

Partners in Flight
Bird Conservation Plan
for the

Mississippi Alluvial Valley

(Physiographic Area # 05)



Version 1.0

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MISSISSIPPI ALLUVIAL VALLEY BIRD CONSERVATION PLAN

EXECUTIVE SUMMARY

Because this physiographic area was historically a nearly contiguous bottomland hardwood forest, and because the majority of bird species of highest concern are dependent on forested wetlands, bottomland hardwood forest is the habitat of greatest concern in the MAV. We established avian population goals based on bottomland hardwood forest habitat objectives. To support source populations of high priority species such as, Swainson's Warbler, Prothonotary Warbler, Cerulean Warbler, and Swallow-tailed Kite, we established a habitat objective to maintain or restore >1,500,000 ha of predominately mature, forested wetlands in 101 patches of contiguous forest. This goal comprises 13 patches of >40,000 ha (100,000 acres), 36 patches >8,000 ha (20,000 acres), and 52 patches >4,000 ha (10,000 acres) distributed among 87 Bird Conservation Areas. Achieving forested habitat objectives within these Bird Conservation Areas will require extensive reforestation of cleared land. Forest management within these areas should promote the structural diversity necessary to support source populations of breeding birds. Avian species preferring early-successional and shrub/scrub habitats, such as Orchard Oriole, White-eyed Vireo, Painted Bunting, and Mississippi Kite will be provided for by maintaining 1 million ha of scrub/shrub or forest edge habitat. This habitat will be provided in existing forest edges and through forest regeneration following timber harvest. Important grassland species (e.g., LeConte's Sparrow, Henslow's Sparrow, Field Sparrow, Grasshopper Sparrow, Loggerhead Shrike, Dickcissel, Short-eared Owl, and Sedge Wren), especially species using the MAV during winter, will be provided for by establishing and maintaining 10 grassland-cropland complexes. Each grassland-cropland complex will provide 4,000 to 8,000 ha of native, warm-season grasses, along with other native flora, associated wetlands, and savannas. Management will ensure disturbance (e.g., fire, grazing) regimes sufficient to maintain prairie conditions. To provide habitat for nonforested wetlands dependent birds, such as shorebirds, long-legged wading birds, bitterns, and rails, mudflat and shallow, open-water habitat must be provided. Because this habitat is least available during late summer and fall, and because migrating shorebirds concurrently require foraging habitat, we have tentatively set a goal of providing >2000 ha of managed shallow-water foraging habitat to support the southward migration of shorebirds through the Mississippi Alluvial Valley.

ACKNOWLEDGMENTS

Partners in Flight Bird Conservation Plans are living documents that are periodically updated and improved as knowledge of bird management and conservation in the physiographic area is improved. Thus the first public draft of this Bird Conservation Plan is Version 1.0. This Plan will remain a work in progress, we encourage those who wish to contribute to do so.

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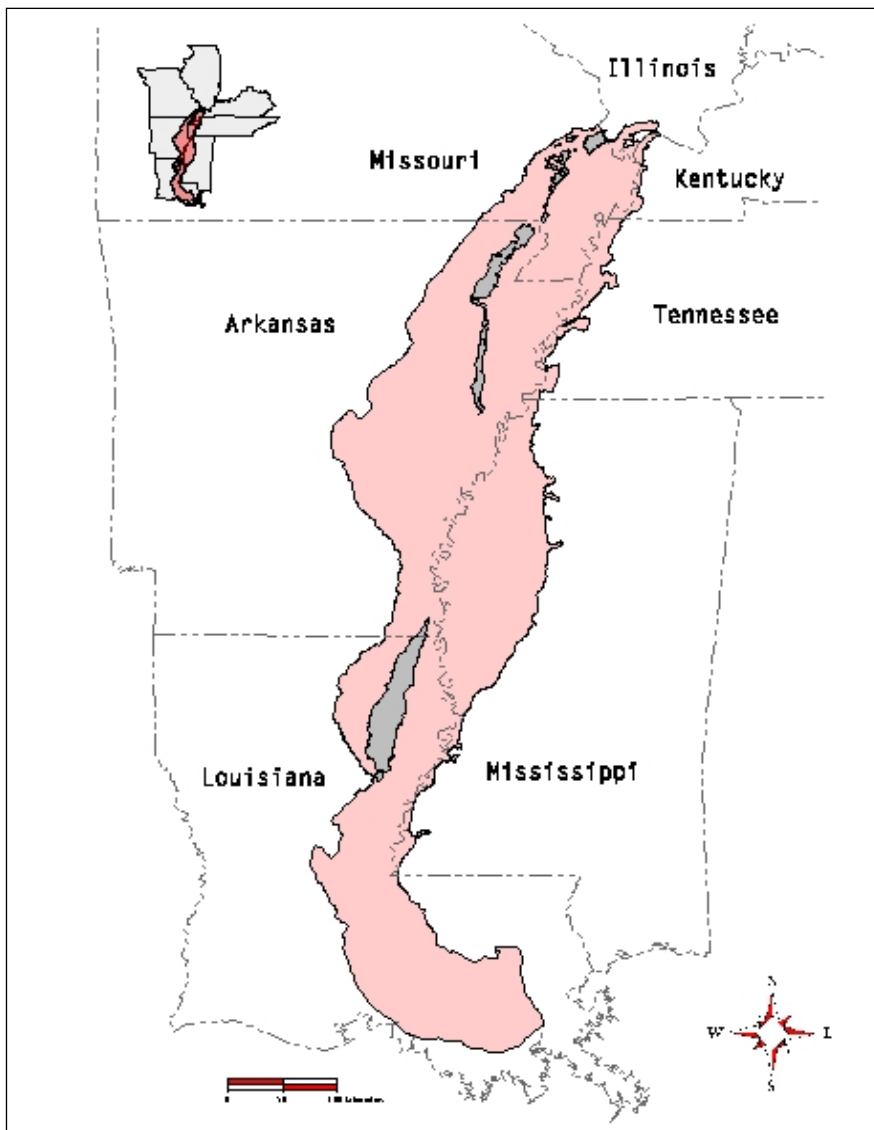
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SECTION 1: THE PLANNING UNIT

Background:

The Mississippi Alluvial Valley (Fig. 1) is an 11 million ha (24 million acres), relatively flat, weakly dissected alluvial plain, comprised of natural levees, basins and flats, point bar formations, terraces, tributary floodplains, and depressional wetlands. Differences in topography and hydrology result in 14 physiographic provinces spanning 7 states ([Table 1](#); Keys et al. 1995). Elevation ranges from 0 to 200 m (0-660 feet) with local relief generally <30 m but reaching up to 100 m along ridges and bluffs bordering the mainstem Mississippi River. Because elevation differences are slight, hydrologic regimes can dramatically influence vegetation. In addition to 21 internal hydrologic units ([Table 2](#)), the Mississippi Alluvial Valley receives drainage from many eastern and central U.S. watersheds, including the Ohio, Arkansas, and Red Rivers. Average annual precipitation is 114 to 165 cm (45-65 in).



Potential natural vegetation for most of the physiographic area is southern floodplain forest with oak-hickory forest on higher ground (e.g., Crowley's Ridge, loess bluffs) and isolated native prairies (e.g., Grand Prairie). Floodplain forests are primarily oak-gum-cypress cover type with co-dominant species being overcup, willow, Nuttall, water, swamp chestnut, and cherrybark oaks, as well as sweetgum, water tupelo, water hickory, willow, cottonwood, sycamore, hackberry,

sugarberry, red maple, boxelder, baldcypress, and green ash (scientific names of trees listed in [Appendix 1](#)). Oak-hickory forests include as co-dominants post, southern red, black, and white oaks, and shellbark, shagbark, and mockernut hickories. Remnant prairies have bluestem (*Andropogon* spp.) and switchgrass (*Panicum virgatum*) as the dominant grasses under natural conditions. Natural vegetation has been cleared from 80% of this physiographic area primarily for conversion to agriculture. Pasture and haylands are common on higher ground and along levees. Cotton, soybean, and rice are the most widespread crops but winter wheat, corn, sorghum, and sugar cane can be locally abundant. Although cleared of natural vegetation, flooded agricultural fields can provide important wildlife habitat.

Flood regimes that have historically dictated vegetative communities within the Mississippi Alluvial Valley have been altered by an extensive system of levees, dikes, and dams. High water events have been reduced in many areas, whereas the rate and extent of flooding has been increased in other areas. The altered hydrology of the Mississippi Alluvial Valley has in turn influenced the composition and structure of forested wetlands as well as the amount of open water-shoreline habitat. Local perturbations include ice-storms, tornadoes, hurricanes, beaver ponds, and fire. The northern portion of the Mississippi Alluvial Valley overlays the New Madrid fault line with the potential for earthquakes.

Table 1. Native habitats and current land use of physiographic provinces within the Mississippi Alluvial Valley.

State	Physiographic Province	Native Habitats	Land Use
Arkansas	Southern Mississippi River Alluvial Plain	cottonwood - willow, oak - sweetgum, tupelo - cypress	cropland, forestry
	Crowley's Ridge	post - blackjack oak, southern red oak - white oak, beech - maple	pasture
	Arkansas Grand Prairie	willow oak - overcup oak, bluestem - switchgrass	agriculture
	Arkansas Alluvial Plain	overcup oak - sweetgum, green ash - American elm-hackberry - sugarberry	agriculture
	Macon Ridge	southern red oak - white oak - post oak - hickory [pignut, mockernut, sand]	agriculture, forestry
	Bastrop Ridge	southern red oak - white oak - post oak - hickory [pignut, mockernut, sand], shortleaf pine - oak [white, southern red, post, black]	agriculture, forestry
	North Mississippi River Alluvial Valley	river birch - sycamore, overcup oak - sweetgum	agriculture
	White and Black Rivers Alluvial Plain	oak - sweetgum, overcup oak - water hickory, tupelo - cypress	cropland
	St. Francis River Alluvial Plain	overcup oak - sweetgum, green ash - American elm - hackberry - sugarberry	agriculture

Illinois	North Mississippi River Alluvial Valley	river birch - sycamore, overcup oak – sweetgum	agriculture
Kentucky	North Mississippi River Alluvial Valley	river birch - sycamore, overcup oak – sweetgum	agriculture
Louisiana	Southern Mississippi River Alluvial Plain	cottonwood - willow, oak - sweetgum, tupelo – cypress	agriculture, forestry
	Baton Rouge Terrace	loblolly pine - oak [cherrybark, swamp chestnut, Shumard], shortleaf pine - oak [white, southern red, post, black]	agriculture
	Atchafalaya Alluvial Plain	water tupelo - bald cypress, overcup oak – sweetgum	agriculture
	Macon Ridge	southern red oak - white oak- post oak - hickory [pignut, mockernut, sand]	agriculture, forestry
	Red River Alluvial Plain	oak [swamp chestnut, cherrybark, shumard] - sweetgum, green ash - American elm – hackberry - sugarberry	agriculture
	Bastrop Ridge	southern red oak - white oak - post oak - hickory [pignut, mockernut, sand], shortleaf pine - oak [white, southern red, post, black]	agriculture, forestry
	Opelousa Ridge	loblolly pine - oak [cherrybark, swamp chestnut, Shumard], oak - sweetgum	agriculture, forestry
	Teche Terrace	oak [swamp chestnut, cherrybark, shumard] - sweetgum, green ash - American elm – hackberry - sugarberry	agriculture
Mississippi	Southern Mississippi River Alluvial Plain	cottonwood - willow, oak - sweetgum, tupelo – cypress	agriculture
	North Mississippi River Alluvial Valley	river birch - sycamore, overcup oak – sweetgum	agriculture
Missouri	Crowley's Ridge	post - blackjack oak, southern red oak - white oak, beech – maple	agriculture, forestry
	North Mississippi River Alluvial Valley	river birch - sycamore, overcup oak – sweetgum	agriculture
	White and Black Rivers Alluvial Plain	oak - sweetgum, overcup oak - water hickory, tupelo - cypress	agriculture
	St. Francis River Alluvial Plain	overcup oak - sweetgum, green ash - American elm - hackberry - sugarberry	agriculture
Tennessee	North Mississippi River Alluvial Valley	river birch - sycamore, overcup oak - sweetgum	agriculture

Conservation issues:

The Mississippi Alluvial Valley is among the most heavily modified physiographic areas in the southeastern U.S. but still supports the largest forested floodplain in North America. In addition to providing forested habitat for breeding birds, the area serves as a major waterfowl wintering area, supplying food and cover from both forested and agricultural habitats. Resident and migrant long-legged wading birds as well as transient shorebirds exploit natural floodwater, flooded farm fields, and aquaculture ponds.

Although habitats for waterbirds have not historically been a focus for Partners in Flight, we address habitat needs of nongame waterbirds because bird conservation between landbirds and waterbirds overlap extensively within the Mississippi Alluvial Valley. Nevertheless, waterbird goals, objectives, and priorities fall under the purview of other bird conservation groups such as the Western Hemispheric Shorebird Reserve Network, the Colonial Waterbird Society, and North American Waterfowl Management Plan Committee. The objectives outlined here will be integrated with objectives established by other conservation groups (e.g., Lower Mississippi Valley Joint Venture Evaluation Plan [Loesch *et al.* 1994]).

Forestry in the southeastern U.S. has a long history, with the present forested acreage referred to as the "South's Fourth Forest" (USDA Forest Service 1988, Walker 1991). Virtually no virgin timber remains and, even with increasing region-wide forest acreage, there have been dramatic changes in forest types dominating the landscape. Indeed, a number of "old-growth" forest species are now extinct, endangered, or vulnerable. Some avian species dependent upon forested habitats are extinct (e.g., passenger pigeon [*Ectopistes migratorius*], Carolina parakeet [*Conuropsis carolinensis*]) and other species are endangered and likely extinct (e.g., Ivory-billed Woodpecker, Bachman's Warbler). Non-avian species, such as the red wolf (*Canis rufus*) and the Louisiana black bear (*Ursus americanus luteolus*) have also suffered from loss of forested wetland habitat.

The Mississippi Alluvial Valley has the dubious distinction of being the most deforested of all southeastern physiographic areas. Forest fragmentation usually refers to a landscape where a still large percentage of forest remains but is fragmented into small blocks surrounded by non-forested habitat (usually agriculture or suburban/urban development). The Mississippi Alluvial Valley, however, is now largely non-forested with >80% of the land in agricultural production. Remaining forest patches are generally surrounded by vast expanses of farmland. Continuing debates on the decline of forest birds in other parts of eastern North America, where the percent of the landscape in forest remains high, have been resolved in the Mississippi Alluvial Valley. Forests, and the birds dependent upon them, have greatly declined throughout this century, with losses continuing since the 1950's (about 360,000 ha [900,000 acres] lost between the mid-1970's and mid-1980's; Hefner *et al.* 1995). Nevertheless, the remaining forests, of all types, provide valuable wildlife habitat.

Table 2. Hydrologic units within the Mississippi Alluvial Valley.	
State	Hydrologic Unit
Arkansas	Black / Middle White, Cache / Lower White, St. Francis / L'Anguille, Lower Arkansas / Bayou Meto, Ouachita, Boeuf / Bayou Bartholomew
Illinois	Cache
Kentucky	West Kentucky
Louisiana	Boeuf / Ouachita, Tensas / Bayou Macon, Red River Backwater, Teche / Vermilion, Atchafalaya, Barataria / Terrebonne
Mississippi	Steele Bayou, Big Sunflower, Tallahatchie, Lower Yazoo, Southwest Mississippi
Missouri	Bootheel
Tennessee	West Tennessee

Conservation opportunities:

The greatest opportunity for bird conservation in the Mississippi Alluvial Valley is the existence of the Lower Mississippi Valley Joint Venture (LMVJV) of the North American Waterfowl Management Plan (NAWMP). This effort was originally devoted to betterment of conditions for waterfowl, but this infers improvement of wetland habitat and improved health of wetland ecosystems. Given that the vast majority of the MAV consists of wetlands, efforts to benefit waterfowl populations and those for forest-breeding non-game birds are often compatible or even identical in nature. Due in part to this overlap, the LMVJV has worked closely with Partners in Flight and others to develop a cohesive effort to conserve all birds within the system. The strength and success of PIF in this physiographic area is in large part due to this close partnership with the Joint Venture.

At the heart of the biological foundation of bird conservation in the MAV is adherence to roles and relationships among planning, implementation, and evaluation. The Joint Venture and its many partners have a long history of implementation during which numerous properties have been acquired by public agencies and managed for waterfowl, other game species, and/or as functional bottomland hardwood systems. Much of the currently forested land in the Valley is either on a National Wildlife Refuge, state Wildlife Management Area, National Forest, or other public property. In recent years, planning and evaluation have become much more significant components of the conservation process in the MAV, and this Bird Conservation Plan is one manifestation of this shift.

One important tool developed for planning and evaluation has been a Geographic Information System (GIS) that is now centered in the Joint Venture office in Vicksburg, MS, with significant support from The Nature Conservancy of Louisiana and other partners. This GIS has been used to characterize and map all forested habitat in the physiographic area, which has been an essential tool in development of forest patch objectives for forest-breeding birds. Public lands and other important features have also

been digitized, and current work is dedicated toward mapping of flood events of various intensities in an effort to locate lands most amenable to restoration.

Another key wildlife conservation planning process in the MAV is underway for the Louisiana black bear, which is listed as federally threatened and the focus of activity of the Black Bear Conservation Committee. Like Partners in Flight, the Black Bear Conservation Committee includes representation from public agencies, private landowners, non-governmental conservation organizations, and academia; it has particularly strong representation from the forest products industry. The goal of the Black Bear Conservation Committee is to restore healthy bear populations in the Alluvial Valley and beyond. A single healthy population requires approximately 100,000 acres of bottomland hardwood forest, under some variety of management regimes. This is comparable, both in size and habitat conditions, to the larger blocks developed as forest bird objectives. The Black Bear Conservation Committee will probably recommend that five or so blocks of this size be restored or maintained between the latitude of the lower stretches of the Arkansas and White Rivers and the Gulf of Mexico. This is entirely compatible with Partners in Flight recommendations, and the combined efforts of the two groups should make this shared goal more achievable.

Management of forests for timber production is in most ways compatible with the conservation of high priority birds. Patch cuts are a widely employed silvicultural options that, within a largely forested landscape, are consistent with the habitat needs of species such as kites that forage over open areas, as well as with those of species such as the Swainson's Warbler that favor a mosaic of forest understory. Special attention to forest openings is necessary to minimize parasitism and predation even in the larger forest patches. For example, it may be advisable to maintain no more than 10-15% of an area in right-of-ways, other permanent openings, regeneration cuts, or other temporary openings at any given time. Edges within the "interior" of forests should be gradual rather than abrupt (Suarez *et al.* 1997). Additionally, retention of scattered patches of tall, >25 m, trees (e.g., baldcypress and cottonwood) in existing forests will provide potential nest site locations.

As another example, uneven age silviculture appears to be compatible with habitat requirements of Cerulean Warblers. However, if timber volume targets are high (e.g. >40% of the canopy removed) this type of uneven-aged management may result in excessive fragmentation. In these cases, larger regeneration cuts (e.g., 8-16 ha) combined with longer rotations (e.g., 150-200 years) and thinning to ensure maximum tree girth may still result on maintenance of large mature hardwood stands over time. Only monitoring, coupled with adaptive management, can confirm which silvicultural practices are beneficial to high priority bird species.

