APPENDIX J: HABITAT EVALUATION PROCEDURE (HEP) REPORT FOR THE PROPOSED LOWER BOIS D'ARC CREEK RESERVOIR SITE

DRAFT HABITAT EVALUATION PROCEDURE (HEP) REPORT

Lower Bois d'Arc Creek Reservoir

NTD06128

April 2008

Prepared for

North Texas Municipal Water District

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1.0 INTRODUCTION

The Habitat Evaluation Procedure (HEP) is a habitat-based evaluation methodology developed by USFWS in 1974 for use as an analytical tool in impact assessments and project planning. HEP is a species-habitat analysis of the ecological value of a study area; its approach is to quantify the value of habitat available to a selected set of wildlife species within a specified geographic area of interest. The method is designed to describe wildlife habitat values at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time or of the same area at different points in time. Because HEP provides a quantitative method for such comparisons, it may be used in planning applications such as the assessment of current and future wildlife habitat, trade-off analyses, or compensation analyses.

HABITAT VALUE (HU) =
Habitat Quantity (Acres)
×
Habitat Quality (HSI)

HEP appraises a study area by quantifying its Habitat Value, calculated as the product of habitat quantity and habitat quality; this value is expressed in Habitat Units (HU). Habitat quantity is simply the total area of habitat available within the study area, usually expressed in number of acres. If the study area is subdivided into Cover Types (i.e., discrete areas with similar ecological characteristics that are adequately homogeneous), habitat quantities used in evaluation may be subsets of the study area. Habitat quality is expressed in terms of a Habitat Suitability Index (HSI), which is determined by comparing the ecological characteristics of the study area to the habitat characteristics that are optimum for Evaluation Species, representative wildlife species with known habitat requirements selected to provide a basis to assess habitat suitability.

HABITAT SUITABILITY INDEX
1.0 = optimal habitat
⇧
0.0 = unsuitable habitat

HSI values are based on two components: the habitat characteristics that provide ideal conditions for an evaluation species, and the habitat characteristics existing in the study area. These characteristics are described by a set of measurable Habitat Variables, such as the height and percent cover of various vegetation types, the distance to water or grain, the availability of perching or nesting sites, or the frequency of flooding. The set of habitat variables needed to determine HSI values are obtained from documented habitat suitability models for each evaluation species. These models describe the species' Life Requisites (i.e., its habitat requirements for food, cover and reproduction), the relationship between the habitat variables' values and the suitability of the area to meet its life

requisites, and the method to integrate these suitability relationships into an HSI value. HSI values range from 0.0 to 1.0, with a ranking of 0.0 being unsuitable and 1.0 being optimum conditions, which are those associated with the highest potential densities of the species. Each increment of change in HSI value must be identical to any other, i.e., HSI must be linearly correlated to carrying capacity.

Habitat values may be calculated for each evaluation species within all its available habitat or for each cover type within the study area. Calculations based on existing ecological conditions can be used to describe baseline conditions and serve as a reference point for resource monitoring or for comparison to predicted future habitat values with or without proposed actions or mitigation measures. HEP provides a consistent means of assessing project impacts by demonstrating, in HUs gained or lost, the beneficial or adverse impacts anticipated as a result of various courses of action. Furthermore, HEP aids mitigation analysis by identifying which factors negatively impact habitat values in various scenarios, e.g., habitat variables resulting in low HSI values, thus suggesting means for improving habitat or selecting mitigation lands.

In summary, the generalized process for conducting a HEP study involves the following components (USFWS 1980):

- Determine the applicability of HEP and define the study area;
- Delineate habitat or vegetation cover types;
- Select the relevant evaluation species;
- Determine each species' life requisites and measure habitat variables for suitability;
- Determine baseline and future habitat units; and
- Develop compensation/mitigation plans for the proposed project.

2.0 APPROACH AND METHODS

LOWER BOIS D'ARC CREEK RESERVOIR HEP TEAM

USACE
EPA
USFS
USFWS
TPWD
TWDB
TCEQ
NTMWD
FNI

The Lower Bois d'Arc Creek Reservoir HEP team included the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service (USFWS), the U.S. Forest Service (USFS), Texas Parks and Wildlife Department (TPWD), Texas Water Development Board (TWDB), Texas Commission on Environmental Quality (TCEQ), North Texas Municipal Water District (NTMWD), and Freese and Nichols, Inc. The HEP team had oversight for the tasks that were required for the analysis, including defining the study area, delineating cover types, field sampling, and selecting evaluation species.

