998). In the Coastal Plain region, 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. Pond cypress also prefers isolated depressions while bald cypress can tolerate greater amounts of moving water. 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 Coastal Plain 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, BH 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 Georgia (Ambrose et al. 2013) include: montane bottomlands and floodplains, bottomland/floodplain forests, and mesic forests to a certain extent. After conferring with a group of natural resource professionals from Georgia, 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, tupelo-cypress mixed, mixed floodplain, and elm/ash/cottonwood forest types.

6.7.1. Tupelo-Cypress Mixed

Tupelo-cypress mixed communities are relatively small, isolated wetlands embedded within Bottomland Hardwood Forests or also various upland, pyrogenic natural communities. Pond or bald cypress (*Taxodium distichum* or *Taxodium ascendens*) and swamp or water tupelo (*Nyssa sylvatica* var. *biflora* or *Nyssa aquatica*) are relatively slow-growing and dominate this forest type together or in pure stands. Bald cypress and water tupelo are usually found in deepwater swamps along red rivers in the coastal plain, and pond cypress and swamp tupelo are usually found in deepwater swamps along black rivers. Water tupelo and bald cypress become more dominant with increasing hydroperiods along both rivers. Because of its thicker, fire-resistant bark, pond cypress becomes more dominant in isolated ponds, stringer swamps, and black rivers located in more pyrogenic natural communities (Messina and Conner, 1998). Isolated ponds have a hydroperiod that lasts most of the year, with tupelo-dominated ponds having a longer hydroperiod than pond cypress-dominated. Pond cypress-dominated stringer swamps occur along intermittent streams that only flow following heavy rainfall. They occur on relatively unproductive organic muck, wet sand, and peat soils. These typically even-aged forest types can be managed sustainably by using the GA BMPs for Forestry.

Cypress/tupelo ponds can contain various mixed hardwoods including bays (*Persea* spp.*, Gordonia lasianthus*, and *Magnolia virginiana*), red maple (*Acer rubrum*), holly (*Ilex sp*), and swamp titi (*Cyrilla racemiflora*). Cypress-dominated ponds and stringer swamps generally occur within pine flatwoods and sand hills, while tupelo-dominated ponds generally occur within upland pine natural communities.

In comparison to the pine-dominated upland forest types, these tupelo-cypress mixed forests have relatively low timber productivity, value and generally are not actively managed silviculturally on most private lands. However, silvicultural opportunities exist within these communities. Cypress dominated ponds and stringers are shade intolerant and best suited for even-aged management. Gum ponds (tupelo-dominated isolated depressions) are shade tolerant, but typically managed even-aged as well. The tupelo-cypress mixed forest type allows the flexibility to manage for timber while also meeting aesthetic and wildlife objectives. These forests produce mostly low value products such as hardwood pulpwood, fuelwood, and cypress mulch. Mature cypress stands can produce saw logs used for various ornamental products such as tables, trim, and furniture.

6.7.2. Mixed Floodplain

Mixed floodplains are a combination of forest types which includes multiple wetland natural communities that are associated with riverine or creek systems. They are each similar in silvicultural operability and hydrology. These are uneven-aged, natural forested wetlands with long hydroperiods. They are not fire tolerant/dependent and each has a closed canopy. The associated natural communities include hardwood flats and flatwoods.

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 Georgia's BMPs for Forestry.

6.7.3. 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 Georgia's BMPs for Forestry.

7
Forest Resources

7. 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 4.2.

7.1. Common Forest Resources

7.1.1. 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 Georgia 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 Emergency Forest Restoration Program Agricultural Conservation Easement Program (ACEP) Healthy Forests Reserve Program Environmental Quality Incentives Program Conservation Stewardship Program National Water Quality Initiative Longleaf Pine Initiative Shortleaf Pine Initiative Wildlife Incentives for Nongame and Game Species (WINGS) National Bobwhite and Grasslands Conservation Initiative Partners for Fish and Wildlife Program
Georgia Department of Natural Resources/Regional Initiatives	Forest Stewardship Program Conservation Use Valuation Assessment Conservation District Program Bobwhite Quail Initiative Forestry for Wildlife Partnership Red-Cockaded Woodpecker Safe Harbor Program Farm Bill Technical Support Program Georgia Land Conservation Program Forest Land Protection Act Working Lands for Wildlife Piedmont Prairie Partnership Georgia Private Lands Program Sustainable Forestry Initiative
Georgia Forestry Commission	Southern Pine Beetle Prevention Cost Share Program Invasive Plant Control Program (IPCP)

Some landowners sign conservation easements ensuring this long-term protection. Landowners can enter their property into a conservation easement agreement through various entities such as the The Nature Conservancy or a local land trust. A list of all Land Trust Alliance members operating within Georgia can be found here: https://www.findalandtrust.org/land-trusts/explore?nearby=false&location=32.1656221%2C%20-82.9000751&radius=160934&locationName=GA. 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. Some landowners may also be available to earn credits on private mitigation banking markets through the enhancement or restoration of wetlands and/or threatened and endangered species habitat.

7.1.1.1. Conservation Incentives Within Ecoregions

Conservation is essential to maintain the abundant natural resources found in Georgia. 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 Georgia. 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.

7.1.1.1.1. 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 Georgia; 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 Program (CRP). Since its inception in 1985, CRP is 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 CRP has 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 Georgia wetland forested habitats.

An aquatic initiative active within Georgia 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 Georgia, the two watersheds meeting the criteria to be classified as "priority watersheds" are Etowah River and the Oostanaula River watersheds. These watersheds contain the Etowah River which flows through Floyd and Bartow counties of northwest Georgia and the Oostanaula River which borders the Etowah River Watershed in northwest Georgia. The majority of land types surrounding these watersheds is forest,

with pastureland and other habitat interspersed. 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. In Georgia, the above-mentioned priority watershed is found only in the Ridge and Valley ecoregion.

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 Georgia 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 Georgia cover all of the different ecoregions within the state, 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 Georgia ecoregions except the Southern Coastal Plain.

A wildlife-focused conservation initiative within Georgia is the National Bobwhite and Grassland 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 Georgia can qualify under the NBCI. For information about the Georgia Bobwhite Initiative, go to: https://georgiawildlife.com/bobwhite-quail.

7.1.1.1.2. State Conservation Initiatives and Programs

The Georgia Statewide Wildlife Action Plan (GSWAP) is a major source of the conservation initiatives and programs available within Georgia to aid in the preservation of species or natural forested resources (GA SWAP 2015). The GSWAP provides lists of Regional Conservation Partnerships. Of these state wildlife initiatives, there are multiple

programs focused on forestry or wildlife programs. These include Private Lands Program (which includes the Forestry for Wildlife Partnership, Georgia Bobwhite Quail Initiative, and Forest Stewardship Program), The Heritage Trust Program, Forest Legacy Program, the Landscape Conservation Cooperatives (including the South Atlantic, Appalachian, and Gulf Coastal Plains and Ozarks LCCs), Georgia Forest Land Protection Act, Association of Georgia Land Trusts, and the Red-cockaded Woodpecker Safe Harbor Program. These programs should be consulted through the above links to determine whether they apply in each location and circumstance.

The Georgia Private Lands Program was born out of the Private Lands Initiative, originally formed in 1995 by the Georgia DNR's Wildlife Resources Division (GADNRWRD). The original goal of the initiative was to intensify efforts in promoting, encouraging, and providing technical assistance for wildlife management on privately-owned lands. The initiative first developed a partnership with corporate forest landowners through the Forestry for Wildlife Partnership before adding the Bobwhite Quail Initiative in 1998 and the Forest Stewardship Program in 1999 to form the overall Private Lands Program. The goal of the organization remains the same, as it is dedicated to serving landowners by incorporating their objectives into a comprehensive wildlife management plan that works for the greater good.

The Sustainable Forestry Initiative (SFI) has been in place in Georgia since 1995. Its main objective is to support responsible forestry within the state and ensure harvesting occurs in a way to promote and provide sustainability into the future for Georgia landowners. In the past, this program has helped train loggers and foresters, provided information and support concerning forestry practices to family landowners, used SFI-endorsed wood procurement practices, and assured customers that their production of paper products come from sustainably managed forests. While the SFI is a worldwide program, with 242 program participants in North America, states have their own local SFI Implementation Committees. Highlights of the Georgia SFI program include the promotion of forestry BMPs, participating in outreach to local Georgia private landowners, and educating loggers toward the Master Timber Harvester certification.

The US Fish and Wildlife Service Partners for Fish and Wildlife Program provides technical and financial assistance to landowners who are interested in helping improve habitat for certain key wildlife species.

The Georgia Forestry Commission (GFC) offers state cost-share programs to those who qualify. The major cost-share program available through the GFC is the Southern Pine Beetle Cost Share Program (SPB), a federally funded program administered by GFC.

SPB is designed to mitigate future forest loss from Southern Pine Beetles for non-industrial private forest landowners through management of pine density using prevention and restoration practices. The minimum practice size for this program is 10 acres. 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. The prevention portion of the plan involves practices such as reducing stem amount within immature, over-stocked stands, and thinning by hand or by machine. The restoration portion involves planting activities to return damaged or harvested areas back to healthy forest densities. All counties/ecoregions are eligible for the prevention practices, and all counties/ecoregions are eligible for the restoration practices involving plantings for all pine species.