The importance of private lands for conservation of avian populations in the Mississippi Alluvial Valley must not be underestimated. Education of and support by private landowners is critical in that most future reforestation efforts are likely to occur on private lands. Opportunities to improve habitat conditions for avian species must consider the management objectives of private landowners. Many of the opportunities to work with private landowners to restore and manage forested wetlands through a variety private lands assistance programs are summarized in Coreil *et al.* 1997 and can be seen at

<http://www.agctr.lsu.edu/wwwac>. As an example of the success of incentive programs on private lands, implementation of the USDA's Wetland Reserve Program has resulted in reforestation of over 100,000 ha of cleared land.

Probably because so much original forest has been removed from the MAV, the forest that remains is highly valued by local residents, both for hunting and aesthetic reasons. Unlike previous decades in which conversion from forest to agricultural use increased land value, most sites that are currently forested lose value when cleared. This is partially because most remaining forested sites are wetter areas least favorable to agriculture, but also because of the value of land on which hunting for deer, waterfowl, turkey, and other small game is an option. Most non-industrial private forested land is now either owned by hunting clubs or is leased for hunting to generate income. Hunting clubs are now often able to bid more for forested land than are farmers intent on conversion. Land in the ownership of limited partnership hunting clubs is extremely unlikely to be cleared for other uses anytime in the near future. The benefits of this condition to non-game forest birds are great, in that bird conservation objectives are being met on private lands, voluntarily by the landowners, at no acquisition or incentives cost to public agencies.

Long term bird conservation in the Mississippi Alluvial Valley can best be sustained through implementation of detailed planning, communication, and working partnerships among an array of government agencies, private conservation organizations, landowners, and citizens. This process will lead to an understanding of this region's natural history, foster regional pride, and instills the conservation ethic necessary to sustain and restore the diverse biotic communities of this ecosystem. Various groups exist that can merge federal, state, and private interests to coordinate management actions and resolve potential conflicts. For instance, much of the current conservation planning effort underway in the Mississippi Alluvial Valley was outlined through the efforts of the Lower Mississippi Valley Joint Venture sanctioned under the North American Waterfowl Management Plan. However, much work needs to be done to better coordinate management needs with the private sector. Landowner incentives, conservation easements, and market development can all be used to increase private participation in conservation efforts.

Within the Mississippi Alluvial Valley, data on land cover (U.S. Geological Survey, Twedt 1996) and ownership (U.S. Fish and Wildlife Service, The Nature Conservancy), forest seral stages, and trends (U.S. Forest Service [www.srsfia.usfs.msstate.edu]) are available for assessment of avian habitat. State Working Groups of Partners in Flight can use these data, and the recommendation herein, to assess their public and private land opportunities, thereby defining local roles and responsibilities for achieving the population goals and habitat objectives outlined below.

SECTION 2: AVIFAUNAL ANALYSIS

Species prioritization

At least 107 bird species nest regularly in the Mississippi Alluvial Valley, excluding wading birds and colonial nesting waterbirds ([Appendix 2](#)). Most of these species occur in more than one broad habitat type as defined within this plan. Forest breeding species

remain the most important component of the avifauna, despite the loss of nearly 80% of the forested wetlands in this region. At least 70 species occur in bottomland hardwoods as a primary habitat. Greater than 20% of the breeding populations of Swainson's Warbler, Prothonotary Warbler, and Swallow-tailed Kite are found within the Mississippi Alluvial Valley. Typical species of bottomland hardwood forests include Northern Parula Warbler, Swainson's Warbler, Prothonotary Warbler, Red-shouldered Hawk, and Red-headed Woodpecker.

At least 62 species occur in upland oak-hickory forests, although many of these species occur in bottomland hardwoods as well. Typical species include Yellow-billed Cuckoo, Worm-eating Warbler, Black-and-white Warbler, and Broad-winged Hawk. At least 25 species occur in scrub-shrub habitats in the Mississippi Alluvial Valley. Typical species include Painted Bunting, Orchard Oriole, White-eyed Vireo, Common Yellowthroat, and Indigo Bunting.

At least 18 species occur in Mississippi Alluvial Valley grassland habitats. Typical species include Dickcissel, Loggerhead Shrike, Field Sparrow, Northern Bobwhite, and Grasshopper Sparrow. Seven species are dependent on water and wetlands habitat, including Hooded Merganser, Wood Duck, Belted Kingfisher, and Marsh Wren. Another 19 species occur in a variety of other habitats, such as open water or river banks. These species include Purple Martin, Tree Swallow, and Barn Owl.

The Partners in Flight prioritization process was developed to guide conservation actions among diverse birds and habitats (see Hunter et al. 1993, Carter et al. in press). The system ranks each species based on 7 measures of conservation vulnerability: relative abundance, size of breeding and non-breeding ranges, threats during breeding and non-breeding seasons, population trend, and relative density. In addition, the percentage of a species global breeding population that occurs in a physiographic area has been provided (Rosenberg and Wells, pers. comm.). To further refine species prioritization within a physiographic area, population trends and area importance are examined independently of total scores.

Birds were prioritized according to this scheme in the Mississippi Alluvial Valley ([Table 3](#)). Category I lists highest priority birds and included 14 species which received a Partners in Flight score of 22 or more. Two species were excluded from the prioritization process in the Mississippi Alluvial Valley, Bachman's Warbler and Ivory-billed Woodpecker are most likely extinct. Other species of highest priority are Swainson's Warbler, Prothonotary Warbler, Cerulean Warbler, and Swallow-tailed Kite. The remainder of Category I birds occur mostly in bottomland hardwood forests, although birds of upland forests and scrub-shrub habitats are represented.

Category II provides a list of slightly lower priority species, and included another 9 species with slightly lower total scores (19 to 21), but combined with a high score for area importance and population trend. These species reflected mostly scrub-shrub habitats. Four species are included in Category III. These birds received high global concern scores as Watchlist species (Cater et al. in press), regardless of their status in the Mississippi Alluvial Valley.

Category IV birds have a high combination of scores for area importance and population trend, regardless of total score. In the Mississippi Alluvial Valley, 4 species occur in this category. Nine species are in Category V; each species has greater than 5% of their national breeding status within the Mississippi Alluvial Valley. Species with greater than 10% of their breeding population, that have not been listed elsewhere in this table, include Barred Owl and

Mississippi Kite. Categories VI and VII list federally threatened and endangered species, as well as species of state concern. Combined, these categories include 7 species.

Table 3. Priority bird species listed by total PIF concern score, and segregated by entry criteria. Other measures include are of importance and population trends scores, percent of BBS populations, and local migratory status. [Refer to Appendix 2 for scientific names]

Priority and species	Total PIF score	Concern scores		Percent BBS	Migratory status
		A1	PT		
Ia. Highest overall priority					
Swainson's Warbler	29	5	3	20.8	B
Swallow-tailed Kite	28	4	3	25.1	E
Cerulean Warbler	28	3	4	-	E
Ib. High overall priority					
Prothonotary Warbler	24	5	2	34.8	B
Painted Bunting	24	3	5	4.4	B
Red-headed Woodpecker	23	5	5	3.0	D
Bell's Vireo	23	2	3	1.0	B
Northern Parula	23	5	5	6.9	B
Worm-eating Warbler	23	2	3	-	B
Kentucky Warbler	22	3	3	4.7	B
Orchard Oriole	22	5	5	7.4	B
Yellow-billed Cuckoo	22	5	5	6.0	B
Wood Thrush	22	3	3	1.3	B
White-eyed Vireo	22	4	5	8.4	B
II. Physiographic area priority species					
Yellow-breasted Chat	21	5	5	6.2	B
Northern Bobwhite	20	3	5	-	R
Eastern Wood-Pewee	20	3	5	-	B
Carolina Chickadee	20	4	5	-	R
Loggerhead Shrike	20	4	4	-	R
Field Sparrow	20	3	5	-	D

Baltimore Oriole	20	3	5	-	B
Ruby-throated Hummingbird	19	5	3	7.3	B
Blue-gray Gnatcatcher	19	4	5	-	B
III. Additional species: global priority					
Scissor-tailed Flycatcher	21	3	3	-	B
Dickcissel	21	4	2	5.1	B
Chuck-will's-widow	21	4	3	3.1	B
Prairie Warbler	20	2	3	-	B
IV. Additional species: abundant and declining in physiographic area					
Indigo Bunting	17	4	5	-	B
Common Grackle	16	5	5	-	D
Mourning Dove	14	4	5	-	D
Northern Mockingbird	14	4	5	-	D
V. Additional species: responsibility for monitoring (>5% BBS population estimate)					
Mississippi Kite	21	4	2	13.4	B
Acadian Flycatcher	20	3	2	5.6	B
Carolina Wren	18	5	3	6.5	R
Red-bellied Woodpecker	18	5	2	6.1	R
Red-shouldered Hawk	17	4	2	9.8	D
Purple Martin	17	5	2	7.8	B
Barred Owl	16	5	2	15.6	R
Northern Cardinal	16	5	2	5.7	R
Black Vulture	12	3	3	8.3	D
VI. Federal listed species					
Bald Eagle	18	3	3	-	D
VII. Local, state, or regional interest species					
Hooded Warbler	21	3	3	-	
Yellow-throated Warbler	20	3	2	-	
American Redstart	20	3	3	-	
Yellow-throated Vireo	20	3	2	-	
Summer Tanager	18	2	3	-	
Pileated Woodpecker	16	4	2	-	

Conservation area size considerations

Other than the above issues of site characteristics, the basic consideration regarding habitat is that the current landscape of the MAV is 80% deforested, most remaining

forested patches are small and isolated (Twedt and Loesch, in press), and there is no reason to presume that the vast majority of this system will ever again be forested. Objectives for bird populations in forested habitat, therefore, are related to size, configuration, number (and to some extent distribution and inter-connectivity) of individual habitat patches. The quantity of habitat required can conceptually be separated into

issues of 1) patch size and context; and 2) number and distribution of patches (populations). Size and configuration will be addressed in this section whereas the issue of number of patches and their distribution will be addressed thereafter.

Forest patches should be of sufficient size to support source populations of targeted bird species, to minimize the likelihood of extirpation, and to ensure a low probability of genetic degradation. The issues that must be resolved in order to select an appropriately-sized patch of habitat for breeding birds are: 1) context, or how ought breeding birds be buffered from the negative influence of surrounding matrices; 2) desired number of breeding pairs to constitute a source population with a high probability of long-term viability; and 3) the density at which birds tend to occur within habitat likely to be included in average patches. Area can be conceptually calculated using the formula:

$$A = (N * D) + B,$$

where A = Area of forest required to support a source population (ha),

N = Desired number of breeding pairs

D = Density of breeding birds (expressed as area / breeding pair), and

B = The area (ha) of a 1-km-wide forested buffer around the core forest area (N * D).

The agricultural matrix in which forest patches in the MAV are embedded is generally considered hostile to forest breeding birds in that many MAV land uses support Brown-headed Cowbirds and a wide range of nest predators. We assume that the edges of forest blocks are more seriously affected by brood parasitism and nest predation than are areas farther into the interior of blocks, although the relationship between negative effects distance from edge has not been rigorously tested in the MAV. However, there are data that indicate that the distance between breeding and feeding locations for Brown-headed Cowbirds averages 1.2 km (Thompson 1994). For planning purposes, therefore, we have assumed that the negative impacts on a core surrounded by a 1 km forest buffer will be reduced. Furthermore, for at least some species, birds breeding in forest interiors are more likely to be paired with a mate than are birds breeding near forest edges (Van Horn et al. 1995). Only those pairs within the forest core, therefore, are assumed to reproduce at a rate sufficient to serve as a source population. Clearly, the assumptions in this logical process need to be tested.

The area occupied by a 1-km-wide buffer will vary with the geometric configuration of forest patches. For planning purposes, until the actual area of interior forest within each forest patch is determined, doubling the core forest area (i.e., 2 * [N * D]) will generally

result in a total area that includes a 1-km-wide buffer around the desired interior forest area. This assumption holds for more compact small forest patches. For example, a relatively compact 4,000 ha forest patch would be expected to have 2,000 ha of forest interior inside its 1-km-wide forest buffer. This interior area is assumed capable of harboring 500 breeding pairs of all bottomland forest species that occur at densities of <4 ha per breeding pair (i.e., 500 pairs * 4 ha/pair = 2000 ha). The ratio of land required to maintain a 1 km wide buffer to interior core area increases as block configuration becomes less compact.

Minimum viable population and source populations

The concepts of minimum viable populations and source populations are relevant to considerations of desired size, but, unfortunately, what constitutes these threshold population sizes remains unknown for almost all species. Minimum viable population sizes have been calculated from 250 (Reed *et al.* 1988) to several thousand (Thomas 1990). A somewhat arbitrary population goal of 500 breeding pairs (1000 breeding individuals) per forest patch was adopted for the MAV. This goal raises a number of concerns, but 500 pairs sufficiently buffered from strong negative influences on reproductive success is assumed to be large enough to constitute a source that is unlikely to undergo extirpation in a patch as long as habitat quality is maintained.

Area recommendations are based upon the amount of buffered forest interior core habitat necessary to support 500 breeding pairs of the high priority birds that occur at lower densities than do other priority species. Assuming that microhabitat needs are satisfied, an area that supports 500 pairs of the least densely distributed species ought to support 500 or more pairs of all of the species that occur at greater densities. It is recognized that at least some of these density data used were derived from study sites with optimal habitat conditions, and that large-scale habitat restoration will be accomplished in a variable landscape, often including sites unlikely to be able to support densities reported in the literature. These data and assumptions must be improved upon in the future.

Based on density estimates in Hamel 1992b and empirical observations ([Table 4](#); Mueller *et al.*, in press), there are three high priority birds that each can be used to define area thresholds: Swainson's Warbler, Cerulean Warbler, and Swallow-tailed Kite. Based on area (and to some extent habitat quality) needs, each of these three birds can be a "focal" or "umbrella" species for each of three general size thresholds.

The Swainson's Warbler occurs throughout the area; viable source populations presumably can persist in patches equaling or exceeding 4000 ha in size (assuming that configuration allows about half of that to be protected by a 1 km wide buffer). Other birds expected to do well in this sized patch include Blue-gray Gnatcatcher and American Redstart. The next sized patch, set at about 8000 hectares, supports Cerulean Warblers (but only in the northern half of the valley where they breed) as well as Yellow-throated Warbler, Kentucky Warbler, Yellow-billed Cuckoo, Eastern Wood-pewee, Great Crested Flycatcher, Scarlet Tanager, Summer Tanager, and Yellow-throated Vireo (all of which occur throughout the area). The threshold of the largest sized patch, 40,000 ha, supports Swallow-tailed Kites, but as far as is known in numbers well below 500 pairs. Birds for which such sites could serve as source areas include Cooper's Hawk, Red-shouldered

Hawk, and Broad-winged Hawk. Additionally, source populations of some species should thrive in forest patches smaller than any identified in this plan, such as those that contain interior areas of between 2,000 to 4,000 ha. These species include Prothonotary and Hooded Warbler, Northern Parula, Wood Thrush, Acadian Flycatcher, and Red-eyed Vireo.

The step taken prior to setting population/patch number objectives was to assess the current status of suitable habitat patches. All forested habitat was classified from satellite imagery. Maps produced through this process have been invaluable tools in all phases of bird conservation planning. All forest patches were categorized as <4,000 ha, 4-8,000 ha, 8-40,000 ha, and >40,000 ha. Each patch was then further assessed to determine whether restoration of additional forested area could move the patch into the next higher category or whether two or more patches could be joined to form a larger patch.

Swainson's Warbler and Prothonotary Warbler are among the most highly ranked species within the Mississippi Alluvial Valley but their habitat and area requirements are perhaps more easily met than are those of other highly ranked species. A source population of Swainson's Warbler probably requires >2500 ha (4700 ha in agriculturally-dominated landscapes) of mature forested wetlands, whereas Prothonotary Warblers probably require only 1600 ha (2700 ha in agriculturally-dominated landscapes) of bottomland forest. Source populations of the remaining highly ranked species all require >7000 ha of forested habitat ([Table 4](#)).

Table 4. Hypothesized forest area (hectares) required to support viable populations of 500 breeding birds within the Mississippi Alluvial Valley (from Mueller et al. 1999). [Refer to Appendix 2 for scientific names]

Species	Patch Size Recommendation	Habitat Area Objective
Swainson's Warbler	4,700	4,000
Cerulean Warbler	8,000	8,000
Swallow-tailed Kite a	40,000	40,000
Prothonotary Warbler	2,700	4,000
Northern Parula	3,000	4,000
Hooded Warbler	2,500	4,000
Kentucky Warbler	8,400	8,000
Yellow-billed Cuckoo	6,600	8,000
Wood Thrush	2,800	4,000
Louisiana Waterthrush	7,200	8,000
Acadian Flycatcher	2,800	4,000
Eastern Wood-pewee	5,500	8,000
Yellow-throated Vireo	7,900	8,000
Yellow-throated Warbler	7,800	8,000
Blue-gray Gnatcatcher	4,000	4,000
Summer Tanager	6,600	8,000

Great-crested Flycatcher	7,200	8,000
Red-shouldered Hawk	57,800	40,000
Scarlet Tanager	4,900	8,000
Red-eyed Vireo	1,800	4,000
American Redstart	4,600	4,000
Broad-winged Hawk	101,000	40,000
Pileated Woodpecker	19,000	40,000
Cooper's Hawk	45,000	40,000
White-breasted Nuthatch	8,600	8,000

^a Based on Cely and Sorrow (1990), a 40,000 ha patch of bottomland hardwood forest would only support approximately 80 pairs of Swallow-tailed Kites. A secure (source) population would realistically have to be based on a regional (southeastern U.S.) population.

SECTION 3: HABITATS AND OBJECTIVES

Breeding birds are grouped into 6 priority habitat-species suites for the Mississippi Alluvial Valley ([Table 5](#)). Each of these habitats, forested wetlands, forest openings and scrub-shrub, upland oak-hickory, grasslands and savannas, nonforested wetlands, and urban, suburban, rural woodlots, is discussed below.

Forested wetlands, bottomland hardwood forests

Status and importance

Bottomland forests, floodplain forests, and swamps in the Mississippi Alluvial Valley are adapted to and a result of frequent floods. High tree species diversity, dense midstories and understories, and various levels of wetness create conditions that support many species not commonly found away from forested wetlands. The most frequently occurring wetland forest cover types making up the oak-gum-cypress forest complex within the Mississippi Alluvial Valley are sugarberry-American elm-green ash, sweetgum-Nuttall oak-willow oak, and cypress-tupelo ([Table 6](#)). Understory development within each of these forest types is dependent on local flooding patterns and canopy density.

Extensive drainage and conversion of forested wetlands within the Mississippi Alluvial Valley has increased the extent of farmland, pine or hardwood monocultures, and residential, industrial and commercial development (Sharitz and Mitsch 1993). Drainage and clearing of floodplain forests was underway by the mid-1800's and by the 1940's less than 5 million ha (12 million acres) remained. Significant forest clearing occurred in the 1940's and from the 1960's to the early 1970's (McWilliams and Rosson 1990). By 1978, the 2.1 million ha that remained were the wettest areas, consisting of 60% seasonally flooded forests and 40% swamps (MacDonald *et al.* 1979). Although forested wetland losses have continued, the rate of loss has slowed (McWilliams and Rosson 1990). The remaining forested wetlands in the Mississippi Alluvial Valley have almost all been cut over at least once. What remains forested is highly fragmented. Of the more than 38,000 forest patches >2 ha within the Mississippi Alluvial Valley, only 267 patches were over

1,012 ha but they contained >50% of the total forest area. The average patch size is 64 ha (USGS, unpublished data).

