

# **Desired Future Conditions for Bottomland Hardwood Forests within the Southeastern Coastal Plain of North Carolina**

## **Intended Use:**

This document is intended to provide recommends for landowners in eastern North Carolina who wish to manage bottomland hardwood forests with a primary interest in improving wildlife habitat and a secondary interest in generating revenue. We have based our recommendations on the needs of several indicator species. These are species of conservation concern, species closely associated with bottomland hardwood habitats, or species of management interest (i.e. game species). We believe these species will provide an umbrella or other animals associate with the community type, and that providing for their habitat needs will accommodate the needs of most wildlife and plants associated with bottomland forests in eastern NC. This document describes desired future conditions (DFC) and provides literature-based justifications for these conditions. Land managers can assess their current forest conditions, compare them to the DFCs, and utilize the management recommendations to move their forest closer to the DFC.

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## **Management Objectives:**

Management of mature hardwood floodplain forest to maximize preferred habitat for the following indicator and management interest species: **northern long-eared bat, Rafinesque's big-eared bat, southeastern myotis, bald eagle, Swainson's warbler, hooded warbler, Kentucky warbler, Acadian flycatcher, American woodcock, marbled salamander, wild turkey, black bear, and white-tailed deer.**

A bottomland hardwood forest that supports these species should have the following characteristics:

### Overstory:

- Average 60-70 % canopy closure across the entire stand, with 2-10 acre patch openings and 80-90% canopy closure across the rest of the forest. (Norris et al. 2009, Somershoe et al. 2003, Thomas et al. 1996, LMVJV Forest Resource Working Group 2007).
- Average of at least 2 dominant (emergent or "supercanopy") trees per acre.
- Diverse mix of plant species dominated by Most Desirable and Desirable species and with a minority of Less Desirable species and relatively few Undesirable species (see Table 1).
- Significant component of large diameter trees. What constitutes "large" varies by species, but in general  $\sim >18$  in dbh, with some trees  $>36$  in dbh. (Gooding G. and J. R. Langford. 2004, Cochran, S. M. 1999).
- Presence of snags (4+/ac) and trees with hollows. (Mirowsky 1998, Cochran 1999, Hoffman 1999, Gooding and Langford 2004, Loeb and O'Keefe 2006).

### Midstory:

- 25-40% cover that includes diverse mix of species dominated by Most Desirable and Desirable species and with a minority of Less Desirable species and relatively few Undesirable species (see Table 1) (LMVJV Forest Resource Working Group 2007).
- Presence of mature midstory trees (e.g. dogwood, ironwood, etc.) as well as regen of overstory trees.

### Understory:

- Presence of regeneration of Most Desirable and Desirable species. Total regen (midstory and understory) should average 30-40% cover across the stand.
- Abundance of coarse woody debris  $>10$ -inch diameter (average  $>200$  ft<sup>3</sup> per acre) (LMVJV Forest Resource Working Group 2007).
- Presence of switchcane and a diversity of native herbaceous plants, vines, and shrubs, with dense concentration of these plants in the patch openings. (Thomas et al. 1996, Thompson, J. 2005).
- Minimal coverage of invasive species.

Special habitat features

- Steep slopes, rock outcrops, seeps, floodplain pools, and oxbow lakes are protected and connected to forested habitat.

Landscape context:

- Large (>10,000 acres) contiguous forested areas are desired. This should include early seral forests in addition to mature forests (LMVJV Forest Resource Working Group 2007).
- Mature forest present and adjacent to both sides of the river.
- Forested cover extends at least 300 feet, ideally 600+ feet from the river and covers entire floodplain (NCWRC 2012).
- Ideally, bottomland hardwood forests are adjacent to forested uplands and are located in watersheds with <10% impervious surface.

**Table 1** List of Desirable and Undesirable tree species based on their wildlife value, including value for producing hard or soft mast, supporting invertebrate diversity, or providing cover or nesting substrate. A secondary consideration is commercial value.