The HEP methodology incorporated into this study is recommended by the USFWS as their basic tool for evaluating project impacts and developing mitigation recommendations (USFWS 1993). HEP has been used as a method to evaluate impacts to wildlife habitat for similar projects in Texas. The steps include defining the study limits, describing the baseline conditions in habitat units, and the projection of future habitat conditions. The following describes this method as applied in the present study.

2.1 Study Limits

The process to define the study limits includes the delineation of the study area, determination of cover types, and selection of the evaluation species.

The study area is the geographic area where ecological changes associated with the project are expected to occur and for which evaluation of habitat conditions is conducted. The proposed study area for the Lower Bois d'Arc Creek Reservoir Project is the approximately 17,068-acre area, which includes the area that will be inundated at the normal pool elevation of 534 feet NGVD, and the footprints of the dams, spillways and pump station.

COVER TYPES

Upland Deciduous Forest
Evergreen Forest
Tree Savanna
Shrubland
Cropland
Grassland / Old Field
Riparian Woodland / Bottomland Hardwood
Shrub Wetland
Emergent / Herbaceous Wetland

2.2 Cover Type Determination and Delineation

Cover types were delineated using digital color infrared photography flown on January 10, 2007. Nine cover types were identified for HEP analysis within the Lower Bois d'Arc Creek Reservoir project area. The upland cover types included *Upland Deciduous Forest*, *Evergreen Forest*, *Tree Savanna*, *Shrubland*, *Cropland*, and *Grassland / Old Field*. The wetland cover types included *Riparian Woodland / Bottomland Hardwood* (included forested wetland habitat), *Shrub Wetland*, and *Emergent / Herbaceous Wetland*. In addition, the project area included *Shrub Savanna*, *Riverine* and *Lacustrine* cover types that were not used in HEP analysis. Table 1 provides the number of acres in each cover type.

Table 1. Cover Type Areas.

Cover Type	Area (acres)
Upland Deciduous Forest	2216
Evergreen Forest	228
Tree Savanna	132
Shrubland	63
Cropland	1757
Grassland / Old Field	4761
Riparian Woodland / Bottomland Hardwood	6330
Shrub Wetland	49
Emergent / Herbaceous Wetland	1223

2.3 Evaluation Species Selection and Descriptions

Sixteen evaluation species were selected by the HEP team based on their ecological significance and the availability of applicable HSI models. The species models used in this study were the American kestrel, barred owl, brown thrasher, Carolina chickadee, downy woodpecker, eastern cottontail, eastern meadowlark, eastern turkey, field sparrow, fox squirrel, green heron, raccoon, racer, scissortailed flycatcher, swamp rabbit, and the wood duck.

EVALUATION SPECIES

American kestrel
Barred owl
Brown thrasher
Carolina chickadee
Downy woodpecker
Eastern cottontail
Eastern meadowlark
Eastern turkey
Field sparrow
Fox squirrel
Green heron
Raccoon
Racer
Scissortailed flycatcher
Swamp rabbit
Wood duck

The following are descriptions of the habitat preferences and life requisites for the study species, along with the cover types that make up their available habitat. Detailed HSI calculations for each species in each cover type, along with any assumptions or exceptions made for the applications of the species models are reported in Appendix A.

American Kestrel (*Falco sparverius*)

The American kestrel is a small, predatory bird associated with open prairies and agricultural lands as well as where these areas border forested habitats. This raptor hunts insects, birds, small mammals and reptiles in areas of low, open vegetation from adjacent perch sites such as fence posts, trees, and utility lines. Nest sites are found near their hunting habitat, often in mature trees with cavities excavated by other species, as well as in cliffs and on the roofs of old buildings (Author Unknown 1980a).