GFC also funds the Invasive Plant Control Program (IPCP). This program is open to all private non-industrial landowners with a minimum forested land size of 10 acres. The IPCP covers the use of herbicides or a combination of herbicidal and mechanical treatments to eradicate NNIP. Species targeted by this program are listed as a top

concern for Georgia and include Privet, Japanese climbing fern, Chinese tallow, chinaberry, and Callery pear. Participants in the plan receive a rate of $60 per acre for treatment of these above-listed species.

Within the America's Longleaf Restoration Initiative, three different Implementation Teams exist across the state of Georgia: the Chattahoochee Fall Line Conservation Partnership, the Fort Stewart/Altamaha Longleaf Conservation Partnership, and the Okefenokee-Osceola Partnership. Each of these partnerships has the goal of reestablishing, maintaining, and enhancing the longleaf pine ecosystem using a variety of management practices and collaboration within stakeholders. Each of these local partnerships are composed of a mix of state, federal, and private organizations as well as private landowners within the respective regions. Participating in the various land management activities promoted by these individual partnerships may qualify the landowner for cost-share benefits.

7.1.2. 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 Georgia, but they may develop in coming years. One notable exception is the Lower Savannah River Watershed Initiative described in Section 4.0. Also, Georgia has begun to participate in the carbon sequestration market. The GFC and the University of Georgia have defined a Carbon Registry protocol for Georgia while also developing an online carbon sequestration registry to track and list forest products that are managed to actively sequester carbon. Companies may be able to cost-share tree planting or reforestation activities in exchange for "carbon credits", which would help to offset cost. Georgia, California, Maine, and Oregon are the current states that have begun to develop a carbon credits system, with more expected to follow. More information on this system can be found here: https://www.conserve-energy-future.com/carbon-credits.php.

7.1.3. 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 Georgia Archives and local historical societies and museums. The Historical Structures and Cemeteries layers within the LMP geodatabase can also be used to provide information on site-specific historic and cultural resources.

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 Georgia Archives 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, etc.
- Geological formations, sinkholes, limestone bluffs or outcroppings, caves/entrances, spring heads, springs, etc.
- Rare plant populations, pitcher plant bogs, champion trees, bear dens, etc.

7.1.4. Recreation

Georgia's geography and variability of different habitats within the state, ranging from the coastal "Lowcountry" to the foothills of the Appalachians, lend itself to providing a wide range of recreation opportunities through its natural areas. Georgia'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
- Equestrianism
- Camping
- Environmental education
- Geocaching
- Paddling

7.1.5. Aesthetics

From a towering pine stand with a sea of grasses to a lush, mixed bottomland hardwood forest to the unique landscape of the many barrier islands, the wide range of forest types, topography and aquatic features throughout Georgia provide unique forest aesthetic values. The forests themselves vary from open, pine-dominated rolling hills to dense cypress ponds. Southern Georgia boasts hardwood forests more fitting of the Appalachian Mountains as you move toward the north Georgia/North Carolina borders. These dense forests are composed of many northern species, providing a different aesthetic than the southeastern lowlands of South Georgia and the Atlantic coast, where the cypress lined rivers and ponds have their own prehistoric beauty.

Georgia is quite diverse in its topography due to its stretching from coastal lowlands to the Appalachian foothills. It has rolling sand and clay hills in the Piedmont, steep-head spring ravines, slope forests, and high river bluffs. Various aquatic features such as forested wetlands, lakes, ponds, rivers, streams, and springs 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.

7.1.6. 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.

7.1.6.1. 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 Georgia'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.

7.1.6.1.1. Public Lands

Due to their recognized conservation priorities for protecting habitat, biodiversity, water resources, cultural sites, and unique geologic features, all area federal and state protected public lands are considered FORIs within this LMP. This designation includes state forests, state parks, national forests, national parks, water management areas, wildlife management areas, and wildlife refuges.

Landowner Actions to Protect FORIs

For family landowners, a likely scenario is that their property is adjacent to a state or federally protected area 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.

7.2. Forest Type-Specific Forest Resources

7.2.1. Fish & Wildlife

The forests and associated aquatic ecosystems of Georgia 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 recommendations in the GA BMPs for Forestry to protect water quality could also be used to compile strategies and considerations for managing and protecting these species and their habitat during silvicultural operations, such as using flagging, paint, or signage to protect during harvest operations, regular active monitoring and following up with post-harvest inspection(s).

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 gopher tortoise, bald eagle, frosted flatwoods salamander, Indiana bat, and red-cockaded woodpecker (Table 2). Hardwood forests also provide habitat for their own collection of game and non-game species.

7.2.2. 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. The LMP Geodatabase can be utilized to locate and contact local mills and calculate haul distance. Mills in Alabama, Georgia, North Carolina, and South Carolina purchase these products from Georgia 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. Product classes are generally expressed in terms of diameter measured at breast height (DBH) and are given below:

- **Pulpwood:** 6-9" DBH. Pulpwood trees are chipped into small pieces, chemically treated, and made into paper. Pulpwood is measured in tons or standard cords.
- **Superpulp:** This is an unofficial designation used to describe pulpwood-sized pine trees from which one 2 x 4 board could be cut. Superpulp is more valuable than regular pulpwood, but markets for this product are not always available. Another name for superpulp is "canterwood."
- **Palletwood:** This is an unofficial designation for low-quality hardwood timber that is not good enough for lumber but can be sawed into slats for pallet-making. Palletwood is sometimes called "skrag."
- **Chip-n-saw:** 9-12" DBH. By using a combination of techniques, these mid-sized trees produce chips for pulpwood as well as small dimension lumber. Chip-n-saw is measured in tons or standard cords. Value is heavily dependent on tree quality.
- **Sawtimber:** 12"+ DBH. Trees are cut into lumber. Waste material is converted into chips for fuel or paper production. Sawtimber is measured in tons or board feet. Value is heavily dependent on tree quality.
- **Pole and Piling:** 10-20" DBH. Poles and pilings are used to hold vertical loads and must be straight. Eligible trees have straight, cylindrical trunks free of limbs and defects for at least 32', and trunk sweep should not exceed 1" for every 10' of trunk length. The demand for poles and pilings and their sizes is highly variable, and ultimately, the buyer of those product classes determines whether a tree is a pole or piling tree. For valuation purposes, most pole and piling quality trees are considered sawtimber.
- **Veneer:** 16"+ DBH. By means of a large lathe, the tree is converted into continuous sheets of thin wood. This is used in the manufacture of plywood and furniture, depending on the type of tree. Veneer is measured in tons or board feet. Value is heavily dependent on tree quality. For valuation purposes, most veneer quality trees are considered sawtimber.

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.

Sawtimber is complicated in its nomenclature. There are three recognized methods of computing the number of board feet in a given tree. Called "log rules," these are tables estimating the amount of lumber that can be cut from trees of various sizes. The Scribner Log Rule is the commonly accepted measurement standard for pine sawtimber in GA; the Doyle Log Rule is frequently used to estimate hardwood timber. The third rule, International Quarter-Inch, may actually be the most accurate but has never gained much acceptance in the state. Sawtimber volume is usually quoted in thousands of board feet (MBF).

Any of the three log rules are legal, but all give a different estimate of timber volume in a given tree. The seller should understand that an offer of $200 per thousand board feet on the Scribner rule usually returns more money than $200 per thousand board feet on the Doyle rule. There is no easy way to convert among the three.

The price paid for standing timber is called "stumpage." This is the amount the landowner is paid in a timber sale. Stumpage will be expressed as dollars per cord, dollars per ton, or dollars per thousand board feet. The amount the timber brings at the mill is called the "delivered price." The delivered price will be higher than the stumpage price because it includes the cost of logging and hauling.

An 18-wheel truck/trailer can haul about 25 tons of timber. This is the equivalent of about 9.3 standard cords of pine pulpwood or chip-n-saw. If the load is sawtimber or veneer size, the truck can haul about 3.3 MBF.

7.2.3. Pine forest products

Timber is considered **pre-merchantable** if it is too small in diameter and/or height for 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 and slash pine are 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.

7.2.4. Hardwood forest products

All the major timber product groups can be harvested from 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

The following timber product groups can be harvested from Tupelo-Cypress Mixed forests: hardwood pulpwood, cypress mulch and sawtimber and fuelwood. This forest type is commonly managed for lower value products such as hardwood pulpwood, and cypress mulch.

7.3. Non-Timber Forest Products

Many non-timber forest products (NTFP) opportunities exist within pine forests, including pine straw (slash and longleaf pine), silvopasture (all pine forests), bee-keeping (all pine forests), and saw palmetto drupe harvests (all pine forests). NTFPs exist to a certain scale within hardwood forests as well. Pine/hardwood mixed, upland hardwood, mixed floodplain, tupelo-cypress mixed, and cottonwood, sycamore, and birch all provide opportunities for bee-keeping and fruit harvests, while tupelo-cypress mixed forest types provide opportunities for the collection of cypress knees as well.

