Wildlife Forestry in Bottomland Hardwood Forests of the Atlantic Coastal Plain

MANAGEMENT PLAN TEMPLATE APPENDICES

Forest Stewards Guild
putting the forest first

ACKNOWLEDGEMENTS

This management plan template and corresponding appendices were created to inform and guide foresters, land managers, and landowners on wildlife forestry practices in bottomland hardwood forests. Wildlife forestry is managing forestland to improve wildlife habitat, as well as overall forest health, while improving timber stand conditions, providing for forest regeneration, and producing forest products in an ever-changing environment (Locascio 2019). The focal area of this guide includes sections of the Mid-Atlantic Coastal Plain and South-Atlantic Coastal Plain ecoregions of Virginia, North Carolina, South Carolina, Georgia, and North Florida, but concepts may be broadly applicable to other areas. For the purpose of this guide, these regions will be combined and referred to as the Atlantic Coastal Plain (ACP).

This template is based heavily on the 2015 national management plan, “Managing Your Woodlands: A Template for Your Plans for the Future”, developed by the US Forest Service, NRCS, and the American Forest Foundatin’s American Tree Farm System (ATFS). This template incorporates information from several leading resources and can be found in the References section of this document.

This template was developed by the Forest Stewards Guild with assistance from individuals from the National Audubon Society, the US Fish and Wildlife Service, NC Forest Service, the Natural Resources Conservation Service (NRCS), Enviva Biomass, GFR Forestry Consultants, Milliken Forestry, and the South Carolina Forestry Commission. The creation of this template was made possible thanks to the National Fish and Wildlife Foundation.

Thanks to the following reviewers: Aimee Tomcho, Amanda Mahaffey, Barry New, Ben Larson, Bruce White, Chuck Hunter, Dakota Wagner, Darrel Pendris, Eddie Reese, Haven Barnhill, Henry Sansing, Russel Hubright, Tim Evans, and Timothy Beard.

On the cover: River view from Watermelon Bluff by Bruce White (top), adult male Kentucky warbler by Andrew Weitzel (left), fox squirrel by Chuck Bryan NCWRC (right).

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Appendix A: Atlantic Coastal Plain States BMP Resources

Florida

Florida's Silviculture Best Management Practices
https://www.fdacs.gov/ezs3download/download/25527/516407/Media/Files/Florida-Forest-Service-Files/silvicultural_bmp_manual.pdf

Georgia

Georgia Best Management Practices for Forestry
https://gatrees.org/wp-content/uploads/2020/02/BMP-Manual-2019-Web.pdf

North Carolina

North Carolina Forestry Best Management Practices to Protect Water Quality
https://ncforestservice.gov/water_quality/bmp_manual.htm

South Carolina

South Carolina Best Management Practices for Forestry
https://www.state.sc.us/forest/refbmp.htm

Virginia

Virginia's Forestry Best Management Practices for Water Quality
http://www.dof.virginia.gov/infopubs/BMP-Field-Guide_pub.pdf

Appendix B: Determining Forest Type Based on Abiotic Conditions

Classifying Bottomlands

Bottomland hardwood forests in the Atlantic Coastal Plain (ACP) are classified in varying ways. For example, the Society of American Foresters lists 13 forest cover types in their forest cover type classification system while other reports, such as the US Forest Service's "Status and Trends of Bottomland Hardwood Forests in the Mid-Atlantic Region", list only two (Allen et al. 2004; Rose and Meadows 2016). The NC Natural Heritage Program describes 34 different Coastal Plain Floodplain natural communities in their most recent approximation, mostly distinguished by water type (brownwater versus blackwater) and by landform (Schafale 2012). It is also common to group bottomland hardwood site types by surface water classification.

Photo courtesy of Forest Stewards Guild

Site Types

For the purpose of this management plan template, **seven** site types have been defined using the characterizations from "Regenerating and Managing Natural Stands of Bottomland Hardwoods" (Kellison et al. 1988):

- Muck swamp
- Red river bottom
- Branch bottom
- Black river bottom
- Cypress strand
- Cypress dome
- Piedmont bottomland

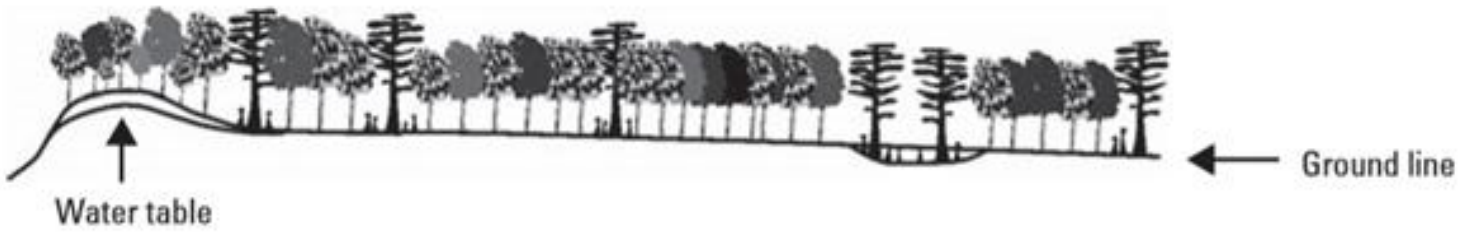
DETERMINING SITE TYPE

DOMINANT FOREST TYPES

Muck Swamp

Description: Broad expanses between tidewater and upstream runs, and along black rivers and branch bottom stands, also in areas of organic matter accumulation in red rivers and branch bottoms. Flooded 10 to 12 months.

Indicator Species: Baldcypress, tupelo



Red River Bottom

Description: Floodplain of major drainage system originating in the Piedmont or Mountains. Flooded winter and spring.

Indicator Species: Sycamore, sweetgum, cherrybark oak

Branch Bottom

Description: Relatively flat, alluvial land along minor drainage systems which is subject to minor overflow. Boggy throughout year.