Table 5. Area of bottomland hardwood forest types within the Arkansas, Louisiana, and Mississippi portion of the Mississippi Alluvial Valley. Data from McWilliams and Rosson (1990). Society of American Foresters (SAF) cover type from Eyre (1980). Temporarily Flooded Forest Alliance (TFFA), Seasonally Flooded Forest Alliance (SFFA), and Semipermanently Flooded Forest Alliance (SPFFA) name and identification number from The Nature Conservancy (1997). [Refer to Appendix 1 for scientific names]

Forest Type	Hectares
Swamp chestnut oak - cherrybark oak (SAF cover type 91) I.B.2.N.d.210. (Swamp chestnut oak, cherrybark oak, Shumard oak) - sweetgum TFFA	30,000
Cottonwood (SAF cover type 63) I.B.2.N.d.160. cottonwood TFFA	52,000
Sweetgum - Nuttall oak - willow oak (SAF cover types 88, 88 var., 92) I.B.2.N.d.250. willow oak, water oak, diamondleaf oak TFFA I.B.2.N.e.130. willow oak SFFA	433,000
sugarberry - American elm - green ash (SAF cover type 93) I.B.2.N.d.090. sugarberry - cedar elm TFFA I.B.2.N.d.110. green ash - American elm TFFA I.B.2.N.d.260. Nuttall oak - sugarberry - (American elm, cedar elm) - (honey locust) TFFA	534,000
willow (SAF cover type 95) I.B.2.N.d.280. black willow TFFA I.B.2.N.e.160. black willow SFFA	163,000
overcup oak-water hickory (SAF cover type 96) I.B.2.N.e.032. water hickory - water locust SFFA I.B.2.N.e.100. overcup oak - water hickory SFFA I.B.2.N.e.140. Nuttall oak - (overcup oak) SFFA	248,000
cypress-tupelo (SAF cover types 101, 102, 103) I.B.2.N.d.290. bald cypress - sycamore TFFA I.B.2.N.e.190. bald cypress - (water tupelo, swamp blackgum, ogeechee tupelo) SFFA I.B.2.N.f.030. bald cypress - (water tupelo, swamp blackgum, ogeechee tupelo) SPFFA	396,000
Other forest types; sycamore - sweetgum - American elm (SAF cover type 94) live oak (SAF cover type 89) river birch - sycamore (SAF cover type 61) silver maple - American elm (SAF cover type 62) pin oak - sweetgum (SAF cover type 65) I.B.2.N.d.010. box elder TFFA I.B.2.N.d.030. silver maple TFFA I.B.2.N.d.040. sugar maple - bitternut hickory TFFA I.B.2.N.d.050. river birch - (sycamore) TFFA I.B.2.N.d.070. pecan - (sugarberry) TFFA I.B.2.N.d.140. sycamore - (green ash, sugarberry, silver maple) TFFA I.B.2.N.d.200. bur oak - swamp white oak - (kingnut hickory) TFFA I.B.2.N.d.255. willow oak - cedar elm TFFA I.B.2.N.e.020. red maple - green ash SFFA I.B.2.N.e.045. (eastern mayhaw, western mayhaw, rufus mayhaw) SFFA I.B.2.N.e.090. planertree SFFA I.B.2.N.e.120. pin oak - (swamp white oak) SFFA	84,000
Total bottomland hardwood	1,994,000

In forested wetlands in the MAV, habitat quality can be limited to issues of vegetative composition and structure, which are determined by moisture regimes and disturbance patterns. Due to a ridge and swale topography, most sites of any size will include low, wet areas as well as some that are higher and drier. Most large sites will therefore include a diversity of conditions that in sum are potentially satisfactory for all of the birds in this species suite. This microhabitat diversity is important because high priority species dependent upon forested wetlands vary in their microhabitat requirements (Pashley and Barrow 1992). Because the driest sites are best for agriculture, however, places that remain in forest tend to represent the wettest conditions in the Valley. The primary issue of concern regarding quality is that a sufficient amount of dry ridge habitat be included in each patch or set of patches to support those birds (including Swainson's Warbler and Cerulean Warbler) that prefer the structure associated with dry sites.

Disturbance patterns other than flooding also affect habitat quality. Historically these were treefalls caused by wind, ice storms, or other climatic events or perhaps very infrequent fire in the drier areas. The immediate result of each of these disturbances was a small to moderate-sized gap into which sunlight penetrated that was quickly occupied by shrubs, vines, and saplings. These gaps may be used preferentially by some birds (perhaps Hooded Warblers and surely White-eyed Vireos). The longer-term result was that each gap grew up as a small even-aged group of trees, resulting in a forest that consisted of a mosaic of many such even-aged groups of varying ages. An "old growth" bottomland hardwood, therefore, was not a continuous closed canopy that we associate with many older forests, but rather a dynamic mixture of patches ranging in age from very young to very old (Pashley and Barrow 1992, Keith Ouchley, pers. comm.).

Table 6. Habitat objectives for predominately mature, forested wetlands within the Mississippi Alluvial Valley. [See also Fig.2 and Appendix 5]

State	Number of Bird Conservation Areas	Number of forest patches (ha)		
		4,000-8,000	8,000-40,000	>40,000
Arkansas	18	9	11	3
Illinois	1	0	1	0
Kentucky	4	3	1	0
Louisiana	33	19	15	7
Mississippi	21	14	6	2
Missouri	7	6	1	0
Tennessee	3	1	1	1
Totals	87	52	36	13

Priority species, species suites, and habitat requirements

Swainson's Warbler habitat has been described as "rich damp woods with deep shade, moderately dense undergrowth, and relatively dry ground" (Meanly 1971). Swainson's Warblers favor breeding sites that are moist but not flooded with understory vegetation of

cane (*Arundinaria gigantea*), dwarf palmetto (*Sabal minor*), and sweet pepperbush (*Clethra alnifolia*) (Meanley 1971, Eddleman *et al.* 1980). These habitats may be produced in forested wetlands where tree fall or selective harvest (thinning, single tree selection, or patch cuts) of closed canopies has allowed light to hit the ground, in turn allowing vegetative development. Many of these sites are now prime agricultural sites for cotton production due to edaphic and hydrologic features that favor better drainage. Thus, the sites most conducive to restoration (less productive cropland and frequently flooded areas) are often not prime Swainson's Warbler habitat. However, because of topographic variability, larger restoration sites are likely to include high ground that supports Swainson's Warblers. Populations of this species at the northern end of the Mississippi Alluvial Valley (north of the Tensas Basin) are increasingly isolated from populations in the coastal plains and the southern Mississippi Alluvial Valley. Birds in small forest patches, as in Missouri, may suffer from effects of genetic isolation (Thomas *et al.* 1996 ; G. Graves, Smithsonian Institution, pers. comm.).

Generally numerous wherever moderately large forested wetlands are flooded through the breeding season, Prothonotary Warblers are probably the most secure of the high priority species within the Mississippi Alluvial Valley. This is a result of comparatively small area requirements and preference for the flooded forested habitat that persists in the Mississippi Alluvial Valley. However, nest depredation and parasitism rates may be high for this cavity-nesting species and should be monitored where feasible.

The only currently known Swallow-tailed Kite breeding populations in the Mississippi Alluvial Valley are in the Atchafalaya Basin of Louisiana. This species historically bred in 21 states with concentrations in 9, but now breeds in only 7 states with concentrations only in Florida (Meyer 1990, 1995; Meyer and Collopy 1990). Since the turn of the century, it has suffered the most dramatic reduction of any extant landbird in eastern North America.

The North American subspecies of Swallow-tailed Kite is probably the most vulnerable bird in the southeastern U.S. that is not federally listed as a threatened or endangered species nor a candidate for such listing. Total population size for this species is unknown but is certainly <5000 individuals, and probably <1150 breeding pairs (Meyer and Collopy 1990). This species appears to be expanding into some river systems where it has been absent from most of this century (*e.g.*, Sabine, Louisiana-Texas, and Pee Dee, South Carolina). This suggests that the population may expand in response to improved habitat conditions. About 40,000 ha (100,000 acres) of mature forested wetlands appear to be necessary to support 80 to 100 kite pairs (Cely and Sorrow 1990). Within patches of sufficient size for Swallow-tailed Kites, management should increase the availability of nest sites (*i.e.*, small stands of >30 m (100 ft) tall or higher trees, presumably cottonwood and baldcypress). Security for the Swallow-tailed Kite may require maintenance of >80 breeding pairs in 8 of the 13 proposed forest patches of >40,000 ha in the Mississippi Alluvial Valley in combination with populations in 13 major coastal plain floodplains from South Carolina to Texas outside of peninsular Florida. Mississippi Alluvial Valley forested wetlands may serve as staging sites from which Swallow-tailed Kites could reclaim their former breeding distribution throughout the mid-western United States.

Within the Mississippi Alluvial Valley, Cerulean Warblers breed almost exclusively north of the Arkansas-Louisiana state boundary. Although isolated breeding pairs have been reported in north Louisiana and in Mississippi, no significant populations are currently known from either of these states. Although persisting in some numbers in the highlands and plateaus from the southern Appalachians westward, this species has been much reduced within its historical breeding distribution throughout the southeastern coastal plain, including the Mississippi Alluvial Valley. Hamel (1992a; also see Robbins *et al.* 1992) surmised that a minimum of 4,000 ha of mature forested wetlands was required to maintain a source population of Cerulean Warblers based on his work in Tennessee. In areas where the landscape is dominated by agriculture, however, a more conservative estimate of 8,000 ha may be necessary to support source populations. Past forestry practices, hydrology, and perhaps other factors confound our ability to predict the locations of Cerulean Warbler populations. Habitats occupied by Cerulean Warblers tend to contain numerous very large trees towering above a multi-layered canopy structure and interrupted by frequent canopy gaps (Hamel 1992a, Robbins *et al.* 1992). It is important to note that Cerulean Warblers persist in commercial forests in which timber harvests mimic tree fall gaps (Hamel 1992a).

Although this plan only explicitly addresses the forested wetland needs of breeding birds, this physiographic area also provides important wintering habitat for temperate migrants and in-transit habitat for long-distance migrants. We have tentatively assumed that the habitats provided for breeding birds are also sufficient for wintering and migrant birds. This assumption needs to be rigorously tested. Additionally, some areas not suitable for high priority breeding birds may be very important for wintering and transient birds.

Habitat and population objectives

Population goals in the MAV are to ensure maintenance of conditions suitable for support of source populations of target species in 52 predominately mature, forested wetlands patches >4,000 ha (>10,000 acres), 36 patches >8,000 ha (>20,000 acres), and 13 patches >40,000 ha (>100,000 acres). However, other forest patches that are smaller than the minimum required to support source populations may still benefit breeding, wintering, or migrating birds. The distribution of patches among states ([Table 7](#), [Appendices 4](#) and [5](#)) is not even, largely reflecting existing opportunities. For example, there are more and larger blocks in south Louisiana than in Missouri. In order to improve the distribution of blocks, more marginal blocks were included in under represented areas. Patch size objectives were generally set at the highest threshold of realistically achievable restoration ([Fig. 2](#)) and distributed among states. This was a practical assessment of what is relatively easy to achieve. The main remaining question is whether it is enough. At least two relevant points to consider in answering this question are population viability and percentage of ecosystem health being maintained.

Although he strongly cautioned that minimum viable population size should be independently calculated for each species, Soulé (1987) suggested that a population size "in the low thousands" should be adequate for most vertebrates. Individuals breeding within a forest patch, however, are probably not genetically isolated from individuals in other patches. Because virtually all species of high concern in the MAV are neotropical migrants that exhibit low natal site fidelity, there is presumably a high likelihood of gene

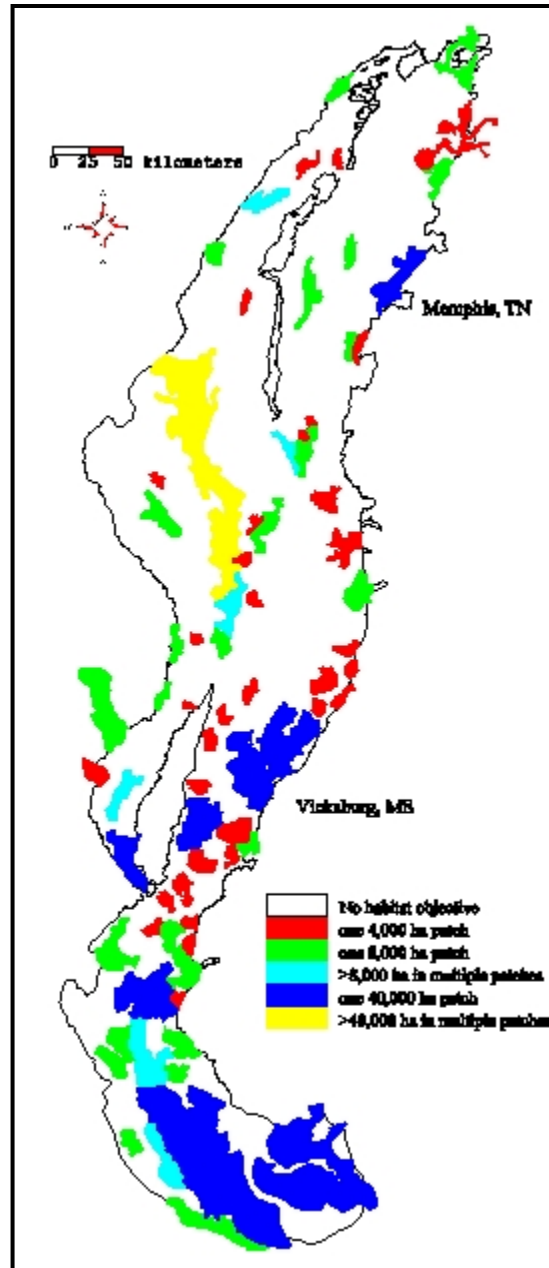
flow among bird populations breeding in different forest patches. Thus, maintaining avian populations above the "low thousands" in the entire physiographic area may assure viability of most species from a genetic perspective. The possible exception to confidence in this regard is the Swallow-tailed Kite, for which it may be necessary to perform a population and habitat viability analysis (Beardmore, in press) throughout the species' range in the Southeast to generate reliable population goals.

There is a level of effectiveness below which ecosystems begin to lose species.

Effectiveness includes some unknown combination of extent and function, and the threshold below which loss occurs is also largely unknown. Even though much about this is unknown, it is safe to say that the Mississippi Alluvial Valley bottomland hardwood ecosystem, through some combination of reduction in acreage, fragmentation, change in age and structure, and/or hydrological alteration, has fallen below that level. Ivory-billed Woodpecker and Bachman's Warbler are extinct, the red wolf is extirpated, and black bears and Swallow-tailed Kites are relegated to tiny segments of their former range.

It has been suggested that at least 10% of an ecosystem be maintained to prevent extirpation of species (Jon Haufler, pers. comm.). Even though something like 20% of the MAV remains forested, the vast majority of that forest exists as tiny fragments in which all but the least area-sensitive wildlife cannot persist. A reasonable objective to this bird conservation plan, therefore, could be to restore or maintain 10% of the original area of the MAV as functional forest habitat.

Although this rather arbitrary objective is enticing in many ways, it also raises some logical inconsistencies. First, the system has already lost those species that the theoretical maintenance of a 10% level is supposed to retain. Those organisms next most threatened with extirpation in the MAV may be big river fish. There is no doubt that aquatic organisms will benefit from reforestation, but the degree to which they will enjoy protection as a result of restoration to health of 10% of the terrestrial system is unknown. It is likely that the status of aquatic organisms will continue to be precarious without major hydrological improvements beyond the scope of this plan.



Will implementation of the objectives of this plan bring back the most area-sensitive terrestrial organisms that remain - the Swallow-tailed Kite and Louisiana black bear? Each of these animals is postulated to require patches of 40,000 ha of forest. Regardless of the sum of the total area in this plan's objectives for the 100 forest patches, the sum of acreage in patches exceeding 40,000 ha is considerably less than 10% of the original extent of the system. A second and rather surprising logical consideration of a 10% objective, therefore, is that the 100 forest patches recommended herein are insufficient.

An objective of 100 healthy populations, including 36 that support birds with area needs of 8,000 ha and 13 for birds requiring 40,000 ha is surely enough to maintain viability of all save perhaps one species of bird. Even this may be biologically acceptable if the sum of objectives of this plan plus those of plans for nearby physiographic areas in the Southeast is enough to provide long-term security for the Swallow-tailed Kite. On the other hand, although the objective adds up to a very significant area, it is nonetheless doubtful that it is enough to recreate and perpetuate a healthy bottomland hardwood ecosystem in the MAV.

In some ways, however, the issue of sufficiency of population goals at the physiographic area level is not biological in nature, but instead depends upon our anticipation of the demands of society in future centuries for populations of birds and other elements of biological diversity. From this perspective, it is difficult to evaluate the sufficiency of these ambitious but realistic goals.

Table 7. Area in hectares of forested habitat within the Mississippi Alluvial Valley based on 1992 satellite imagery.

State	Total land area	Forested area	Swamp forests	Bottomland hardwoods	Thin-edge forest	Number of patches > 1012 ha
Arkansas	3,755,000	718,000	93,000	420,000	115,000	67
Illinois	55,000	10,000	1,000	5,000	3,000	3
Kentucky	69,000	20,000	4,000	12,000	3,000	14
Louisiana	3,835,000	1,397,000	411,000	719,000	163,000	130
Missouri	1,008,000	61,000	4,000	39,000	14,000	7
Mississippi	2,038,000	454,000	64,000	314,000	62,000	38
Tennessee	273,000	59,000	9,000	36,000	11,000	8
Total	11,033,000	2,719,000	586,000	1,545,000	371,000	267

Implementation recommendations and opportunities

Within the context of the Partners in Flight "Flight Plan", each of these blocks is a Bird Conservation Area, in that each block is intended to support a healthy source population of all targeted bird species. Site specific planning within each of these Bird Conservation Areas will be based upon size and configuration of existing forests, ownership and intent of landowners, flood regimes, and our current knowledge of the avifauna. An example of a detailed process to determine site specific objectives is provided in Appendix 6. In

general, the long-term security of forest habitat on public land, private industrial forest products property, and in land held under limited partnerships (e.g., hunting clubs) is considered high. A variety of conservation tools may be employed on lands in other ownership categories. Private landowner involvement will be essential, in that land acquisition by public and private conservation agencies will never be adequate to accomplish these objectives. Subjective ([Appendix 4](#)) and objective (Appendix 5) criteria can be used to prioritize restoration efforts among proposed Bird Conservation Areas. Even so, we cannot ensure that bird population goals will be attained simply by implementing habitat strategies. Research and monitoring are required to assess progress and to refine both population goals and habitat objectives

Land use and management within Bird Conservation Areas will determine whether they are used to their fullest by high priority bird species. Within limits set by topography and location, areas in which natural hydrological processes are allowed to influence native plant communities will create conditions most suitable for most of the birds. Irreversible historical alterations and landowner objectives limit this option to only a few of the Bird Conservation Areas. In other areas, maintenance of vegetative structure preferred or required by high priority birds may be compatible with other management objectives. For example, Cerulean Warblers may benefit most from fast growing trees like cottonwoods and tulip-poplars, but current reforestation is usually concentrated on slow-growing species such as oaks and pecans. Nevertheless, reforestation emphasizing oaks and hickories can be easily modified to include soft-seeded, faster growing trees. Other forest management practices can be modified to provide denser understory vegetation for many understory breeding birds.

