CONSERVATION ISSUES

Conservation Strategies and Vegetation Characterization in the Columbia Bottomlands, an Under-recognized Southern Floodplain Forest Formation

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Natural Areas Journal 28:74–82

ABSTRACT: The Columbia Bottomlands, a Southern floodplain forest formation on the upper Texas coast, historically covered over 283,000 ha but has since been reduced to 25% of its former extent. The importance of this regional ecosystem as critical stopover and staging habitat for Nearctic-Neotropical migratory landbirds gave rise to the Columbia Bottomlands Conservation Plan, an active land acquisition and conservation program administered by the U.S. Fish and Wildlife Service and its governmental and non-governmental partners. The Plan seeks to establish an integrated network of protected tracts as representative examples of the regional landscape, and thus conserve ecosystem integrity, function, heterogeneity, and biological diversity. We describe the Conservation Plan and its progress to date, and we summarize data on the plant composition of a typical preserved tract. Vegetation sampling at the Dance Bayou Unit, a mature forest remnant, revealed a mosaic of species composition across habitats varying in microtopography, soil type, and flooding pattern. The Dance Bayou study is a formative step in developing guidelines for future plant inventories, for site characterization in aid of land acquisition, and for restoration targets. As threats from urban development accelerate, intensified efforts may be needed to reach the Conservation Plan goal of protecting 10% of the original ecosystem extent.

Index terms: bioreserve network, floodplain forests, Gulf Coast forests, Nearctic-Neotropical migratory landbirds

INTRODUCTION

Southern floodplain forests of the United States include bottomland hardwood forests and deepwater alluvial swamps occurring along numerous Southeastern river and stream systems. The ecological importance, productivity, and diversity of these forests are well documented (e.g., Wharton et al. 1982; Sharitz and Mitsch 1993; Hodges 1998; Kellison et al. 1998). Reasons frequently cited for preserving and restoring these forests include contributions to water quality, stormwater retention, recreation, and habitat for fish and wildlife. Following Küchler's (1964) vegetation classification, Sharitz and Mitsch (1993) described the range of Southern floodplain forests as coincident with the subtropical forested ecoregions (Bailey 1998) that extend from the mid-Atlantic Coastal Plain to the lower Mississippi River alluvial valley and west to the Trinity, Sabine, and Neches Rivers of east Texas, at roughly the 95th meridian. Less recognized are extensions of bottomland hardwood forests located further westward along the Texas Gulf Coast (Bray 1906; Putnam et al. 1960). Upland vegetation characterized by coastal prairie and oak savanna indicates this westward area as occurring within the subtropical prairie parkland ecoregion (Bailey 1998). However, the rivers dissecting this coastal terrain also support floodplain forests, which have received little attention beyond brief descriptions by early observers.

A notable example of these westward bottomland forests occurs along the Brazos, Colorado, and San Bernard Rivers of the upper Texas Gulf Coast. Known regionally as the Columbia Bottomlands (Figure 1), the forests along these rivers had a pre-settlement expanse of over 283,000 ha extending in a broad corridor from the coast to approximately 150 km inland (U.S. Fish and Wildlife Service 1997). Today, these forests cover only about 72,000 ha; the remaining stands are highly fragmented and are threatened by residential and commercial development, agricultural conversion, timber removal, and infestation by invasive plants (U.S. Fish and Wildlife Service 1997; Barrow and Renne 2001; Barrow et al. 2005). Recently, forests adjacent to the Gulf of Mexico have been recognized as providing critical stopover and staging habitat for Nearctic-Neotropical migratory landbirds (Barrow et al. 2005). In the northwestern Gulf, the Columbia Bottomlands may support as many as 29 million birds of 237 species that migrate through, overwinter, or breed in the area. Across the Gulf of Mexico region, migration routes and bird use can shift yearly and seasonally depending on prevailing wind patterns; however, the Columbia Bottomlands appear to be consistently used year to year and in both migration seasons. The rapid destruction of bottomland hardwood forests in this area, and the concerns of conservationists about preserving a sustainable area of this habitat, gave rise to the Columbia Bottomlands Conservation Plan (U.S. Fish and Wildlife Service 1997).