Indicator Species: Swamp black gum

DETERMINING SITE TYPE

Black River Bottom

Description: Floodplain of major water systems originating in the Coastal Plain. Flooded winter and spring.

Indicator Species: Tupelo, swamp black gum

Cypress Strand

Description: Low areas in south Georgia and northern Florida where shallow water flows during the wet season above the hardpan, which is usually present. Cypress forests in these strands are usually open with sedges beneath. The values for pH and available nutrients are generally low. Flooded winter, spring, and summer.

Indicator Species: Baldcypress

Cypress Dome

Description: Isolated peaty acid depression (dome) usually found in Florida, which is moist or inundated for weeks or months at a time. Ground cover is usually absent except on hummocks, and the tallest trees occur in the center of the domes. Flooded throughout the year.

Indicator Species: Pond cypress, bald cypress

DETERMINING SITE TYPE

Piedmont Bottomland

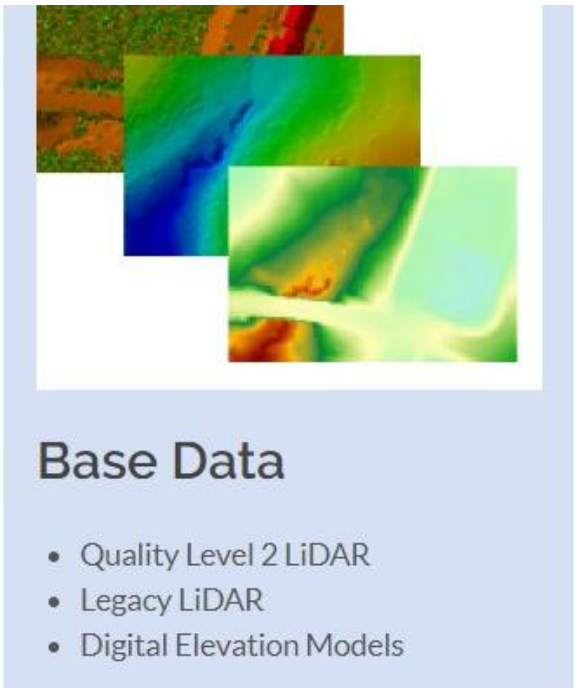
Description: In lower Piedmont, identical to red river bottom; upstream, however, features decrease in frequency and area until only well-drained bottomland is encountered. Flooded winter.

Indicator Species: Yellow-poplar, sweetgum

TOPOGRAPHY

Once you have determined your site type, it's time to identify your topographic position, as this plays a significant role in determining the hydroperiod of your site and appropriate species to manage for on the stand-level. Provided is a basic guide of topographic positions in major stream valleys and their descriptions.

The use of LiDAR imagery to evaluate topographic variation in bottomland forests can also be a beneficial tool to visualize hydrologic flow, and can often be obtained from your state's Department of Transportation spatial data portals (e.g. NC DOT).



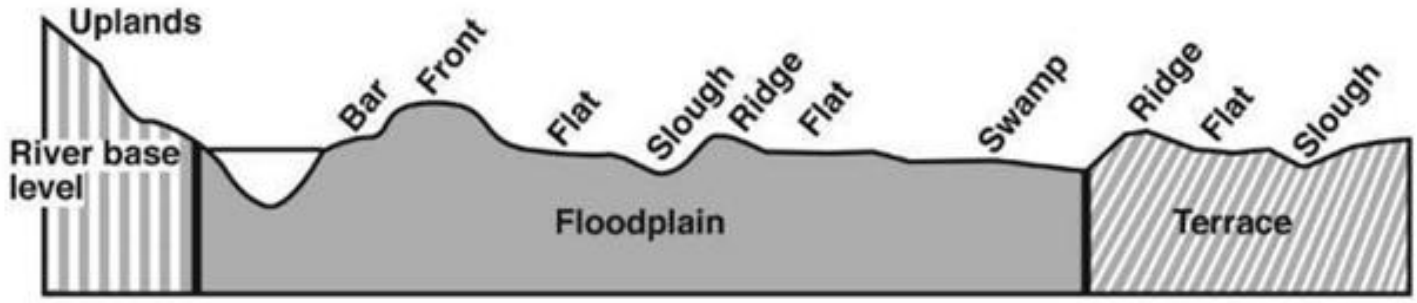
LiDar data from NC Department of Transportation.

MINOR STREAMS VS MAJOR STREAMS

Minor stream bottoms are essentially smaller versions of major river bottoms. They have the same physical features, and most of the same species composition.

DETERMINING SITE TYPE

The following figure describes possible topographic positions within major stream valleys (Rousseau 2004). Keep in mind that although these features occur in this general sequence, they may not occur in the order shown. For more information on the descriptions of topography within bottomlands and species-site relationships, please see Mississippi State University Extension Service's Bottomland Hardwood Management publication.



Topographic positions within major stream valleys. Rousseau et al 2004.