AMERICAN KESTREL

COVER TYPES:
Tree Savanna
Cropland
Grassland / Old Field

LIFE REQUISITES:
Open fields with perches
Cavities in lone trees or cliffs

Barred Owl (*Strix varia*)

Barred owls are forest-dwelling birds that prefer expansive, mature forests with open sub-canopies allowing for the flying space needed for hunting small game. The species shows no marked preference between upland and bottomland forests. However, since upland forests are more accessible to logging, forested wetland sites less accessible to timber harvest are currently more likely to provide for their needs. Specifically, barred owl habitat must provide large, decadent trees with adequate numbers of nesting cavities, although nesting has been recorded in abandoned raptor nests. Due to the foliage cover, live trees provide superior nesting sites compared to snags (Allen 1987).

BARRED OWL

COVER TYPES:
Upland Deciduous Forest
Riparian Woodland / Bottomland Hardwood

LIFE REQUISITES:
Large, living trees
Adequate nesting cavities

Brown Thrasher (*Toxostoma rufum*)

BROWN TRASHER

COVER TYPE:
Evergreen Forest

LIFE REQUISITES:
Available but sparse trees
Dense understory & leaf litter

The brown thrasher is a bird species often associated with thickets, hedgerows, midsuccessional forests, and habitats that provide trees in low density and support dense understory growth of shrubs. They primarily forage in the deep leaf litter, using bill sweeps to locate insects and other arthropods, but will also feed in shrubs for seeds and berries. Shrubs are most often used as nest sites, but the presence of evergreen and deciduous trees increases nesting success and provides alternative nest sites (Cade 1986).

Carolina Chickadee (*Poecile carolinensis*)

CAROLINA CHICKADEE

COVER TYPE:
Upland Deciduous Forest
Evergreen Forest

LIFE REQUISITES:
Forests with deciduous / evergreen mix
Closed canopies and open understories
Snags for nesting

Carolina chickadees are residents of forests and forest boundaries, preferring the well-developed canopies and open understories of these habitats, but also utilizing shrub layers. This bird captures moths, caterpillars and other arthropods from the bark and foliage of the trees within these habitats as well as exploiting shrubs for berries and seeds. Carolina chickadees are cavity nesters that utilize natural and excavated sites in tree limbs, snags, and fence posts (Author Unknown 1980b)

Downy Woodpecker (*Picoides pubescens*)

DOWNY WOODPECKER

COVER TYPE:
Upland Deciduous Forest
Riparian Woodland / Bottomland Hardwood

LIFE REQUISITES:
Open woodlots
Soft snags

Downy woodpeckers show a preference for open woodlots, but the species is found across North America wherever there are trees that they can drill and glean for the insects they eat. They inhabit both coniferous and deciduous forests. These woodpeckers are not strong excavators, so their nest cavity placement is limited by the availability of soft snags, often with both surface sap rot and fungal heart rot. Living trees with broken crowns are also chosen as nesting sites (Schroeder 1983).

Eastern Cottontail (*Sylvilagus floridanus*)

Eastern cottontails are habitat generalists within a wide range of early- to mid-succession habitats. They require an abundance of both well-distributed escape cover and open areas for nocturnal browsing; this combination often consists of old-field bordered by shrubby edge habitat. Eastern cottontails also need dense thickets or hedgerows for resting and daytime shelter. Nests are usually located in areas of thick grass cover, such as hayfields and fallow fields that lie near escape cover (Allen 1984).

EASTERN COTTONTAIL

COVER TYPE:
Evergreen Forest
Tree Savanna
Shrubland
Cropland
Grassland / Old Field

LIFE REQUISITES:
Fields with shrubby edges
Dense thickets or hedgerows
Thick grass or hayfields

Eastern Meadowlark (*Sturnella magna*)

Eastern meadowlarks inhabit grasslands, meadows, pastures, and fallow fields in the south and central United States. While they do need numerous perch sites, such as tall forbs, shrubs, small trees and fences, their preferred habitat consists of relatively open grasslands with low shrub and forb coverage. The eastern meadowlark is a ground-nesting species, so groundcover must be thick for nest concealment (Schroeder and Sousa 1982).

