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An Old-Growth Definition for Eastern Riverfront Forests

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A Section of the Old-Growth Definition Series

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Preface

Old growth is widely acknowledged today as an essential part of managed forests, particularly on public lands. However, this concept is relatively new, evolving since the 1970's when a grassroots movement in the Pacific Northwest began in earnest to define old growth. In response to changes in public attitude, the USDA Forest Service began reevaluating its policy regarding old-growth forests in the 1980's. Indeed, the ecological significance of old growth and its contribution to biodiversity were apparent. It was also evident that definitions were needed to adequately assess and manage the old-growth resource. However, definitions of old growth varied widely among scientists. To address this discrepancy and other old-growth issues, the National Old-Growth Task Group was formed in 1988. At the recommendation of this committee, old growth was officially recognized as a distinct resource by the Forest Service, greatly enhancing its status in forest management planning. The committee devised "The Generic Definition and Description of Old-Growth Forests" to serve as a basis for further work and to ensure uniformity between Forest Service Stations and Regions. Emphasis was placed on the quantification of old-growth attributes.

At the urging of the Chief of the Forest Service, all Forest Service Stations and Regions began developing old-growth definitions for specific forest types. Because the Southern and Eastern Regions share many forest communities (together they encompass the entire Eastern United States), their efforts were combined, and a cooperative agreement was established with The Nature Conservancy for technical support. The resulting project represents the first large-scale effort to define old growth for all forests in the Eastern United States. This project helped bring the old-growth issue to public attention in the East.

Definitions will first be developed for broad forest types and based mainly on published information and so must be viewed accordingly. Refinements will be made by the Forest Service as new information becomes available. This document represents 1 of 35 forest types for which old-growth definitions will be drafted.

In preparing individual old-growth definitions, authors followed National Old-Growth Task Group guidelines, which differ from the standard General Technical Report format in two ways—the abstract (missing in this report) and the literature citations (listed in Southern Journal of Applied Forestry style). Allowing for these deviations will ensure consistency across organizational and geographic boundaries.

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Introduction

Eastern riverfront forests fall into one of three types: (1) nearly pure eastern cottonwood (*Populus deltoides* Bartr. ex Marsh.) stands, (2) nearly pure black willow (*Salix nigra* Marsh.) stands, and (3) typical riverfront hardwood stands containing many species, but generally dominated by sycamore (*Platanus occidentalis* L.), pecan [*Carya illinoensis* (Wangenh.) K. Koch], green ash (*Fraxinus pennsylvanica* Marsh.), sugarberry (*Celtis laevigata* Willd.), and American elm (*Ulmus americana* L.). Both eastern cottonwood and black willow are temporary, pioneer forest types that become established on newly exposed river margins. Both species are short-lived and individuals rarely exceed 85 to 120 years of age. The eastern riverfront forest generally succeeds both eastern cottonwood and black willow forests, and represents an intermediate successional stage between these pioneer types and the sweetgum (*Liquidambar styraciflua* L.)-water oaks (*Quercus nigra* L., *Q. phellos* L., and *Q. nuttallii* Palmer) type on drier sites and the overcup oak (*Q. lyrata* Walt.)-water hickory [*Carya aquatica* (Michx. f.) Nutt.] type on wetter sites. Some evidence indicates that cottonwood/willow forests begin to break up at about 35 years of age and are replaced by eastern riverfront forests by 85 years of age. The eastern riverfront type lives for about 80 years before being gradually invaded by sweetgum and water oaks. However, repeated disturbances may allow eastern riverfront forests to persist on a site for several generations.

Description of Eastern Riverfront Forests

Description

Eastern riverfront forests occur over a large portion of the Eastern United States, essentially from the forest-prairie margin eastward to the Atlantic coastline and from Massachusetts to northeast Florida. These forests are most abundant within the Mississippi River watershed and along the East Coast, and are least common in the Appalachians. As the name implies, the forest type is predominant on sites immediately adjacent to large rivers and streams (i.e., river banks and first bottoms, natural levees, sandbars, and islands). Soils are alluvial and range widely in texture from sand to clay. Soils are generally moist year-round due to their topographic position and proximity to open water. Flooding occurs seasonally on most sites and often damages the vegetation. Because of flooding and rapid decomposition rates, litter accumulation on the forest floor is negligible except in depressions.