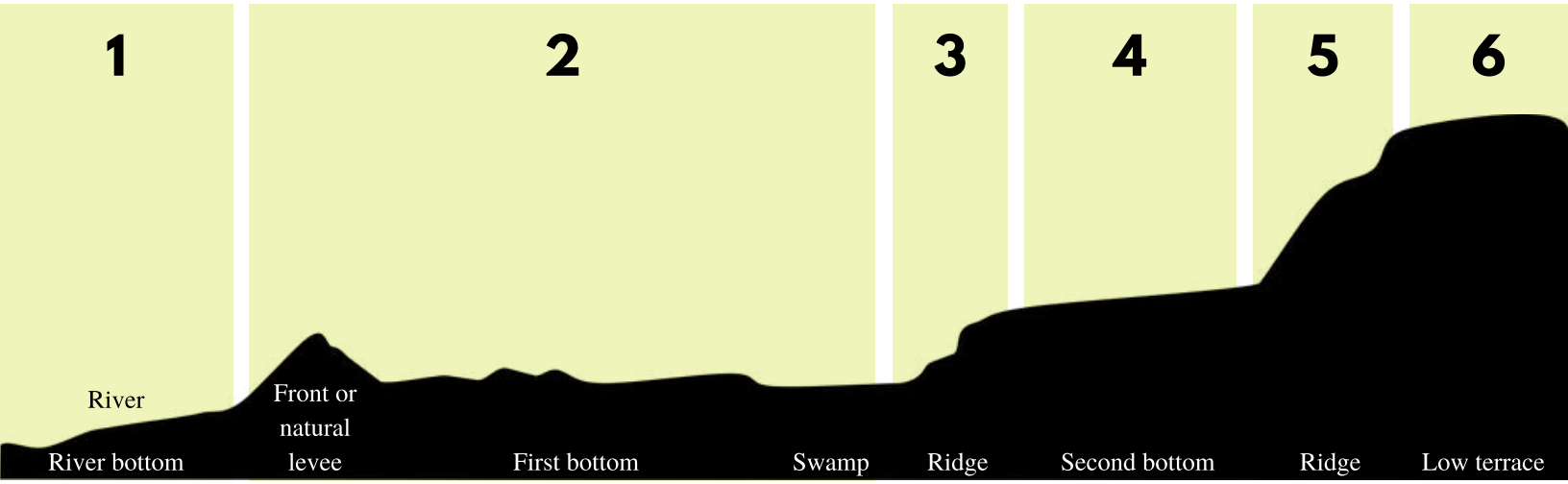
SOILS

Soil type is another critical abiotic factor in determining site capabilities. Soils in bottomland hardwood forests are often hydric, meaning they formed under conditions of saturation (i.e. flooding). They are dynamic as they are formed from stream and river deposits of a variety of texture classes and nutrients. It is important to know what soil type you are working with because factors such as soil oxygen, structure, organic matter, and nutrient composition can greatly affect the rooting and growth of existing trees and regeneration opportunities (USDA Forest Service Northern Research Station 2009).

Flooded bottomland hardwood stand. Brain Lockhart, US Forest Service, bugwood.org

When determining the soil composition of your property, it may be more important to take note of the soil type within each stand rather than as a whole. County soil maps can be used, however in many cases maps for floodplains can be misleading given their dynamic nature. Topography and soils tend to be correlated, so you may be able to make a preliminary assessment based on the topographical makeup of each stand. Use the following figure to determine potential soil composition of each stand (USDA Forest Service Northern Research Station 2009; Patrick et al. 1981).

DETERMINING SITE TYPE



Soil Zones

Zone 1: Riverbed.

Zone 2: Soils in this zone are dominated by silty clays or sands. They are generally gray to olive-gray with greenish gray, bluish gray and grayish green mottles. Soil oxygen is very low for much of the growing season and changes from aerobic when moving water is present to anaerobic when water is stagnant. Organic matter and nutrient content is relatively high, when compared to other ecological zones within the system.

Zone 3: Dense clays which are gray with olive colored mottles. Soil organic matter and nutrient content are slightly lower than Zone 2.

Zone 4: Clays and coarser particles dominate. Soil colors range from gray to reddish with brownish gray and grayish brown mottles. Soil oxygen alternates between aerobic and anaerobic. Soil organic content and nutrient levels are similar to those in Zone 3.

Zone 5: Clay and sandy loams dominate and sandy soils are frequent. Depending on elevation, oxygenation is mostly aerobic but occasionally becomes anaerobic during major flooding events. Soil color varies from gray or grayish brown with brown, yellowish brown and reddish brown mottles. Soil organic matter and nutrient content are slightly lower in this zone than in zones closer to the water body.

Zone 6: This zone is commonly made up of sands, silts and clays. Soil oxygen levels are typically not limiting although during extreme flood events the soil environment may become anaerobic for short periods of time. Soil color is predominantly red, brown, reddish brown yellow, yellowish red and yellowish brown with a variety of mottled colors. Soil organic matter and nutrient content tend to be slightly higher than on upland sites although they are lower than bottomland zones closer to the water body.

Appendix C: Description of landscape-scale wildlife habitat needs


Rob Routledge, Sault College, Bugwood.org

Bottomland hardwood forests of the ACP have been severely fragmented and only small sections of the original millions of acres exist (North Carolina Wildlife Resources Commission 2015). Due to this, it is important to understand the function, condition, and needs of these forests on the landscape-level, particularly when managing for wildlife. Some wildlife species require large areas of intact forest for nesting, feeding, and travel corridors (National Audubon Society 2014). Large tracts of bottomland hardwood forest often provide adequate wildlife habitat without human interference and do not require intensive management (Ober 2019).

The landscape-scale needs for wildlife in bottomland hardwood forests of the ACP are to mitigate threats to forest health; maintain landscape connectivity; have varying habitat types, high structural diversity, and high species richness.

Habitat Needs

- Landscape connectivity
- Mitigate threats to forest health
- Varying habitat types
- High structutral diversity
- High species richness

Both natural and silvicultural disturbances can support these conditions, however it should be noted that the historic range of disturbance (from tornados, hurricanes, etc.) for these forests is less than two percent (Greenberg and Collins 2015). This should be taken into consideration when determining landowner goals and long-term site capabilities.

Landscape Connectivity

Landscape connectivity is any contiguous forested area that allows for the movement of wildlife, unimpeded by human intervention (e.g. roads, buildings, or intensive clearcutting). Animals like black bears and several interior forest songbirds need a lot of intact forest to thrive.

Ask yourself... Is my forest well connected? When I look up, do leaves block out most of the sky?


Brain Lockhart, USDA Forest Service, Bugwood.org

Mitigate Threats to Forest Health

It is important to do what you can to help keep your forest healthy. Common threats to bottomland forests of the ACP include: hydrologic alterations (e.g. damming and draining), invasive species such as the Emerald Ash Borer (EAB) and Japanese stilt grass, loss of old growth characteristics, and site inappropriate logging practices (e.g. high-grading) (NC Forest Service 2018b; North Carolina Wildlife Resources Commission 2015).