Modern-day disturbance, largely silvicultural activities, can mimic the historical pattern of a landscape mosaic of young and old forests. Small clear cuts or selective harvest can leave conditions similar to treefall gaps, and can result in forest consisting of a mosaic of patches of different ages, with each patch even-aged internally. Modern forestry does not, however, tend to leave patches in older age classes. The one bird most closely associated with those older conditions, the Ivory-billed Woodpecker, is now extinct, so the negative impact of such omission is not obvious. In some ways, industrial forests mimic natural conditions better than many protected areas, in that the forests now protected were last cut midway through the century, which means that each large area is even-aged and about forty to eighty years old. This is too young for a forest to begin undergoing much in the way of treefall, which results in a lack of gaps and a greatly reduced volume and diversity of understory and midstory vegetation. Given time, protected forest will assume the diverse characteristics of pre-settlement bottomland hardwoods. In the meantime, it is possible that timber stand improvement practices, single tree selection, and/or group selection could hasten the development of structure and benefit some of the bird species most dependent on mid- or understory vegetation.

All of these recommendations for forest-breeding birds must be integrated with objectives set for waterfowl and shorebirds. Bottomland hardwood forests are important habitat for waterfowl during winter, but whether the amount and distribution of forest for breeding birds is sufficient for waterfowl has yet to be rigorously examined. Some waterfowl and all shorebird needs are to be met on open wetlands. The balance between open and forested land on public property and issues of the impact of open land on

adjacent forest (e.g., do these areas support large numbers of cowbirds and predators?) also needs to be investigated. Also, there must be a concerted effort, in the future, to assure that these bird conservation areas adequately represent the range of naturally occurring soil and community conditions in the MAV. Failure to meet these conditions may ultimately require more restoration and expense than currently contemplated.

Evaluation of assumption

Population objectives for forest birds are based upon the assumed spatial requirements of territorial individuals. It is assumed that habitat availability is the primary limiting factor for these birds and that maintaining or restoring "suitable" forest patches (i.e., patches of adequate size, shape, and management) will result in bird population increase and eventual stabilization. We also assumed that the breeding bird densities recorded in Hamel (1992b) reflect the average densities of birds in the Mississippi Alluvial Valley and that the target number of 500 breeding pairs of the appropriate species (with some exceptions, such as Swallow-tailed Kite) will occur within forest patches exceeding minimum size thresholds. Each forest patch that meets designated criteria is assumed to support a source population of each of its representative breeding species; that is, populations that on average produce more offspring than the number required to compensate for adult mortality. Finally, we assumed that gene flow among populations in forest patches is sufficient to maintain genetic diversity. The assumptions in this Plan will be tested on the basis of the following objectives.

Objective 1: The total area, geographic distribution, fragment size, interior area, and qualitative characteristics (e.g., ownership, habitat type, hydrological regime, etc) of bottomland hardwood forests within the Mississippi Alluvial Valley must be determined. Much of this has already been done. Forest cover within the Mississippi Alluvial Valley has been classified from thematic mapper (TM) imagery ([Table 8](#)). Discrete forest patches have been delineated and public land boundaries have been defined. Now available are data on the total area of bottomland hardwood forest by state, the number, size distribution, and geographic distribution of forest patches, and the area of forest in public and in private ownership. The Lower Mississippi Valley Joint Venture office is continuing to pursue other applications of Geographic Information Systems, including the distribution of flood stages across all habitat types. Long-term monitoring strategies are required to gauge progress toward habitat objectives and ultimately population goals.

Objective 2: Additional information is needed on the diversity and abundance of breeding birds using forest patches of different sizes and different forest types in the Mississippi Alluvial Valley. This could lead to development of models that predict bird distribution and abundance based on landscape and vegetative characteristics of forest patches.

Inventories of breeding and wintering birds are still needed for many managed areas. Established Breeding Bird Surveys (Robbins *et al.* 1986) should be conducted annually and completion of Breeding Bird Atlases encouraged. Standard avian monitoring techniques have been developed (Ralph *et al.* 1993) and point count methods refined for

Table 8. Area of shrub/scrub and grassland habitats (in hectares) within the Mississippi Alluvial Valley classified from 1992 satellite imagery (USGS, unpublished data).

State	Scrub/Shrub Habitats ^a	Grassland Habitats ^b
Arkansas	206,000	120,000
Illinois	3,000	1,000
Kentucky	5,000	3,000
Louisiana	240,000	129,000
Missouri	27,000	15,000
Mississippi	134,000	54,000
Tennessee	16,000	9,000
Total	637,000	331,000

^a Shrub/scrub habitats can include weedy agricultural fields, brushy swamps, overgrown watercourses, and regenerating forests.

^b Grassland habitats includes, pastures, hayfields, municipal grasslands (airstrips, golf courses, etc.), and levee berms.

use in the Mississippi Alluvial Valley (Smith et al. 1993, Hamel *et al.* 1995). Breeding Bird Point Counts should be established and conducted annually in each of 50 disjunct stands with the following habitats: (1) semi-permanent flooded forests, such as those dominated by cypress or tupelo; (2) frequently flooded forests such as those dominated by overcup oak, water hickory, willow, and red maple; (3) infrequently flooded bottomland hardwood forests such as those dominated by red oaks, sweetgum, sugarberry, and ash; (4) upland forests located within or adjacent to the Mississippi Alluvial Valley [including pine, hardwood, and mixed pine-hardwood forests]; (5) early successional forests resulting from timber harvest or forest plantings; (6) grasslands; and (7) agricultural habitats. Until a regional or national repository for point count data is established, these data should be submitted in standard ASCII format (Hamel *et al.* 1995) to the Breeding Bird Point Count Repository, c/o Mark S. Woodrey, Mississippi Museum of Natural Science, 111 North Jefferson Street, Jackson, MS 39202.

Objective 3: Breeding bird densities in bottomland hardwood forests should be determined in order to assess the adequacy of forest patches to meet the area requirements of 500 breeding pairs of priority species. The assumption that the breeding densities reported in Hamel (1992b) are reflective of densities in the Mississippi Alluvial Valley requires validation. Research is needed to determine breeding bird densities (with associated confidence intervals) that reflect variability in patch characteristics and habitat types. Habitat within and among forest patches is clearly not uniformly suitable for breeding by a particular species and breeding bird densities are not constant over time and space.

Densities of birds can be assessed indirectly by using point count surveys in that accurate assessment of actual breeding bird density at a landscape scale (i.e., thousands of ha) is not economically feasible. The relative abundance determined from these surveys can be used as an index to the actual densities. Actual densities on small plots, such as 10 to 50 ha Breeding Bird Census (Hall 1964) plots used in demographic assessments, can be

indexed to relative abundance estimates derived from point count surveys on those same sites (Hamel 1984). This tool can be used to extrapolate results of point count surveys over larger areas and among forest patches with different characteristics using ratio or regression estimators (Cochran 1977).

Objective 4: Quantification and modeling of the species-specific demographics of high priority forest bird populations is necessary in order to address the assumption that the proposed forest patches of 4,000, 8,000, and 40,000 ha will support source populations of targeted species. Species-specific demographic analyses conducted over a broad geographic range and over extended time periods will require information on nest survivorship, nest parasitism rates, nest predation rates, and re-nesting effort. Additionally, data are needed on age-specific survival of individuals, their dispersal, and philopatry. All these data are time consuming, difficult, and expensive to obtain, but they are essential to understanding the ability of forest patches to support populations of breeding birds.

Research designs that identify habitat use and dispersal of post-breeding adults and of young-of-the-year will be extremely useful in evaluating landscape conditions that promote persistence of source populations. Current assumptions about habitat use, patch characteristics, and survivorship are based upon knowledge of breeding adults. Few, or no, data exist on differences in habitat utilization between breeding adults and non-breeding adults during the breeding season, or between post-breeding adults and their offspring.

Logistic and fiscal constraints mandate collection of demographic data at only a relatively few locations. We assume, however, that demographic parameters related to forest patch characteristics can be extrapolated to other, similar forest patches within the Mississippi Alluvial Valley. To do this, however, we must be able to relate demographic parameters to forest patch metrics and within-patch vegetation characteristics.

Demographic studies are currently underway in bottomland hardwood forests in the Mississippi Alluvial Valley from southern Illinois to southern Louisiana. Current studies target different species, are conducted by different personnel, and have different overall objectives. However, these studies generally follow standardized methods of data collection to obtain estimates of productivity, nest survival, nest parasitism rates, and nest predation rates. Some of these data are from certain high priority species, such as the Cerulean Warbler, but the majority are from more common species such as Acadian Flycatchers and Prothonotary Warblers. Results of these studies may be applicable to other sites and to other species within these sites.

One of the reasons that survival of individuals, including age-specific estimates within and among seasons, is difficult to assess is a lack of data on the dispersal of individuals. Data on site fidelity and dispersal are similarly difficult to obtain and require extensive investigations across both area and time to estimate. Also important but even more difficult to measure is the impact of forest management on rates and distances of dispersal. Minimal estimates of survival of individuals and site fidelity, however, are being obtained through color-marking of individuals in mark-recapture studies or through constant-effort mist netting. Application of open population models (e.g., Pollock *et al.*

1990, Lebreton *et al.* 1992) to these data should result in estimates of survival with defined confidence limits.

Finally, predictive models need to be created that estimate species-specific demographic parameters based on the characteristics of the forest patch and under different forest management regimes. It may thereafter be possible to evaluate the assumption that demographic parameters can be predicted from forest patch metrics.

Objective 5: There should be tests of the assumption that the number of source populations proposed within the Mississippi Alluvial Valley constitutes an adequate number of breeding individuals within an overall meta-population to ensure long-term maintenance of genetic diversity and population viability. We are not now in position to test whether the proposed minimum of 500 breeding pairs is sufficient to ensure viability within a forest patch nor do we have sufficient data to support meta-population dispersal within the Mississippi Alluvial Valley. Data required to begin a meta-population analysis within the Mississippi Alluvial Valley include species-specific estimates of survival rates of hatching-year birds, rates and distances of dispersal of young from natal to breeding sites, among year dispersal of adult breeders, and rates of gene flow among breeding populations.

Other Objectives: Other research needs related to migratory landbirds include investigation of habitat use during migration, use of non-forested habitats by forest breeding birds, use and availability of food resources, and winter habitat use.

Specific research objectives, including investigators, study plans, cooperators, and time tables, have been identified for wintering waterfowl (Loesch *et al.* 1994). Similarly detailed research objectives are needed for shorebirds. In all cases, however, completion of proposed research and implementation of monitoring plans will require increased resource levels and as much, or more, cooperation as is currently the hallmark of this physiographic area.

Forest Openings, Edges, Early-Successional Shrub-Scrub

Status and importance

Within mature forests, small forest openings occur naturally in gaps created by fallen trees. Larger openings containing shrub-scrub habitat are created and maintained in these forests by disturbance phenomena such as: grazing, wind, tornados, hurricanes, ice storms, flooding, and most notably fire. Additionally, Yaich (in press) speculated that, formerly, passenger pigeon roosts, covering up to several thousand acres, caused catastrophic disturbances through breaking of tree limbs and guano deposition. Naturally occurring edge habitats are still associated with these disturbances but edge and early-successional habitats are now largely the result of human intervention. These disturbances all promote subsequent successional shrub-scrub development.

Earlier this century, land clearing for small farms and inefficient farming practices on these farms was common in the Mississippi Alluvial Valley. These small logging and farming operations provided an anthropogenic supplement to naturally occurring shrub-

scrub habitats. Since the 1940's, small-scale timber harvests have been replaced by large-scale land clearing with subsequent conversion to large-scale agricultural operations. With more efficient farming techniques on these large cleared fields, much of the "old-field" and "hedgerow" habitats associated with small farms has been lost. Additionally, suburban development has encroached on cleared land, and forest succession has proceeded towards more mature forest stages. Currently, lands managed through even-aged silvicultural practices that remove all or most of the standing timber (i.e., "clearcut"), but are not converted to land uses other than forest production, provide most of the early successional shrub-scrub habitat within the Mississippi Alluvial Valley. As with natural disturbances, clearcuts provide transitory habitats and do not provide long-term stability for shrub-scrub species in any one tract. The current trend, however, is away from large clearcuts on both public land and non-industrial private lands. Similarly, the trend continues away from inefficient farming. Efforts to restore natural disturbance regimes to this bottomland ecosystem are minimal. Thus, active management to create and maintain early successional shrub-scrub habitats may be required to provide for those biotic communities and birds dependent on shrub-scrub habitats.

Although estimating the area of this relatively ephemeral habitat is difficult, classified TM imagery from 1992 suggests that >600,000 ha of scrub-shrub habitat are currently within the Mississippi Alluvial Valley (Table 9). This area includes weedy fields, idled farmland, overgrown drainages, and shrubby swampland as well as regenerating forests, but they do not include forest edge or thinned forest habitats that may account for an additional >300,000 ha in the Mississippi Alluvial Valley (see Table 8).

Table 9. Area of upland forest (in hectares) on ridges within the Mississippi Alluvial Valley classified from 1992 satellite imagery (USGS, unpublished data).

Physiographic Area (State)	Total Area	Forested Area
Crowley's Ridge		
Arkansas	145,000	84,000
Missouri	55,000	17,000
Macon's Ridge		
Arkansas	7,000	1,000
Louisiana	276,000	40,000
Sicily Island		
Louisiana	5,000	4,000
Total	488,000	146,000

Priority species, species suites, and habitat requirements

Several forest edge species, including Mississippi Kite, Orchard Oriole, and White-eyed Vireo, warrant management attention within the Mississippi Alluvial Valley. These species can also be found in the interior of bottomland forests, particularly where disturbance has opened the existing canopy. Forest edge species may be highly

susceptible to nest depredation and parasitism as these habitats also harbor foraging cowbirds and nest predators (Robinson *et al.* 1995). Other species with high concern scores, such as Painted Bunting and Loggerhead Shrike, are more typically associated with early successional habitats or grass-dominated forest edges. Although limited in abundance and restricted in distribution to the far northern portions of the Mississippi Alluvial Valley, Bell's Vireo has a high concern score and may be of local concern in scrub-shrub habitats.

Population trends for widespread breeding species associated with shrub-scrub habitats exhibit an overall decline in the southeastern U.S., some of which are very steep. In addition to nongame species, range-wide declines in American Woodcock and Northern Bobwhite are

alarming. The habitat requirements of game bird populations should be addressed in conjunction with plans to formalize area, distribution, and rotation objectives for early-successional habitats.

Habitat and population objectives

Specific population goals have not been established but the tentative goal is to provide forest openings, edges, and early-successional habitats for scrub/shrub dependent species without subjecting forest-interior species in the Mississippi Alluvial Valley to increased nest depredation or parasitism. Because it takes little time to shift land use to a shrub-scrub condition, but conversion to mature forest takes decades, critical to considerations of area objectives for shrub/scrub species are the habitat objectives for species dependent upon more mature forests.

Within the southeastern United States, Capel *et al.* (1994) recommended a combination of early successional habitats to provide foraging, nesting, and cover needs of early-successional wildlife populations. Specifically, habitat objectives were set at 1 million ha of 5-year idled lands in native vegetation or grass-legume mixes, 1 million ha of annual vegetation (forbs or annually established cover), and 2 million ha of long-term (10-20 years) herbaceous or shrub cover. Long-term cover provides the greatest benefit to most shrub-scrub species, especially if managed with controlled burns rather than by mowing.

An appropriate allocation of the above recommendations has yet to be made within the Mississippi Alluvial Valley. However, based on current estimates of scrub-shrub habitat (>600,000 ha) and forest edge habitat (>300,000 ha), an overall habitat objective of 1 million ha may not be unreasonable, particularly if long term scrub/shrub habitats can be positioned to provide gradual (soft) edges to mature forest patches.

Implementation recommendations and opportunities

Management strategies to provide suitable forest edge and early-successional habitats should minimize detrimental impacts on birds dependent upon mature forests. Land ownership and silvicultural objectives may influence which management strategies are employed. Regeneration on large consolidated clearcuts (*e.g.*, 10-20 acres on public lands, 50-100 acres on private lands) will provide suitable habitat for shrub-scrub

dependent birds but, in small forest patches, openings of this magnitude may negatively impact forest-interior breeding birds. Conversely, a similar area of small gaps within a single forest patch may be equally detrimental to forest-interior species. Undoubtedly, the impact of area of harvest (i.e., gap size) and harvest frequency on the reproductive success of shrub-scrub species, as well as forest-interior species, requires additional research before specific recommendations can be made.

Over the next few decades, much early successional habitat will be created through reforestation associated with implementation of Wetland Reserve and Conservation Reserve Programs and through reforestation on public lands. In the long-term, however, we anticipate most shrub-scrub habitat will result from harvested and subsequently regenerated forests.

Towards this end, opportunities to create large blocks of early-successional habitat on private lands exist through agro-forestry (e.g., short-rotation, planted or coppiced cottonwoods or other fast-growing hardwoods such as sycamore [Twedt and Portwood, in press]). Large blocks of early-successional habitat can be provided in these forest-farms on a continuing basis as trees are harvested and subsequently regenerated. Currently, most short-rotation forest production goes into pulpwood but the potential exists for increased area devoted to woody crop production intended for biomass production (Ranney *et al.* 1985). Agro-forestry should be promoted as a replacement for annual agricultural crops, such as cotton and soybean, but not as a replacement for existing or potential forests managed for saw-timber. When possible, forest farms should be located adjacent to existing mature forests, under longer rotation silvicultural management, to provide a buffer against nest predation and parasitism within the more mature forest stands, thereby increasing the effective "interior area" of the forest patches.

When early-successional habitat objectives targeting a continuing flow of early-successional habitats within the Mississippi Alluvial Valley are finalized, these objectives should be allocated to individual states and, where appropriate, to individual bird conservation areas.

Evaluation of assumptions

Species densities and demographic data are needed for species breeding at the interface of forest and agriculture ("hard" forest-edges), for species breeding in early-successional habitats, and for species breeding at the interface of mature forests and early-successional habitats ("soft" forest-edges). Of particular relevance is an examination of the ability of shrub/scrub buffers to mitigate negative impacts of predation and parasitism on interior nesting species. These parameters should be investigated in a variety of landscape contexts, particularly in largely forested and largely non-forested landscapes, to develop sound recommendations that can be adapted to the objectives of different landowners. Short-rotation managed forests may provide opportunities for manipulative experimentation to address issues such as population demographics, dispersal, and provide insight into the fates of birds displaced by timber harvest..