7.3.1. Pine-specific forest types

7.3.1.1. Pine straw

Longleaf pine straw is the most valuable and desirable as it produces long, resilient, attractive needles ideal for landscaping. Pine straw raking for landscaping material is the most common NTFP market in the region. It often generates $100-$150 per acre per year or more and can be conducted while the timber is still pre-merchantable, providing landowners with early returns on their stand establishment investment (i.e. site preparation and reforestation costs). Raking is generally initiated at crown closure (year 10) and ceases following first thinning (year 18-20). This period of raking usually coincides with the stand's crown lifting via shade. If landowner objectives are focused on maximizing revenue, they may wish to forego thinning and rake straw beyond economic or biological thinning age, clearcutting for pulpwood at age 22-25 and starting over. If landowner objectives are varied and involve thinning, the stand should be thinned at economic or biological thinning age (year 20-22) to promote proper stand development.

Traditional pine straw raking reduces or eliminates the native groundcover with annual herbicide and mowing and removal of coarse woody debris. This eliminates impurities being mixed in with the pine straw and allows for efficient raking. The result is a monoculture of the pine species, drastically reducing the quality of wildlife habitat. However, a more conservation-oriented form of pine straw management has been developed which entails raking the pine straw from the top of native groundcover and avoids frequent herbicide and mechanical treatments (NWF 2015), which might be a better fit for landowners balancing pine straw revenue with timber, wildlife, and aesthetic objectives. This approach will likely not include annual raking and may generate less revenue, but splitting a stand in two sections and raking one section per year is one approach to gain annual revenue. Pine straw stands are often fertilized to produce more pine straw, promote tree growth, and avoid depleting soils. Pine straw raking can be rewarding yet requires a lot of work to be successful. Planning and site selection begin prior to stand establishment.

Visit "Pine Straw -A Profitable Agroforestry Enterprise" and "Lifting Longleaf Pine Straw: An Option to Balance Income and Wildlife" for more information.

7.3.1.2. 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 Georgia, 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).

7.3.2. Hardwood-specific forest types

7.3.2.1. Cypress knees

Tupelo-cypress mixed forests produce knees that can be cut and used for art and craft purposes. This is non-commercial and on a small-scale

7.3.3. Pine and hardwood forest types

7.3.3.1. 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 Georgia Code of Laws (https://agr.georgia.gov/sites/default/files/documents/assets/legal/ocga/ocga-georgia-bee-law.pdf). In order to protect this industry from pests and unwanted species of honey bees, they require inspections of new colonies through the state of Georgia Plant Protection Section. Additional resources and professional association affiliation can be found through the Georgia Beekeepers Association.

7.3.3.2. Fruits

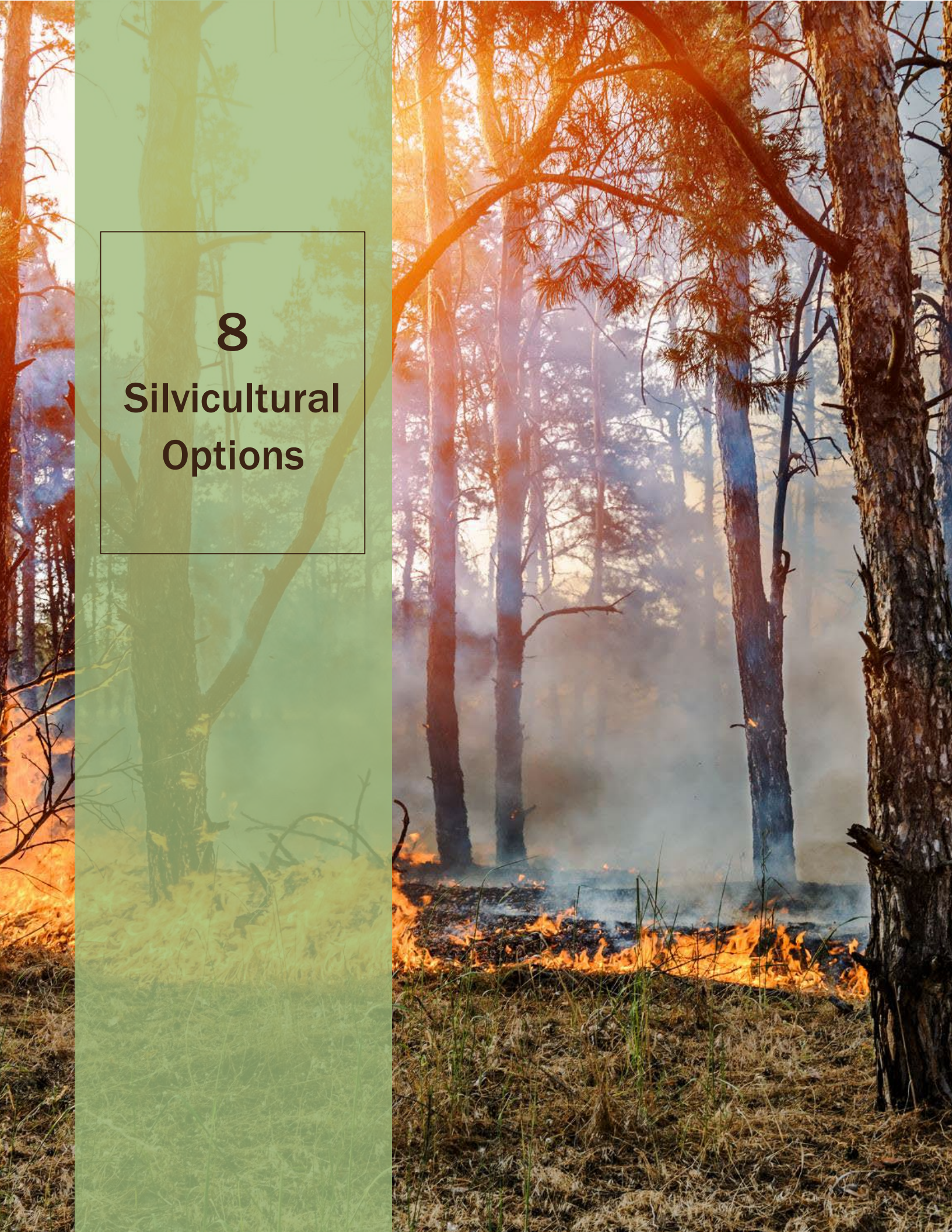
Saw palmetto drupes are harvested from all pine forest types, but shortleaf pine forests to a lesser degree than slash, longleaf, and sand pine forests. They can also be harvested from Mixed Floodplain, Upland Mixed Hardwood-Pine, and Upland Hardwood forest types within Georgia. Saw palmetto drupes are harvested to produce medicines used to treat symptoms of enlarged prostate and prostate cancer prevention (Anderson and Oakes 2012). Palmetto drupes can be sold to producers through contract, permit or by leasing land for harvests, providing landowners short-term revenue. However, pickers can be troublesome and need to be monitored. Trespassing, cutting fence and other issues have arisen without adequate permitting and monitoring of crews. Prescribed fire stimulates palmetto drupe production and they ripen August through October (Anderson and Oakes 2012).

Palmetto drupes are a primary dietary staple of Florida black bear (US Fish and Wildlife Service 2019) and provide valuable nutrition to raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), gopher tortoise (*Gopherus poloyphemus*), opossums (*Didelphis marsupialis*), white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), bobwhite (*Colinus virginianus*), black bear (*Ursus americanus*), feral hog, and various birds such as American robin (*Turdus migratorius*), northern mockingbird (*Mimus polyglottos*), yellow-rumped warbler (*Dendroica coronata*) and pileated woodpecker (*Dryocopus pileatus*) (Anderson and Oakes 2012). If wildlife management is an objective, landowners may wish to avoid or limit palmetto drupe harvests.

Hawthorn (*Crataegus* spp.) can be collected from mixed bottomland and upland forests 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:

7.4. Other Current and Potential NTFP Markets

- Medicinal Native Plants
  - Ginseng
  - St. John's Wort
- Other Edible Products
  - Nuts
  - Mushrooms (Shitake)
- Ornamental Products
  - Spanish Moss
  - Pine Tips for Garlands
  - Pine Cones
  - Pine Tree Gum
  - Grapevines
  - Burl and Crooked Wood
  - Christmas Trees
- Landscape Products
  - Firewood
  - Pine Bark Mulches



8 Silvicultural Options

8. SILVICULTURAL OPTIONS

8.1. Timber Harvest

The following silvicultural and land management tools are available to Georgia 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 GA BMPs for Forestry 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. GA BMPs for Forestry apply to all forest management practices such as but not limited 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. These BMPs are critical to the protection of timber lands and the communities they support. Conversion of forestland from peatland, wetlands, and other hydric systems after 2007 should be evaluated judiciously. If sites are peatland, wetlands, or other hydric systems, special consideration should be taken to ensure that harvesting timber does not result in water depletion of a previously undrained soil. Forest management typically occurs outside of wetland areas; in rare cases where wetland harvesting may occur or there may be justification to convert a wetland to timberland, state BMPs would preclude the conversion of these areas.