Ask yourself... Can I find anything that needs special care? Things like waterbodies, patches of invasive plants, etc.


National Park Service


Troy Kimoto, Canadian Food Inspection Agency


Chris Evans, University of Illinois, Bugwood.org

From left to right: wetland drainage, EAB damage, and Japanese stilt grass takes over a stand.

LANDSCAPE NEEDS

High Species Richness

Species richness is the number of different species of trees, shrubs, and plants and how many of each. It is important to restore and maintain trees of different species that provide food and shelter throughout the year.

Ask yourself... What kind of trees can I see? How many different species?

High Structural Diversity

A forest with high structural diversity will have trees of varying sizes and shapes.

Ask yourself... What is the average size and age of trees dominating my forest? Larger/older, smaller/younger, or a mixture of both?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Varying Habitat Types

Early successional habitat: We recommend no more than 10% of the forest be in early succession at a landscape level.

Late successional habitat: Retain no less than 5 percent of stands in the late-successional phase of stand dynamics, where possible.

Ask yourself... Are there any gaps in my forest where the sun can reach the forest floor? Look for gaps about 2 acres in size.

DESIRED STAND CONDITIONS

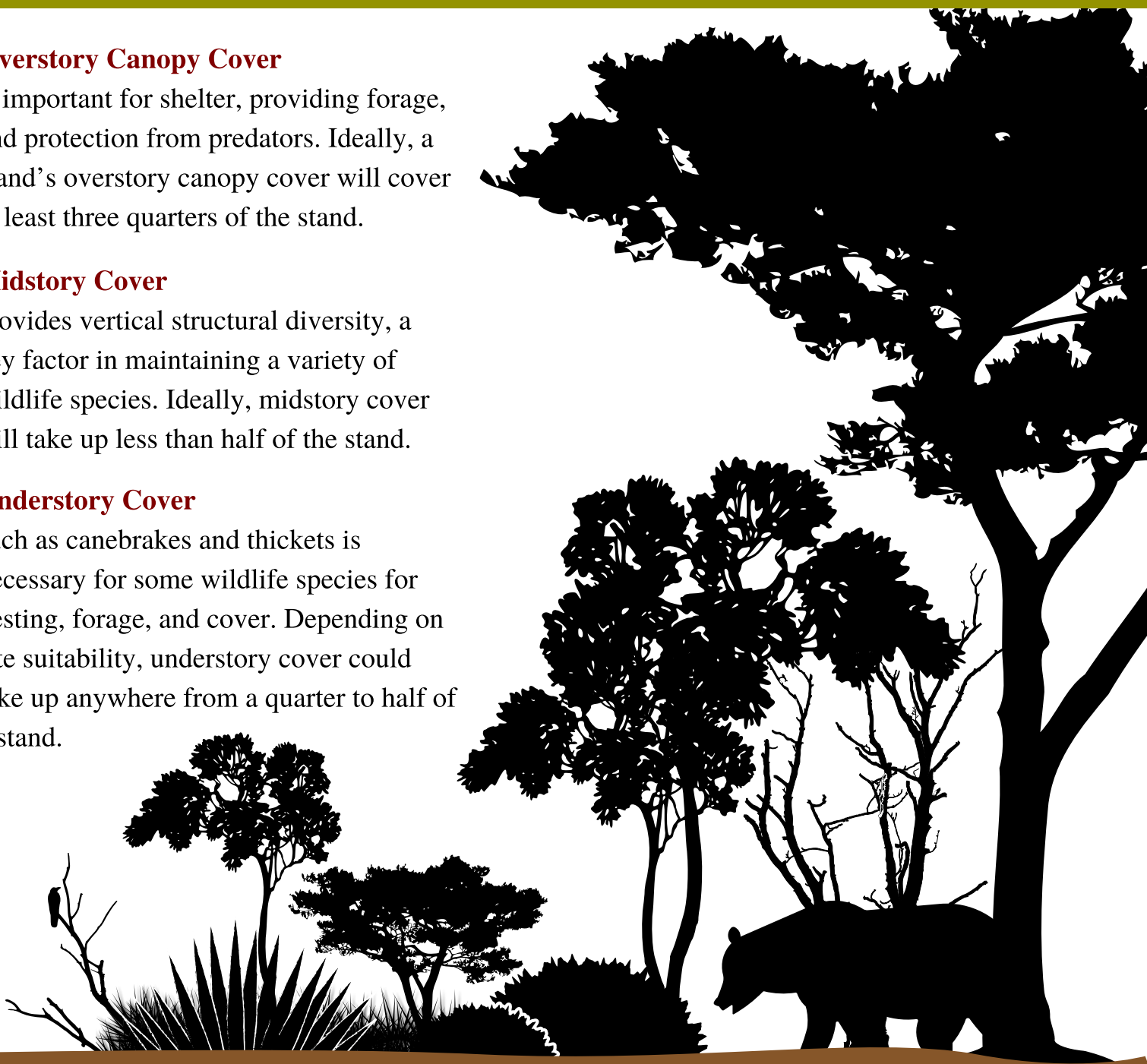
For desirable wildlife habitat, promotion of species and structural diversity within stands is the underlying principle of management. A variety of management factors can influence the condition of a stand: overstory canopy cover, midstory and understory cover, dominant trees, regeneration, coarse woody debris, tree cavities and den trees, nonnative invasive plants, and snags.

COVER

Overstory Canopy Cover
is important for shelter, providing forage, and protection from predators. Ideally, a stand's overstory canopy cover will cover at least three quarters of the stand.

Midstory Cover
provides vertical structural diversity, a key factor in maintaining a variety of wildlife species. Ideally, midstory cover will take up less than half of the stand.

Understory Cover
such as canebrakes and thickets is necessary for some wildlife species for nesting, forage, and cover. Depending on site suitability, understory cover could take up anywhere from a quarter to half of a stand.