EASTERN MEADOWLARK

COVER TYPE:
Tree Savanna
Grassland / Old Field

LIFE REQUISITES:
Herbaceous or grassy canopy
Nearby perch sites

Eastern Turkey (*Meleagris gallopavo sylvestris*)

The eastern turkey prefers habitats that provide diverse vegetation regimes, such as riparian or upland forests adjacent to grass or agricultural fields. The diets of these opportunistic omnivores are dominated by plant material including fruits, seeds and leaves, but insects and other arthropods are eaten as well. Acorns are particularly important components of the turkey's fall and winter diet. These ground-nesters rely on habitats with dense brush and herbaceous cover for nesting and for raising their young (Schroeder 1985).

EASTERN TURKEY

COVER TYPE:
Upland Deciduous Forest
Evergreen Forest

LIFE REQUISITES:
Sparse shrub cover
Nearby mature forests

Field Sparrow (*Spizella pusilla*)

FIELD SPARROW

COVER TYPE:
Shrubland

LIFE REQUISITES:
Short, sparse shrubs
Small trees
Thick grass cover in Spring

The field sparrow prefers brushy fencerows and old fields with scattered woody vegetation, and can also be found in grasslands and forested areas. The diet of this ground-foraging species is predominated by vegetative plant material in the spring and summer and by seeds in the fall, but they also forage for insects, especially for the feeding of nestlings. Small trees and shrubby vegetation are used for roosting and winter cover, while a mix of herbaceous vegetation with short, sparse shrubs provides ideal breeding and ground-nesting cover (Sousa 1983).

Fox Squirrel (*Sciurus niger*)

While fox squirrels prefer open forest stands with little understory vegetation, they will inhabit a wide variety of forest types. Upland and well-drained bottomland forest habitats are used more often than poorly-drained lowland areas. Small stands of large trees situated in agricultural areas allow fox squirrels to supplement their diet, which consists of mast and a variety of other plant and animal foods, with grains as needed. Mature mast trees provide both food and nesting sites. Fox squirrels will nest in tree cavities, but also build leaf nests; therefore, quality habitat is not limited by the availability of nesting cavities (Allen 1982a).

FOX SQUIRREL

COVER TYPE:
Upland Deciduous Forest
Riparian Woodland /
Bottomland Hardwood

LIFE REQUISITES:
Open forests
Little understory
Nearby grain

Green Heron (*Butorides virescens*)

GREEN HERON

COVER TYPE:
Shrub Wetland
Herbaceous wetland

LIFE REQUISITES:
Shallow, open water
Nearby shrubs or small trees

Green herons are predators that wade in or perch above the shallow waters of rivers, lakes, ponds, lagoons, ditches, marshes and swamps, where they hunt for fish, frogs, crawfish and other aquatic animals. They are adaptable generalists within these aquatic environments and inhabit both freshwater and saltwater ecosystems. Their preferred feeding habitat consists of open, permanent, shallow waters that are free of emergent aquatic vegetation. Ideally, adequate cover such as dense stands of reeds and cattails, which also provide nesting areas, are available in proximity to hunting sites. More often, nests are built in shrubs or small trees near the shoreline (Author Unknown 1980c).

Raccoon (*Procyon lotor*)

Costal swamps, marshes and bottomland hardwood forests maintain the greatest numbers of raccoons by supplying their daily need for water and cover. Upland populations are limited by their access to water, preferring hardwood forests near rivers, streams or swamps. Raccoons forage nocturnally on a limitless variety of food, including fruits, insects, aquatic animals, small mammals and reptiles; access to open areas increases the availability of many of their food sources. These solitary mammals prefer to locate their dens in overmature hardwood trees, especially for raising their young, but will also utilize rock crevices, caves and brush piles (Author Unknown 1980d).

RACCOON

COVER TYPE:
Riparian Woodland / Bottomland Hardwood
Shrub Wetland
Herbaceous Wetland

LIFE REQUISITES:
Daily access to water
Mature forests

Racer (*Coluber constrictor*)

Racers are snakes that live in grasslands, open woods, and brushy areas. Tall-grass prairie is ideal summer habitat, but pastureland, brushy ravines, hay or grain fields, and open woodlands with adequate cover are widely used by the species. Eggs are often laid in the tunnels of burrowing mammals as well as in rotten logs and stumps. In the fall, racers migrate to rocky outcroppings and ledges with southern exposures where they hibernate in deep crevices (Author Unknown 1980e).