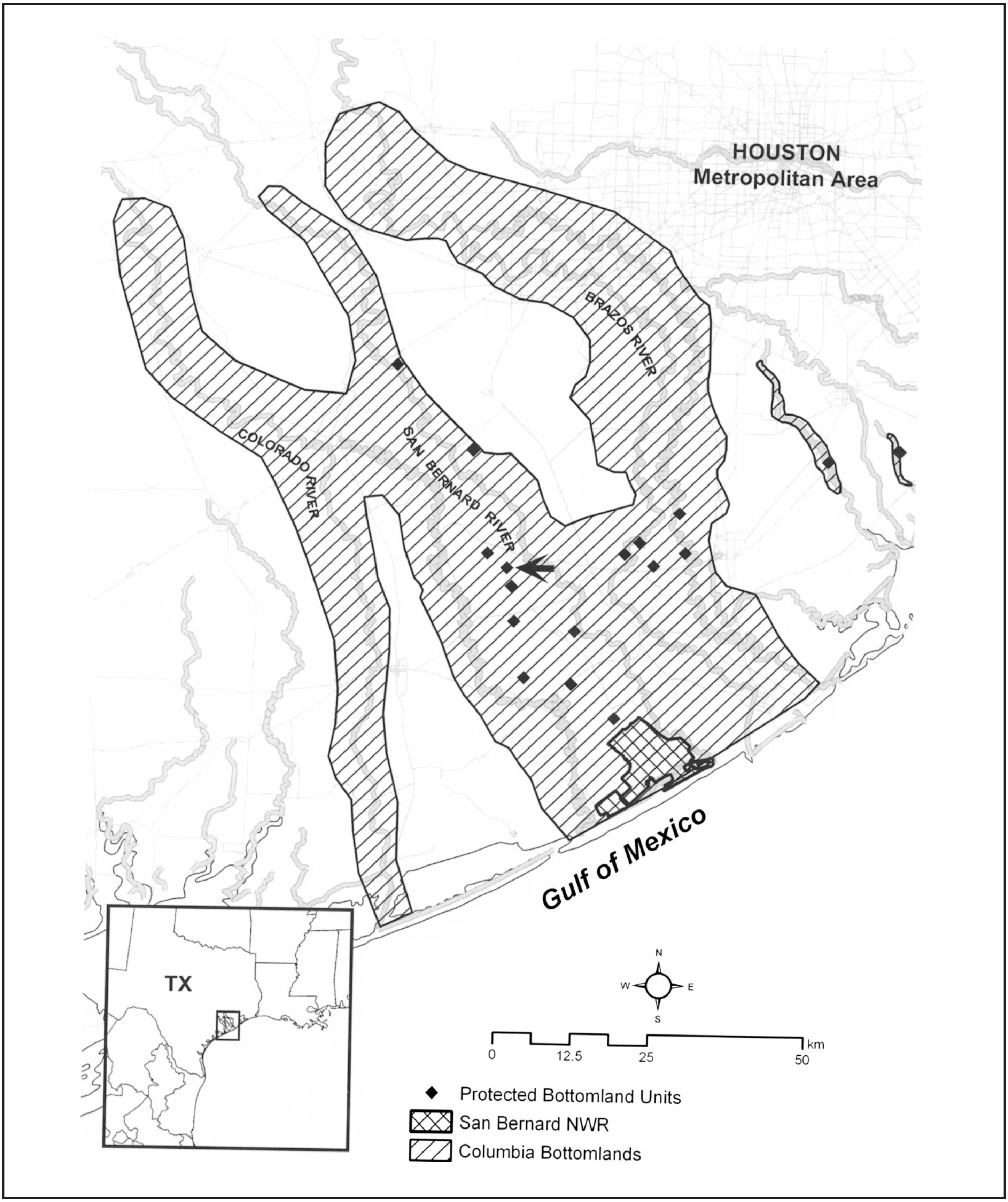

Figure 1. Approximate historic extent of the Columbia Bottomlands ecosystem, showing currently protected bottomland tracts and the San Bernard National Wildlife Refuge. Arrow indicates the Dance Bayou Unit.

This paper has two objectives. First, we describe the Columbia Bottomlands Conservation Plan and its progress to date. The Plan illustrates a strategy that combines federal habitat protection efforts with the conservation efforts of local communities. Second, we describe vegetation characteristics of a mature Columbia Bottomlands forest remnant as a formative step in guiding the evaluation, acquisition, and management of other protected tracts. The accelerating loss of habitat, particularly large stands with mature composition and structure, has heightened the need to characterize these forests and provide a complete account of the flora (Rosen and Miller 2005).