The general descriptions of each specific Georgia 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). Annual harvest levels (which may be referred to as annual allowable cut or annual yield) should be determined based on the silvicultural options described in this LMP and should be informed by current stand conditions and other factors (such as those described above). Harvest rates and volumes should support forest productivity that can be sustained in the medium and long-term. Below are descriptions of each type of silvicultural activity and how each activity is applicable to the different forest types within Georgia. 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.

8.1.1. Thinning

8.1.1.1. Pine Forest Types

Thinning is a primary land management tool used in Georgia 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 GA BMPs for Forestry related to thinning harvests, particularly in wetlands and streamside management zones.

Several types of merchantable thinnings are utilized in pine stands in Georgia. 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.

Natural pine stands are typically thinned like planted stands, but instead of rows being removed strips referred to as corridors are removed. The type of thinning can impact future harvesting strategies: the closer the thinned rows are, the fewer trees will be left for the next harvest. Depending on the initial and desired residual densities, first thinnings in young, over-dense stands will usually have 12' wide corridors removed for every 12-24' wide corridors of leave trees. A 40% corridor thinning will have 12' wide corridors removed for every 18' wide corridor of leave trees. Operator select is usually only done in second thinnings and later, or within older stands in combination with a corridor thinning. In older, sawtimber-sized stands, 12-20' wide corridors are removed every 50-60' and then operator select is done in between. Corridors and take trees are sometimes marked by a forester in older stands. Marking natural stands allows more control over residual quality due to their variable nature.

Basal area is a term used in forestry to measure stand density, which is the cross-sectional area of trees measured at breast height (4.5' above ground) in square feet per acre. Knowing the density helps foresters know what the thinning rate should be to meet the landowner objectives. If wildlife, aesthetics, or biodiversity are primary objectives, stands should be thinned to a lower density than if economic return is the main objective. If managing for multiple uses, a moderate density can be used.

Most stands managed for timber production are maintained between 120-70 BA per acre. Once the stand reaches 120 BA it is thinned to 80 BA, which is repeated for each subsequent thinning until the final harvest. When managing for poles and pilings, this range is usually 90-130 BA per acre, and for wildlife this range is usually 60-100 BA. Maintaining higher densities ensures straighter trees and maintaining lower densities ensures sunlight reaching the forest floor to benefit wildlife. Stands having densities greater than 120 BA are more at risk to SPB.

Maintaining healthy live crown ratios (crown length/total tree length) is important to consider as well. Most first thinnings are done when the average crown ratio is 50% and then are maintained with an average crown ratio of 33%

when moving forward. Natural, over-dense pines stand greater than 20 years old with average crown ratios less than 20% should be considered for a final harvest, since the residual trees likely will not have enough crown to benefit from the thinning.

Planted loblolly pine during timber management on productive sites generally requires a first thinning around age 13-15, a second thinning around age 18-22, and a final harvest beginning around age 30-32. The first thinning will usually come sooner for wildlife management and later for poles and pilings, and subsequent thinnings generally take place every 5 to 7 years in planted and natural stands.

Planted longleaf pine, because of its slower growth, generally requires a first thinning around age 17-20, a second thinning around age 30-34, and a final harvest beginning around age 45-50. Many landowners tend to continue pine straw raking in planted longleaf pine stands beyond the biological and economic thinning ages. This decision can have negative impacts on stand development in terms of forest health and timber quality and value.

Young pine stands overstocked with natural regeneration (>1,000 stems per acre) should have a pre-commercial thinning by hand prior to age 10. The GFC's SPB Program offers cost-share assistance for these thinnings. For young, overstocked stands growing on productive soils and greater than 40 acres in size, a corridor thinning or fuelwood chipping at age 15-20 can take the place of a pre-commercial thinning. The "economies-of-scale" and available markets together play a large role in these thinnings.

Releasing the understory at a faster rate than the overstory may occur when a stand with a heavy understory and poor crown ratio are thinned too heavy. Prescribed burns and understory herbicide releases are usually conducted in between thinnings to control the understory from being released.

Pulpwood-sized stands with poor crown ratios that have been recently first-thinned below 70 BA are most susceptible to ice storm damage. To minimize the risks, stands can be thinned to a higher BA, or thinned in early spring so the residual stems can form compression wood over the summer making them more resistant to an ice storm the following winter.

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.

8.1.1.2. Pine/Hardwood Mixed Forest Type

Thinning shortleaf pine/hardwood mixed and loblolly pine/hardwood mixed forests is not commonly practiced in Georgia. 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 GA BMPs for Forestry related to thinning

harvests, particularly in wetlands and streamside management zones. Mixed pine/hardwood 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 loblolly 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 the 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.

8.1.1.3. Hardwood Forest Type

Thinning upland hardwood stands is a primary land management tool used in Tennessee 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. The type of thinning required may involve techniques such as selections depending on the particular habitat. This is a stand-specific determination that can be made by a forester. There are also site-specific GA BMPs for Forestry related to thinning harvests, particularly in wetlands and streamside management zones.

While thinning is used to harvest healthy, desirable trees to meet revenue objectives for a landowner, thinning may also be a method employed to rehabilitate stands that have been damaged by previous harvests. Nyland (2006) gives four steps needed in the rehabilitation of degraded stands, with a chief component being to protect the desirable trees to be kept and promote their growth through the removal of poor or undesirable trees. This removal of trees helps to facilitate a healthier growing condition for desirable trees with less competition for sunlight and nutrients; in turn, the stand is rehabilitated into a more healthy, two-age stand structure with a sparse older class supporting the younger, desired trees (Clatterbuck 2006).

8.1.1.3.1. Low Thinning

Thinning from below, or utilizing a hardwood pulpwood or fuelwood chipping harvest, is sometimes done in hardwood forests to favor the residual (unharvested) trees, improve overall forest health, and improve wildlife habitat. This type of thinning focuses on removing the stems that would eventually be lost to natural mortality due to competition and creating a concentration of desirable trees that remain. On a stand level, the overall density of trees is decreased while the health, size, and growth potential of the stand's remaining trees is increased. A focus should be made to prioritize retaining quality stems over quantity in hardwood thinnings to result in the best quality products possible (Self 2020). Landowners may choose to occasionally lightly thin their stands for revenue, forest health, and maintaining overstory composition.

8.1.1.3.2. Crown Thinning

Crown thinning, or a form of "crown touching" release used in Crop Tree Release, is a form of thinning that attempts to reduce branch crowding within the canopy layer of a forest. The goal of this thinning method is to promote the growth of desirable species through the removal of other large, dominant species in the canopy that are currently removing resources from the desirable tree (sunlight, water, nutrients, etc.; Nyland 1996). A benefit of this thinning method is that it can keep the vertical structure of the forest in place, which benefits wildlife species that utilize the

forest. In performing crown thinning, it is not necessary to remove canopy trees that are below the desired trees canopy as these do not adversely impact resources to the select trees.

8.1.1.3.3. Marked Selection Thinning

Hardwood stands can be thinned using marked selection by a professional 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, taking care to allow space for the operation's success and minimize damage to residual trees.

Natural regeneration harvests are discussed in the reforestation section.

8.1.1.3.4. Crop Tree Release (Free Thinning)

Crop tree release (CTR) is a practice of selectively killing trees surrounding valuable crop trees in a younger (precommercial), overstocked forest stands in order to release desirable crop trees and allow them to flourish. This method of thinning can be used to alter aspects of the stand's species composition while leaving a remainder of the stand unthinned and selectively focus resources on trees that will become the most valuable and desirable. If CTR is applied correctly to a stand, the end result is a faster-growing, healthier stand whose composition is dominated by well-spaced, acceptable trees (Mercker 2007).

While most forests in need of rehabilitation could benefit from CTR, it should be applied on highly productive sites with good soils, protection from winds, and the ability to support trees of 70-75 feet tall; these sites can typically be found in cove habitats, along floodplains, and on north or east-facing slopes. Stands in these areas should only be chosen if they already contain species that are desirable, which in Tennessee are mainly the white or red oak association or other trees predicted to be valuable in the future; stands previously harvested that contain few desirable trees are candidates for regeneration, not rehabilitation through CTR (Mercker 2007).

CTR is accomplished by first locating the crop trees that should be retained and then determine which trees to remove in order to promote the crop trees' success. As taken from Mercker (2007), criteria used to select crop trees include: healthy trees, trees with good form, trees with few knots/better grade wood, trees between 15-30 years old, and trees in the upper canopy. A target goal is to release no more than 36 crop trees per acre. Trees that should be deadened in CTR are any whose crowns touch that of the crop tree on either 3 or all 4 of the crop trees sides; trees below the crop tree can remain. For additional information on how to deaden the other trees, click here.

8.1.1.4. 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 (Kentucky 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.

8.1.2. Clearcut

Clearcutting is a standard silvicultural practice in managing shade intolerant pine as well as hardwoods for timber and other objectives. In most Georgia 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's 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, slash, or loblolly pine. Clearcutting can be used to remove offsite pine/hardwood mixed stands and replant with the appropriate pine species. The common Georgia 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, slash on certain spodisols, or loblolly on certain clay soils.