Upland Oak-Hickory Hardwoods

Status and importance

The most striking upland forests within the Mississippi Alluvial Valley are located on ridges and domes embedded within this floodplain (e.g., Crowley's Ridge, Macon's Ridge, and Sicily Island). Other oak-hickory hardwood forests (Bryant *et al.* 1993, Skeen *et al.* 1993) are found along the edges of the valley in loess bluffs (this habitat is covered within the East Gulf Coastal Plain conservation plan) and otherwise localized in small stands along the highest ridges within forests dominated by bottomland tree species. Upland woodlands on braided stream terraces may be the most poorly represented habitat on public lands in the Mississippi Alluvial Valley (M. Swan, pers. com.).

Crowley's Ridge is a high ridge completely embedded within the Mississippi valley that runs north to south from Missouri through Arkansas. Macon's Ridge, running from southeast Arkansas southwesterly through northeast Louisiana, is wider and lower than Crowley's Ridge. Sicily Island is a dome cut off from the Valley's western bluff by the Quachita River floodplain. Because these ridges are on high, often sloping ground, they are generally unsuitable for large-scale agriculture but are instead heavily spotted with homes, pastures, small fields, and even pine stands, leaving the remaining hardwoods in a highly fragmented state. Of the 487,655 ha of uplands comprising Sicily Island, Crowley's Ridge, and Macon's Ridges, 146,405 ha remain forested ([Table 10](#)). Nevertheless, neotropical migratory landbird species that are not expected within most of valley's forested wetlands occur where relatively large, mature hardwood forest patches remain on these ridges.

The upland forests on the eastern loess bluff of the Mississippi Alluvial Valley remain relatively intact and predominately in hardwood forests. Because underlying soils are highly erodible, large scale deforestation of the loess bluff forests is not likely. However, potential threats to bluff hardwood forests include increasing urbanization, fragmentation from small agricultural fields and pastures, and conversion to managed pine forests.

Priority bird species, species suites, and habitat requirements

Many of the species of concern in forested wetlands (e.g., Swainson's Warbler, Yellow-billed Cuckoo, Cerulean Warbler, Orchard Oriole, White-eyed Vireo, Hooded Warbler, and Red-headed Woodpecker) also occur at lower densities within upland hardwood forests (Moore 1995). Two species with lower concern scores, Worm-eating Warbler and Louisiana Waterthrush, are generally restricted during breeding season to these upland habitats. Worm-eating Warbler favors ravines and slopes in forests with dense understory, whereas Louisiana Waterthrush is typically found in deciduous forests with small flowing streams.

Table 10. Twenty-five years (1966-1991) of Breeding Bird Survey population trends for the southeastern U.S. among widespread grassland birds found in the Mississippi Alluvial Valley.

Species	Population trend (% / yr)	Number of Routes	Proportion of Decreasing Routes	Mean Birds per Route
Killdeer <i>Charadrius vociferus</i>	0.1	807	0.48	4
Eastern Kingbird <i>Tyrannus tyrannus</i>	-1.0	784	0.57**	5
Horned Lark <i>Eremophila alpestris</i>	-1.5*	398	0.60**	8
Loggerhead Shrike <i>Lanius ludovicianus</i>	-3.7**	628	0.67**	3
Common Yellowthroat <i>Geothlypis trichas</i>	-1.5**	739	0.60**	8
Dickcissel <i>Spiza americana</i>	-0.2	367	0.56*	13
Grasshopper Sparrow <i>Ammodramus savannarum</i>	-3.9*	487	0.57**	2
Eastern Meadowlark <i>Sturnella magna</i>	-1.6*	829	0.67**	36

* = P < 0.05, ** = P < 0.01

Habitat and population objectives

Neither specific population goals nor habitat objectives have been established for upland oak-hickory hardwoods within the Mississippi Alluvial Valley. However, in order of priority general habitat objectives are: to maintain existing upland oak-hickory forests, to reforest gaps and intrusions within larger patches of upland forest, to connect upland forests with adjacent forested wetlands, to consolidate smaller forested blocks into larger ones by reforesting intervening habitat, and to minimize conversion of hardwood forests to managed pine forests.

Implementation recommendations and opportunities

Promotion of hardwood forests within both ridges and bluffs of the Mississippi Alluvial Valley should be encouraged through Forest Stewardship programs, soil conservation education, and development of markets for hardwood forest products. Conservation programs, such as the Conservation Reserve Program, should encourage landowners to reforest using hardwood species and conversion of hardwood forests to softwood (pine) monocultures should be discouraged.

Evaluation of assumptions

Distribution and density of breeding birds in upland forests located on both internal ridges and loess bluffs should be further refined. The ability of silvicultural techniques to diversify vegetative structure of forest understory and its impact on breeding birds should be examined.

Grasslands/Savannas, Pastures, and Associated Wetlands

Status and importance

The loss of native grass-dominated ecosystems and resulting decline of their dependent flora and fauna over the last two centuries is well documented, especially for the extensive grasslands covering the middle portions of the North American continent. Historical grass-dominated ecosystems of the southeastern United States, east of the tallgrass prairies of Texas and Oklahoma and the coastal prairies of Texas and Louisiana, consisted mostly of relatively small and isolated patches within a forest-dominated landscape. Nevertheless, remnant southeastern grasslands remain centers of biodiversity, with many endemic species (DeSelm and Murdock 1993). As a result of habitat loss, several species of southeastern grassland birds require protection under the Endangered Species Act. Thus, restoration and management of grasslands and prairies is high on the list of conservation actions within the southeastern U.S.

Although limited in area and distribution, native prairies have historically been part of the Mississippi Alluvial Valley ecosystem. The Grand Prairie, historically covering nearly 200,000 ha, is the largest tallgrass prairie within the MAV. It is dominated by bluestem and switch grass interspersed with wetlands, riparian ribbons, and oak savannas. Remnants of Grand Prairie (<400 ha) are on low, flat, mostly poorly drained river terraces (DeSelm and Murdock 1993). These small areas are of undetermined value to birds, but remain highly important to regional plant and invertebrate diversity. Arkansas' remaining prairies are "wet-mesic," dominated by switch grass with their wetter, lower borders supporting cordgrass (*Spartina* spp.), gamagrass (*Tripsacum* spp.) or slough grass (*Beckmannia syzigachne*) (DeSelm and Murdock 1993). Although other prairie remnants can be found south to Ascension Parish, Louisiana, most prairies on private lands were quickly converted to agricultural production. Where remnant prairie patches remain, lack of fire is threatening this habitat as it succeeds to woodland.

Currently, pastures, hayland, rice and other "grass" crops, airfields, and other anthropogenic grasslands provide grassland bird habitat within the Mississippi Alluvial Valley. An estimate of the area of all types of grasslands (excluding crops) in the Mississippi Alluvial Valley is about 300,000 ha (see [Table 9](#)). Although many species

benefit from these non-native grasslands, remnant native grasslands still provide core habitat for the most highly vulnerable species. More widespread open-country birds make extensive use of cropland and pastureland but even these relatively common grassland species are showing population declines. These declines may be due, in part, to changes in landowner preference for cool-season over warm-season grasses in pastures as well as efficient and frequent mowing (haying) practices.

Priority species, species suites, and habitat requirements

As previously stated, both Swallow-tailed and Mississippi Kites frequently forage over open grasslands. Otherwise, the only breeding species of high concern that make extensive use of grasslands are Loggerhead Shrike and Field Sparrow. Loggerhead Shrike remains a fairly common resident species, at least in the southern portion of the Mississippi Alluvial Valley, but widespread declines and reduction in distribution during the latter part of this century have led to concern for this species throughout most of its eastern range. Field Sparrows, like shrikes and buntings, favor grass dominated shrub-scrub habitats for breeding. Although their concern scores are slightly lower, two additional breeding species, Dickcissel and Grasshopper Sparrow, are found in grassland habitats. The relative abundance of breeding Dickcissel make it a potential species for use in monitoring the impact of grassland restoration in the Mississippi Alluvial Valley.

Perhaps the most important role for the grasslands of the Mississippi Alluvial Valley is to provide wintering habitat for grassland birds. Short distance migrants, both Field and Grasshopper Sparrows breed and winter in the Mississippi Alluvial Valley. Several other species with high or moderately high concern scores use grassland habitats in the Mississippi Alluvial Valley during winter including: LeConte's Sparrow Henslow's Sparrow, Rusty Blackbird, Short-eared Owl, and Sedge Wren. LeConte's and Henslow's Sparrows are perhaps the most vulnerable birds dependent upon grasslands within the Mississippi Alluvial Valley. However, the importance of this physiographic area for these species is questionable when compared to larger wintering populations in the adjacent coastal plains. Although Henslow's Sparrow favors pine flatwoods and savannas, both this species and LeConte's Sparrow will use moist sites dominated by grasses during winter. No data exist on the abundance of high priority species wintering within the Mississippi Alluvial Valley and development of protocols that provide for widespread monitoring for these, often secretive, species during winter is needed.

Breeding Bird Survey data ([Table 11](#)) show that 5 of 8 widespread southeastern U.S. grassland species that are likely to breed in the Mississippi Alluvial Valley have significant population declines during the past quarter-century. Although none of these widespread species are in immediate danger of extirpation anywhere within their distribution (with the possible exception of Loggerhead Shrike), primarily because these species successfully exploit cropland and pasture, the steep declines of some of these species are alarming. These declines likely reflect changes in agricultural practices and loss of suitable habitat in historical cropland and pasture, as well as long-term loss of native grasslands, throughout the southeastern U.S.

Table 11. Shorebird species, average mass, and hypothesized abundance during southward migration through the Mississippi Alluvial Valley based on data from International Shorebird Survey sites (data from Loesch *et al.* in press).

Common Name	Scientific Name	Mass (g)	Abundance
American Avocet	<i>Recurvirostra americana</i>	150	232
Black-necked Stilt	<i>Himantopus mexicanus</i>	125	778
Piping Plover	<i>Charadrius melodus</i>	40	121
Semipalmated Plover	<i>Charadrius semipalmatus</i>	35	4,765
Killdeer	<i>Charadrius vociferus</i>	50	91,838
Black-bellied Plover	<i>Pluvialis squatarola</i>	150	769
Lesser Golden-plover	<i>Pluvialis dominica</i>	130	449
Marbled Godwit	<i>Limosa fedoa</i>	200	39
Willet	<i>Catoptrophorus semipalmatus</i>	175	92
Greater Yellowlegs	<i>Tringa melanoleuca</i>	125	3,235
Lesser Yellowlegs	<i>Tringa flavipes</i>	75	21,120
Solitary Sandpiper	<i>Tringa solitaria</i>	60	2,608
Spotted Sandpiper	<i>Actitis macularia</i>	40	4,112
Wilson's Phalarope	<i>Phalaropus tricolor</i>	50	171
Dowitcher spp.	<i>Limnodromus</i> spp.	125	2,242
Stilt Sandpiper	<i>Calidris himantopus</i>	75	3,310
Common Snipe	<i>Gallinago gallinago</i>	150	2,374
Ruddy Turnstone	<i>Arenaria interpres</i>	140	405
Red Knot	<i>Calidris canutus</i>	140	162
Dunlin	<i>Calidris alpina</i>	35	7,866
Sanderling	<i>Calidris alba</i>	60	5,052
Semipalmated Sandpiper	<i>Calidris pusilla</i>	30	37,713
Western Sandpiper	<i>Calidris mauri</i>	30	3382
Least Sandpiper	<i>Calidris minutilla</i>	25	151,119
Calidrid spp. ('peeps')	<i>Calidris</i> spp.	30	32,286
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	40	221
Baird's Sandpiper	<i>Calidris bairdii</i>	40	690
Pectoral Sandpiper	<i>Calidris melanotos</i>	60	121,077
Upland Sandpiper	<i>Bartramia longicauda</i>	125	237
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	50	964
Other shorebirds		40	571
		mean weighted mass = 45	total = 500,000

Habitat and population objectives

General habitat objectives are to maintain, convert, or restore native warm-season grasslands and other native prairie flora, in conjunction with associated wetlands and savannas, and to maintain these grasslands using appropriate disturbance (*e.g.*, fire, grazing) regimes.

To restore grassland wildlife populations to pre-1980 levels, declines in pasture and range acreage must be reversed and cool-season grass pastures should be converted to native warm-season grasslands (Capel *et al.* 1994). The area of warm-season grassland in the Mississippi Alluvial Valley is unknown but is probably small. Warm-season grasses are more drought tolerant, thus providing livestock with reliable summer forage. Furthermore, as the only rapid developer of topsoil in the A soil horizon, warm-season grasses contribute significantly to soil quality. Soil development is a major consideration for many southeastern soils that have been farmed for >200 years.

Tentative population goals are to provide sufficient habitat for 10 populations of grassland breeding birds, along with their wintering counterparts, within the Mississippi Alluvial Valley. Each population of 500 breeding pairs of more abundant grassland species will require a minimum of 1000 ha (assuming densities of circa 2 ha/breeding pair; D. Zoller, pers. comm.) whereas >8,000 ha may be required to support a target population of less numerous species. We assume that several grassland habitat blocks (>100 ha) will meet the habitat objective for a population and that these grasslands will be interspersed among compatible agricultural lands to provide additional foraging opportunities. Thus, specific habitat objectives are to provide 10 grassland-cropland complexes within the Mississippi Alluvial Valley, with 4,000 to 8,000 ha of native, warm-season grasslands within each complex. Where possible, these grassland complexes should be targeted for historical grassland sites such as the Grand Prairie.

Implementation recommendations and opportunities

Opportunities to work with private landowners to restore native grassland communities is as important, if not more so, in specific areas of the southeastern United States than in any other region. Most grassland species of highest concern do not use crop and pasture for breeding, regardless of the presence or absence of nearby native grasslands. However, the foraging requirements of species breeding in native grasslands as well as the foraging needs of many migratory and wintering species can be met by farmers and ranchers. Thus, the restoration of native grass-dominated habitats, in combination with cooperative agreements with private landowners to provide compatible stewardship of croplands and pastures, will have the greatest conservation benefit for grassland species.

Smaller scale restoration and management of grasslands, particularly along utility right-of-ways, marsh edges, and fallow fields can provide benefits to vulnerable grassland birds on a limited scale. In many cases, these conservation efforts involve cooperative agreements with private or corporate landowners. Recommendations for implementing

wildlife oriented management and working with landowners are available (Heckert *et al.* 1993).

Evaluation of assumptions

Knowledge of the status of Henslow's and LeConte's Sparrows within the Mississippi Alluvial Valley would help to determine the amount of attention that is warranted in providing these species' habitat requirements. Management protocols targeting these species during winter should also be developed. Monitoring and documenting the response of breeding grassland birds (e.g., Dickcissel, Loggerhead Shrike, and Northern Bobwhite) to habitat restoration would allow for improved management recommendations.

Lacustrine (open-water) Wetlands, Palustrine (emergent) Wetlands, and Mudflats

Status and importance

Freshwater wetlands, or marshes, are important habitats for many birds within the Mississippi Alluvial Valley (Hackney and Adams 1992). Extensive drainage and other alterations in hydrology over the past century has reduced the area and number of natural marshes within this physiographic area (Noss *et al.* 1995). Recent losses, however, have been negligible as Hefner *et al.* (1995) found no net change to freshwater marsh acreage from the mid-1970's to the mid-1980's. Many of today's freshwater marshes are man-made replacements of natural marshes and forested wetlands (e.g., borrow pits alongside levees, aquaculture ponds, and irrigation reservoirs). Shallow-water marsh margins and mudflats exposed within and adjacent to freshwater marshes or other shorelines are particularly important for foraging shorebirds and long-legged wading birds. Unfortunately, the area of exposed mudflats can be extremely limited, especially during critical migration period of late summer and early fall.

Priority species, species suites, and habitat requirements

Table 12. Proposed distribution of managed foraging habitat for shorebirds among states within the Mississippi Alluvial Valley.	
State	Hectares
Arkansas	520
Illinois	70
Kentucky	35
Louisiana	520
Mississippi	600
Missouri	70
Tennessee	185
Total	2,000

Although some shorebirds breed (Robbins *et al.* 1986) or winter (Ouchley 1992) in the Mississippi Alluvial Valley, many more shorebirds, both total individuals and species, use this floodplain as a migratory corridor between breeding areas to the north and wintering areas to the south (Reid *et al.* 1983, Helmers 1994, Twedt *et al.* 1998; [Table 12](#)). Thus, the greatest conservation need for shorebirds within the Mississippi Alluvial Valley is foraging habitat during migration. Though populations are small compared with spectacular migrations through the Great Plains and along coastal areas, steady or increasing numbers of many species, including Buff-breasted Sandpiper and

American Golden-plover, are being reported within the Mississippi Alluvial Valley. Whether these records are due to increasing awareness or actual increases in occurrence is unknown, but hemisphere-wide concern for shorebird populations and limitation of mudflat and shallow-water habitat during migration of southbound migrants suggest attention to these species is warranted.

Typically, receding winter floodwater during early spring and agricultural flood irrigation, particularly of rice, during late spring provide abundant mudflat and shallow-water foraging habitat during the northward migration of shorebirds. During southward migration in late summer and fall, however, naturally occurring floodwater is rare because of high evapo-transpiration and seasonally low precipitation (Reinecke *et al.* 1988). Also, agricultural fields are purposefully kept dry at this time to facilitate harvest of crops. Thus, the period from 15 July through 30 September has been identified as the time interval when foraging habitat for migrating shorebirds is least available. Shorebird habitat requirements range from moist, short-grass (or plowed) fields for Buff-breasted Sandpipers and American Golden-plovers, to very shallow water (<10 cm) for small sandpipers and plovers, to deeper water (circa 15 cm) for larger shorebirds (*e.g.*, Stilt Sandpiper, dowitchers, and yellowlegs). Ideally, water should be drawn-down gradually during migration to expose new foraging habitat for each of the above foraging groups (Helmers 1992).

Freshwater emergent marshes are important for supporting populations of Sora, King Rail, and Virginia Rail during winter. Although their status in the Mississippi Alluvial Valley is poorly known, continent-wide wetland losses have led to increasing concern for these often secretive species. Also secretive and poorly documented in the Mississippi Alluvial Valley, Least Bitterns use freshwater marshes during the breeding season whereas American Bitterns occur principally during winter. Emergent marshes of the Mississippi Alluvial Valley also harbor several species of wintering "grassland" birds (*e.g.*, LeConte's Sparrow and Sedge Wren).

Often the most visible avian species in the Mississippi Alluvial Valley, herons (Ardeidae), storks (Ciconiidae), and ibises (Threskiornithidae), forage in emergent marsh, open-water, and mudflat habitats. In addition to foraging habitat, these long-legged wading birds, require secure nest and roost sites. Maintaining appropriate water levels is critical for successful reproduction at nest sites. The primary threat to these colonially-nesting species is continued human encroachment and alteration of wetlands, especially degradation of water quality, from toxic contaminants and siltation.

The Mississippi Alluvial Valley probably supports stable or increasing numbers of most long-legged wading birds, in part, due to the availability of aquaculture ponds. However, this readily available food source for these piscivorous birds has led to depredation concerns requiring issuance of "take permits" under the Migratory Bird Treaty Act of 1918. Populations of two additional species, Double-crested Cormorant and White Pelican, warrant monitoring because of their potential for depredation at aquaculture facilities. These piscivores also forage extensively on lakes and ponds.