COLUMBIA BOTTOMLANDS CONSERVATION PLAN

The Columbia Bottomlands lie within the Coastal Plain physiographic province in the subtropical climate zone (Bailey 1998). The regional climate is moist subhumid mesothermal characterized by long hot summers and mild winters (Thornthwaite 1948). Average annual rainfall is 132 cm, with 60% occurring from April through September (Crenwelge et al. 1981). The average daily summer temperature is 27ºC, and average daily winter temperature is 13ºC (Crenwelge et al. 1981). The three major rivers transecting the Bottomlands all flow generally southeasterly to the Gulf of Mexico (Figure 1). In addition to its biological resources, the area has archaeological and historical significance. Known locally as Austin's Woods, the Bottomlands include the historic 1820s site of Texas "founder" Stephen F. Austin's First Colony (U.S. Fish and Wildlife Service 1997). The proximity of the Columbia Bottomlands to the Houston metropolitan area (Figure 1), where Jacob and Lopez (2005) report rapid and massive wetland loss due to urban sprawl, places the area at increasing risk. Barrow et al. (2005) also noted the expanding Houston area as a threat to coastal forests that are critical to Nearctic-Neotropical migratory landbirds.

The Columbia Bottomlands represent a watershed-scale ecosystem; thus, conservation of ecosystem integrity, function, heterogeneity, and biological diversity are best approached in that context. Barrett and Barrett (1997) suggested that adequate representation of a watershed-scale or regional landscape requires a conservation design establishing an integrated network of individual preserves that provide representative samples of the regional landscape, or what they refer to as a "bioreserve" network. This differs from earlier concepts of a "biosphere reserve" as a large contiguous area with preserved core habitat and peripheral managed habitat (e.g., Meffe and Carroll 1994).

Reflecting the concept of a bioreserve network, the Columbia Bottomlands Conservation Plan is an active land acquisition and conservation program administered by the U.S. Fish and Wildlife Service (FWS) along with its governmental and non-governmental partners. The Plan proposes a goal of 28,328 ha of habitat conserved under the combined efforts of private, state, and federal entities, thus ensuring protection of at least 10% of the original ecosystem area (U.S. Fish and Wildlife Service 1997). In response to local concerns about maintaining land use options for private landowners, an important aspect of the Plan is emphasis on cooperation with local conservation partners. The FWS has not designated an all-encompassing "acquisition boundary" that would impact non-FWS lands across the Bottomlands area. This strategy allows for promoting private conservation efforts (e.g., conservation easements, habitat management cooperatives) but does not restrict development or other land uses on private lands adjacent to refuge units. The FWS acquires lands from willing sellers and donors, particularly where local conservation initiatives are not feasible. The anticipated outcome is a mosaic of land blocks that collectively protect the regional ecosystem and maintain essential ecological functions.

The process of identifying, evaluating, and selecting tracts for refuge acquisition involves staff from the FWS, the Texas Parks and Wildlife Department, the National Fish and Wildlife Foundation, and other partner organizations. Properties are considered based on their potential contribution to biological diversity and ecological integrity (U.S. Fish and Wildlife Service 1997). Specifically, high priority is given to tracts that protect all or part of biological communities, community elements, or that provide a link between communities (e.g., coastal prairie-bottomland ecotones). Other criteria that may guide tract acquisition include any or all of the following: presence of unique, diverse, or characteristic biological communities or taxa (Heritage Program element occurrence); undisturbed forest stands or stands with structural complexity (vegetative or topographical); large area (but no minimum size); links to previously preserved tracts; preservation/enhancement of ecosystem functions and processes; opportunities provided for future expansion; opportunities for restoration; and vulnerability or threat. Tracts are purchased or accepted from willing sellers or donors as private and government funds are made available. Both fee title interests and conservation easements are used to protect the land. Lands added to the refuge system may be used for compatible activities such as scientific research, public hunting, fishing, and environmental education programs.

Many partner organizations (Table 1), as well as individual donors, have contributed to the conservation efforts. As of 2007, twenty-six tracts ranging in size from 4-963 ha (average 220 ha) have been permanently protected through a combination of easement donation, title donation, or fee title acquisition. Most tracts are administered and managed as satellite units of the San Bernard National Wildlife Refuge (SBNWR), and have thus far been concentrated near the San Bernard and Brazos Rivers (Figure 1).