Most Desirable (≥30%)		Desirable		Less Desirable		Undesirable	
Species	Shade Tolerance <sup>1</sup>	Species	Shade Tolerance <sup>1</sup>	Species	Shade Tolerance <sup>1</sup>	Species	Shade Tolerance <sup>1</sup>
Oaks	IST & SI	White ash	SI	Sweetgum	SI	Chinese Privet	ST
Hickories	IST	Green ash	ST			Japanese stilt grass	ST
Mockernut hickory	SI	Loblolly pine <sup>3</sup>	SI			Multiflora rose	ST
Dogwood	ST	Pond pine	SI			Autumn Olive	ST
Blackgum	ST	Yellow-poplar	SI			Wisteria	ST
Cypress	IST	Beech	ST			Bradford Pear	IST
Water tupelo	SI	Maple	ST			Tallow Tree/Pop corn Tree	ST
Black cherry	SI	American elm	IST				
Willow	SI	Winged-elm	ST				
Birch	SI	Black walnut	SI				

Persimmon	ST	American basswood	ST
Paw Paw	ST <sup>2</sup>	Mulberry	ST
Atlantic white cedar	ST	Sycamore	IST
Plum	ST <sup>2</sup>		

- 1) ST=shade tolerant, IST=intermediate shade tolerant, SI=shade intolerant.
- 2) Fruits best in full sun.
- 3) Loblolly pine is desirable when it does not dominate.

**Management Recommendations (For maximizing optimal habitat requirements for all target species):**

1. Patch clearcut harvests between 2-10 acres in size, in addition to group selection removals. Harvest layout and size of patches and groups would depend on shade tolerance of tree species selected for regeneration.
2. Patch clearcuts should not exceed 10 percent of a given stand, and all accompanying removals should not reduce canopy closure below 60-70 percent.
3. Rotation age for patch clearcuts 100-150+ years. Harvesting intervals would then occur every 10-15 years.
4. Leave 300 - 600+ feet of forested riparian buffer. Within these forested buffers, group selection removals should be favored and size of patch clearcuts should be minimized to reduce negative impacts to water quality.
5. Leave all hollow trees and snags in harvest areas, within limits of safety for loggers.
6. Leave at least 2 dominant (emergent or “supercanopy”) trees per acre.
7. Protect isolated wetlands, steep slopes, and rock outcrops. Reducing tree canopy around rock outcrops can benefit basking reptiles, but avoid damaging the outcrop.
8. Ideally, conduct timber harvesting from October 1-December 1 and March 1-April 1 to minimize negative impacts for target species.

**Literature review of habitat requirements for target species:**

**Northern long-eared bat (*Myotis septentrionalis*)** Northern long-eared bats are known to be year-round residents in the Coastal Plain. Throughout most of their range, *M. septentrionalis* are known to make seasonal movements to caves for hibernation, where there is high mortality from white-nose syndrome (WNS). In contrast, these species can remain active year-round on the Coastal Plain of North Carolina, where there are no known hibernacula. These factors could ultimately lead to populations of bats in the Coastal Plain becoming source or rescue populations for re-colonization of locally extinct or depleted populations (Grider et. al. 2016).

**Rafinesque’s big-eared bat (*Corynorhinus rafinesquii*)** In North Carolina and Virginia, foraging habitat for subspecies *Macrotis* is mature hardwood floodplain forest; sites along permanent water bodies, especially rivers, are preferred (Clark 1987). Rafinesque’s big-eared bat utilizes hollow trees for roost sites, especially older water tupelo (*Nyssa aquatica*), blackgum (*Nyssa*

*sylvatica*), and bald cypress (*Taxodium distichum*) that are canopy dominants, characteristic of older cypress/tupelo-gum forests. (Mirowsky 1998, Cochran 1999, Hoffman 1999, Gooding and Langford 2004, Loeb and O'Keefe 2006). Other tree species used occasionally for summer roosts include southern magnolia (*Magnolia grandiflora*), American sycamore (*Platanus occidentalis*), American beech (*Fagus grandifolia*), oaks (*Quercus* spp.) and hickories (*Carya* spp.) (Bat Conservation International and Southeastern Bat Diversity Network 2013).

**Southeastern myotis** (*Myotis austroriparius*) Primary threats to these bats in bottomland hardwood forests include degradation and loss of foraging habitats, and declines in the availability and suitability of tree and human-made structures for roosting (Bat Conservation International and Southeastern Bat Diversity Network 2013). In South Carolina, 36 roosting sites of southeastern myotis were in tupelo gum trees, one was in a black gum, and all were in stands with closed canopies (Clark et al., 1998).