The principal species in eastern riverfront forests include river birch (*Betula nigra* L.), sycamore, silver maple (*Acer saccharinum* L.), American elm, eastern cottonwood, swamp cottonwood (*P. heterophylla* L.), sweetgum, and black willow. Live oak (*Quercus virginiana* Mill.) is an important component in southern forests. Common associates are red maple (*A. rubrum* L.), boxelder (*A. negundo* L.), hackberry (*Celtis occidentalis* L.), slippery elm (*U. rubra* Muhl.), black walnut (*Juglans nigra* L.), pin oak (*Q. palustris* Muenchh.), swamp white oak (*Q. bicolor* Willd.), green ash, sugarberry, water oak, and pecan. These pioneer forests are restricted to riparian zones where intense flooding, accompanied by ice and water scouring, routinely occur. These naturally occurring perturbations expose mineral soil, reduce competing undergrowth, and increase surface light—conditions required by the shade-intolerant species of this type. In this sense, flooding is considered a rejuvenating force. Within a dynamic river system, the location of these forests will shift as the river course changes, remaining adjacent to the active channel. In the absence of major flooding, these forests are susceptible to encroachments by shade-tolerant species. Indeed, many present-day stands are in jeopardy of successional change because hydrologic alterations by humans (e.g., dam and dike construction) have largely controlled this force in many locations.

Associated Society of American Foresters Forest Cover Types

One or more principal species in eastern riverfront forests is an associate species in the following Society of American Foresters forest cover types:

61—river birch-sycamore
62—silver maple-American elm
63—cottonwood
89—live oak
94—sycamore-sweetgum-American elm
95—black willow.

Physiographic Provinces (after Fenneman 1938)

Eastern riverfront forests are found in all physiographic provinces except for New England (White Mountain, Green Mountain, and Taconic sections), Adirondack Mountains, and Superior Upland.

Old-Growth Conditions

Living Tree Component

Eastern riverfront forests generally fall into one of three types: (1) nearly pure eastern cottonwood stands; (2) nearly pure black willow stands; and (3) typical riverfront hardwood stands containing many species but generally dominated by sycamore, pecan, green ash, sugarberry, and American elm.

Eastern cottonwood establishes itself on newly formed sandbars or newly exposed river margins. It forms nearly pure stands and is regarded as a temporary, pioneer forest type. Old-growth stands contain many large eastern cottonwood trees up to 72 inches [183 centimeters (cm)] in diameter at breast height (d.b.h.) and up to 175 feet [53 meters (m)] in height (Williamson 1913, Putnam and Bull 1932). Tree age at maturity ranges from 60 to 125 years; most stands begin to break up at around 85 years of age as significant mortality occurs (Williamson 1913, Putnam and Bull 1932). Openings created by dead trees or windthrow in old-growth eastern cottonwood stands are generally occupied by sycamore, American elm, sugarberry, pecan, and green ash (Putnam and others 1960). Because eastern cottonwood is intolerant of shade, stand density is generally low and may not exceed 32 trees per acre [79 trees per hectare (ha)] at stand maturity (Williamson 1913).

Black willow becomes established on newly exposed mud flats along rivers. It forms nearly pure stands and is also regarded as a temporary, pioneer forest type. Old-growth stands contain many large black willow trees up to 44 inches (112 cm) in d.b.h. and up to 130 feet (40 m) in height (Lamb 1915, Putnam and Bull 1932). Black willow is a short-lived species and rarely exceeds 85 years of age. In fact, most stands begin to break up at around 30 to 55 years of age as significant mortality occurs (Lamb 1915, Putnam and others 1960). Openings in old-growth black willow stands generally support wet-site species and are typically occupied by green ash, sugarberry, American elm, red maple, and baldcypress [*Taxodium distichum* (L.) Rich.] (Putnam and others 1960).

Typical eastern riverfront forests generally succeed both eastern cottonwood and black willow forests. These stands contain many species but are usually dominated by sycamore, pecan, green ash, American elm, and sugarberry and may also contain silver maple, river birch, boxelder, red maple, and baldcypress (Putnam 1951, Putnam and others 1960, Wiseman 1982). Sweetgum and various water oaks, such as water, willow (*Q. phellos* L.), and Nuttall (*Q. nuttallii* Palmer) oaks, may be found in the later stages of stand development (Putnam and others 1960, Sharitz and Mitsch 1993).