RACER

COVER TYPE:
Shrubland
Grassland / Old Field

LIFE REQUISITES:
Herbaceous canopy cover
Tunnels or other refuge sites

Scissor-tailed Flycatcher (*Tyrannus forficatus*)

Scissor-tailed flycatchers prefer open, tall-grass prairies with small, isolated groups of deciduous trees. These birds primarily feed on flying and ground-dwelling insects they hunt from perch sites such as tall prairie plants, utility lines, fences or dead tree limbs, although seeds and berries are eaten as well. Isolated groups of trees within herbland savannas or croplands are preferred for nesting sites (Author Unknown 1980f).

SCISSOR-TAILED FLYCATCHER

COVER TYPE:
Tree Savanna
Cropland
Grassland / Old Field

LIFE REQUISITES:
Tall, dense herbaceous cover
Perch sites in forage habitat
Nearby tall trees

Swamp Rabbit (*Sylvilagus aquaticus*)

SWAMP RABBIT

COVER TYPE:
Shrub Wetland

LIFE REQUISITES:
Open overstory canopies
Dense understories
Fallen trees, stumps, or logs

Swamp rabbits are associated with wetland habitats in the southeastern United States, including bottomland hardwood forests and coastal marshes. In forested settings they prefer open overstory canopies and dense understories that provide for abundant browse. Brush-piles, downfalls, dense herbaceous vegetation such as vine tangles, and even standing, hollow trees provide for swamp rabbit cover. They use tree stumps, logs, and low tree crotches for their resting sites (called forms). The forms must be situated near adequate escape cover (Allen 1985).

Wood Duck (*Aix sponsa*)

WOOD DUCK

COVER TYPE:
Riparian Woodland /
Bottomland Hardwood
Shrub Wetland
Herbaceous Wetland

LIFE REQUISITES:
Slow moving waters
Aquatic vegetation
Mature hardwood forest
Protected "loafing" sites

Year-around residents in the southeastern United States, wood ducks inhabit wooded areas near slow-moving creeks and rivers, as well as those near floodplain lakes, swamps, and beaver ponds. Since wood ducks nest in tree cavities, ideal nesting habitat is mature hardwood forest proximal to aquatic feeding sites. Mast and aquatic vegetation make up the majority of their food-sources. Wood ducks also require adequate loafing sites adjacent to water that have good visibility and proximate cover (Sousa and Farmer 1983).

3.0 BASELINE CONDITIONS DETERMINATION

Field sampling was conducted by the HEP team members on June 19-20, July 30, and August 14-17, 2007. HEP site observation and habitat assessment forms completed during this effort are provided in Appendix B. Photographs taken at each site are presented in Appendix C.

The location of sampling sites and the distribution of cover types used in the current study are shown in Figure 1. The distribution of the sampling sites is shown on an aerial photograph of the project site in Figure 2. Field measurements were made within a 0.1-acre quadrant at each site.

3.1 Cover Type Descriptions and Habitat Variable Measurements

The following descriptions of cover types are based on the results of field measurements and observations made during June-August 2007. A table follows each cover type description detailing the results of field measurements for each of the habitat variables needed for calculation of suitability indices (SIs) and HSI values.