Habitat and population objectives

Tentative habitat objectives for emergent wetlands and mudflats are to provide 2000 hectares of managed shorebird habitat during southward shorebird migration dispersed among all states in the Mississippi Alluvial Valley ([Figure 3](#)). This objective must ultimately be expanded to include unmanaged habitats and modified to cover the conservation needs of all wetland dependent migratory birds. Tentative habitat objectives were established based on an assumed shorebird migration of one-half million birds with an average mass of 45 g, that between 15 July and 30 September, traverse the length of the Mississippi Alluvial Valley in 10 days, consuming $8 \text{ g} \cdot \text{d}^{-1}$ while en route. Derivation of these assumptions and extrapolation to habitat objectives is detailed in [Appendix 3](#). The primary conservation objective is to ensure that adequate shallow-water habitat is available to meet or exceed the foraging requirements of shorebirds during their southward migration.

Neither census data nor specific estimates of shorebird populations moving through the Mississippi Alluvial Valley during migration exist. The current estimate of one-half million was set after examination of data from International Shorebird Survey sites (Manomet Bird Observatory 1993), consultations with shorebird biologists (D. L. Helmers, B. A. Harrington), and review of continental migration patterns and population estimates (Howe *et al.* 1989). Verification of this population estimate is critical to establishing more objective habitat objectives and establishing a population goal.

Specific objectives for other birds dependent on emergent wetlands have not been established but general objectives include maintaining existing marsh habitats, provision of secure nest sites for colonial-nesting species, and minimizing degradation of water quality.

Implementation recommendations and opportunities

Opportunities to manage for high priority shorebirds, long-legged waders, and marshbirds (especially rails and bitterns) exist region wide and detailed management approaches are available (Rundle and Fredrickson 1981, Fredrickson and Taylor 1982, Eddleman *et al.* 1988, Helmers 1992). Opportunities for creation and management of emergent marsh and mudflat habitat on private lands during the critical southward migration of shorebirds have not been fully explored. Thus, current habitat objectives are focused on public lands. We anticipate these tentative objectives will ultimately be allocated to individual management units of public land.

Often shorebirds benefit from waterfowl management efforts during winter and early spring with little need for modification to water management regimes. Comparatively little effort, however, has been made to provide managed floodwater from July through October for migrating waterfowl and shorebirds. Shallow water provided on fallow fields during late summer and early fall would benefit post-breeding colonial wading birds, early migrant waterfowl (especially blue-winged teal [*Anas discors*]), and migrant shorebirds. Whereas foraging habitat for wintering waterfowl may be provided on harvested cropland, the presence of unharvested crops and generally dry conditions during late summer restricts the ability of many private landowners to create shorebird

habitat on lands used for agricultural production. However, shorebird habitat does occur on private lands and opportunities exist, especially at aquaculture facilities, for creation of additional shorebird foraging habitat on private lands (Sykes and Hunter 1978, Hands *et al.* 1991). Management of private lands as shallowly flooded habitat for shorebirds should be encouraged. Thus, while our habitat objectives currently focus on managed foraging habitat for shorebirds on public lands, unmanaged habitats and habitats on private lands also contribute toward meeting the energetic requirements of shorebirds during southward migration. A balance sheet (Fig. 3), similar to that developed to monitor progress toward waterfowl habitat objectives (Loesch *et al.* 1994), should be used to monitor and to refine recommendations for the quantity and distribution of shorebird habitat within the Mississippi Alluvial Valley.

Figure 3. Proposed balance sheet to be used to track progress toward shorebird foraging-habitat objectives. Balance sheet depicts three potential shorebird habitats and three management categories.

	Public Managed	Private Managed	Unmanaged
Mudflat -- Drawdown	?	?	?
Moist Soil -- Flooded	?	?	?
Cropland -- Flooded	?	?	?
Objective (ha)	2000	?	?

Under most water management regimes, and because of temporal vagaries in water conditions, only a portion of any managed habitat is available to shorebirds at a given time. Thus, management practices should be undertaken that maximize the area of foraging habitat available within individual management units while retaining the ability to provide suitable foraging opportunities from 15 July through 30 September (Helmert 1992).

Evaluation of assumptions

The tentative habitat objective of >2000 ha of shorebird foraging habitat in the Mississippi Alluvial Valley from 15 July through 30 September is based on a number of untested assumptions ([Appendix 3](#)). Assumptions requiring validation or reassessment include: (1) about one-half million shorebirds pass through the Mississippi Alluvial Valley during southward migration; (2) the average duration of southward migration, during which time shorebirds forage in the Mississippi Alluvial Valley, is ten days; (3) foraging-habitat limits the carrying capacity of the Mississippi Alluvial Valley and is most limited during late summer and fall; (4) a hectare of managed shorebird foraging-habitat provides about 20 kg of invertebrate forage; (5) migrating shorebirds require about 8 g of invertebrate forage per day; and (6) managed habitats attract and support migrating shorebirds.

Objective 1: A statistically valid estimate of the population of shorebirds passing through the Mississippi Alluvial Valley is required before objective population goals and habitat requirements can be established. All habitats likely to be used by foraging shorebirds must be included in survey designs, although sampling effort may vary among habitats.

Possible habitats to be surveyed include managed foraging habitats (generally on public lands), aquaculture ponds (drawn-down ponds and pond margins), unmanaged anthropogenic wetlands (reservoirs, sewage ponds, etc.), natural wetlands (lake and stream shorelines), and highly ephemeral habitats (temporarily flooded fields).

As a first step towards estimating numbers of migrating shorebirds, Mueller et al, (pers. comm.) suggest limiting surveys to commercial aquaculture operations (*i.e.*, catfish, bait, and crayfish) and managed foraging habitats. When aquaculture ponds are "drawn-down" they provide foraging habitat that attracts shorebirds (Smith *et al.* 1991). Estimating the number of birds, and their average duration of stay, will provide a baseline population estimate of migrant shorebirds upon which to base refined habitat objectives through adaptive management.

International Shorebird Survey (Manomet Bird Observatory 1993) sites within the Mississippi Alluvial Valley should continue to be monitored and additional survey sites established. Where possible, International Shorebird Survey data should be related to population estimates from Mississippi Alluvial Valley-wide surveys using ratio or regression estimators (Cochran 1977).

Other population related issues within the Mississippi Alluvial Valley include: assessing the number of migrants supported on private unmanaged lands, documenting the need for managed shorebird habitat, and assessing the feasibility of increasing the migrant shorebird population.

Objective 2: Assess the phenology of migration through the Mississippi Alluvial Valley by specifically determining the average time required for individual shorebirds to traverse the length of the Mississippi Alluvial Valley during southward migration, estimating the average number of stopover sites used, and estimating the variation in length of stay among stopover sites.

Probably the most cost effective method of establishing the phenology of migration for shorebirds is through use of radio-instrumented birds. As the effort to determine the phenology of all species would be expensive, only the most representative species should be selected for study. Continued monitoring of International Shorebird Survey sites and the addition of other shorebird monitoring sites within this physiographic region will aid in this selection process. After selection of appropriate target species, a sufficient number of individuals must be radio-tagged in the northern part of the Mississippi Alluvial Valley to ensure adequate data are obtained for complete passage through the Valley. Radio-marked birds will require repeated (daily?) monitoring from the ground and from aircraft. Repeated radio-locations of a sufficient number of radio-tagged birds will provide estimates of distances moved daily among stopover sites, identify locations of stopover sites, and provide statistically valid estimates of the time required for migration through the Mississippi Alluvial Valley.

An alternative, albeit less sophisticated, technique is observations of color marked or tagged individuals. This technique would also require the capture of individuals (probably many times more than required for radio-tagging) in the northern portion of the Mississippi Alluvial Valley. To be successful, marking must be done in concert with

intensive monitoring of foraging habitats throughout the Valley. To estimate rates of passage for specific individuals, shorebirds must be uniquely color marked such that they can be recognized by field personnel using binoculars or spotting scopes. Inherent in this approach is the assumption that observers will have a-priori knowledge of the locations of likely shorebird foraging habitats! Time and distance between repeated observations will provide insight into the temporal dynamics of shorebird migration. If shorebirds are indelibly color-marked, subsequent observations during monitoring of International Shorebird Survey sites or other shorebird foraging sites may provide information on movements and survival of shorebirds using the Mississippi Alluvial Valley.

Objective 3: Determine the extent, distribution, ownership, and management of shallow-water foraging habitat during southward migration of shorebirds (circa 15 July - 30 September). As managed shorebird habitats are created, their boundaries should be reported to the Lower Mississippi Valley Joint Venture, (2524 S. Frontage Rd., Vicksburg, MS 39180) whereas both location and monitored shorebird use should be reported to the Western Hemisphere Shorebird Reserve Network (c/o Manomet Bird Observatory, 81 Stage Point Rd., P.O. Box 1770, Manomet, MA 02345). These databases of managed shorebird foraging sites can be used to assess progress toward shorebird foraging habitat objectives.

Identifying suitable unmanaged foraging sites is vital to an assessment of total available shorebird habitat. One method of identifying suitable unmanaged sites is to identify areas that are spectrally similar to managed sites, either from satellite imagery or aerial photography. If this approach is feasible, it should be extended to the spring migration period to verify the assumption that foraging habitat is relatively abundant during the northward migration of shorebirds.

Objective 4: Determine the energetic requirements of shorebirds during migration and the forage base necessary to meet daily energetic demands. Literature reviews should be conducted to assess the extent to which foraging requirements of shorebird species are known. Where a paucity of data exists for shorebird species with large populations within the Mississippi Alluvial Valley, laboratory studies and field experiments will be required to assess species-specific and time-specific forage requirements. Additionally, laboratory experiments will be required to determine the metabolic use of foods items obtained from lands managed for shorebirds.

Objective 5: An estimate of the availability of forage for shorebirds on managed habitats is needed. An assessment of the quantity and types of food available to migrating shorebirds on managed shorebird habitats on public lands or on unmanaged habitats on private lands should take into account both geographic and temporal variation in food resources. Where habitats are being used by foraging birds, enclosure studies may be required to estimate actual productivity of these management units. Estimates of invertebrate abundance in soil samples could also be used to assess the effectiveness of different management strategies (e.g., flood-up versus draw-down) at providing forage for shorebirds.

Objective 6: The ultimate test of the above shorebird conservation strategy is its effectiveness at providing suitable foraging habitat. The effectiveness with which

foraging habitat can be provided on public lands will, in large part, be dictated by the management strategies employed by land managers. Monitoring is needed to assess the extent to which lands managed for shorebirds are used by migrant shorebirds and research is required to determine the most efficacious water management strategies. Also of interest is the impact of shorebird management on the use of these areas by waterfowl and other waterbirds. Data from monitored shorebird management units should become part of the International Shorebird Survey database. Temporal changes in species and abundance of shorebirds should be related to geographic location, local conditions, and management strategies. Management units or management strategies that support few shorebirds should be replaced with alternate locations or management techniques that support a greater density of shorebirds.

In addition to testing the assumptions used to establish shorebird objectives, monitoring and research are also needed for other marsh dependent bird species. During winter, rails, bitterns, Sedge Wrens, and sparrows within freshwater marshes are inconspicuous and require special survey techniques to gather population size and trend data. Development of effective and efficient survey techniques would facilitate monitoring of these species. Additionally, state-wide surveys ("atlases") of breeding colonial waterbirds should be continued at 10-year intervals throughout the Mississippi Alluvial Valley.

Urban, Suburban backyards, Rural Woodlots

Narrow strips of riparian vegetation, mature woods maintained in "non-forested" areas, and urban "green spaces" may provide important bird habitats, at least for transient neotropical migrants (Moore *et al.* 1993, Moore and Woodrey 1995) as they move through the Mississippi Alluvial Valley. Transients may concentrate in isolated woodlots or in woodlands within developed areas, especially where trees and shrubs bear fleshy fruit during southbound (generally March through May) and perhaps northbound (generally September and October) migration. In the Mississippi Alluvial Valley, small woodlots and riparian zones may be dominated by cottonwood, boxelder, and willow or oaks and sweetgum. In wetter areas, these woodlots may be dominated by cypress and water tupelo. Small woodlots are often invaded by exotic plant species that can dominate the shrub layer and ground cover.

Priority nesting species, such as Prothonotary Warbler and Acadian Flycatcher, may also occur in small woodlots and riparian zones in the Mississippi Alluvial Valley. In largely forested landscapes, such as the Ouachita Mountains, many species occur consistently in riparian zones at least 42 to 84 m (150 to 300 feet) in width (Tappe *et al.* 1994). In agricultural landscapes, 84 m (300 feet) may be a minimum width required for some nesting species (Kellert *et al.* 1993). Nesting success is not well known for nesting species in small woodlots and riparian zones in the Mississippi Alluvial Valley.

The general habitat objective is for all urban and rural woodlots (or other small forest patches) to provide adequate cover, food (mostly native trees and shrubs bearing fleshy fruit), and fresh water for migrating birds and provide a forested corridor wide enough for successful nesting of some priority species. One opportunity for accomplishing this objective is to promote "backyard habitat" programs, increase bird conservation efforts in local parks and greenways, and increase incentives for more rural landowners to improve

woodland habitats. These actions would be cumulatively beneficial for transient birds, as well as occasionally breeding species.

The greatest potential for local public involvement for those interested in bird conservation issues within the Mississippi Alluvial Valley will likely be tied to outreach involving backyard and community efforts as described in Flight STAR, the Partners in Flight Bird Education Center Program (Texas Partners in Flight 1998). The purpose of Flight STAR is to recognize and encourage activities in the areas of conservation, monitoring and survey, educational outreach and research. Parks, zoos, nature centers, corporate lands, gardens, neighborhoods, greenways and other partners can contribute to conservation efforts on properties that they own or manage. Flight STAR provides a variety of opportunities for recognition of ongoing and future activities of current partners, and encouragement as well as direction for future partners. Five levels of recognition allow participation to the extent appropriate for each partner at present and in the future.

Cooperating partners should develop joint monitoring efforts in developed habitats to better understand local responses by vulnerable species to on-going suburban expansion within the Mississippi Alluvial Valley. Migration monitoring routes in wooded habitats embedded within developed environments would add valuable information to timing and degree of transient passage through this physiographic area.

SECTION 4: IMPLEMENTATION RECOMMENDATIONS AND SUMMARY

Summary of habitats, bird species suites, and goal statements for the Mississippi Alluvial Valley.

Forested Wetlands.-- Bachman's Warbler, Swainson's Warbler, Prothonotary Warbler, Cerulean Warbler, and Swallow-tailed Kite.

Goal.-- Maintain or restore >1,500,000 ha of predominately mature, forested wetlands in 100 patches of contiguous forest: 13 patches of >40,000 ha (100,000 acres), 36 patches >8,000 ha (20,000 acres), and 13 patches >4,000 ha (10,000 acres). Forest management within these areas should promote the structural diversity necessary to support source populations of breeding birds.

Forest openings, edge, early-succession shrub-scrub.-- Orchard Oriole, White-eyed Vireo, Painted Bunting, and Mississippi Kite.

Goal.-- Provide 1 million ha of scrub/shrub or forest edge habitat for species dependent upon forest openings and edges while not subjecting forest-interior species to increased nest depredation and cowbird parasitism.

Oak-Hickory (Crowley's Ridge, loess bluffs) Hardwoods.-- Swainson's, Prothonotary, Cerulean, and Worm-eating Warblers, Yellow-billed Cuckoo, Red-headed Woodpecker, and Louisiana Waterthrush.

Goal-- Maintain and enhance the area of existing forest patches, consolidate adjacent forest patches, and merge with bottomland forests. Management should promote structural diversity of vegetation.

Grassland/savanna, pasture, associated wetlands-- LeConte's Sparrow, Henslow's Sparrow, Field Sparrow, Grasshopper Sparrow, Loggerhead Shrike, Dickcissel, Short-eared Owl, and Sedge Wren.

Goal-- Provide 10 grassland-cropland complexes within the Mississippi Alluvial Valley, each with 4,000 to 8,000 ha of native, warm-season grasses (or other native flora) and associated wetlands, and savannas. Management should ensure disturbance (*e.g.*, fire, grazing) regimes sufficient to maintain prairie conditions.

Lacustrine Wetlands, Palustrine Wetlands and Mudflats-- shorebirds, long-legged wading birds, bitterns, and rails.

Goal-- Provide sufficient foraging habitat (tentatively >2000 ha) to support southward migration of shorebirds through the Mississippi Alluvial Valley. Manage existing emergent wetlands to provide suitable habitat for wading birds, bitterns, and rails.

Urban, suburban backyards, rural woodlots-- transients migrants.

Goal-- Enhance the quality of "backyard" and woodlot habitats by encouraging adequate cover, food (especially native fleshy-fruit bearing trees and shrubs), and water.

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Appendix 1. Tree species used by U. S. Department of Agriculture, Forest Service, Eastern Forest Inventory and Analysis (FIA), species are ordered alphabetically by genus and species.