Southeastern myotis roosted in cypress-gum swamps in summer and switched to a diverse hardwood floodplain forest with shallower flood waters in winter. As a result, they used smaller roosts in different tree species in winter than in summer. The divergent roosting habits in winter are likely due to the height of roost entrances in relation to flood waters. In summer, southeastern myotis use basal openings that are submerged during winter flooding, whereas Rafinesque's big-eared bats use openings located higher on the tree bole that are not submerged. Therefore, management for southeastern myotis may require provision of separate summer and winter roosting habitats (Clement and Castleberry 2013).

All landowners should be encouraged to implement Best Management Practices (BMPs) when managing forests in areas supporting populations of Rafinesque's big-eared bats and southeastern myotis, and recommendations for wider streamside management zone (SMZ) buffers should be suggested as habitat enhancements for these bats. Presently, no data exist that compare habitat use (foraging and roosting) of Rafinesque's big-eared bat and southeastern myotis to stream buffer dimensions, so in the absence of data a more conservative approach that allows for wider buffer strips is encouraged, at least until habitat use of these bats can be evaluated at replicate stream corridors of varying widths and in different landscape contexts (Bat Conservation International and Southeastern Bat Diversity Network 2013).

At our present state of understanding, management actions that retain late succession forests with high species diversity, structural complexity, and a relatively open understory appear desirable. Activities that dramatically alter forest structure or convert forest land to other land uses should be avoided in areas supporting significant populations of these bat species. The possibility exists that a range of silvicultural practices, such as thinning or small-patch cuts, might enhance both foraging space for bats and the abundance and diversity of insect prey, including moths (Bat Conservation International and Southeastern Bat Diversity Network 2013). Foraging behavior has been observed in bottomland hardwood and bald cypress-tupelo gum swamp in Arkansas and South Carolina (Clark et al. 1998, Hoffman 1999). Its also been found

that southeastern myotis forages in Carolina bays in the coastal plain of South Carolina (Menzel et al., 2005).

**Swainson's warbler** (*Limnothlypis swainsonii*) Nesting begins in late April and early May (Meanley 1971). Swainson's warblers require a well-developed understory. Vines may be an important component of Swainson's warbler habitat. In a managed bottomland hardwood forest in South Carolina, success rate of Swainson's warbler nests located in vines was higher (63%,  $n=8$ ) than success rate of nests in switchcane (20%,  $n=5$ ). In addition, categorical abundance of vines was the variable that was most consistently included in models for predicting Swainson's warbler occurrence. When cane and vines were abundant there was a 59% probability of detecting a Swainson's warbler on a site. Vine species on these sites included greenbrier (*Smilax* spp.), grape (*Vitis* spp.), trumpet creeper (*Campsis radicans*), and peppervine (*Ampelopsis arborea*) (Meyer, 2006).

Swainson's warblers occur in habitats at various stages of succession. In bottomland hardwood forests in North Carolina, Swainson's warblers were captured at a rate of 0.24 birds/100 mist net hours in young stands (6-8 years), 0.38 birds/100 mist net hours in intermediate-aged stands (17-21 years), and 0.71 birds/100 mist net hours in mature stands (>60 years). Swainson's warblers may benefit from some timber harvesting. Restricting harvesting to the nonbreeding season (1 October to 1 April) is likely to minimize negative impacts to Swainson's warblers.

The best evidence available suggests that patch clearcuts of at least two acres, located on the best high bottomland hardwood sites, should develop into productive habitat for Swainson's warbler and its associates. Furthermore, Thomas (1996) states that creating small canopy openings, less than 4 ha (10 ac), will promote and sustain the growth of understory plant species, including cane (*Arundinaria* spp.). Additionally, while small clear-cuts can create habitat for Swainson's warbler, thinning may improve their habitat too (Somershoe et al. 2003).