Wiseman (1982) described an old-growth eastern riverfront forest in the Mississippi Delta that may be regarded as representative of this forest type. The site is a heavy clay flat that typically floods to a depth of 3 to 4 feet (0.9 to 1.2 m) for 1 to 3 weeks each year. The overstory is dense and averages 220 square feet of basal area per acre (50.4 $m^2 ha^{-1}$) across the area. The overstory is dominated by green ash but also contains significant quantities of American elm, water hickory, baldcypress, and Nuttall oak. The stand appears to be in the transition phase between old-growth eastern riverfront forest and immature Nuttall oak-sweetgum. Evidence for this observation lies in the fact that the green ash component of the stand has steadily declined since 1935. Johnson and Price[1] reported that green ash comprised 39 percent of the basal area in 1935 and 34 percent in 1959; Wiseman (1982) found that the green ash component had dropped to only 31 percent of the basal area by 1981. Although no ranges of data were given by Wiseman (1982), average d.b.h. of green ash in the stand in 1981 was 25.8 inches (65.5 cm); average d.b.h. of apparently younger Nuttall oak found in canopy gaps was 16.1 inches (40.9 cm), thus supporting the notion that this old-growth stand is gradually breaking up and will eventually be replaced by a younger stand dominated by Nuttall oak.

Dead Tree Component

The number of standing snags and the volume of downed logs in the old-growth stage of eastern riverfront forests probably vary depending on the specific type of stand and its location. In general, downed logs likely decompose rapidly because decay organisms are active under the prevailing conditions of both high temperature and high relative humidity. Moreover, frequent flooding probably

[1] Johnson, R.L., Price, T.L. 1959. Final report—resumé of 20 years of hardwood management on the Delta Purchase Unit. Unpublished report. On file with: Southern Research Station, Southern Hardwoods Laboratory, P.O. Box 227, Stoneville, MS 38776.

removes much of the downed woody debris from these stands. Although Martin and Smith (1991) reported "several" standing snags and "many" downed logs in an old-growth eastern riverfront forest in Louisiana, no other information was found in the literature that quantified the dead tree component in the old-growth stage of this forest type.

Understory Characteristics

The understory in old-growth eastern riverfront forests is a diverse mixture of small trees, shrubs, seedlings, vines, and herbaceous vegetation. It may range from sparse to dense, particularly in openings created by dead trees or windthrow. Species composition of the understory also varies with the type of old-growth forest.

For example, McKnight (1969) reported that the understory in old-growth eastern cottonwood forests is generally extremely dense and may be composed of several tree species, typically dominated by boxelder, red maple, sugarberry, red mulberry (*Morus rubra* L.), and American elm. Woody vines are also abundant in old-growth eastern cottonwood forests and may restrict tree regeneration, especially in gaps. The most common woody vines and other vegetation found in the ground cover in old-growth eastern cottonwood forests are poison-ivy [*Toxicodendron radicans* (L.) O. Kuntze], grape (*Vitis* sp.), Virginia creeper [*Parthenocissus quinquefolia* (L.) Planch.], peppervine [*Ampelopsis arborea* (L.) Koehne], blackberry (*Rubus* sp.), common greenbrier (*Smilax rotundifolia* L.), and stinging nettle [*Laportea canadensis* (L.) Wedd.], also known as Canada woodnettle (McKnight 1969).

In the old-growth green ash stand in the Mississippi Delta, Wiseman (1982) found that the sapling and seedling component of the stand was dominated primarily by sugarberry, American elm, Nuttall oak, and possumhaw (*Ilex decidua* Walt.). Ground cover was sparse, except in the larger openings where woody vines, especially cat greenbrier (*S. glauca* Walter), common greenbrier, and trumpetcreeper [*Campsis radicans* (L.) Seem.], were abundant. Other woody vines and herbs found in the old-growth tract included peppervine, smallspike false-nettle [*Boehmeria cylindrica* (L.) Swartz], buckwheat vine (*Brunnichia cirrhosa* Gaertn.), sedge (*Carex* sp.), snailseed [*Cocculus carolinsis* (L.) DC.], rice cutgrass [*Leersia oryzoides* (L.) Swartz], Japanese honeysuckle (*Lonicera japonica* L.), Virginia creeper, blackberry, poison-ivy, starjasmine [*Trachelospermum difforme* (Walter) Gray], and grape.

Martin and Smith (1991) described the understory of an old-growth eastern riverfront forest in Louisiana as dominated primarily by American hornbeam (*Carpinus caroliniana* Walt.) but with lesser quantities of winged elm (*U. alata* Michx.), silverbell (*Halesia diptera* Ellis), American holly (*Ilex opaca* Ait.), yaupon (*I. vomitoria* Ait.), pawpaw [*Asimina triloba* (L.) Dunal], blueberry (*Vaccinium elliottii* Chapm.), giant cane [*Arundinaria gigantea* (Walter) Muhl.], and grape. Other woody plants and the major herbs found in the understory included poison-ivy, common greenbrier, elephant's foot (*Elephantopus carolinianus* Raeusch.), panicum (*Panicum* sp.), sedge, violet (*Viola* sp.), and grapefern (*Botrychium* sp.). In general, Martin and Smith (1991) described the understory as sparse except under canopy gaps.