Common Name	Scientific Name
Florida maple	<i>Acer barbatum</i>
boxelder	<i>Acer negundo</i>
black maple	<i>Acer nigrum</i>
red maple	<i>Acer rubrum</i>
silver maple	<i>Acer saccharinum</i>
sugar maple	<i>Acer saccharum</i>
buckeye, horsechestnut	<i>Aesculus</i> sp.
ailanthus	<i>Ailanthus altissima</i>
serviceberry	<i>Amelanchier</i> sp.
pawpaw	<i>Asimina triloba</i>
river birch	<i>Betula nigra</i>
water birch	<i>Betula occidentalis</i>
paper birch	<i>Betula papyrifera</i>
gray birch	<i>Betula populifolia</i>
chittamwood, gum bumelia	<i>Bumelia lanuginosa</i>
American hornbeam, musclewood	<i>Carpinus caroliniana</i>
water hickory	<i>Carya aquatica</i>
bitternut hickory	<i>Carya cordiformis</i>
pignut hickory	<i>Carya glabra</i>
pecan	<i>Carya illinoensis</i>
shellbark (kingnut) hickory	<i>Carya laciniosa</i>
shagbark hickory	<i>Carya ovata</i>
black hickory	<i>Carya texana</i>
mockernut hickory	<i>Carya tomentosa</i>
American chestnut	<i>Castanea dentata</i>
Allegheny chinkapin	<i>Castanea pumila</i>
Ozark chinkapin	<i>Castanea ozarkensis</i>
chinkapin	<i>Castanopsis</i> sp.
southern catalpa	<i>Catalpa bignonioides</i>
northern catalpa	<i>Catalpa speciosa</i>
sugarberry	<i>Celtis laevigata</i>
hackberry	<i>Celtis occidentalis</i>
eastern redbud	<i>Cercis canadensis</i>

flowering dogwood	<i>Cornus florida</i>
hawthorn	<i>Crataegus</i> sp.
persimmon	<i>Diospyros virginiana</i>
American beech	<i>Fagus grandifolia</i>
white ash	<i>Fraxinus americana</i>
green ash	<i>Fraxinus pennsylvanica</i>
pumpkin ash	<i>Fraxinus profunda</i>
waterlocust	<i>Gleditsia aquatica</i>
honeylocust	<i>Gleditsia triacanthos</i>
loblolly-bay	<i>Gordonia lasianthus</i>
Kentucky coffeetree	<i>Gymnocladus dioicus</i>
silverbell	<i>Halesia</i> sp.
American holly	<i>Ilex opaca</i>
butternut	<i>Juglans cinerea</i>
black walnut	<i>Juglans nigra</i>
eastern red cedar	<i>Juniperus virginiana</i>
sweetgum	<i>Liquidambar styraciflua</i>
yellow-poplar	<i>Liriodendron tulipifera</i>
Osage-orange	<i>Maclura pomifera</i>
cucumbertree	<i>Magnolia acuminata</i>
southern magnolia	<i>Magnolia grandiflora</i>
sweetbay	<i>Magnolia virginiana</i>
bigleaf magnolia	<i>Magnolia macrophylla</i>
apple sp.	<i>Malus</i> sp.
white mulberry	<i>Morus alba</i>
red mulberry	<i>Morus rubra</i>
water tupelo	<i>Nyssa aquatica</i>
ogeechee tupelo	<i>Nyssa ogeche</i>
blackgum	<i>Nyssa sylvatica</i>
swamp tupelo	<i>Nyssa sylvatica biflora</i>
eastern hophornbeam, ironwood	<i>Ostrya virginiana</i>
sourwood	<i>Oxydendrum arboreum</i>
paulownia, empress tree	<i>Paulownia tomentosa</i>
redbay	<i>Persea borbonia</i>
shortleaf pine	<i>Pinus echinata</i>
slash pine	<i>Pinus elliotii</i>
longleaf pine	<i>Pinus palustris</i>

pitch pine	<i>Pinus rigida</i>
loblolly pine	<i>Pinus taeda</i>
Virginia pine	<i>Pinus virginiana</i>
sycamore	<i>Platanus occidentalis</i>
cottonwood	<i>Populus spp.</i>
balsam poplar	<i>Populus balsamifera</i>
eastern cottonwood	<i>Populus deltoides</i>
swamp cottonwood	<i>Populus heterophylla</i>
silver poplar	<i>Populus alba</i>
cherry, plum spp.	<i>Prunus sp.</i>
pin cherry	<i>Prunus pensylvanica</i>
black cherry	<i>Prunus serotina</i>
chokecherry	<i>Prunus virginiana</i>
cherrybark oak, swamp red oak	<i>Quercus pagodaefolia</i>
wild plum	<i>Prunus americana</i>
white oak	<i>Quercus alba</i>
swamp white oak	<i>Quercus bicolor</i>
scarlet oak	<i>Quercus coccinea</i>
northern pin oak	<i>Quercus ellipsoidalis</i>
southern red oak	<i>Quercus falcata</i>
bear oak, scrub oak	<i>Quercus ilicifolia</i>
shingle oak	<i>Quercus imbricaria</i>
turkey oak	<i>Quercus laevis</i>
laurel oak	<i>Quercus laurifolia</i>
overcup oak	<i>Quercus lyrata</i>
bur oak	<i>Quercus macrocarpa</i>
blackjack oak	<i>Quercus marilandica</i>
swamp chestnut oak	<i>Quercus michauxii</i>
chinkapin oak	<i>Quercus muehlenbergii</i>
water oak	<i>Quercus nigra</i>
Nuttall oak	<i>Quercus nuttallii</i>
pin oak	<i>Quercus palustris</i>
willow oak	<i>Quercus phellos</i>
chestnut oak	<i>Quercus prinus</i>
northern red oak	<i>Quercus rubra</i>
Shumard oak	<i>Quercus shumardii</i>
post oak	<i>Quercus stellata</i>

black oak	<i>Quercus velutina</i>
live oak	<i>Quercus virginiana</i>
bluejack oak	<i>Quercus incana</i>
scrub oak	<i>Quercus</i> sp.
black locust	<i>Robinia psuedoacacia</i>
black willow	<i>Salix nigra</i>
Chinese tallowtree	<i>Sapium sebiferum</i>
sassafras	<i>Sassafras albidum</i>
baldcypress	<i>Taxodium distichum</i>
pondcypress	<i>Taxodium distichum nutans</i>
American basswood	<i>Tilia americana</i>
white basswood	<i>Tilia heterophylla</i>
winged elm	<i>Ulmus alata</i>
American elm	<i>Ulmus americana</i>
cedar elm	<i>Ulmus crassifolia</i>
slippery elm	<i>Ulmus rubra</i>
rock elm	<i>Ulmus thomasii</i>

Appendix 2. Breeding bird species priorities concern score (CS), percent of population (PP), area's importance (AI), population trend (PT), and typical habitat within the Mississippi Alluvial Valley based on prioritization established by Hunter *et al.* (1993a 1993b), and Carter *et al.* (in press), as modified by the Colorado Bird Observatory (October 1997).

Species ^a	CS ^b	PP ^c	AI ^d	PT ^e	Habitat ^f
Bachman's Warbler (<i>Vermivora bachmanii</i>)	35 - E	Extinct?	-	-	B
Ivory-billed Woodpecker (<i>Campephilus principalis</i>)	35 - E	Extinct?	-	-	B
Swainson's Warbler (<i>Limnothlypis swainsonii</i>)	29 - H+	20.8	5	3	BU
Cerulean Warbler (<i>Dendroica cerulea</i>)	28 - H+	-	3	4	BU
Swallow-tailed Kite (<i>Elanoides forficatus</i>)	26 - H+	25.1	4	3	BGU
Prothonotary Warbler (<i>Protonotaria citrea</i>)	24 - H+	34.8	5	2	BU
Painted Bunting (<i>Passerina ciris</i>)	24 - H+	4.4	3	5	S
Orchard Oriole (<i>Icterus spurius</i>)	23 - H	7.4	5	5	BS
Northern Parula (<i>Parula americana</i>)	23 - H	6.9	5	5	B
White-eyed Vireo (<i>Vireo griseus</i>)	23 - H	8.4	4	5	BSU
Bell's Vireo (<i>Vireo bellii</i>)	23	-	2	3	S
Worm-eating Warbler (<i>Helmitheros vermivorus</i>)	23	-	2	3	U
Kentucky Warbler (<i>Oporornis formosus</i>)	23 - H	4.7	3	3	BU
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	22 - H	6.0	5	5	BU
Wood Thrush (<i>Hylocichla mustelina</i>)	22 - H	-	3	3	BU
Hooded Warbler (<i>Wilsonia citrina</i>)	21 - M	-	3	3	BUS
Mississippi Kite (<i>Ictinia mississippiensis</i>)	21 - M	13.4	4	2	BSG
Red-headed Woodpecker (<i>Melanerpes erythrocephalus</i>)	21 - M	-	4	4	BU
Yellow-breasted Chat (<i>Icteria virens</i>)	21 - M	6.5	5	5	BUS
Prairie Warbler (<i>Dendroica discolor</i>)	21	-	2	3	SG
Dickcissel (<i>Spiza americana</i>)	21	5.1	4	2	G
Chuck-will's-widow (<i>Caprimulgus carolinensis</i>)	21	-	4	3	U
Hooded Merganser (<i>Lophodytes cucullatus</i>)	21	-	3	3	BW
Louisiana Waterthrush (<i>Seiurus motacilla</i>)	21	-	2	3	UB
Scissor-tailed Flycatcher (<i>Tyrannus forficatus</i>)	21	8.0	2	3	G
Eastern Wood-pewee (<i>Contopus virens</i>)	20	-	3	5	BU
Acadian Flycatcher (<i>Empidonax virescens</i>)	20 - M	5.6	3	3	BU
Loggerhead Shrike (<i>Lanius ludovicianus</i>)	20 - M	-	4	4	SG
Field Sparrow (<i>Spizella pusilla</i>)	20 - M	-	3	5	SG
Baltimore Oriole (<i>Icterus glabula</i>)	20	-	3	5	BU
Northern Bobwhite (<i>Colinus virginianus</i>)	20 - M	-	3	5	SG

Yellow-throated Vireo (<i>Vireo flavifrons</i>)	20	-	3	2	BU
Yellow-throated Warbler (<i>Dendroica dominica</i>)	20	-	3	2	BU
Carolina Chickadee (<i>Parus carolinensis</i>)	20 - M	4.6	4	5	BU
Ruby-throated Hummingbird (<i>Archilochus colubris</i>)	19 - M	7.3	5	3	BU
Whip-poor-will (<i>Caprimulgus vociferus</i>)	19	-	2	3	U
Blue-gray Gnatcatcher (<i>Polioptila caerulea</i>)	19 - M	-	4	5	BU
Wood Duck (<i>Aix sponsa</i>)	19	-	5	2	BW
American Woodcock (<i>Scolopax minor</i>)	19	-	2	3	BS
Chimney Swift (<i>Chaetura pelagica</i>)	19	-	4	3	BU
Bald Eagle (<i>Haliaeetus leucocephalus</i>)	18	-	2	3	B
Summer Tanager (<i>Piranga rubra</i>)	18	-	4	2	BU
Eastern Kingbird (<i>Tyrannus tyrannus</i>)	18	-	3	5	G
Eastern Screech-Owl (<i>Otus asio</i>)	18	-	3	3	BU
Red-bellied Woodpecker (<i>Melanerpes carolinus</i>)	18	-	5	2	BU
Carolina Wren (<i>Troglodytes ludovicianus</i>)	18	6.5	5	3	BU
Willow Flycatcher (<i>Empidonax traillii</i>)	18	-	2	3	S
Marsh Wren (<i>Cistothorus palustris</i>)	18	-	2	3	GW
Wild Turkey (<i>Meleagris gallopavo</i>)	18	-	3	3	BU
Fish Crow (<i>Corvus ossifragus</i>)	18	-	3	4	B
Great Crested Flycatcher (<i>Myiarchus crinitus</i>)	17	-	3	3	BU
Gray Catbird (<i>Dumetella carolinensis</i>)	17	-	2	5	BUS
Scarlet Tanager (<i>Piranga olivacea</i>)	17	-	2	3	BU
Grasshopper Sparrow (<i>Ammodramus savannarum</i>)	17	-	2	4	SG
Red-shouldered Hawk (<i>Buteo lineatus</i>)	17	10.4	4	2	BU
Indigo Bunting (<i>Passerina cyanea</i>)	17	-	4	5	BS
Purple Martin (<i>Progne subis</i>)	17	7.8	5	2	O
Brown Thrasher (<i>Toxostoma rufum</i>)	17	-	3	2	BUS
Barn Owl (<i>Tyto alba</i>)	17	-	3	3	O
Pine Warbler (<i>Dendroica pinus</i>)	17	-	2	3	O
Killdeer (<i>Charadrius vociferus</i>)	17	-	5	2	WO
Red-eyed Vireo (<i>Vireo olivaceus</i>)	16	-	2	4	BU
Common Yellowthroat (<i>Geothlypis trichas</i>)	16	-	3	5	BSW
Warbling Vireo (<i>Vireo gilvus</i>)	16	-	2	3	BU
Boat-tailed Grackle (<i>Quiscalus major</i>)	16	-	2	3	O
Blue Grosbeak (<i>Guiraca caerulea</i>)	16	-	3	3	SG
American Redstart (<i>Setophaga ruticilla</i>)	16	-	3	3	BU
Barred Owl (<i>Strix varia</i>)	16	-	5	2	BU

Northern Cardinal (<i>Cardinalis cardinalis</i>)	16	5.7	5	2	BU
Common Grackle (<i>Quiscalus quiscula</i>)	16	-	5	5	BU
Black-and-white Warbler (<i>Mniotilta varia</i>)	16	-	2	3	BU
Northern Flicker (<i>Colaptes auratus</i>)	16	-	3	5	BU
Bronzed Cowbird (<i>Molothrus aeneus</i>)	16	-	2	3	O
Broad-winged Hawk (<i>Buteo platypterus</i>)	15	-	3	3	BU
Eastern Bluebird (<i>Sialia sialis</i>)	15	-	3	3	O
Cooper's Hawk (<i>Accipiter cooperii</i>)	15	-	2	3	BU
Pileated Woodpecker (<i>Dryocopus pileatus</i>)	15	-	4	2	BU
Common Nighthawk (<i>Chordeiles minor</i>)	15	-	2	4	O
Northern Rough-winged Swallow (<i>Stelgidopteryx serripennis</i>)	15	-	4	1	O
Osprey (<i>Pandion haliaetus</i>)	15	-	2	3	O
Eastern Phoebe (<i>Sayornis phoebe</i>)	15	-	2	3	BU
Eastern Towhee (<i>Pipilo erythrophthalmus</i>)	15	-	3	2	BU
Downy Woodpecker (<i>Picoides pubescens</i>)	15	-	5	2	BU
Tufted Titmouse (<i>Parus bicolor</i>)	14	-	4	2	BU
Bank Swallow (<i>Riparia riparia</i>)	14	-	3	3	O
Northern Mockingbird (<i>Mimus polyglottos</i>)	14	-	4	5	O
Tree Swallow (<i>Tachycineta bicolor</i>)	14	-	2	3	O
White-breasted Nuthatch (<i>Sitta carolinensis</i>)	14	-	2	3	BU
Hairy Woodpecker (<i>Picoides villosus</i>)	14	-	3	2	BU
Belted Kingfisher (<i>Ceryle alcyon</i>)	14	-	3	2	W
Mourning Dove (<i>Zenaida macroura</i>)	14	-	4	5	BUSG
Brown-headed Cowbird (<i>Molothrus ater</i>)	13	-	4	4	BUSG
Red-tailed Hawk (<i>Buteo jamaicensis</i>)	13	-	3	3	BUSG
Great horned Owl (<i>Bubo virginianus</i>)	13	-	3	3	BU
Chipping Sparrow (<i>Spizella passerina</i>)	13	-	2	3	O
Blue Jay (<i>Cyanocitta cristata</i>)	13	-	4	2	BU
House Wren (<i>Troglodytes aedon</i>)	12	-	3	3	BU
Yellow Warbler (<i>Dendroica petechia</i>)	12	-	2	3	S
Cliff Swallow (<i>Hirundo pyrrhonota</i>)	12	-	2	3	O
Black Vulture (<i>Coragyps atratus</i>)	12	-	3	3	BU
Turkey Vulture (<i>Cathartes aura</i>)	12	-	2	3	BU
American Kestrel (<i>Falco sparverius</i>)	12	-	2	3	SGO
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)	12	-	5	1	SGW
Song Sparrow (<i>Melospiza melodia</i>)	12	-	3	3	SG

Barn Swallow (<i>Hirundo rustica</i>)	11	-	4	1	O
Horned Lark (<i>Eremophila alpestris</i>)	10	-	2	2	G0
American Crow (<i>Corvus brachyrhynchos</i>)	10	-	4	1	BU
American Robin (<i>Turdus migratorius</i>)	9	-	3	1	BU

a - Excluding wading birds (Anhingidae and Ciconiiformes)
b - Species priorities: E = endangered, H+ = highest priority, H = high priority, M = moderate priority.
c - Percent of Population (PP) that breeds within the Mississippi Alluvial Valley based on Breeding Bird Survey data (Ken Rosenberg and Jeff Wells, pers. comm.)
d - Areas Importance (AI) to species based on relative abundance: range 1 - 5 (1 = little importance, 5 = extremely important)
e - Population Trend (PT): 5 = significant (P 0.10) decrease, 4 = possible decrease, 3 = no trend or unknown, 2 = possible increase, 1 = significant (P 0.10) increase
f - habitats used: B = bottomland hardwood forests, U = upland hardwood forests, S = shrub/scrub, G = grasslands, W = wetlands, and O = other habitats]

Appendix 3. Methodology used to establish foraging habitat objectives for shorebirds within the Mississippi Alluvial Valley.

Although data on shorebirds moving through Mississippi Alluvial Valley are fragmentary, data on the numbers and species are available from International Shorebird Survey sites as well as from local studies (e.g., Reid *et al.* 1983, Ouchley 1992, Rettig and Aycock 1994). These data indicate that although shorebirds as small as 30 g and as large as 200 g migrate through the Mississippi Alluvial Valley, the average mass (weighted by abundance) of shorebirds using International Shorebird Survey sites is 45 g (Table 10). Subsequent estimates of energetic needs and foraging-habitat requirements are based upon this assumed mean mass of 45 g.

The amount of energy (kj) required by a 45 g shorebird to maintain its existence metabolic rate (EMR) was calculated following Kersten and Piersma (1987) as:

$$\text{EMR (kj)} = 912 (\text{BODY MASS (kg)})^{0.704}$$

$$102.77 \text{ kj} = 912 (0.045 \text{ kg})^{0.704}.$$

Thus, 103 kj are required per day to sustain a 45 g shorebird.

For the purpose of modeling, we have assumed that chironomids are a primary food item consumed by shorebirds. A gram dry weight (g_{dw}) of chironomids has a gross energy content of 23.8 kj (Cummins and Wuycheck 1971). Because the assimilation efficiency of birds feeding on invertebrates is approximately 73 percent (Castro *et al.* 1989), the net energy content (NEC) of chironomids is about $17.6 \text{ kj g}_{\text{dw}}^{-1}$

$$\text{NEC} = \text{GROSS ENERGY CONTENT} \times \text{ASSIMILATION EFFICIENCY}$$

$$17.6 \text{ kj g}_{\text{dw}}^{-1} = 23.8 \text{ kj g}_{\text{dw}}^{-1} \times 0.73.$$

The mass of invertebrates that a 45 g shorebird requires to maintain its existence metabolic rate can then be extrapolated as:

$$\text{MAINTENANCE INVERTEBRATE MASS (IM}_{\text{MAINTENANCE}}) = \text{EMR NEC}^{-1}$$

$$5.84 \text{ g}_{\text{dw}} = 102.77 \text{ kj d}^{-1} (17.6 \text{ kj g}_{\text{dw}}^{-1} \text{ d}^{-1})^{-1}.$$

Thus, a 45 g shorebird requires about 6 g_{dw} of invertebrate forage each day to maintain its body mass.

To provide the fat reserves necessary to complete migration shorebirds must increase their biomass (consisting of 85% fat, 10% water, and 5% protein) by about 1 g per day. Assuming about 2 g_{dw} of invertebrate forage must be consumed each day to increase biomass by 1 g (Kersten and Piersma 1987), the mass of invertebrates required for fat

deposition ($IM_{DEPOSITION}$) becomes 2 g_{dw} per day. The daily food requirement during migration ($IM_{MIGRATION}$) of a 45 g shorebird then becomes about 8 g_{dw} :

$$MIGRATION\ INVERTEBRATE\ MASS\ (IM_{MIGRATION}) = IM_{MAINTENANCE} + IM_{DEPOSITION}$$

$$8\ g_{dw}\ d^{-1} = 6\ g_{dw}\ d^{-1} + 2\ g_{dw}\ d^{-1}.$$

For purposes of proposing the area of habitat required to support migrating shorebirds, we have assumed that habitat will be provided primarily in the form of shallow-water habitats managed such that optimal foraging habitat is created for shorebirds and about 2 g_{dw} of benthic invertebrates are available per square meter (D. Helmers, pers. comm.). Thus, an average shorebird requires about 4 m^2 of foraging habitat each day. Over the duration of an assumed 10-day migration period, each shorebird migrating through the Mississippi Alluvial Valley would therefore require 40 m^2 of managed shorebird foraging-habitat. Each of the 0.5 million shorebirds that we assume move through the Mississippi Alluvial Valley during southward migration requires 40 m^2 (0.004 ha) of foraging habitat. By extrapolation, a total of 2,000 ha (ca. 5,000 acres) of foraging habitat are needed for shorebirds within the Mississippi Alluvial Valley between 15 July and 30 September.

$$FORAGING\ HABITAT = IM_{MIGRATION}\ DURATION\ FORAGE\ DENSITY^{-1}\ POPULATION$$

$$2,000\ ha = 20,000,000\ m^2 = 8\ g_{dw}\ bird^{-1}\ d^{-1}\ 10\ d\ [2\ g_{dw}\ (m^2)^{-1}]^{-1}\ 500,000\ birds$$

Appendix 4. Qualitative Characterization of Bird Conservation Areas in the Mississippi Alluvial Valley.