VEGETATION OF THE DANCE BAYOU UNIT

The Conservation Plan was launched in 1997 with the donation of the 266-ha Dance Bayou Unit. This tract is botanically diverse and is considered a good-quality example of intact Columbia Bottomland forest; thus, it has become a focal site for floristic and forest bird studies (e.g., Hamilton et al. 2005; Rosen and Miller 2005). As there

Table 1. Current partner organizations in the Columbia Bottomlands Conservation Plan.

Community Foundation of Brazoria County	North American Wetlands Conservation Council
Conoco Phillips Corporation	Reliant Energy
Cradle of Texas Conservancy	Texas General Land Office
Friends of Brazoria Refuges	Texas Parks and Wildlife Department
Gulf Coast Bird Observatory	The Migratory Bird Conservation Commission
Houston Audubon Society	The Nature Conservancy of Texas
Hudson Foundation	Trust for Public Land
John M. O'Quinn Foundation	U. S. Fish and Wildlife Service
National Fish and Wildlife Foundation	U. S. Geological Survey, Biological Resources Division
National Oceanic and Atmospheric Administration	USDA Natural Resources Conservation Service

were few existing vegetation descriptions for these forests, quantitative sampling was undertaken to characterize species composition and forest structure across the Dance Bayou Unit.

Study Area and Methods

The Dance Bayou Unit is located approximately 35 km NW of the SBNWR headquarters, in SW Brazoria County, Texas, USA (Figure 1). Hamilton et al. (2005) included this tract in an enumeration of extant "old-growth" bottomland forests of the southeast United States, although old-growth status is difficult to establish with certainty. The Unit is currently without obvious large-scale human disturbance such as timbering, thinning, selective cutting, burning, or overgrazing, and appears to represents mature vegetation. There is scant information on past land use, but it is believed that the tract was used historically as a hunting preserve and was subjected to only limited grazing. Some minor clearing has occurred to accommodate hunting, an abandoned county dirt road and a pipeline right-of-way, but the overall area disturbed by these activities was small. The Unit is bounded on all sides by private farms and pastures, and is traversed by Dance Bayou, a small distributary of the San Bernard River. Elevation ranges from 12 to 13 m above sea level. The tract slopes upward gradually from SW to NE and reaches its highest elevation along the natural levee banks of Dance Bayou. The topography is mainly flat with a series of swales and depressions. The major soil series are Asa silty clay loam on natural levee ridges adjacent to active and inactive stream channels, and Pledger clay on nearly level flats and in concave abandoned channels (Crenwelge et al. 1981; Rosen and Miller 2005). The concave features (meander scars) are seasonally flooded, whereas higher flats and levee ridges flood infrequently. Waters are supplied chiefly by seasonal precipitation and tropical storms, with little or no overbank flooding.

Color infrared aerial photo interpretation and ground truthing were used to delineate different vegetation cover types on the Unit. Cover-type polygons were traced in ArcView® GIS 3.3, and random points were placed within each polygon using a random point generator extension. Twenty-five points were selected for vegetation sampling, with at least three in each major cover type. Sampling was conducted between April and October 2004. Sample points were located in the field with a hand-held GPS unit and used to establish a 10-m × 25-m (250 m^2) rectangular plot with its long axis oriented in a N-S direction. Within each plot, all overstory trees (canopy, defined as ≥20 cm dbh, and subcanopy, defined as ≥ 7.5-20 cm dbh) were identified, tallied, and their diameters measured. All individual shrubs and woody saplings in the woody understory (≥ 0.3 m tall to <7.5 cm dbh) were counted in a 25-m^2 nested subplot. Percent covers of all species in the ground layer (plants < 0.3 m tall) were estimated in ten 1-m^2 quadrats placed randomly within each overstory plot. Habitat data (soil series, topographic position, and flooding pattern) were also noted for each plot location.