Soils and Microtopography

Eastern riverfront forests occur along the margins of both major rivers and minor streams on sites that are seasonally flooded for short periods. Flooding may be deep, as much as 6 to 8 feet (1.8 to 2.4 m) during atypical years, but generally lasts only 1 to 3 weeks. Soils are young and generally have little or no profile development.

Both eastern cottonwood and black willow become established on newly formed sandbars or mud flats and on newly exposed river margins. Soils range from coarse sand to fine clay, with eastern cottonwood generally found on coarse sediments and black willow found on fine sediments. As further deposition of silt and other sediments occurs on these sites and the substrate develops, the cottonwood/willow type is replaced by the riverfront hardwood type, dominated by sycamore, pecan, and American elm on the drier sites and by green ash, sugarberry, and American elm on the wetter sites (Sharitz and Mitsch 1993).

Topography is generally the ridge and swale type commonly found adjacent to rivers and streams. Both low and high flats separate the ridges. Eastern riverfront forests occur on all these topographic features; species occurrence depends greatly upon landscape position, soil texture, and soil moisture regime.

Other Important Features

Although species diversity and other measures of richness are generally expected to increase as forests approach the old-growth stage of stand development, Wiseman (1982) reported only moderate diversity and evenness (H'=1.79; J'=0.86) in an old-growth eastern riverfront forest in the Mississippi Delta.

Forest Dynamics and Ecosystem Function

The cottonwood/willow forest types represent temporary, pioneer stages of forest succession. Because both of these species require bare mineral soil for establishment, their natural development is generally restricted to newly exposed sandbars and mud flats along the margins of rivers and streams. They both attain their best development along major rivers in the Lower Mississippi Valley. Because of their extreme intolerance to shade, neither species is capable of succeeding itself on these newly formed lands. Continued natural establishment of these species depends upon continued formation of new land along major rivers. However, because many of the rivers within the Lower Mississippi Valley have been channelized and leveed, formation of new land has dramatically declined in the recent past. Natural establishment of new eastern cottonwood and black willow forests has declined concomitantly during this same period. Although never abundant, due to premature logging of these commercially valuable timber species, old-growth eastern cottonwood and black willow forests will likely decline in number because human-caused alterations in the hydrology of major river systems within the Lower Mississippi Valley prevent establishment.

The eastern riverfront forest represents an intermediate successional stage between the pioneer cottonwood/willow types and the sweetgum-water oaks (water, willow, and Nuttall) type on drier sites and the overcup oak-water hickory type on wetter sites (Putnam and others 1960). Shelford (1954, 1974) speculated that cottonwood/willow forests begin to break up at about 35 years of age and are replaced by eastern riverfront forests by 85 years of age. The eastern riverfront type lives for about 80 years before being gradually invaded by sweetgum and water oaks. This begins about 165 years after initial establishment of the cottonwood/willow forests on new land and generally lasts for about 85 years, so that the sweetgum-water oaks type has replaced the eastern riverfront forest about 250 years after initial invasion of the site by eastern cottonwood and black willow. However, Sharitz and Mitsch (1993) pointed out that repeated disturbances, such as severe flooding or logging, may allow the eastern riverfront forest type to persist on the site for several generations over long periods of time. In the absence of such severe disturbances, the eastern riverfront forest will soon be replaced by the sweetgum-water oaks type.

Representative Old-Growth Stands

Representative old-growth eastern riverfront forests occur at the following two locations:

- Green Ash Natural Area, Delta National Forest, near Rolling Fork, MS—60 acres (24 ha)
- River Birch Bottom, Kisatchie National Forest, near Alexandria, LA—9 acres (3.6 ha)

Areas where representative old-growth eastern riverfront forests may occur include:

- Dardenne Creek, August A. Busch Memorial Wildlife Area, near Weldon Spring, MO
- Big Oak Tree State Park, Mississippi County, Missouri
- Westport Island Natural Area, near Elsberry, MO—480 acres (194 ha)
- Cow Shoals, Cleburne County, Arkansas
- Sulphur River Wildlife Management Area, Miller County, Arkansas
- Broad River, Chester County, South Carolina

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Table 1 (English units)—Standardized table of old-growth attributes for eastern riverfront forests