DESIRED STAND CONDITIONS

DOMINANT OR SUPERDOMINANT TREES

English oak. Photo courtesy of Brian Lockhart, USDA Forest Service, Bugwood.org

Dominant or super-dominant trees are very large, over-mature remnants that have survived past disturbances. They are very important for a variety of bird species. There should be an average of two per acre.

REGENERATION

Regeneration of desirable shade-intolerant tree species is important to ensure their succession into the forest canopy and maintaining various successional stages in one stand is beneficial to multiple wildlife species.

Overcup oak regeneration. Photo courtesy of Brian Lockhart, USDA Forest Service, Bugwood.org

COARSE WOODY DEBRIS

Coarse woody debris of various sizes provides habitat for amphibians and reptiles as well as food for lower organisms such as invertebrates, in turn providing food for wildlife such as birds and bears. Leaving some tops, stumps, and logging slash can provide this habitat.

Coarse woody debris. Photo courtesy of David Stephens, Bugwood.org

DESIRED STAND CONDITIONS

TREE CAVITIES

Tree cavities, both small and large, provide roosting, denning, and nesting sites for various wildlife species. Retaining trees containing small (<10 inches diameter) and large (>10 inches diameter) cavities and limiting damage to cavity trees during harvest will ensure the habitat availability to multiple wildlife species.


Steven Katovich, Bugwood.org

DEN TREES

Den Trees are often large in diameter (at least 10 inches) and contain cavities big enough for species such as black bear. It is recommended to retain at least one visible den every ten acres.

STANDING DEAD TREES


US National Park Service

Snags/Standing Dead/Stressed Trees provide a number of services for wildlife including food for lower organisms and in turn forage for birds, bears, skinks, and others; nesting and roosting habitat; and are important in the nutrient cycling process. Keep snags of varying size classes, species, and stages of decay.

For specific metrics on desired stand conditions, the Lower Mississippi Valley Joint Venture has produced a detailed report for bottomland hardwood forests within the Mississippi Alluvial Valley and can be viewed here.

Appendix D: Silviculture Treatment Recommendations

Once you have determined which forest types are present on the property, your site type, your topographic position, and what the desired goals of the landowner are, you can refer to this section to determine which silvicultural practices best fit the management desires.

Natural Disturbance


Robert L. Anderson, USDA Forest Service, Bugwood.org

For bottomland hardwood forests, it's best to mimic the normal range of variation that would occur through natural disturbances. Events such as **hurricanes**, **tornadoes**, **fires**, and **flooding** helped shape this landscape. However, the majority of the bottomland hardwood ecosystem is so highly altered that these natural disturbance events do not occur as they have historically. Human-caused alterations such as fire suppression and the construction of dams, levees, ditches, and other hydrologically altering practices have interrupted the normal disturbance regimes in this ecosystem. Properly implemented silvicultural practices that mimic natural disturbance events can help to restore these forests and the important wildlife habitat they provide. For example, stand-replacing disturbances such as hurricanes can be mimicked by silvicultural practices such as patch cuts, while smaller disturbance events can be mimicked by practices such as single-tree and group selections. Overall, strive for variability by incorporating a range of silvicultural practices within every stand.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SILVICULTURE TREATMENTS

REGENERATION TREATMENTS

When the goal is to regenerate a stand, appropriate regeneration treatments include **individual** and **group selections**, **shelterwoods**, **seedtree**, and **patch cuts** (small clearcuts up to 10 acres). Implemented as a **variable retention harvest**, such treatments can also include passively managed areas that are not harvested to provide a diversity of conditions across a broad spectrum. Functionally, this mimics natural forest succession, providing a broad range of successional conditions, maintaining a perpetual forest capable of providing many values including revenue for a landowner over a long time period, and quality habitat for a wide variety of species.

Individual Selection
Gap left by individual tree selection. Photo by Brian Lockhart, USDA Forest Service.

Group Selection
Gap left by group tree selection. Photo by Brian Lockhart, USDA Forest Service.

A NOTE ON SELECTION SILVICULTURE

For a guide on selection silviculture, see Appendix E. Note that selection silviculture should not be confused with selective harvesting, which is often synonymous with “high-grading” or “diameter-limit cutting”, which is an unsustainable forestry practice of removing the largest and highest value trees in stand, with little to no thought for appropriate regeneration for the long term. Shelterwood systems might also be appropriate for certain sites, especially where the goal is to regenerate or retain oak and shade intermediate trees as a component of the stand’s composition.

SILVICULTURE TREATMENTS

Shelterwood
Shelterwood system in flooded hardwood stand. Photo by Brian Lockhart, USDA Forest Service.

Seedtree
Loblolly seedtree system. Photo by Michael Fountain.

Patch Cut
Patch cut of bottomland hardwood stand. Photo by Brian Lockhart, USDA Forest Service.

INTERMEDIATE TREATMENTS

For stands that are not yet ready to regenerate, implement intermediate treatments and release treatments if needed to promote desired tree species. In pre-commercial stands, release treatments such as cleanings and sanitations can be performed with a hack-and-squirt application. Where mid-rotation stands can be harvested commercially, consider implementing a variable density thinning to increase structural diversity and achieve thinning goals.

Cleaning with Hack-and-Squirt
Hack-and-squirt method. Photo by James H. Miller, USDA Forest Service.

Variable Density Thinning
Variable density thinning. Photo by Brian Lockhart, USDA Forest Service.

RECOMMENDATIONS BASED ON WILDLIFE

WHAT DO YOU WANT TO SEE IN YOUR WOODS?

Black Bear

Ken Taylor

Habitat Description

Large, contiguous forested tracts with multiple tree species and structural diversity.

Management Strategies

Variable retention harvest that incorporates group and individual selections.