For each woody species in the overstory and understory plots, we calculated stem density, basal area (for stems ≥7.5 cm dbh), and a modified importance value (I.V. = sum of relative density and relative basal area). Percent cover for each ground-layer species was averaged over the 10 quadrats of each plot. Woody plant data were aggregated over all plots to describe general stand composition and size structure across the Unit. In addition, to assess compositional variation in relation to local environmental properties, the plot-level data were analyzed by non-metric multidimensional scaling ordination (NMS) on Sorenson dissimilarities between plots, using the importance values for woody overstory species and log-transformed cover values for ground-layer species occurring in >15% of plots. One disturbed outlier plot was omitted in each ordination. Ordinations were performed using SYSTAT® statistical software. Three dimensions yielded the best-fit ordinations, with the principal data patterns represented by the first two dimensions. Environmental data correlating with the resulting ordination patterns were displayed and evaluated qualitatively.

Vegetation Composition

The vascular flora of the Dance Bayou Unit was previously reported to comprise 356 species representing 83 families and 237 genera, with 301 native species including several endemic and rare taxa (Rosen and Miller 2005). Across all 25-sample plots, 46 woody species and 79 herbaceous species were recorded. In the woody overstory and understory (Table 2), 18 tree species and 17 shrub/vine species contributed total densities of 3022 and 3784 stems ha^{-1}, respectively. Of the total overstory basal area (32 m^2 ha^{-1}), 87% was represented by canopy trees. Across the forest stand, the common trees were typical bottomland species, including green ash (*Fraxinus pennsylvanica* Marshall), sugarberry (*Celtis laevigata* Willd.), cedar elm (*Ulmus crassifolia* Nutt.), and American elm (*Ulmus americana* L.) (Table 2). Carolina laurel cherry (*Prunus caroliniana* Aiton) had locally high densities in the understory; shrubs and vines were also abundant. Canopy taxa such as green ash, sugarberry, and elms were well represented in the understory size classes (< 7.5 cm dbh), and their densities generally decreased with increasing size class, suggesting that they are regenerating successfully within the forest stand. In contrast, oaks (*Quercus* spp.) were poorly represented in the smaller size classes and contributed most of their basal area as larger-diameter trees (Table 2).

Ordination analysis revealed compositional differences with respect to habitats defined by topographic position and soil type. Ridges and flats had 65% of their species in common, whereas the wetter meander-scar habitats shared only 35-39% of species with the drier ridges and flats. Seasonally flooded meander scars and channels supported a distinctive assemblage characterized by green ash, American elm, and water hickory (*Carya aquatica* (F. Michx.) Nutt.) in the overstory, with swamp-privet

Table 2. Stem density (ha^{-1}) by diameter class and total basal area for the woody overstory (dbh ≥ 7.5 cm) and understory (dbh < 7.5 cm) across the Dance Bayou Unit, summed over 25 plots.

	Stem diameter class (cm)					total density	basal area
Species	< 7.5	7.5-20	20-40	40-60	> 60	(stems ha^{-1})	(m^2 ha^{-1})[a]
Trees							
Acer negundo	-	1.6	1.6	-	-	3.2	0.1
Carya aquatica	-	20.8	9.6	1.6	-	32.0	1.2
Carya illinoiensis	-	1.6	4.8	1.6	-	8.0	0.7
Celtis laevigata	48.0	33.6	27.2	1.6	-	110.4	2.8
Fraxinus pennsylvanica	32.0	36.8	67.2	19.2	3.2	158.4	10.2
Ilex opaca	-	1.6	-	-	-	1.6	< 0.1
Juniperus virginiana	240.0	8.0	-	1.6	-	249.6	0.4
Prunus caroliniana	1616.0	91.2	3.2	-	-	1710.4	1.2
Quercus nigra	-	3.2	3.2	4.8	3.2	14.4	2.4
Quercus shumardii	-	1.6	-	4.8	-	6.4	0.8
Quercus texana	-	-	1.6	4.8	-	6.4	1.2
Quercus virginiana	-	-	-	-	6.4	6.4	4.9
Salix nigra	-	1.6	-	1.6	-	3.2	0.4
Sapindus saponaria	400.0	20.8	8.0	-	-	428.8	0.6
Sideroxylon lanuginosum	-	1.6	-	-	-	1.6	< 0.1
Ulmus americana	32.0	11.2	11.2	1.6	-	56.0	1.2
Triadica sebifera[b]	144.0	8.0	1.6	-	-	153.6	0.2
Ulmus crassifolia	16.0	27.2	22.4	6.4	-	72.0	3.4
Totals	2528.0	270.4	161.6	49.6	12.8	3022.4	31.7

continued

[a] For overstory

[b] Non-native species

Table 2. Continued.

