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A Complex Stand on the White River National Wildlife Refuge: Implications for Bottomland Hardwood Old Growth

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With the possible re-discovery of the ivory-billed woodpecker (*Campephilus principalis*), interest has increased in the habitat requirements for the species and the current state of these habitats (Fitzpatrick et al. 2005). Tanner (1942) indicated that the ivory-billed woodpecker needs large, decadent trees for foraging. Trees in such decline provide habitat for wood-boring beetles, whose grubs are a primary food-source for the ivory-billed woodpecker. Old trees in various states of decline are an integral part of old-growth forests (Davis 1996, Oliver and Larson 1996). Unfortunately, we have little information on the species composition and structure of bottomland hardwood old-growth forests, especially in the Lower Mississippi Alluvial Valley. Therefore, the objective of this study was to determine the species composition of a potential old-growth bottomland hardwood stand located in east-central Arkansas near the possible sightings and recordings of the ivory-billed woodpecker.

Location.—The study site is located on about 50 ha within the 280-ha Sugarberry Research Natural Area in the White River National Wildlife Refuge in Desha County, AR within the unprotected lands along Scrubgrass Bayou and the White River in the Lower Mississippi Alluvial Valley (34°06' north, 91°05' west). The site is characterized by ridge and swale topography due to channel migration of the White River (Mitsch and Gosselink 1986). Soils vary but are primarily composed of Commerce silt loam (fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts) and Robinsonville very fine sandy loam (coarse-loamy, mixed, superactive, nonacid, thermic Typic Udifluvents) on the ridge tops to Sharkey clay (very-fine, smectitic, thermic Chromic Epiaquerts) in the swales. Climatically, the site has hot, humid summers and mild winters (SCS 1972). The average monthly high temperature is 24.5° C and peaks in July and August (34.9° C) and the average monthly low temperature is 11.1° C with the low occurring in January (1.6° C, SCS 1972). Precipitation averages 1,321 mm per year with the greatest monthly average in March (144 mm) and the lowest monthly average in October (68 mm) (SCS 1972). Past activities in the stand may have included light cutting for firewood around 1900 when paddle boats used Scrubgrass Bayou for traveling from the White River to the Mississippi and Arkansas rivers.

Measurements and Analyses.—Twenty north-south transects were installed on the eastern and southern portions of the Sugarberry Research Natural Area beginning 50 m from the edge of Scrubgrass Bayou. Transects were located 100 m apart and points were established at 50 m intervals along each transect. Most transects contained only four or fewer points before reaching a large beaver pond. No points were taken in the water impounded area. Twenty points were randomly selected from the 93 total to establish 0.1-ha circular tree plots. All trees greater than 10 cm DBH (diameter at breast height, 1.4 m above the ground) were tallied by species, DBH, and crown class (dominant, codominant, intermediate, or suppressed; Smith et al. 1997). Importance values, the sum of relative density and relative dominance, were calculated for each plot and averaged across all plots (Curtis and McIntosh 1991, Skeen 1973).

Six-hundred and twenty three trees greater than 10 cm DBH was tallied from 19 species in this study. The two most prominent species were sugarberry (*Celtis laevigata* Willd.) and sweet pecan (*Carya illinoensis* (Wang.) K. Koch; Table 1). Other important species included overcup oak (*Quercus lyrata* Walt.), Nuttall oak (*Q. nuttallii* Palmer), and green ash (*Fraxinus pennsylvanica* Marsh.), all with importance values greater than 10 (Table 1).

A key characteristic of most bottomland hardwood old-growth stands is large tree diameters (Lynch 1996). Noteworthy in the Sugarberry Research Natural Area were 3 trees greater than 100 cm DBH – a 143 cm American sycamore (*Platanus occidentalis* L.), a 119 cm Nuttall oak and a 102 cm overcup oak. Three additional trees not located on the tree plots but measured were a 185 cm eastern cottonwood (*Populos deltoides* Bartr. ex Marsh.), a 145 cm American elm (*Ulmus americana* L.), and a 76 cm common persimmon (*Diospyros virginiana* L.; a large DBH for this species).

Mean number of trees per hectare was 311.5 (standard error = 28.4) and mean basal area was 30.4 m^2 ha^{-1} (standard error = 2.5). The trees-per-hectare value is within the range of old-growth attributes as described by Meadows and Nowacki (1996) for eastern riverfront forests. The basal area value is low relative to Meadows and Nowacki (1996), probably due to the number of canopy gaps located throughout the Sugarberry Research Natural Area, but is within the values reported for other bottomland hardwood old-growth forests (Jackson 1969, Phillippe and Ebinger 1973, Ramp 1990, Devall and Ramp 1992, Roovers and Shifley 1997).

Nineteen percent of the sampled trees in the study area were classified in dominant or codominant crown classes, that is, with a majority of their crowns in the upper canopy (Table 2). Species with at least 25 percent of their crowns classed as dominant or codominant included American sycamore, green ash, honey-locust (*Gleditsia triacanthos* L.), cedar elm (*U.*

Table 1. Relative density, relative dominance, and importance values for trees located on the Sugarberry Research Natural Area, Desha County, AR.