There are site-specific GA BMPs for Forestry, when using clearcuts, particularly in wetlands and SMZs. The size and shape of clearcuts should be considered if wildlife and aesthetics are also objectives. Timing and seasonality are crucial as well 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.

8.1.2.1. 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.

8.1.3. Chipping/Pellets

Another form of timber harvest in Georgia 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 logs. 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 Georgia 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, 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.

8.1.4. 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 southern pine beetle 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 can be 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.

8.2. **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 Georgia at a significant scale worth discussion. If a landowner wishes to artificially regenerate these forest types, a GFC forester should be contacted.

8.2.1. 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 with longleaf pine	
	Less fire exclusion time due to faster growth	
Natural	Less expensive: no seedling and planting costs	Less productive timber management
	More conducive to uneven-aged management	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, slash, and shortleaf pine will initiate fast, early vertical growth. For longleaf pine, adequate site preparation is essential for seedling survival.

8.2.2.1. 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 (UF IFAS Extension 2009). 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 GA BMPs for Forestry 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 usually does not affect the soil of a site, meaning that soil compaction does not occur and the soil is protected; however, some chemical applications may be remnant in the soil for long periods and damage subsequent plantings. 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. If herbicides are to be used in forestry practices on the landowner's property, all state and national pesticide requirements and regulations must receive strict adherence. For Georgia, the Department of Agriculture is the state authority, while the EPA maintains its national authority on pesticide use. There are also site-specific GA BMPs for Forestry related to site preparation, particularly in wetlands and streamside management zones.

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.

8.2.2.1.1. All Herbicide Spray Application Types

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.

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.

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.

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.

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.

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.

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.

Cut Stump

The cut stump application method involves application of an 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.

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.

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.

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.

8.2.2.2. 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; for example, there are very specific rules governing site preparation within a wetland. All the following methods can be used with establishing all the pine forest types.

8.2.2.2.1. 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 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

8.2.2.2.2. 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 chopping 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 bull dozers or skidding machines, depending on horsepower requirements and site conditions.

8.2.2.2.3. 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. Subsoil must be at least 14” deep to improve root development.

8.2.2.2.4. 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. Care and research of burning regulations should be undertaken prior to a pile burn.

8.2.2.2.5. 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. It can also help increase herbicide coverage through removing large grasses and herbaceous weeds.

8.2.2.2.6. 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.

8.2.2.2.7. Shearing

Shearing involves a heavy bulldozer equipped with an oversized V-blade of KG-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 that occurs following the site being stagnant for a long period of time. 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.

8.2.2.2.8. 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.

8.2.2.2.9. Anchor chain/dragging

Anchor chain/dragging is an efficient way to remove dense stands of trees and shrubs (Doerr 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 Georgia, and typically relegated to site prep following a devastating event such as a hurricane.

8.2.2.3. 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 Georgia, 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.

8.2.3. 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. Planting too soon after bedding or subsoiling 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, the availability of containerized seedlings, good competition control of other species, 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. To ensure a manageable stand, a minimum density of 300 trees per acre should be obtained after the first growing season.

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, although other spacings may be more applicable. 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 slash 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 saw palmetto (Serenoa repens) and gallberry (Ilex glabra). 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 Georgia has no regulation regarding survival standards, attaining 90+% survival rates with pine species can be achieved with careful reforestation planning and execution. Guidelines for planting seedlings can be found through the GFC (Guidelines for Planting Seedlings). 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.

8.2.3.1. Hand Planting Vs. Machine Planting

8.2.3.1.1. Hand planting

Hand planting entails crews planting seedlings by hand. Refer to Table 6 for more information on this method and a comparison with machine planting.

8.2.3.1.2. 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 bulldozer 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 have already been performed. Refer to Table 6 for 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

8.2.3.2. Under-Planting

Under-planting longleaf pine in heavily thinned slash or 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.

8.2.3.3. 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 Georgia. 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, although bareroot can be found as well in certain markets. 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.

8.2.3.3.1. Containerized Vs. Bare Root

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). Slash, longleaf, and loblolly pine seedlings may be available with various genetic improvements, such as growth rate, form, and disease resistance. Improved, containerized slash and loblolly 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 Georgia is from December to March.

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. For example, bareroot longleaf may be better in excessively well-drained sands.

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 (rubber tire machine), and V-blade planting methods can be used to plant all the Georgia pine species, bare root or containerized.

8.2.3.4. Afforestation

Georgia has a long history of agricultural production such as tobacco, peanuts, pecans, peaches, and cotton. These industries have faded and changed in recent decades, resulting in land-use conversions to timber and cattle production. 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 (largely longleaf; slash and loblolly have improved genetic resistance) 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.

8.2.4. 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 Georgia. 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 and slash pine stands can be naturally regenerated to meet various objectives, including two-aged management and aesthetics. Due to the growth characteristics and product markets, these pine species are 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 and slash pine produce 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.

8.2.4.1. Site preparation

8.2.4.1.1. 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.

8.2.4.1.2. Hardwood forest types

For 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. 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 Georgia.

8.2.4.2. Shelterwood

Pine Species

Shelterwood is generally the most effective method of natural regeneration across Georgia 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 Pine/Hardwood Mixed and Upland Hardwood forest types.

Hardwood Species

In hardwood stands needing regeneration where the most valuable species are intolerant of shade, either shelterwood or clearcutting harvests are best suited. The determining factor of which technique to utilize is whether the stand contains the appropriate number of advance regeneration seedlings of the target species; if it does, clearcutting is used, but a lack of this advance regeneration causes shelterwood to be the preferred harvest method (Marquis and Jacobs 1989).

The main goal of a shelterwood harvest is to leave mature trees of the desired species to promote regeneration into the future. This is achieved by a series or cuts (2-3) typically. The first step is the removal of the majority of small-diameter, undesirable trees from the stand (through cutting and subsequent herbicide) in an effort to reduce future competition and promote the success of desirable species. The second step is then removal of approximately half of the larger merchantable trees present. This harvest both removes trees to promote sunlight accessibility and space for future seedlings and also leaves trees to serve as future stand contributors (Cunningham and Walkingstick 2016). It is possible to focus the majority of harvesting on midstory species through modified shelterwood techniques of the larger, valuable trees are already spaced appropriately.

8.2.4.3. 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.

8.2.4.4. Group Selection

Pine Species

The next 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.

Hardwood Species

Group selection in hardwood forests is a proven method to promote the propagation of light-demanding, moderately tolerant species such as oak (Forest Practice Guidelines for Tennessee 1995). Using group selection would be an acceptable method of attempting to rehabilitate a degraded oak forest to a more valuable and productive stand. Group selection is essentially a series of micro-clearcuts within a forest that creates a small area (1-2 acres) that will

proceed in regeneration similarly to a clearcut forest (Cunningham and Walkingstick 2016). The openings provided by this type of harvest also create a mosaic of various-sized opening and habitats for a wide variety of wildlife.

8.2.4.5. Thinning from Above

This method of thinning can be used to release existing natural regeneration in 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.

8.3. Release

Early and mid-rotation release treatments are common in pine management and less common in Pine/Hardwood Mixed forest types within Georgia. 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 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. A merchantable thinning harvest is another form of release and discussed in the timber harvest section.

8.3.1. 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 ATV-mounted sprayers
  - Spot (grid)
    - ATV or backpack sprayers
- Aerial
  - Broadcast
    - Helicopter

8.3.1.1. 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.

8.3.1.2. 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.

8.3.2. 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.

8.3.3. 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 and slash stands.

8.3.4. 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 GFC's SPB 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.

8.4. **Prescribed Fire**

8.4.1. Pine forest types

Georgia's natural communities 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 Georgia 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, slash, 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, slash, 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.

8.4.2. Hardwood forest types

Aside from the previously discussed upland pine natural community (longleaf, loblolly, slash, and shortleaf pines), 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 has also shown that certain hardwood types, particularly oak-dominated communities as seen in the mountainous regions of Tennessee, 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. Some potential scenarios where prescribed fire could benefit an oak stand include: a mature forest with no oak advance reproduction, a mature forest with abundant small oak advance reproduction, a stand with uneven-aged management, a savanna or degraded woodland restoration, or a forest in the stand initiation stage after the final shelterwood removal or clearcut,. As evidenced by these examples, the use of prescribed fire on hardwood stands is increasing in these forest management practices across the Southeast (Dey and Schweitzer 2018). A forester should be contacted before initiated burning to prescribe the proper management technique for individual stands.

Certain factors must be considered when burning in oak-dominated Upland Hardwood forests. Oaks can tolerate higher-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. For instance, fire can cause large scars on oaks, which will severely decrease their merchantability.

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.

8.4.3. 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.

8.4.4. Disadvantages of Prescribed Fire and Ways to Mitigate

Inappropriately applied prescribed fire can reduce growth rates and lead to mortality in pine and hardwood 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.), and/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 hire a state or private contractor to conduct their burning. Georgia has strong prescribed fire statutes which protect safe, responsible prescribed burn managers (Georgia Prescribed Burning Act O.C.G.A 12-6-145 to O.C.G.A. 12-6-149). 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.