Species	Stem diameter class (cm) < 7.5	7.5-20	20-40	40-60	> 60	total density (stems ha^{-1})	basal area (m^2 ha^{-1})
Shrubs & Woody Vines†							
Cephalanthus occidentalis	272.0	24.0	-	-	-	296.0	-
Cornus drummondii	80.0	-	-	-	-	80.0	-
Crataegus spathulata	16.0	-	-	-	-	16.0	-
Forestiera acuminata	1136.0	3.2	-	-	-	1139.2	-
Forestiera ligustrina	112.0	-	-	-	-	112.0	-
Ilex decidua	16.0	-	-	-	-	16.0	-
Ilex vomitoria	1248.0	11.2	-	-	-	1259.2	-
†*Ampelopsis arborea*	32.0	-	-	-	-	32.0	-
†*Berchemia scandens*	128.0	-	-	-	-	128.0	-
†*Brunnichia ovata*	16.0	-	-	-	-	16.0	-
†*Campsis radicans*	176.0	1.6	-	-	-	177.6	-
†*Cocculus carolinus*	16.0	-	-	-	-	16.0	-
†*Smilax rotundifolia*	128.0	-	-	-	-	128.0	-
†*Vitis aestivalis*	96.0	8.0	-	-	-	104.0	-
†*Vitis cinerea*	160.0	4.8	-	-	-	164.8	-
†*Vitis mustangensis*	64.0	3.2	-	-	-	67.2	-
†*Vitis palmata*	32.0	-	-	-	-	32.0	-
Totals	3728.0	56.0	-	-	-	3784.0	-

(*Forestiera acuminata* (Michx.) Poir.) and buttonbush (*Cephalanthus occidentalis* L.) in the understory (Figure 2A; Table 3). These wetter sites have also been colonized by the invasive Chinese tallowtree (*Triadica sebifera* (L.) Small). In contrast, less frequently flooded flats and ridges were generally dominated by sugarberry, cedar elm, and water oak (*Quercus nigra* L.) in the overstory and the shrubs yaupon (*Ilex vomitoria* Aiton) and soapberry (*Sapindus saponaria* L.) in the understory. Live oak (*Q. virginiana* Mill.) and pecan (*Carya illinoiensis* (Wangenh) K. Koch) occurred on clay backflats, whereas dense Carolina laurel cherry distinguishing the silty-loam ridges (Figure 2A) was associated with disturbance from localized clearing. Overstory stem density was lower on flats (347 stems ha^{-1}) compared to either ridges or meander scars (ca. 600 stems ha^{-1}).

Ground-layer composition was also strongly differentiated across the topographic and soil habitats (Figure 2B). Wetter meander scars and channels had lower ground-layer species richness (Table 3), but they supported a distinctive species composition with aquatic plants such as heart-leaf burhead (*Echinodorus cordifolius* (L.) Griseb.) and little duckweed (*Lemna obscura* (Austin) Daubs.). Only 15-20% of species in these wetter sites were shared with drier flat or ridge habitats. The ground layers of ridges and flats had 71% of their species in common, but dwarf palmetto (*Sabal minor* (Jacq.) Pers.) and Cherokee caric-sedge (*Carex cherokeensis* Schwein.) were more abundant on the flats (Table 3). The ground layers on silty-loam ridges generally had sparser total cover and greater representation of woody species compared to either flats or the wetter meander scars (Table 3).

DISCUSSION AND FUTURE DIRECTIONS

This small Columbia Bottomland forest remnant has a diverse flora of ca. 300 native plant species. Plant species composition and structural diversity, aspects of forest structure known to be important to Nearctic-Neotropical migratory landbirds, are correlated with varied topography and hydrology. Riparian forest composition at Dance Bayou is similar to Southern floodplain forest (Sharitz and Mitsch 1993) and coastal forests eastward along the northeastern Gulf of Mexico, but dissimilar to drier coastal forests to the west that include species of semi-arid habitats (Barrow et al. 2005). To the extent that the Dance Bayou Unit is representative, a typical conserved stand in the Columbia Bottomlands is a habitat mosaic with differing plant species assemblages. Plant