These high bottomland hardwood forest sites, where the best thickets develop, not surprisingly experience infrequent and short duration flooding, leaving the dry leaves on the forest floor loose, fluffy and easy to turn for the foraging warblers. In fact, a dense leaf litter layer seems to be an essential component of good Swainson's warbler habitat (Savage and others 2010). Thompson (2005) further described the most productive Swainson's understory thickets as being close to swamp sloughs but not cypress-tupelo flats and streams, with lots of dry leaves on the ground and little or no grass. They should also be as far as possible from a forest edge, ideally 1000 m or more, to reduce brown-headed cowbird parasitism (Twedt and others 1999).

When some revenue is desired, multiple clear-cuts of up to 10 acres in size, up to 10 percent of the forest stand, could be recommended to create regenerating, dense understory habitat (aka "thickets"). Thickets can be isolated or near one another. In the latter situation, two or more thickets might be connected by a single skid trail, to minimize the area of disturbance and

fragmentation resulting from a larger single cut, and avoid multiple loading decks. The result would be a “string of pearls” harvest design (fig. 1a) (Brunswick et. al. 2016).

An alternate design would be to locate the loading deck in the middle and cut patches like spokes of a wheel (fig. 1b) (Brunswick et. al. 2016). Foresters should also consider the surrounding forest landscape when deciding upon the location of clearcuts. It is also a recommendation to “feather” the edges of any clearcuts to soften the edge effect (fig. 2) (Brunswick et. al. 2016). Feathering edges - If clearcuts alone do not provide a sufficient economic opportunity to justify a harvest, landowners can thin bottomland hardwood forest stands using single tree and group selection, so long as they do not reduce the canopy closure from 90 percent to below 60 percent-70 percent. To benefit wildlife, foresters can select trees to retain and release mast-producing trees, large-diameter trees, trees with hollows, and snags. Using a variety of techniques, foresters can estimate the before-treatment canopy closure and the impact on canopy closure of the removal of each tree as it is being marked for harvest.

If understory thickets are to be created by multiple clearcuts and a stand-wide thinning is to take place as parts of the same harvest operation in the same stand, it is important to mark the thickets (clearcuts) first, to know how many acres and how much canopy opening will result from them before marking the thinning. When determining the number and size of understory thickets to be created in a particular stand, the canopy openings generated from the combined harvest (clearcuts and thinning) must be included in the total canopy opening estimate. To reiterate, for the best possible bottomland hardwood bird habitat conservation outcome, patch clearcuts should not exceed 10 percent of a given stand, and all accompanying thinning (single tree and group selection) should not reduce canopy closure below 60-70 percent.



Figure 1a—String of Pearls.

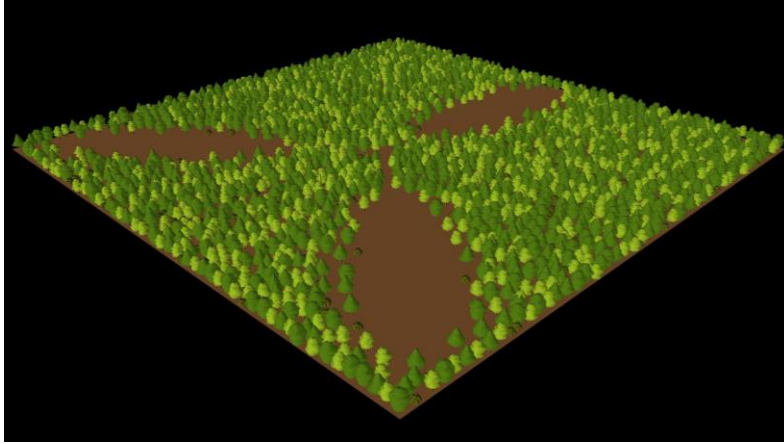


Figure 1b—Spokes of Wheel.



Figure 2—Feathered Edges of Clear-cut.

**Kentucky warbler** (*Geothlypis formosa*) and **Hooded warbler** (*Setophaga citrina*) Mature bottomland hardwood forest, with lush ground cover for nesting and a fair bit of canopy openness. Utilize large diameter downed logs for foraging and nesting near. Results reported by Norris et al. (2009) suggest that thinning established bottomland hardwood stands, which does not reduce canopy closure below 60-70 percent, improves habitat for several birds that need conservation action, while not dramatically degrading the habitat for several others that also need such help.