UPLAND DECIDUOUS FORESTS

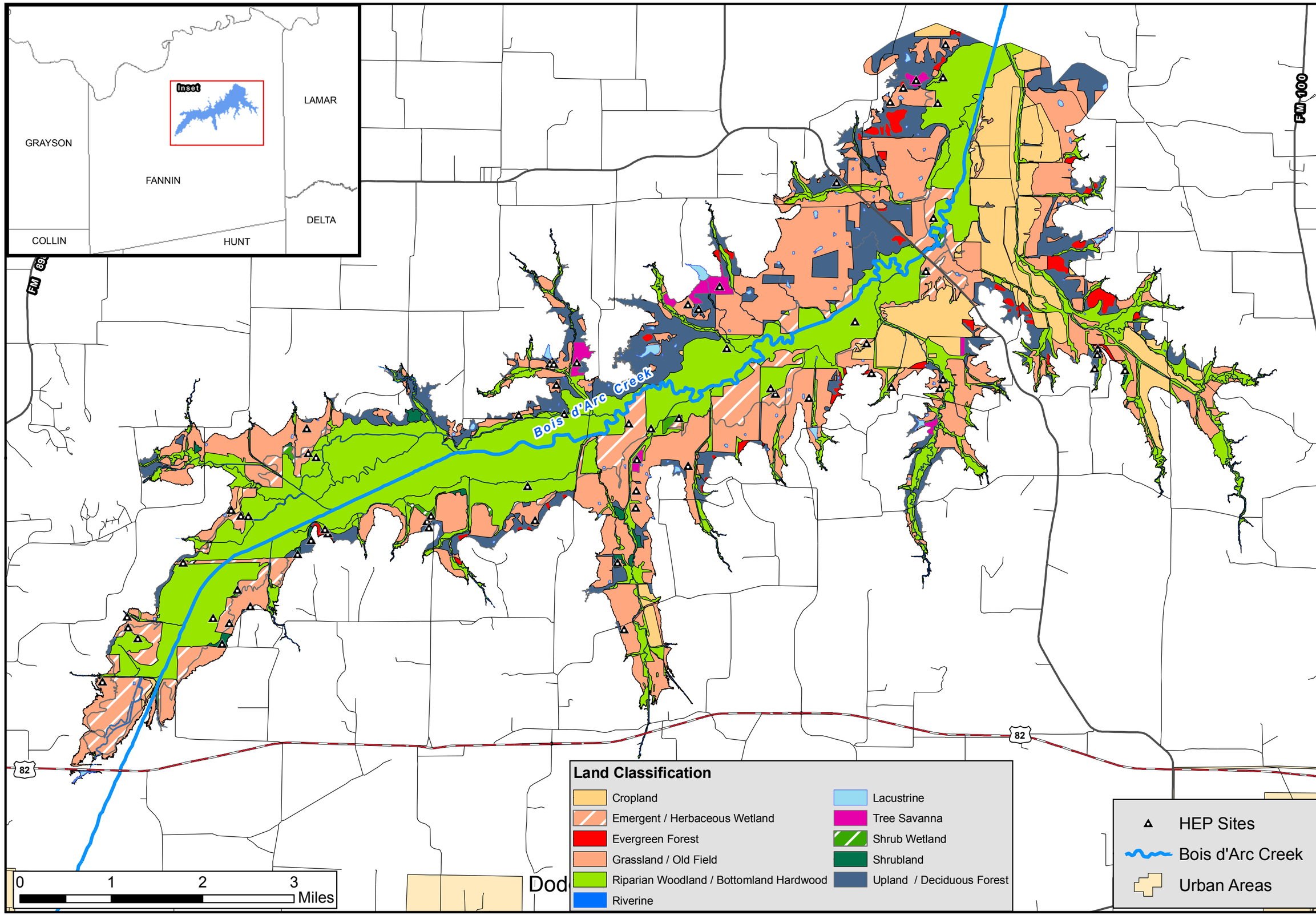
Non-wetland areas dominated by trees and with a minimal tree canopy closure of 25%.

EVALUATION SPECIES:
Barred Owl
Carolina Chickadee
Downy Woodpecker
Eastern Turkey
Fox Squirrel

Upland Deciduous Forest

Upland forests are defined as non-wetland areas dominated by trees of at least 5 meters in height with a minimum tree canopy closure of 25 percent. In upland deciduous forests, at least 50 percent of that canopy is composed of deciduous species, or those that completely shed their foliage during part of the year (USFWS 1980c). Upland deciduous forests in the project area are composed of 90 percent deciduous trees on average and with an average height of overstory trees of 43 feet. The upland forest cover type makes up approximately 2,216 acres of the proposed Lower Bois d'Arc Creek Reservoir.