NAME	Upland forest or river buffer	# or size of goal(s) maximum	Block shape optimal	Block goal met	More forest needed	Habitat Value ¹	Primary forest owner ²	Secure ³	Cost ⁴	Restoration priority ⁵	Protection priority ⁶
ARKANSAS											
Ashbrook	Y	Y	Y	Y	N	M	3	N	L	L	M/H
Bayou DeView	N	Y	N	N	Y	M	4	N	Hp Hr	L/M	L/M
Bayou Meto	N	N	Y	Y	Y	H	4	N	Lp Lr	M/H	H
Big Ditch	N	Y	N	Y	Y	M	4	N	Lp Lr	M/H	M/H
Big Lake	N	Y	Y	Y	N	M	1	Y	L	L	L
Black River	N	Y	N	Y	Y	H	1	Y	Lp Lr	H	L
Cut-off Creek	Y	Y	N	N	Y	M	1	Y	Lp Lr	M/H	L
Dermot	N	Y	N	N	Y	M	3	Y	Lp Hr	L/M	L
Island 65	Y	Y	Y	Y	N	M	3	Y	Lp Hr	L	L
Overflow	Y	Y	N	Y	Y	M	1	Y	Lp Lr	M/H	L
Peters Island	Y	Y	Y	Y	N	M	4	N	Lp Hr	L	M/H
Whiskey Island	Y	Y	N	N	Y	M	4	N	Hp Lr	M/H	L/M
Rainy Brake	N	N	N	N	Y	M	1	Y	Lp Hr	L/M	L
St. Francis National Forest	Y	Y	N	N	Y	M	2	Y	Lp Hr	L/M	L
Sunken Lands	N	Y	N	Y	Y	M	4	N	Hp Hr	L/M	L/M
Brandywine Island	Y	Y	N	Y	Y	M	4	N	Hp Lr	M/H	L/M
White River North	N	Y	N	N	Y	H	4	N	Lp Lr	H	H
White River South	Y	Y	Y	Y	N	H	1	Y	L	L	L
LOUISIANA											
Atchafalaya Basin Floodway	Y	Y	Y	Y	N	M	4	N	H	L	L/M
Lower Atchafalaya											
Atchafalaya Basin East	Y	Y	Y	Y	N	M	4	N	H	L	L/M
Atchafalaya	Y	Y	Y	Y	N	H	4	N	H	L	M

Basin West												
Maurepas	N	Y	Y	Y	N	H	4	N	H	L	M	
Des Allemandes	N	Y	Y	Y	N	H	4	N	H	L	M	
Morganza Floodway	N	N	N	Y	Y	H	4	N	Hp Lr	H	M	
West Atchafalaya Floodway	N	N	N	Y	Y	H	4	N	Hp Hr	M	M	
Cypress Island	N	Y	Y	Y	N	H	4	N	L	L	H	
Thistlewaite	N	Y	N	Y	Y	H	4	N	Lp Lr	H	H	
Palmetto	N	Y	N	N	Y	M	4		?	?	?	
West False River	N	Y	Y	Y	N	H	?		?	?	?	
Cat Island	Y	Y	N	Y	Y	M	4	N	Lp Lr	M/H	M/H	
Raccouci Island	Y	Y	Y	Y	N	M	4	N	H	L	L/M	
Three Rivers	Y	N	N	Y	Y	H	1	Y	Lp Lr	H	L	
Saline	Y	Y	N	Y	Y	H	1	Y	Lp Lr	H	L	
Glasscock Island	Y	Y	N	N	Y	M	4	N	Lp Lr	M/H	M/H	
Bayou Cocodrie	N	Y	N	N	Y	H	1	Y	Lp Lr	H	L	
Boggy Bayou	N	Y	N	N	Y	M	4	N	Hp Hr	L/M	L/M	
Short Bayou	N	Y	N	N	Y	M	4	N	Hp Hr	L/M	L/M	
Concordia	Y	Y	Y	Y	N	M	4	N	L	L	M/H	
Fletcher's Lake	N	Y	N	N	Y	M	4	N	Hp Hr	L/M	L/M	
Glade Woods	N	Y	N	Y	Y	H	4	N	Hp Lr	H	M	
Bayou Boeuf	Y	Y	N	?	Y	H	1	Y	Lp Lr	H	L	
Russell Sage	Y	Y	N	Y	Y	H	1	Y	Lp Lr	H	L	
D'Arbonne	?	?	?	?	?	?	?		?	?	?	
Upper Ouachita	?	?	?	?	?	?	?		?	?	?	
Buckhorn	N	Y	N	N	Y	H	1	Y	Lp Lr	H	L	
Yucatan	Y	Y	N	Y	Y	M	2	Y	Lp Lr	M/H	L	
Davis Island (inside levee)	Y	Y	Y	Y	N	H	2	Y	L	L	L	

Davis Island (outside levee)	N	Y	N	Y	Y	H	4	N	Hp Lr	H	M
Tensas River	N	Y	N	N	Y	H	1	Y	Lp Lr	H	L
Deltic Lands	N	Y	N	N	Y	H	2	Y	Lp Hr	M	L
Bayou Macon	N	Y	N	N	Y	M	1	Y	Lp Lr	M/H	L
MISSISSIPPI											
Buffalo River	Y	Y	Y	Y	N	M	4	N	H	L	L/M
Homochitto	Y	Y	N	Y	Y	M	4	N	Hp Lr	M/H	L/M
St. Catherine's Creek	N	Y	N	N	Y	M	1	Y	Lp Lr	M/H	L
Big Black	Y	Y	Y	Y	N	M	2	Y	L	L	L
Mahannah	Y	N	N	N	Y	H	4	N	Lp Lr	H	H
Delta National Forest	N	?	N	N	Y	H	1	Y	Lp Lr	H	L
Pittman Island	N	Y	Y	Y	N	M	2	Y	L	L	L
Yazoo	N	Y	N	N	Y	M	1	Y	Lp Hr	L/M	L
Whittington(N)	Y	Y	Y	Y	N	M	2	Y	L	L	L
Whittington(S)	Y	Y	Y	Y	N	M	3	Y	L	L	M
Dahomey	N	Y	N	N	Y	M	1	Y	Lp Hr	L/M	L
Gunnison	Y	Y	Y	Y	N	M	4	N	H	L	L/M
Coahoma	Y	Y	N	Y	Y	M	3	N	Lp Lr	M/H	M/H
Tunica	Y	Y	N	Y	Y	M	4	N	Lp Lr	M/H	M/H
Coldwater Creek	N	Y	N	N	Y	M	4	N	Hp Hr	L/M	L/M
O'Keefe	Y	Y	N	N	Y	M	1	Y	Lp Lr	M/H	L
Malmaison	Y	Y	N	Y	Y	M	1	Y	Lp Lr	M/H	L
Mathews Brake	Y	Y	N	N	Y	M	1	Y	Lp Hr	L/M	L
Hillside(N)	Y	Y	N	Y	Y	M	1	Y	Lp Lr	M/H	L
Hillside(S)	Y	Y	N	Y	Y	M	1	Y	Lp Hr	L/M	L
Belzoni	N	Y	N	N	Y	H	3	N	Lp Lr	H	H
Tribble	N	Y	N	N	Y	M	4	N	Hp Lr	M/H	L/M
TENNESSEE											
Meeman Shelby	Y	Y	N	N	Y	H	1	Y	LpLr	H	L
Chickasaw	Y	Y	N	N	Y	H	4	N	LpLr	H	H
Reelfoot	N	Y	N	N	Y	M	1	Y	LpLr	M/H	L

1. Priority Conservation Area (PCA) has high potential for Louisiana black bear or more diverse habitat based on GIS land-form analysis.

2. Owner of >50% of forest: 1 = public, 2 = private timber industry, 3 = hunting clubs, 4 = other or unknown.

3. Forest block is generally considered secure if used for hunting, timber production, or public ownership. However, a unique condition (e.g. pending sale of property) could determine status.

4. Opportunity costs are defined by the cost :benefit of protection or restoration efforts in a PCA. In general, protection costs are low if majority of forest ownership is public, private industrial, limited partnership hunting clubs, or single family. Also, if large ecological benefit is anticipated, relative to costs of dealing with multiple landowners, etc., overall cost is considered low. It is considered high if majority of forest is owned by many individuals/entities or if ownership is unknown. Restoration costs are high if the PCA contains a good deal of highly productive agricultural land (e.g. cotton, land-leveled rice); if little forest currently exists thus requiring a vast amount of reforestation to achieve goal; or, if reforestation would need to take place across multiple ownerships within the PCA. In general, restoration costs are considered low if minimal acreage is needed to achieve reforestation goal; a large amount of reforestation is currently taking place through such programs as WRP, FmHA activity, etc.; or, if restoration will take place on acres owned by only few individuals/entities. (Lp=low protection; Lr=low restoration; Hp=high protection; Hr=high restoration

L=low protect, low restoration assumed; H=high protect., low restoration assumed)

5. To determine restoration priority, three factors were considered: reforestation need, habitat value, and opportunity cost for restoration. Each response was weighted as follows:

REFORESTATION NEED HABITAT VALUE OPPORTUNITY COST

Y = 50, N = 0 M = 0, H = 10 L = 20, H = 0

Values were calculated for each PCA and ranged from 0 - 80. Prioritization categories broke out as follows:

0-30 = LOW, 50 = LOW/MODERATE, 60 = MODERATE, 70 = MODERATE/HIGH, 80 = HIGH

6. To determine protection priority, three factors were considered: security status, habitat value and opportunity cost for protection. Each response was weighted as follows:

SECURITY HABITAT VALUE OPPORTUNITY COST

Y = 50, N = 0 M = 0, H = 10 L = 20, H = 0

Values were calculated for each PCA and ranged from 0 - 80. Prioritization categories broke out as follows:

0-30 = LOW, 50 = LOW/MODERATE, 60 = MODERATE, 70 = MODERATE/HIGH, 80 = HIGH

Appendix 5. Quantitative Characterization of Bird Conservation Areas (BCA) in the Mississippi Alluvial Valley.

NAME	Size of BCA	Forest area within BCA	Forest Core within BCA	Core Goal 2100 ha or 34,000 ha	Goal Achieved?	Area with restoration potential within BCA	Area of "highest" priority restoration (>2 SD above mean)	Area of "high" priority restoration (>1 SD to <2 SD above mean)	Area of "moderate" priority restoration (mean to 1 SD above mean)	Relative priority for restoration
ARKANSAS										
Ashbrook	16708	13191	8406	5200	Yes	1372	7	873	546	G1
Bayou DeView	7303	3464	246	2100	No	3476	4	554	2683	1
Bayou Meto	34481	21208	6323	5200	Yes	10645	51	7191	3246	G2
Big Ditch	6497	4345	897	2100	No	1376	0	1190	162	3
Big Lake	14316	9455	5044	5200	No	3160	22	1084	1960	7
Black River	27703	16106	3345	5200 & 2100	No	10277	51	4965	5174	5
Boeuf Farms	3740	465	0	2100*	No	3147	0	0	69	0
Brandywine Island	10956	5528	1210	5200	No	4480	0	2329	2157	1
Cut-off Creek	13620	6922	2451	5200	No	6468	42	3953	2552	5
Dermot	5713	1582	1	2100	No	4019	0	450	3533	0
Island 65	7099	4131	1598	2100	No	1882	407	1477	38	9
Overflow	9370	4758	2003	5200	No	4516	759	2436	1292	7
Peters Island	10015	5370	803	2100	No	3408	78	3235	240	6
Rainy Brake	15795	6883	1447	5200	No	8157	87	3299	4749	3
St. Francis National Forest	15409	6693	1631	5200 & 2100	No	6823	122	4618	2017	3
Sunken Lands	31736	13521	2875	5200	No	16563	8	2970	10927	4
White River North	194516	70634	12006	34000 & 5200 & 2100	No	105612	779	27667	65513	3
White River South	173944	129421	80292	34000 & 34000	Yes	32945	1180	13839	18259	G2

ILLINOIS										
Cache River	18410*	4749	0	5200	No	12467	0	356	6721	0
KENTUCKY										
Ballard	13670	5555	18	5200	No	6789	19	3172	3568	2
Obion	7171	3077	2	2100	No	3708	0	1628	2278	2
West Island	5450	2174	0	2100	No	2811				
Westvaco	3569	1375	0	<2100	No	1867	12	1199	667	2
LOUISIANA										
Three Rivers	114611	69776	32481	34000	No	33083	7247	23940	1629	10
Atchafalaya Basin East	220925	154090	75925	34000	Yes	43845	2825	33598	13884	G1
Atchafalaya Basin West	44318	21906	7706	2100 & 2100 & 2100 & 2100	No	11305	264	6774	4148	8
Lower Atchafalaya	30547	18916	6078	5200	Yes	6579	1452	6150	200	G3
Maurepas	137868	95963	45699	34000	Yes	24290	3285	10039	8719	G2
Bayou Boeuf	53030	22950	7738	34000	No	26256	1618	18225	5932	3
Bayou Cocodrie	24404	10301	868	5200	No	13059	411	8897	3683	6
Bayou Macon	12079	2514	213	2100	No	9541	208	1561	5657	3
Boggy Bayou	10226	5561	288	2100	No	4402	96	2820	1438	6
Buckhorn	23490	8979	288	2100	No	14100	519	8664	4806	8
Cat Island	15268	10413	4444	5200	No	3245	1315	2282	0	10
Concordia	8001	5651	3426	2100	Yes	922	183	816	45	G2
Cypress Island	16737	9668	1082	5200	No	5415	0	2501	2787	1
D'Arbonne*	9139*	3724	741	2100	No	2872	1193	2446	477	9
Davis Island	32787	20224	4413	2100 & 2100	No	10858	970	9122	654	10
Deltic Lands	11407	3300	5	2100	No	7893	0	1582	5088	3
Des Allemandes	186936	93048	28677	34000	No	63048	2577	18563	37568	8
Fletcher's Lake	4980	2250	67	2100	No	2453	0	1495	902	2
Atchafalaya Basin	249691	201792	166805	34000	Yes	10017	2149	9206	1465	G1

Floodway										
Glade Woods	13184	6099	1377	2100	No	6163	0	4499	1581	4
Glasscock Island	11184	7549	3491	5200	No	2018	112	1859	133	6
Morganza Floodway	22399	15024	6651	5200 & 2100	No	6799	366	6062	375	9
Palmetto	26008	12105	1228	5200	No	13601	999	8555	3821	8
Raccouci Island	15287	10600	7976	5200	Yes	1137	656	880	160	G1
Russell Sage	31489	16004	4784	5200 & 2100	No	14020	708	11051	2128	8
Saline	51559	36823	23133	5200	Yes	9993	1284	8333	1023	G1
Short Bayou	10179	4113	57	2100	No	5633	0	3597	1944	4
Tensas River	77499	39753	16228	34000	No	36498	4162	26778	5234	8
Thistlewaite	25444	12225	1751	5200	No	12449	606	6999	4629	7
Upper Ouachita*	3488*	1642	161	5200	No	1630	424	1242	1011	1
West False River	14292	10057	3434	5200	No	4039	907	3150	1	9
West Atchafalaya Floodway	62772	26589	5854	5200 & 5200 & 2100	No	32728	5312	20120	6900	10
Yucatan	9881	6313	1248	2100	No	2007	420	1624	0	9
MISSOURI										
Big Oak Tree	5965	2557	4	2100	No	2909	0	483	2407	0
Black River	11174	5132	224	2100	No	5688	13	1467	3924	3
Mingo	14432	7927	1441	5200	No	4983	770	2983	1388	4
New Madrid	8263	3400	360	2100	No	4137	6	911	3235	2
River	8936	3735	292	2100	No	4547	0	2046	2479	4
Ten Mile	7109	960	0	2100	No	6102	0	0	584	0
Wileminna State Forest	6764	1666	0	2100	No	4845	0	0	97	0
MISSISSIPPI										
Belzoni	23761	8630	0	2100	No	12390	0	379	8260	0
Big Black	12085	9122	5512	5200	Yes	2265	169	2291	0	G3
Buffalo River	7295	4940	1809	2100	No	922	430	641	0	10
Coahoma	29841	19510	8106	5200	Yes	7537	526	4962	2161	G2

Coldwater Creek	21191	2081	0	2100	No	18544	0	12	998	0
Dahomey	7989	3394	115	2100	No	4513	96	1190	3199	3
Delta National Forest	125248	57932	22793	34000	No	62721	3014	30339	22466	8
Gunnison	8508	6474	3301	2100	Yes	1172	368	760	78	G2
Hillside	9765	6836	1589	2100	No	2460	582	1568	272	10
Homochitto	24302	14696	6154	5200	Yes	7372	3386	4322	0	G3
Mahannah	113295	61540	22054	34000	No	41342	7358	28976	5238	9
Malmaison	34387	13375	781	5200	No	18353	381	9819	7876	6
Mathews Brake	10881	2591	20	2100	No	7248	0	1212	5755	2
Morgan Brake	8192	3985	271	2100	No	3695	186	3094	294	7
O'Keefe	33029	6164	112	2100	No	25205	64	777	16480	1
Pittman Island	8477	5570	2250	2100	Yes	1666	0	1239	411	G2
St. Catherine's Creek	9703	4386	1672	2100	No	4368	1009	3727	609	10
Tribble	10189	2915	0	2100	No	6085	0	220	3736	0
Tunica	25978	16411	6098	5200	Yes	5571	701	3358	1561	G3
Whittington	38267	26077	17059	5200 & 2100	Yes	7773	339	6394	2051	G1
Yazoo	10706	4488	73	2100	No	5757	208	3374	2048	7
TENNESSEE										
Chickasaw	59408	24954	5650	34000	No	29347	578	18591	10026	2
Meeman Shelby	8518	5061	2322	2100	Yes	2049	179	1178	802	G3
Reelfoot	23313	8504	2966	5200	No	10825	188	4480	5674	6
BCA Totals	2955271	1649397	708050	738400		1017446	66447	502708	380482	

* Only part of Bird Conservation Area (BCA) is included.

Priorities among BCA are assigned based on the proportion of the unmet forest core goal that can be achieved through reforestation of 'highest priority' and 'high priority' habitat. (e.g., if 100% of goals can be met through reforestation of 'highest priority' habitat the BCA conservation priority was 10).

Priority	% of goal met with highest priority habitat	% of goal met with high priority habitat	% of goal possible to meet.
10	>100%	-	>100%
9	>50%	>100%	>100%
8	>25%	-	>100%
7	>10%	-	>100%
6	>5%	-	>100%

5	<5%	-	>100%
4	-	>100%	>100%
3	-	-	> 80%
2	-	-	> 50%
1	-	-	> 25%
0	-	-	< 25%

Priorities for BCA with goals achieved are designated with a 'G' and are based on the ratio of priority restoration habitat to the area of forest core that exceeds goals.