8.4.5. Methods of Prescribed Fire

8.4.5.1. 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.

8.4.5.2. 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.

8.4.5.3. 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 slash 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. When pile burning it is essential to manage the smoke production adequately in order to prevent adverse smoke effects.

8.4.6. 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, slash, 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.

8.4.7. 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 Georgia, 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 gallberry, largeleaf gallberry (*Ilex coriacea*), 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 to burn 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 time of year in Georgia (Spring being second driest) 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.

8.4.8. 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).

Relative humidity (RH) is the amount of moisture in the air in relation to the air temperature. RH is the main factor for spotting potential and 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. RH 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 Keech-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.

8.4.9. Prescribed Burning Regulations

Prescribed burning in Georgia must be carried out according to the state rules and regulations. In the GA Code of Laws, O.C.G.A 12-6-145 to O.C.G.A. 12-6-149, known as the Georgia Prescribed Burning Act, it requires persons doing outdoor burning to (1) notify the GA Forestry Commission, (2) clear around the area to be burned and have adequate personnel and equipment to keep the fire contained, and (3) stay with the fire until it is safe to leave. Go to https://advance.lexis.com/container/?pdmfid=1000516&crid=62f0c03a-98fa-441f-8251-b4de58195fab&pdtocsearchterm=Georgia+Prescribed+Burning+Act&pdtocsearchoption=docsonly&pdsearchterms=&pdtypeofsearch=TOCSearchDoc&pdfilterstring=MTA5MTIwMw&pdsearchdisplaytext=Official+Code+of+Georgia+Annotated&pdcontextvalue=statutes-legislation&pdtocfullpath=%2Fshared%2Ftableofcontents%2Furn%3AcontentItem%3A63RH-PW33-CH1B-T4TR-00008-00&pdbcts=1704913738003&config=00JABlN2Q2OTIwYi1kMjQwLTQxMWEtOWM1YS00MzUwY2MzYjQ5ZTAKAFBvZENhdGFsb2eiEwC2ZWq2J6k0Uwbdk8jZ&ecomp=bgf5kkk&prid=fd0de136-b6e0-47ca-99cc-d5358062590f for the complete wording of this law.

To become a certified burner, an individual must successfully complete a training program, which includes home study and a written exam, and the applicant must also have 2 years' experience and meet a prerequisite of having been the person in charge of five prescribed burns. 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.

8.4.10. Prescribed Fire Assistance

The Georgia Forestry Commission provides several services related to prescribed burning for a fee. These services include plan preparation, loaning of equipment, and on-site burn assistance. Several private consulting foresters also offer prescribed burning as a service.

Financial assistance to help cover the costs associated with prescribed burning is sometimes available through the Environmental Quality Incentives Program (EQIP). Contact your local NRCS office to apply for these funds.

8.5. **Fertilization**

Fertilization can be utilized on nutrient poor soils within Georgia. 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 GA BMPs for Forestry provide additional guidance on application procedures and rates.

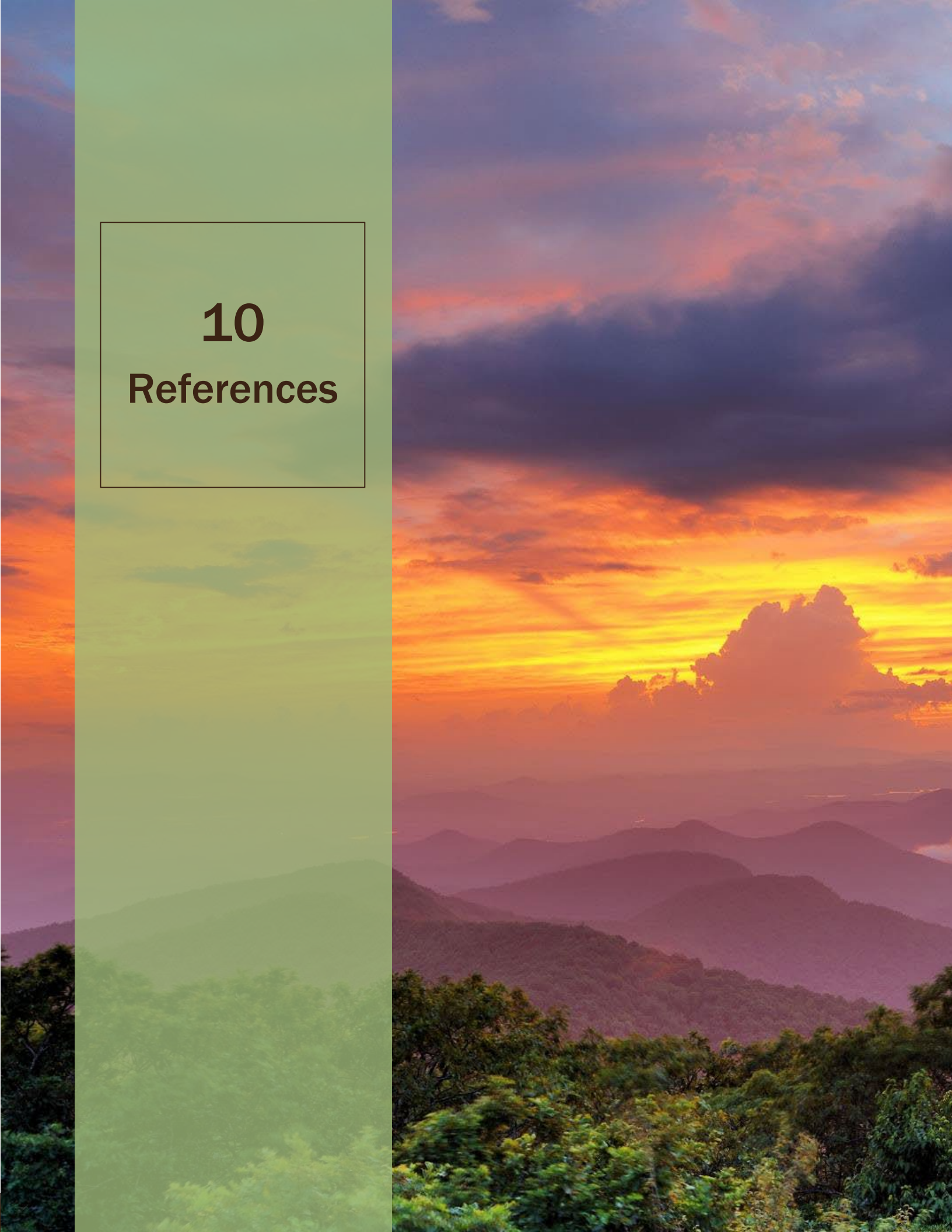
9
Acronymic Key

9. 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
CI	Conservation Initiative
CRP	Conservation Reserve Program
EAB	Emerald Ash Borer
ECOS	Environmental Conservation Online System
EFRP	Emergency Forest Restoration Program
EIN	Employee Identification Number
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FSA	Farm Service Agency
FEMA	Federal Emergency Management Agency
FHTET	Forest Health Technology and Enterprise Team
FMV	Fair Market Value
FORI	Forests of Recognized Importance
FRP	Forest Renewal Program
FSA	Farm Service Agency
FSP	Forest Stewardship Program
FSP Standards	FSP National Guidelines and Standards
GADNR	Georgia Department of Natural Resources
GFC	Georgia Forestry Commission
GFSP	Georgia Forest Stewardship Program
GIS	Geographic Information System
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IOBC	International Organization for Biological Control
IPCP	Invasive Plant Control Program
IPM	Integrated Pest Management
KBDI	Keech-Byram Drought Index
LLC	Limited Liability Company
LLPI	Longleaf Pine Initiative
LMP	Landscape Management Plan
MBF	Thousand Board Feet of Timber

Abbreviation	Name
NARSAL	UGA's Natural Resources Spatial Analysis Laboratory
NBCI	National Bobwhite Conservation Initiative
NCREIF	National Council of Real Estate Investment Fiduciaries
NIPF	Non-Industrial Private Forest
NNIA	Non-Native Invasive Animal
NNIP	Non-Native Invasive Plant
NNIS	Non-Native Invasive Species
NRCS	National Resource 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 Vehicles
OSB	Oriented Strand Board
PEFC	Programme for the Endorsement of Forest Certification
QTP	Qualified Timber Property
RCW	Red-cockaded Woodpecker
REPI	Readiness and Environmental Protection Integration
RH	Relative Humidity
RV	Ridge and Valley ecoregion
SA	Southwestern Appalachians ecoregion
SAF	Society of American Foresters
SFC	Southern Forestry Consultants
SFI	Sustainable Forestry Initiative
Silviculture BMPs	Georgia Forestry Commission Best Management Practices for Silviculture
SMZ	Streamside Management Zone
SOD	Sudden Oak Death
SP	Southeastern Plains ecoregion
SPB	Southern Pine Beetle
SPI	Shortleaf Pine Initiative
Support Committee	Landscape Management Plan Development Support Committee
SWRA	Southern Wildfire Risk Assessment
T&E	Threatened and Endangered Species
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
WBD	Water Boundary Dataset
WINGS	Wildlife Incentives for Nongame and Game Species (WINGS)
WLfW	Working Lands for Wildlife
WUI	Wildland Urban Interface

10
References



10. REFERENCES

Ambrose, J., L.K. Kirkman, L. Edwards, C. Nourse, H. Nourse, B. Winn, C.D. Camp, J. Renner, J. McCollum, J. Costello, K. Terrell, K. McIntyre, M. Morris, M. Moffett, N.A. Klaus, P. Freshley, S. Beeching, T.S. Keyes, T.M. Schneider, and W. Hicks. 2013. The Natural Communities of Georgia. University of Georgia Press. Athens, Georgia, USA.