Leave hard and soft mast tree species such as oaks, sweet pecan, and mulberry as well as fruiting understory species such as blackberry and palmetto

James H Miller, USDA Forest Service, Bugwood.org

American Woodcock

Simon RB Thompson

Habitat Description

Juxtaposition of open canopy stands with high densities of saplings, shrubs, and cane; and open fields.

Management Strategies

Variable retention harvest that incorporates patch cuts, shelterwood, and group selections.

David Stephens

RECOMMENDATIONS BASED ON WILDLIFE

Kentucky Warbler

Don Martin

Habitat Description

Mature bottomland hardwood forests with lush undergrowth habitat.

Management Strategies

Patch cuts, shelterwood, group selections

Also benefits white-eyed vireo, hooded warbler, and eastern towhee

Brian Lockhart, USDA Forest Service, Bugwood.org

Amphibians and Reptiles

National Park Service

Habitat Description

Isolated wetlands and floodplain pools with few trees and areas with abundant coarse woody debris.

Management Strategies

Retain coarse woody debris especially in wetter sites

Maintain forested riparian buffers

Steven McNamara, National Park Service

RECOMMENDATIONS BASED ON WILDLIFE

Wild Turkey


Monte Loomis, NWTF

Habitat Description

Understory thickets with sufficient cover and mature overstory trees for roosting, nesting, and brooding.

Management Strategies

Variable retention harvest

Group selection


NC Tree Farm

Fox Squirrel


Chuck Bryan NCWRC

Habitat Description

Mature, open hardwood forests with sparse understory.

Management Strategies

Variable retention harvest, group selection, individual selection

Keep trees that provide a diversity of food resources throughout the year and cavity trees/snags


Chris Evans, University of Illinois

Rabbits - Swamp and Eastern Cottontail


Mark Buckler, NCWRC

Habitat Description

Early successional habitat in spatially distributed canopy gaps.

Management Strategies

Variable retention harvests that incorporate group selection cuts, shelterwoods, and patch cuts.

Also benefits white-tailed deer.


Brad Hutnik, WI DNR

Swainson's Warbler


Nate Swick, Flickr

Habitat Description

Understory thickets in swamps and stream bottoms and thick woodland brush in gaps.

Management Strategies

Small 2-10 acre patch cuts on high bottomland sites


Brian Lockhart, USDA Forest Service

Chimney Swift


Paul Reeves, Shutterstock

Habitat Description

Open sky. Nests in large hollow trees.

Management Strategies

Leave standing hollow and hollow dead trees if possible


USGS

Bats


Michael Durham, Minden Pictures

Habitat Description

Mature bottomland hardwood forests. Nests in large hollow trees, namely Nyssa spp.

Management Strategies

Leave cavity trees and snags, namely Nyssa spp.


Joseph OBrien, USDA Forest Service

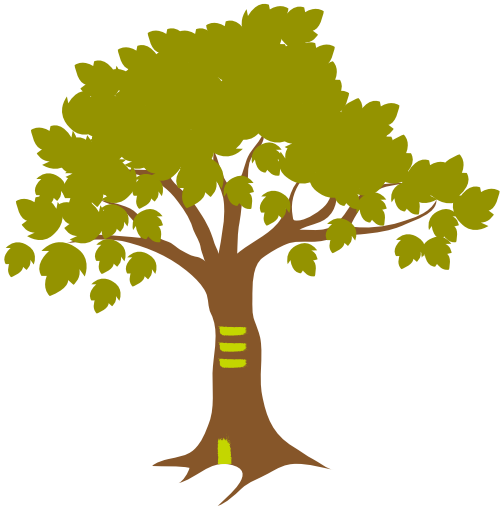
Appendix E: Marking Timber in Selection Silviculture

A guide on how to mark a selection harvest, per our contributors.

To successfully implement a selection silviculture treatment, a forester must consider the following variables:

Soil: some fragile soils are impossible to log without causing significant damages to soil health, however some tree species require soil disturbance to regenerate.

Oak: oak doesn't grow everywhere. It's best to work with what you have in hand and not try to force a site to produce. Hydrologic changes may be the reason you can't regenerate it.



Group Selection: a group selection regeneration method should happen in the field and occur organically as opportunities present themselves. For example, groups could be formed around patches of advanced regeneration.

Natural Regeneration: the point of selection harvests is to set the stage for regeneration. Natural regeneration should always be the first option. Planting is expensive and risky.

STEPS TO MARKING TIMBER

STEP 1

Identify the residual stand species and density.

Learn to visualize what your desired forest condition looks like and know going into marking what the stand will look like post-harvest. A pre-harvest vs a target post-harvest stand and stock table could help guide the marking operation.

STEP 2

Identify the individual trees to be retained.

Identify the individual trees to be retained. First, consider desired tree species, then judge whether it is capable of 3-dimensional growth. If there are multiple trees competing for light determine if they can increase in grade, increase in merchantable height, or increase in diameter. For example, if one tree can only increase in diameter while it's neighbor can put on a second log, then select the neighbor. Free-to-grow crowns on the trees most likely to increase in value (habitat value and financial value) is the goal.

STEP 3

Clear communication to contractors.

Communicate to contractors the reason for taking or leaving specific trees and stress the need to avoid damage to the residual stand when felling/skidding.

STEP 4

Be realistic.

The contractor is going to fear a loss of production. This will likely require an increase in normal cut-and-haul rates to compensate for the lower per acre production rate.

Appendix F: Forest Operations and Harvesting Constraints

Bottomland hardwood forests are hydrologically complex, and management requires unique operational considerations and specialized equipment and methods.

As a general practice, you should adhere to your state's BMPs as they relate to operations in wetland forests. While timber harvesting and other ongoing silviculture activities are exempt from having to obtain a federal water quality permit under Section 404 of the Clean Water Act, implementing BMPs is important to maintain this exemption. A list of where to find ACP states BMPs can be found in Appendix A.

Practices to follow to protect water quality during timber harvesting (Mahaffey and Evans 2016):

Harvest during dry periods to reduce damage to soil and equipment and diminish hydrologic impacts. In the ACP, late summer and early fall may offer dry periods.