Thickets developed for Swainson's warbler will provide good habitat for several other bottomland birds in need of conservation action, such as hooded warbler, Kentucky warbler, white-eyed vireo (*Vireo griseus*) and eastern towhee (*Pipilo erythrophthalmus*). Kentucky warbler and eastern towhee are rated High Priority and hooded warbler and white-eyed vireo are rated Moderate Priority on the SAMBI list, providing the opportunity to assist a suite of birds with one management prescription (Brunswick et. al. 2016). There is also some support that recently fledged overbirds (*Seiurus aurocapilla*) and Acadian flycatchers (*Empidonax virescens*) move less when there is dense groundcover and move more when there is a dense overstory. This supports the hypothesis that creating canopy gaps and patches of denser, early

successional habitat is beneficial for some life stages of birds that breed in mature forest, which presumably leads to greater survival (Jenkins et. al. 2017).

**Marbled salamander** (*Ambystoma opacum*) Given the reliance of marbled salamanders on small isolated seasonal wetlands and intact forested floodplain habitats, their abundance presumably has declined as wetland habitats have been destroyed (Petranka 1998). Small isolated wetlands are the most valuable wetlands for maintaining amphibian biodiversity, but it is precisely these wetlands that are unprotected by current wetlands regulations and that are most “at risk” (Semlitsch and Bodie 1998).

As isolated wetlands disappear and remaining wetlands become increasingly separated, the cumulative impact on amphibian populations such as marbled salamanders will likely be substantial and perhaps non-linear, as elimination of remaining wetlands results in proportionally larger and larger effects on pond-breeding amphibian populations. For conservation efforts to succeed, it will also be critical that the wetland ecosystem be viewed not solely as the wetland itself, but also the adjacent terrestrial habitat that is essential to the persistence of pond-breeding amphibians (Scott 1999; Gibbons 2003). In bottomlands, marbled salamanders breed in floodplain pools, oxbow lakes, and other isolated, ephemeral depressional wetlands. During the non-breeding portion of their lives, the adults live in the bottomland and adjacent upland forests. Much of their time is spent underground or under cover, utilizing stump holes, mammal burrows, and coarse woody debris.

**White-tailed deer** (*Odocoileus virginianus*) Hard and soft mast producing trees provide food, dense thickets provide bedding areas, patches of early successional habitat provide forage.

**Wild turkey** (*Meleagris gallopavo*) Hard and soft mast producing trees provide food, early successional patches provide cover and bugging areas for chicks, herbaceous and low woody understory provides nesting cover.

**American woodcock** (*Scolopax minor*) Favors young, second-growth hardwoods and “mature” hardwood stands with a relatively open canopy for diurnal cover (Roberts 1993). These habitat types are typically characterized by high densities of saplings, shrubs, cane, and/or vines that facilitate predator avoidance. Conversely, nocturnal habitat of American woodcock tends towards open fields where they forage and conduct courtship activities (Krementz and Jackson 1999). Benefit from moist soils and shallow wetlands.

**Aquatic species (e.g., rare fish and mussels and amphibians)** NC Wildlife Resources Commission recommends maintaining a forested riparian buffer of 50 feet on intermittent streams, 100 feet on perennial streams, and 200 feet on perennial streams supporting Threatened and Endangered aquatic species to protect water quality (NCWRC 2002). In addition, NCWRC recommends a minimum of 300 feet and ideally 600+ feet of forested riparian buffer to benefit terrestrial and semi-aquatic species associated with riparian habitats (NCWRC 2012). Within these forested buffers, there are opportunities to conduct timber operations and other management activities, so long as they maintain the integrity of the mature forest and

protect water quality. There should be very minimal tree cutting, soil disturbance or heavy equipment operation within 50 feet of waterways, and logging operations should follow Best Management Practices ([http://ncforestservice.gov/water\\_quality/bmp\\_manual.htm](http://ncforestservice.gov/water_quality/bmp_manual.htm)).

**Landscape context** To maximize wildlife use, bottomland hardwood forests should be embedded within a forested landscape of at least 10,000 contiguous acres (LMVJV Forest Resource Conservation Working Group. 2007).

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