Quantifiable attribute	Value		Number of stands[a]	References
	Range	Mean		
Stand density (no.acre^{-1}) —trees ≥4 in. d.b.h.	32-179	112	3	Williamson 1913 Winters et al. 1938 Wiseman 1982
Stand basal area (ft^2 acre^{-1}) —trees ≥ 4 in. d.b.h.	160-220	190	2	Robertson et al. 1978 Wiseman 1982
Age of large trees (yrs)[b] —all species	58-120	84	9	Hardin et al. 1989 Lamb 1915 Martin and Smith 1991 Putnam and Bull 1932 Williamson 1913
Number of 4-in. size classes —starting at 4 in. d.b.h.	6-10	8	3	Martin and Smith 1991 Winters et al. 1938 Wiseman 1982
D.b.h. (or maximum d.b.h.) of largest trees (in)[b] —all species	25-72	39	6	Lamb 1915 Martin and Smith 1991 Putnam and Bull 1932 Williamson 1913
Standing snags (no.acre^{-1}) —snags ≥ 4 in. d.b.h.	Several		1	Martin and Smith 1991
Downed logs (ft^3 acre^{-1})	Many	Many	1	Martin and Smith 1991
Decadent trees (no.acre^{-1})[c] —trees ≥ 4 in. d.b.h.	62	62	1	Winters et al. 1938
Number of canopy layers	3+	3+	5	Martin and Smith 1991 Putnam and Bull 1932 Wiseman 1982
Percent canopy in gaps[d]				
Other features	H'=1.79 J'=0.86		1	Wiseman 1982

[a] Number of stands may not equal the number of citations.

[b] Includes dominant and codominant trees that comprise the upper canopy.

[c] Includes deformed, bole-scarred, spike-topped, and wind-damaged trees.

[d] Data unavailable.

Table 1 (metric units)—Standardized table of old-growth attributes for eastern riverfront forests

Quantifiable attribute	Value		Number of stands[a]	References
	Range	Mean		
Stand density (no.ha^{-1}) —trees ≥10 cm d.b.h.	79-442	277	3	Williamson 1913 Winters et al. 1938 Wiseman 1982
Stand basal area (m^2 ha^{-1}) —trees ≥10 cm d.b.h	37-50	44	2	Robertson et al. 1978 Wiseman 1982
Age of large trees (yrs)[b] —all species	58-120	84	9	Hardin et al. 1989 Lamb 1915 Martin and Smith 1991 Putnam and Bull 1932 Williamson 1913
Number of 10-cm size classes —starting at 10 cm d.b.h.	6-10	8	3	Martin and Smith 1991 Winters et al. 1938 Wiseman 1982
D.b.h. (or maximum d.b.h.) of largest trees (cm)[b] —all species	64-183	99	6	Lamb 1915 Martin and Smith 1991 Putnam and Bull 1932 Williamson 1913
Standing snags (no.ha^{-1}) —snags ≥10 cm d.b.h.	Several		1	Martin and Smith 1991
Downed logs (m^3 ha^{-1})	Many	Many	1	Martin and Smith 1991
Decadent trees (no.ha^{-1})[c] —trees ≥10 cm d.b.h.	153	153	1	Winters et al. 1938
Number of canopy layers	3+	3+	5	Martin and Smith 1991 Putnam and Bull 1932 Wiseman 1982
Percent canopy in gaps[d]				
Other features	H'=1.79 J'=0.86		1	Wiseman 1982

[a] Number of stands may not equal the number of citations.
[b] Includes dominant and codominant trees that comprise the upper canopy.
[c] Includes deformed, bole-scarred, spike-topped, and wind-damaged trees.
[d] Data unavailable.

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Eastern riverfront forests fall into one of three types: (1) nearly pure eastern cottonwood stands, (2) nearly pure black willow stands, and (3) typical riverfront hardwood stands containing many species, but generally dominated by sycamore, pecan, green ash, sugarberry, and American elm. The eastern riverfront forest represents an intermediate successional stage between the pioneer cottonwood-willow types and the sweetgum-water oaks type on drier sites and the overcup oak-water hickory type on wetter sites. Typical attributes of the living tree component of old-growth eastern riverfront forests are given, but little quantitative data are available for the dead tree component of these forests. The understory in old-growth eastern riverfront forests is a diverse mixture of small trees, shrubs, seedlings, vines, and herbaceous vegetation.

Keywords: Black willow, bottomland hardwood forests, eastern cottonwood, forest dynamics, pioneer communities, riverfront hardwoods, succession.

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