Species	Relative Density	Relative Dominance	Importance Value
boxelder (*Acer negundo* L.)	0.48	0.20	0.68
silver maple (*Acer saccharinum* L.)	0.32	0.24	0.56
water hickory (*Carya aquatica* (Michx. f.) Nutt.)	1.28	1.15	2.43
sweet pecan (*Carya illinoensis* (Wang.) K. Koch)	20.55	19.19	39.74
sugarberry (*Celtis laevigata* Willd.)	30.39	33.82	64.21
hawthorn (*Crataegus* spp.)	0.16	0.01	0.17
common persimmon (*Diospyros virginiana* L.)	4.17	2.58	6.75
swamp privet (*Forestiera acuminata* (Michx.) Poir)	1.28	0.15	1.43
green ash (*Fraxinus pennsylvanica* Marsh.)	5.46	9.98	15.44
honey-locust (*Gleditsia triacanthos* L.)	0.48	0.44	0.92
deciduous holly (*Ilex decidua* Walt.)	1.12	0.11	1.23
red mulberry (*Morus rubra* L.)	1.12	0.13	1.25
American sycamore (*Platanus occidentalis* L.)	0.16	2.64	2.80
overcup oak (*Quercus lyrata* Walt.)	14.45	17.36	31.81
Nuttall oak (*Quercus nuttallii* Palmer)	11.24	6.88	18.12
winged elm (*Ulmus alata* Michx.)	0.16	0.09	0.25
American elm (*Ulmus americana* L.)	4.94	3.99	8.93
cedar elm (*Ulmus crassifolia* Nutt.)	1.12	0.85	1.97
slippery elm (*Ulmus rubra* Muhl.)	1.12	0.19	1.31

crassifolia Nutt.), water hickory (*C. aquatica* (Michx. f.) Nutt.), and overcup oak. Species which were completely overtopped by the overstory included boxelder (*Acer negunda* L.), hawthorns (*Crataegous* spp.), deciduous holly (*Ilex decidua* Walt.), red mulberry (*Morus rubra* L.), and slippery elm (*U. rubra* Muhl.), all shade-tolerant, understory species.

Oliver (1981) described four stages of stand development following a major disturbance. The stand initiation stage immediately follows the disturbance when regeneration of the site begins. The stem exclusion stage begins when regeneration can no longer become established due to the intense competition among trees for available growing space. The understory reinitiation stage begins following a relatively long period of growth and mortality during the stem exclusion stage. Mortality of a few overstory trees releases growing space, thereby allowing tree regeneration to become established in the understory. The final stage of stand development, old growth, occurs when continued mortality in the overstory allows regeneration to eventually grow into the overstory canopy. These stages of stand development progress from an even-aged stand structure to an uneven-aged stand structure with trees of various ages and diameters occupying different canopy strata. Old-growth stands are further characterized as containing canopy gaps of different ages and sizes, depending on the number of trees that have died or fallen in a disturbance. The old-growth stage of stand development has also been called the steady-state stage of ecosystem development where total stand biomass and nutrient cycling fluctuate around a consistent mean (Bormann and Likens 1979). Oliver (1981), Meadows (1994), and Oliver and Larson (1996) state that the old-growth stage of stand development is rarely achieved due to the long time period necessary to reach these stand structures and the likelihood that a major disturbance will set the stand back to an earlier stage of development.

We hypothesize that the stand at the Sugarberry Research Natural Area is in the old-growth stage of stand development. In addition to the large tree diameters, many snags occur throughout the stand and large coarse woody debris exists on the forest floor. Snags and coarse woody debris are important structural components in many old-growth forests (Maser and Trappe 1983, Spetich et al. 1999, Fan et al. 2003). Further study is needed to quantify these structural characteristics and relate them to other studies of old-growth in eastern hardwood forests.

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Table 2. Percent of trees by crown class within each species located on the Sugarberry Research Natural Area, Desha County, AR.

Species	n	Dominant	Co-Dominant	Intermediate	Overtopped
		percent			
boxelder	3	0	0	0	100
silver maple	2	0	0	50	50
water hickory	8	25	0	13	62
sweet pecan	128	13	9	12	66
sugarberry	192	7	11	32	50
hawthorn	1	0	0	0	100
common persimmon	26	8	4	31	57
swamp privet	8	0	0	13	87
green ash	34	21	26	41	12
honey-locust	3	33	0	0	67
deciduous holly	7	0	0	0	100
red mulberry	7	0	0	0	100
American sycamore	1	100	0	0	0
overcup oak	90	11	14	26	49
Nuttall oak	70	1	7	30	62
winged elm	1	0	0	100	0
American elm	28	7	0	18	75
cedar elm	7	14	14	0	72
slippery elm	7	0	0	0	100

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