Use low ground pressure harvesting equipment to help distribute the weight and reduce soil compaction. Put in fords (preferred), culverts, dips, bridges, or box culverts in roads to enable water flow and remove after use. Additionally, build in fencing features around drainage areas to prevent backup of logging slash and debris.

Harvest smaller areas, as applicable. Larger harvests can inhibit evapotranspiration through trees on a larger scale and create more inundation and saturation on the site.


NC Forest Service


Warren Wilson College


Forest Stewards Guild

FOREST OPERATIONS IN BOTTOMLANDS

Large woody debris from a logging operation. Photo courtesy of Jeremy Stovall.

Minimizing Disturbance

Forest operations in bottomland hardwood forests should minimize disturbance to natural hydrologic processes. In all cases, aim to reduce the amount of permanent infrastructure such as roads and landings. Reducing the number of skid trails will limit disturbance and mitigate degradation. Cleaning log decks post-harvest will often result in debris piles suitable for wildlife habitat and provide patches for regeneration. Additionally, aim to minimize damage to residual stems.

Shovel-Mat Logging Method

For wetter sites (e.g. cypress-tupelo), one of the most used operational methods to minimizing soil and aquatic disturbance is the shovel mat-logging method (NC Forest Service 2018a). This method of logging uses multiple machines mounted upon crawler tracks in tandem with machines that are mounted on extra-wide or dual-rubber tires. The goal of this method is to avoid heavy machinery coming in direct contact with the fragile soils of the wettest bottomland sites. For more information on the shovel mat-logging method, please see NC Forest Service's Forestry Leaflet No. 4: Harvesting Timber Using the Shovel-Mat Logging Method.

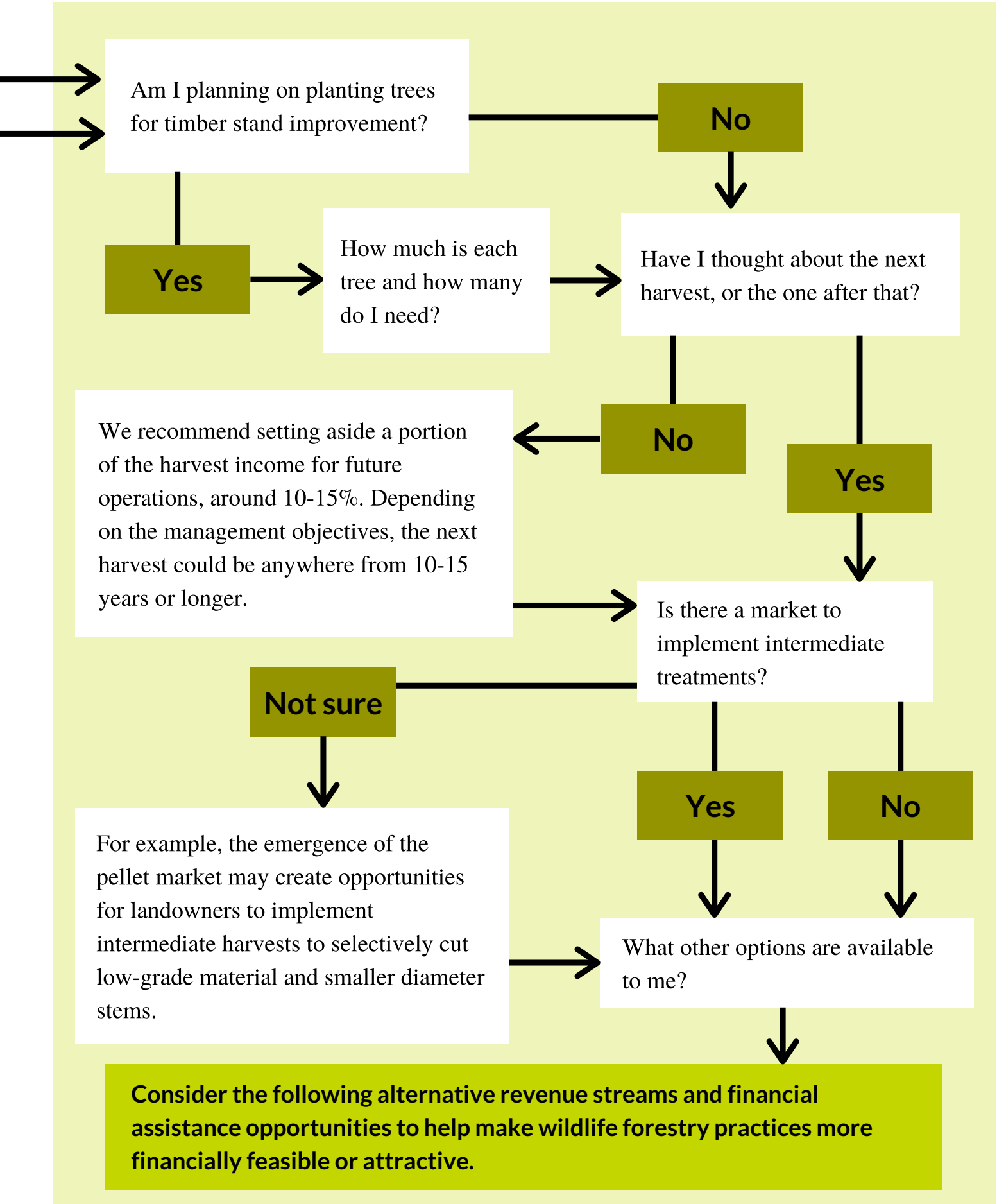
Appendix G: Forest Economics and Financial Constraints

Implementing wildlife forestry practices in bottomland hardwood forests may not be financially feasible for every landowner, as less timber revenue is generated with each harvest entry compared to conventional practices. Market conditions are constantly in flux and forest product market access heavily influences what can and cannot happen operationally in the woods.