American Tree Farm System. 2022. 2021 Standards of Sustainability for Forest Certification. https://www.treefarmsystem.org/view-standards#:~:text=The%202021%20ATFS%20Standards%20of,2015%2D2020%20Standards%20of%20Sustainability.

Anderson, M.K. and T. Oakes, 2012. Plant Guide for Saw Palmetto (Serenoa repens). USDA-Natural Resources Conservation Service, National Plants Data Team. Davis, California 95616. https://plants.sc.egov.usda.gov/DocumentLibrary/plantguide/pdf/cs_sere2.pdf

Andreu, A. and L.A. Hermansen-Baez. 2008. Fire in the South 2: The Southern Wildfire Risk Assessment. Southern Group of State Foresters. https://www.srs.fs.usda.gov/pubs/ja/ja_andreu001.pdf

Ashton, P.S., and R.E. Ashton, Jr. 2004. The gopher tortoise: a life history. Pineapple Press Incorporated, Sarasota, Florida, USA.

Brockway, D.G., K. W. Outcalt, and W.D. Boyer. 2006. Longleaf pine regeneration ecology and methods. In: Jose, S., Jokela, E.J., Miller, D.L. (Eds.), Longleaf Pine Ecosystems: Ecology, Silviculture and Restoration. Springer Science, New York. pp. 95-133.

Brose, P.H. and D.H. Van Lear. 1998. Responses of hardwood advance regeneration to seasonal prescribed fires in oak-dominated shelterwood stands. Canadian Journal of Forest Research 28: 331-339

Bryson, C.T. and R. Carter. 1993. "Cogongrass, Imperata cylindrica, in the United States." Weed Technology 7:1005-1009.

Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. vol.2, 877 p. https://www.srs.fs.usda.gov/pubs/misc/ag_654/table_of_contents.htm

Butler, Brett J.; Hewes, Jaketon H.; Dickinson, Brenton J.; Andrejczyk, Kyle; Butler, Sarah M.; Markowski-Lindsay, Marla. 2016. USDA Forest Service National Woodland Owner Survey: national, regional, and state statistics for family forest and woodland ownerships with 10+ acres, 2011-2013. Res. Bull. NRS-99. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

Chamberlain, J.L. and M. Predny. Non-Timber Forest Products in the South: Perceived Distribution and Implications for Sustainable Forest Management. United States Department of Agriculture, Southern Research Station. https://www.srs.fs.usda.gov/pubs/VT_Publications/03t22.pdf

Clatterbuck, Wayne. 2006. Treatments for Improving Degraded Hardwood Stands. University of Tennessee Knoxville Extension Series: Publication SP-680.

Conner, W.H. and M.G. Messina. 1998. Southern Forested Wetlands: Ecology and Management. CRC Press. 640 pp.

Cunningham, K. and T Walkingstick. 2016. Using Natural Regeneration to Promote Oaks in Upland Hardwood Stands. University of Arkansas Division of Agriculture and Natural Resources. FSA5010. https://www.uaex.uada.edu/publications/pdf/FSA-5010.pdf

Davis, L.S., and K.N. Johnson. 1997. Forest Management: Third Edition. Chapter 14: pp 538-565.

Dey, D.C. and C.J. Schweitzer. 2018. A Review on the Dynamics of Prescribed Fire, Tree Mortality, and Injury in Managing Oak Natural Communities to Minimize Economic Loss in North America. Forests: 9, 461. https://www.fs.usda.gov/research/treesearch/56569.

Doerr, T.B., M.C. Landin, and C.O. Martin. 1986. Mechanical Site Preparation Techniques. U.S. Army Corps of Engineers Wildlife Resources Management Manual, Section 5.7.1.

EDDMapS. 2019. Early Detection & Distribution Mapping System. The University of Georgia - Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/; last accessed March 25, 2019.

Environmental Protection Agency (EPA). 2019. Ecoregions of the United States. https://www.epa.gov/eco-research/ecoregions.

Environmental Protection Agency (EPA). 2019. Wetlands Types: Bottomlands Hardwoods. https://www.epa.gov/wetlands/bottomland-hardwoods

Etters, Karl. 2019. Timber Farms in Florida, Georgia Suffering After Hurricane Michael. Insurance Journal.com, January 2, 2019.https://www.insurancejournal.com/news/southeast/2019/01/02/513281.htm

Florida Department of Agriculture and Consumer Services. 2012-2019. Using Fire Wisely. Accessed August 21, 2019. https://www.fdacs.gov/Forest-Wildfire/Wildland-Fire/Prescribed-Fire/Using-Fire-Wisely

Forest Stewards Guild. 2016. Ecological Forestry Practices for Bottomland Hardwood Forests of the Southeastern U.S. https://foreststewardsguild.org/wp-content/uploads/2019/05/FSG_Bottomland_Hardwoodsweb.pdf

Gandhi, K.J.K., K.D. Klepzig, B.F. Barnes, B. Gochnour, E.P. McCarty, T.N. Sheehan, C. Villari, and J.T. Vogt. 2019. Bark and Woodboring Beetles in Wind-Damaged Pine Stands in the Southern United States. University of Georgia Extension Publication 19-38. https://bugwoodcloud.org/resource/files/19016.pdf.

Georgia Department of Natural Resources. 2015. Georgia State Wildlife Action Plan. https://georgiawildlife.com/sites/default/files/wrd/pdf/swap/SWAP2015MainReport_92015.pdf

Georgia Exotic Pest Plant Council. 2014. Terrestrial Exotic Invasive Species List. https://www.gaeppc.org/

Georgia Forestry Association. 2020. How Does Forestry Impact Georgia. https://gfagrow.org/about/numberone/

Georgia Forestry Commission. 2011. Georgia Forest Facts. https://www.stateforesters.org/wp-content/uploads/2018/07/GAFY2019Standard.pdf

Georgia Forestry Commission. 2015. Georgia Statewide Assessment of Forest Resources. https://gatrees.org/wp-content/uploads/2020/03/GAStatewideAssessmentofForestResources2015.pdf

Georgia Forestry Commission. 2015. Georgia Statewide Forest Resources Strategy. https://gatrees.org/wp-content/uploads/2020/03/GAStatewideForestResourcesStrategy2015.pdf

Georgia Forestry Commission. 2019. Southern Pine Beetle Cost Share Program. https://gatrees.org/forest-management-conservation/cost-share-incentive-programs/#:~:text=Southern%20Pine%20Beetle%20Cost%20Share,and%20suppress%20current%20beetle%20infestations.

Georgia Heirs Property Law Center. 2024. Building Generational Wealth and Strengthening Communities by Securing and Preserving Property Rights. https://www.gaheirsproperty.org/

Hamilton, Jim, ed. 2008. Silvopasture: Establishment & management principles for pine forests in the Southeastern United States. United States Department of Agriculture, National Agroforestry Center. http://www.silvopasture.org/pdf_content/silvopasture_handbook.pdf

Jacobson, Michael, and C.D. Ray. 2023. Federal Income Taxes: Four Essential “To Do’s” for Forest Landowners. https://extension.psu.edu/federal-income-taxes-four-essential-to-dos-for-forest-landowners

Jose, Shibu, Eric J. Jokela, and Deborah L. Miller, eds. 2006. The longleaf pine ecosystem: ecology, silviculture, and restoration. Springer Science Business Media, LLC, New York (USA); 438 pages.

Kentucky Department of Fish and Wildlife Resources. 2019. Habitat How-To’s: Edge Feathering. https://fw.ky.gov/Wildlife/Documents/edgefeathering.pdf

King, Bob. 2019. The Basics of Timberland Investing. Realtors Land Institute. https://www.rliland.com/Voices/The-Voices-of-Land-blog/ArticleID/311

Kochenderfer, J.D., J.N. Kochenderfer, and G.W. Miller. 2011. Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forests. USDA-FS Northern Research Station; General Technical Report NRS-96.

Landscape America. 2019. Ecoregions. National Geographic and NatureServe. http://www.landscope.org/explore/natural_geographies/ecoregions/Piedmont/

Marquis, D.A. and R. Jacobs. 1989. Principles of managing stands. USDA-FS North Central Forest Experiment Station: Central Hardwood Notes 6.01.

McEvoy, T.J. 2003. Sustainable Family Forests: The Benefits of an LLC. Journal of Northeastern Agriculture. Vol 6: Nos 9 & 10. Pp 49-58.