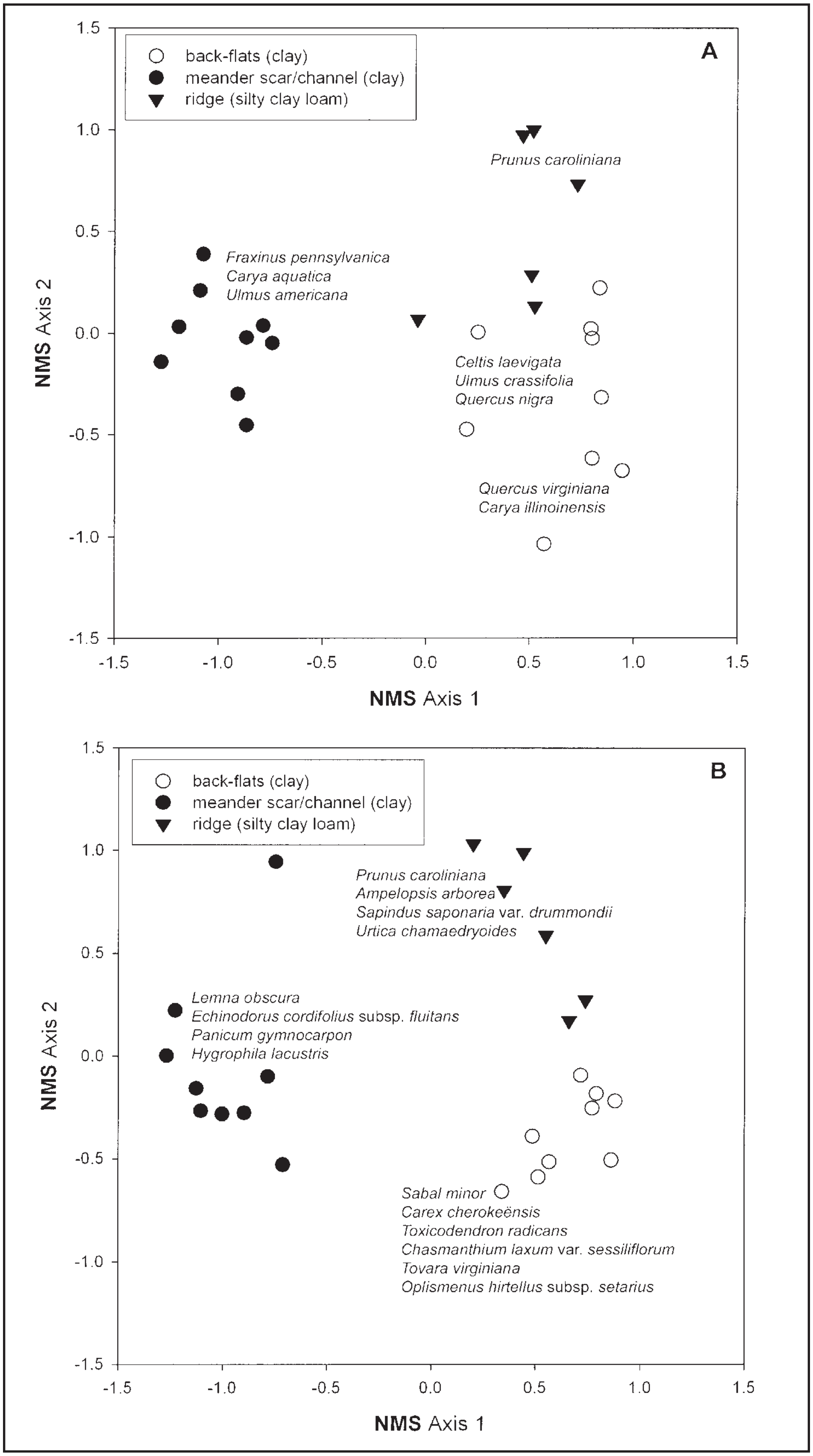

Figure 2. NMS ordinations for overstory plots (A) and ground-layer plots (B) at the Dance Bayou Unit, with symbols indicating plot habitat (topography and soil type). Species influencing the ordination patterns are listed (graphical placements are qualitative only).

composition is more differentiated where flooding is more frequent and varies in relation to soil type, particularly in the ground layer. Apart from poor representation of most oak species in smaller size classes, the forest stand, otherwise, has abundant understory stem densities and appears to be self-regenerating.