Dominant tree species include post oak (*Quercus stellata*), water oak (*Q. nigra)*, southern red oak (*Q. falcata*), cedar elm (*Ulmus crassifolia*), sugarberry (*Celtis laevigata*), bois d'arc (*Maclura pomifera*), green ash (*Fraxinus pennsylvanica*) and eastern red cedar (*Juniperus virginiana*). Average tree canopy closure and overstory tree height equal approximately 68 percent and 43 feet, respectively. Deciduous trees comprised 92 percent of the tree canopy on average.



F&N JOB NO: NTD06128
DATE: March 2008
SCALE: 1:60,000
DESIGNED: BME
DRAFTED: BME
FILE: Figure1.mxd

North Texas Municipal Water District
Proposed Lower Bois d'Arc Creek Reservoir

HEP Cover Type Mapping

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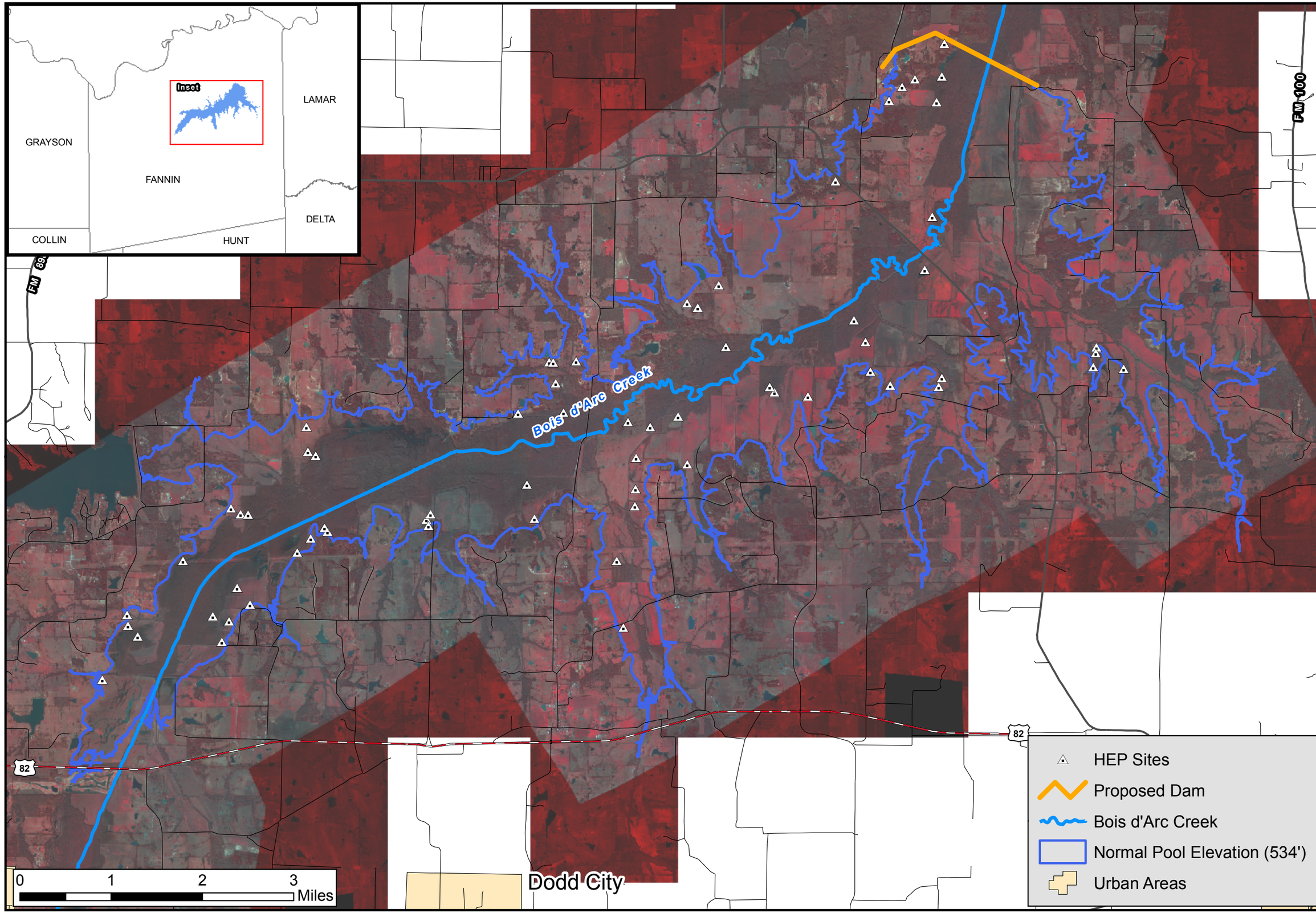
1
FIGURE