McGee, C.E. 1982. Low-quality hardwood stands. Opportunities for management in the Interior Uplands. USDA-FS, Southern Forest Experiment Station. General Technical Report SO-40.

Megalos, M., G. van der Hoeven, and C. Lambert. 2016. Understanding Your Timber Basis. Eastern Forestry Notes. https://content.ces.ncsu.edu/understanding-your-timber-basis.

Mercker, D. 2007. Crop Tree Release in Precommercial Hardwood Stands. University of Tennessee Extension, SP559. https://utia.tennessee.edu/publications/wp-content/uploads/sites/269/2023/10/SP559.pdf

Miller, James H., Steven T. Manning, and Stephen F. Enloe. 2015. A management guide for invasive plants in southern forests. United States Department of Agriculture, Forest Service, Southern Research Stations. General Technical Report SRS-131; 132 pages.

Myers, C.C. and R.G. Buchman. 1984. Manager's Handbook for Elm-Ash-Cottonwood in the North Central States. USDA Forest Service, North Central Forest Experiment Station; General Technical Report NC-98. https://www.fs.usda.gov/research/treesearch/10162

National Bobwhite Conservation Initiative (NBCI). 2015. NBCI Brochure: A Bobwhite Revival. https://bringbackbobwhites.org/wp-content/uploads/2015/12/NBCI-brocure2015-web1.pdf

National Fire Protection Association. 2019. FireWise USA: Residents Reducing Wildfire Risks. https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA

National Wildlife Federation (NWF). 2015. Lifting Longleaf Pine Straw: An Option to Balance Income and Wildlife. https://www.youtube.com/watch?v=WLo5qHxNrnQ

Noss, R.F. 1989. Longleaf pine and wiregrass: Keystone components of an endangered ecosystem. Natural Areas Journal, 9:211-213.

Natural Resources Conservation Service (NRCS) Georgia. 2019. Longleaf Pine Initiative in Georgia. https://www.nrcs.usda.gov/programs-initiatives/longleaf-pine-initiative#:~:text=NRCS%20works%20with%20agricultural%20producers,870%2C000%20acres%20on%20private%20lands.

National Resources Conservation Service (NRCS). 2019. Environmental Quality Incentives Program. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

National Resources Conservation Service (NRCS). 2019. National Water Quality Initiative. https://www.nrcs.usda.gov/programs-initiatives/national-water-quality-initiative

Natural Resources Conservation Service (NRCS) New York. 2018. Conservation Practice Standard: Herbaceous Weed Treatment (Code 315). https://www.nrcs.usda.gov/sites/default/files/2022-09/Herbaceous_Weed_Treatment_315_CPS_10_2020.pdf

The Nature Conservancy. 2019. Southern Georgia Named a Sentinel Landscape. https://www.nature.org/en-us/about-us/where-we-work/united-states/georgia/stories-in-georgia/southern-georgia-sentinel-landscape/

North Carolina Forestry Library. 2009. Managing and Regenerating Timber in Bottomland Swamps. Accessed August 20, 2019. https://www.ncforestservice.gov/publications/Forestry%20Leaflets/FM17.pdf.

North Carolina Wildlife Resources Commission. 2019. Piedmont Habitats: Floodplain Forest. Accessed August 20, 2019. https://www.ncwildlife.org/Conserving/Habitats/Piedmont

Nyland, R.D. 1996. Silviculture: concepts and applications. New York: McGraw-Hill. 633 p.

Nyland, R.D. 2006. Rehabilitating cutover stands: Some ideas to ponder. USDA-FS, Northeast Research Station. General Technical Report NE-342:pp.47-51.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map (scale 1:7,500,000). Annals of the Association of American Geographers 77(1):118-125.

Osiecka, A., J. Nowak, and A. Long. 2005. Primer on Chemical Vegetation Management in Florida Pine Plantations. University of Florida Institute of Food and Agricultural Sciences. CIR 1477.

Peet, R.K., and Allard, D.J. 1993. Longleaf pine-dominated vegetation of the southern Atlantic and eastern Gulf Coast region, USA. In Proceedings of the 18th Tall Timbers Fire Ecology Conference, ed. S.M. Hermann, pp. 45-81. Tall Timbers Research Station, Tallahassee, FL.

Self, A.B. 2020. Hardwoods: Intermediate Treatments. Mississippi State University Extension: Publication 3468. https://extension.msstate.edu/sites/default/files/publications/publications/P3468.pdf

Shortleaf Pine Restoration Plan. 2016. https://shortleafpine.org/shortleaf-pine-initiative/shortleaf-pine-restoration-plan

Siegel, W.C., H.L. Haney, Jr., and J.L. Greene. 2009. Estate Planning for Forest Landowners: What Will Become of Your Timberland?. USDA-FS Southern Research Station; General Technical Report SRS-112. https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs112.pdf

Society of Ecological Restoration (SER). 2004. The SER International primer on ecological restoration. Society for Ecological Restoration International, Science and Policy Working Group. Version 2, October 2004, Tucson, Arizona.

South Carolina Forestry Commission. 2019. Managing Your Hurricane-Damaged Woods. https://www.state.sc.us/forest/pubs/hurricanedamagemanagement.pdf

Trefethen, J.B. 1975. An American crusade for wildlife. Winchester Press, New York. 409 pp.

United States Department of Agriculture: Animal and Plant Health Inspection Service. 2009. Program Aid No. 769

United States Geological Survey. 2019. Water Resources of the United States. https://water.usgs.gov/GIS/huc.html

USDA-FS. 2019. The forest Landowners Guide to the Federal Income Tax: Form of Forest Land Ownership and Business Organizations. https://www.timbertax.org/publications/aghandbook731/Chapter%2012.%20Forms%20of%20Forest%20Land%20Ownership%20and%20Business%20Organization/

USDA-FS. 2009. Forest Stewardship Program National Standards and Guidelines. https://www.fs.usda.gov/sites/default/files/forest-stewardship-program-standards-guidelines.pdf

USDA-FS. 2019. Reforestation Glossary. https://www.fs.usda.gov/restoration/reforestation/glossary.shtml

USDA Natural Resources Conservation Service (USDA-NRCS). 2015. Prescribed grazing: inclusion of woodlands in small ruminant grazing systems. United States Department of Agriculture, Natural Resource Conservation Service. Alabama guide sheet AL528B. https://efotg.sc.egov.usda.gov/api/CPSFile/24547/528_AL_OTH_Small_Ruminant_Grazing_Woodland_Systems_Guide_Sheet_2015

University of Florida: IFAS Extension. 2009. Florida Forest Stewardship: Site Preparation. https://programs.ifas.ufl.edu/florida-land-steward/forest-management/timber-management/site-preparation/

University of Georgia: Savannah River Ecology Laboratory. 2019. Carolina Bays Fact Sheet. University of Georgia Archives. http://archive-srel.uga.edu/outreach/factsheet/carolinabays.html

University of Georgia: Savannah River Ecology Laboratory. 2019. Sandhills Fact Sheet. University of Georgia Archives. University of Georgia. (https://archive-srel.uga.edu/outreach/factsheet/sandhills.html)

Van Lear, D., P.H. Brose, and P.D. Keyser. 1999. A Shelterwood-Burn Technique for Regenerating Productive Upland Oak Sites in the Piedmont Region. Southern Journal of Applied Forestry 23(3): 158-163.

van Lenteren, J.C., ed. 2016. International Organization for Biological Control (IOBC) Internet Book of Biological Control – Version 6. Laboratory of Entomology, Wageningen University, Netherlands. http://www.iobc-global.org/download/IOBC_InternetBookBiCoVersion6Spring2012.pdf

Wade, Dale D. and James D. Lunsford. 1989. A Guide for Prescribed Fire in Southern Forests. United States Department of Agriculture, Forest Service, Southern Research Stations. Technical Publication R8-TP11. USDA Forest Service; 63 pgs. https://ncprescribedfirecouncil.org/wp-content/uploads//guide_for_prescribed_fire.pdf

Waggoner, Gary S. 1975. Eastern deciduous forest, Vol. 1: Southeastern evergreen and oak-pine region. Natural History Theme Studies No. 1, NPS 135. Washington, DC: U.S. Department of the Interior, National Park Service. 206 p.

Wallace, D. and Thomas Ward. Pine straw – a profitable agroforestry enterprise. United States Department of Agriculture: Agroforestry Notes 37: October 2011.

Wang, Linda. 2018. Tax Tips for Forest Landowners for the 2018 Tax Year. USDA Forest Service Bulletin.

Ware, S., C. Frost, and P.D. Doerr. 1993. Southern mixed hardwood forest: The former longleaf pine forest. In Biodiversity of the Southeastern United States, eds. W.H. Martin, S.G. Boyce, and A.C. Echternacht, pp.447-493. New York: John Wiley & Sons.

Zielke, K. and B. Bancroft. 1999. Introduction to Silvicultural Systems. British Columbia Ministry of Forests, Lands and Natural Resource Operations: Resource Practices Branch. https://www.for.gov.bc.ca/hfd/pubs/ssintroworkbook/index.htm