The wetland-upland mosaic of this forest stand illustrates that conservation of only "wetland" habitats in the Columbia Bottomlands will not conserve all the forest heterogeneity known to be important to Nearctic-Neotropical migratory landbirds, nor will it completely encompass the potential botanical diversity of the broader ecosystem. Protecting larger tracts can incorporate these habitat mosaics to insure that important ecological processes between and within habitats are functional. Nonetheless, smaller tracts with regionally rare plant species or plant assemblages may also have value in preserving the genetic variability that is important for long-term population survival. A network of protected tracts can ensure that adequate forest habitat will be available even if individual stands are damaged by stochastic events such as hurricanes. Within tracts, management activities that maintain plant diversity and forest structural complexity will also be important for long-term habitat sustainability.

The Dance Bayou study represents a formative step in guiding future inventory and habitat descriptions. Other preserved tracts still await botanical surveys, and it is likely that other species compositions not reported here also occur in the Bottomlands area. In particular, the fungi and bryoflora of the Columbia Bottomlands still remain virtually unknown and unsurveyed.

Conservation of the Columbia Bottomlands remains a high priority for the U.S. Fish and Wildlife Service and a growing number of supporting organizations and individuals. Approximately 8100 ha were permanently conserved between 1997 and 2007, representing an average rate of 810 ha yr^{-1}. Judging by the biodiversity and high wildlife value of the lands protected thus far, the strategies of the Conservation Plan appear to be effective. However, at

Table 3. Richness and abundance of principal species in the woody strata and ground layer for three habitat types of the Dance Bayou Unit. Relative importance value is based on 100% total. Number of plots is 7, 9, and 9 for ridges, flats, and meander scars, respectively.

		Ridge	Flat	Meander Scar/ Channel
Overstory/understory plots				
Number of woody species (average)		7	8	6
Total woody species (all plots)		19	21	15
Principal species	Common name	Average relative importance value (%)		
Prunus caroliniana	laurel cherry	40	6	–
Celtis laevigata	sugarberry	10	8	<1
Quercus nigra	water oak	10	2	<1
Sapindus saponaria	western soapberry	5	9	–
Quercus virginiana	live oak	–	12	–
Ulmus crassifolia	cedar elm	3	16	<1
Ilex vomitoria	yaupon	14	23	–
Fraxinus pennsylvanica	green ash	3	2	30
Forestiera acuminata	swamp-privet	–	–	28
Cephalanthus occidentalis	buttonbush	–	–	16
Carya aquatica	water hickory	–	–	5
Triadica sebifera [a]	Chinese tallowtree	–	–	6
Ground-layer plots				
Number of species (average)		21	29	10
Total species (all plots)		58	78	32
Percent herbaceous species (all plots)		52	69	75
Total percent cover (average)		56	148	101
Principal species	Common name	Average cover (%)		
Prunus caroliniana	laurel cherry	9	1	–
Oplismenus hirtellus [a]	basket-grass	6	9	–
Tovara virginiana	Virginia jumpseed	2	9	–
Chasmanthium laxum	hairy-collar wood-oats	1	10	–
Toxicodendron radicans	poison ivy	1	15	<1
Carex cherokeensis	Cherokee sedge	<1	30	–
Sabal minor	dwarf palmetto	4	23	11
Lemna obscura	little duckweed	–	–	29
Echinodorus cordifolia	heart-leaf burhead	–	–	18
Panicum gymnocarpon	swamp panic-grass	–	–	14
Hygrophila lacustris	gulf swampweed	–	–	8

[a]Non-native species

the current rate of acquisition, another 25 years would be needed to reach the Plan objective of 28,328 ha conserved. While the goal is still considered feasible, intensified conservation efforts by governmental and non-governmental partners may be needed to reach that goal in the face of rising real estate values and accelerated rates of land conversion to other uses.

ACKNOWLEDGMENTS

We are grateful to Stanley Jones, Catherine Yeargan, and Bradley Christoffersen for assistance with fieldwork, and to Jennifer Sanchez, Tom Smith, Lena Marie, Riesley Jones, and Ron Bisbee for their enthusiasm and support of this project. Partial funding for fieldwork in 2004 was provided by the Texas Nature Conservancy's Conservation by Design Research Program.

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