Yes! → Great! Before moving on, make sure your management objectives address wildlife needs. Then, ask yourself the following questions when planning for wildlife forestry management.

Do I need to do any site prep? Activities can include shearing, bedding, mowing, and herbicide treatment.

- **Yes** → How much will that cost?
- **No**


Am I planning on planting trees for timber stand improvement?
No
Yes
How much is each tree and how many do I need?
Have I thought about the next harvest, or the one after that?
No
Yes
We recommend setting aside a portion of the harvest income for future operations, around 10-15%. Depending on the management objectives, the next harvest could be anywhere from 10-15 years or longer.
Is there a market to implement intermediate treatments?
Not sure
Yes
No
For example, the emergence of the pellet market may create opportunities for landowners to implement intermediate harvests to selectively cut low-grade material and smaller diameter stems.
What other options are available to me?
Consider the following alternative revenue streams and financial assistance opportunities to help make wildlife forestry practices more financially feasible or attractive.

CONSERVATION INCENTIVES

COST-SHARE PROGRAMS

There are several cost-share programs available to help landowners implement a variety of forestry and conservation practices on their land. Utilizing these programs or other partnership opportunities and cooperative approaches can help offset costs of desired wildlife forestry practices. The USDA Natural Resources Conservation Service (NRCS) and Farm Service Agency offer a variety of federal programs, including the Conservation Reserve Program, Wetland Reserve Program, Emergency Forest Restoration Program, Healthy Forests Reserve Program, Environmental Quality Incentives Program (EQIP), Regional Conservation Partnership Program, and Conservation Stewardship Program. EQIP is an especially good option for landowners interested in implementing wildlife forestry in their bottomlands. These programs provide matching funds to landowners for practices, including reforestation, thinning, invasive exotic plant control, and wildlife habitat improvement.

The U.S. Fish & Wildlife Service (USFWS) through their Partners for Fish and Wildlife Program works with state wildlife agencies to provide technical and financial assistance. The state wildlife agencies provide assistance on behalf of these programs. State forestry agencies also provide financial assistance for forestry and conservation practices to landowners in Virginia, North Carolina, South Carolina, and Georgia.

Some conservation nonprofit organizations also administer financial assistance to private landowners for forestry and conservation practices in close partnership with state and federal agencies. For example, Audubon North Carolina's Forest Landbird Legacy Program provides financial support for land management and habitat restoration to benefit imperiled forest birds.

CONSERVATION EASEMENTS

Landowners can enter their property into a conservation easement, which is a legally binding document, to ensure the permanent protection of the conservation values associated with their land. Many conservation easements allow for responsible forest management, referred to as "working forest easements". Conservation easements can be held by a variety of entities, including state or federal agencies (e.g. NRCS Wetland Reserve Program) and local land trusts. Easements vary, but most ensure that the land is never developed, while allowing for appropriate management activities and providing a property tax break.

CONSERVATION INCENTIVES

FOREST CERTIFICATION OPTIONS

Wildlife forestry practices often align with various forest certification standards, such as managing your forest in a way that protects biological diversity. Forest management certification focuses on more than just timber management. Through focusing on making sure forests are managed sustainably for all of their ecosystem services, these programs ensure that wood products come from responsibly managed forests that provide environmental, social, and economic benefits. In the Southeast, the Forest Stewardship Council, Sustainable Forestry Initiative, and American Tree Farm System are the top leaders in forest certification.

CARBON OFFSETS

Forests sequester and store large amounts of carbon, mitigating the negative effects of greenhouse gas emissions. Carbon sequestration is the rate at which a forest absorbs carbon dioxide (CO2) from the air while carbon storage is a measure of the volume of carbon (measured in CO2 equivalents) in aboveground live and dead trees (Pinchot Institute 2018). Carbon credits are awarded to a landowner based on how much carbon is stored on the property in above-ground biomass. Companies, organizations, and individuals can then purchase carbon offset credits to mitigate their own carbon emissions.

At a basic level, approximately 50% of a tree's dry biomass weight is carbon, and larger, more vigorous trees are able to store and sequester the most carbon (Pinchot Institute 2018). As highly productive forests, bottomland hardwood forests have a high capacity to sequester carbon (Shoch et al. 2009; Moerschbaecher, Keim, and Day 2016).

Generally, for forest carbon offset projects to be profitable they need to cover a minimum of 3,000 acres. However, there are methods being developed in the Southeast to bring down the costs of project development for small-scale forest landowners. Landowner aggregation can also help split these costs between several landowners with smaller acreages. There are several private groups that work with landowners to develop carbon projects and enter the trading market such as Weyerhaeuser, the Forestry Association of South Carolina, and Lyme Timber Company.

Appendix H: Historical Landscape Context

It is important to acknowledge the history of the landscape as a whole, including the presence of Indigenous peoples and their connection to the land. As the original stewards of this land, they shaped the forest's unique mix of tree and other plant species, soils and waterways, and habitat for wildlife.

Landowner Example in North Carolina

The Willitts property is located in the Chowan River Basin, the historic homeland of the Chowanoke Indians. The Chowanoke are a Southern Algonkian Indian tribe. Before European settlement, the Chowan River was home to Algonkian Indians, who lived for centuries on the riverbanks of the Chowan River. They fished, farmed, and foraged much of what can still be found today. Plants such as palmetto, yucca, white oak, devil's walking stick, and tulip poplar were foraged and cultivated for numerous uses such as food, pharmacy, construction materials, and musical instruments. The practice of using fire for hunting deer and other game was a large part of the southeastern Indigenous culture and helped shape the landscape (Chowanoke Indian Reservation 2013, Native Land Digital 2015, NC Cooperative Extension n.d.).

Tips and External Resources

- For territory information: Native Land Digital interactive map
- For general information: State and federally-recognized tribes often have websites
- For ethnobotany information: North Carolina Extension Gardener Plant Toolbox
- If you can't find information specific to your property, try widening your scope to your ecoregion, state, or even Southeast-wide.

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