North Texas Municipal Water District

Proposed Lower Bois d'Arc Creek Reservoir

2007 Aerial Imagery

F&N JOB NO:	NTD06128
DATE:	March 2008
SCALE:	1:60,000
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FILE:	Figure1.mxd

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2

FIGURE

Common shrub and vine species include coralberry (*Symphoricarpos orbiculatus*), greenbrier (*Smilax* spp.), honey locust (*Gleditsia triacanthos*), poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and dogwood (*Cornus drummondii*). Shrub canopy closure in the typical upland forest averages about 33 percent.

Dominant herbs include sedge (*Carex* spp.), flatsedge (*Cyperus* spp.), panicgrass (*Dichanthelium* spp.), corn salad (*Valerianella* sp.), Virginia wildrye (*Elymus virginicus*), ironweed (*Vernonia* spp.), Venus' looking-glass (*Triodanis* sp.), and wild onion (*Allium ascalonicum*). Average herbaceous canopy cover equals approximately 38 percent. Complete results of HEP field measurements for this cover type are shown in Table 2.

Wildlife observed in this cover type included a variety of bird species such as northern cardinal (*Cardinalis cardinalis*), blue-grey gnatcatcher (*Polioptila caerulea*), downy woodpecker (*Picoides pubescens*), yellow-billed cuckoo (*Coccyzus americanus*), great blue heron (*Ardea herodias*), American crow (*Corvus brachyrhynchos*), brown-headed cowbird (*Molothrus ater*), Carolina chickadee (*Poecile carolinensis*), barred owl (*Strix varia*). Also resident in these areas are various reptiles such as turtles (Order: Testudines), frogs (Order: Anura), snake such as racers (*Coluber constrictor*), and mammals including the eastern fox squirrel (*Sciurus niger*).

Table 2. HEP Field Data Summary:
Habitat Variable Measurements at Upland Deciduous Forest Sites.

Cover Type: Upland Deciduous Forest

Species: Barred Owl, Carolina Chickadee, Downy Woodpecker, Eastern Turkey, Fox Squirrel

Habitat Variable	Sample Site Number					
	1	2	3	4	5	20
% tree canopy closure	85	50	45	85	95	50
% tree canopy closure of hard mast producers >10" dbh*	0	0	35	10	70	50
% tree canopy closure of soft mast producing trees	60	50	10	90	20	5
% canopy closure deciduous trees in stand	85	25	45	85	80	50
% canopy closure of overstory trees	40	40	35	85	70	50
Average dbh of overstory trees (in)	15	12	18	8	15	16
Average height of overstory trees (ft)	30	35	35	35	60	60
# per acre of snags <10" dbh	200	3	90	10	10	1
# per acre of snags >6" dbh	40	3	0	2	0	1
% shrub crown cover	20	20	15	5	90	45
% herbaceous canopy cover	95	25	15	60	0	30
Average height of herbaceous canopy cover in summer (in)	18	12	12	14	0	6
# per acre of trees >20" dbh	0	0	30	0	0	0
Distance to grain (yd)	660	660	660	660	660	660
Basal Area: area of exposed woody stems if cut horizontally at 4.5 ft height (ft^2/ac)	120	140	60	80	5	160
Average dbh of hard mast producing trees that are >10" dbh (in)	0	0	18	0	40	16
# per hectare of hard mast producing trees >10" dbh	0	0	124	0	99	8
% of shrub crown cover comprised of soft mast producing shrubs	100	5	90	100	15	30
% of forest canopy comprised of evergreens	0	25	0	2	20	0

*dbh: diameter at breast height - the diameter of the stem/trunk measured at a distance of 4.5 feet above the ground.

EVERGREEN FORESTS

Tree canopy closure of 25%. Evergreens make up 50% of canopy.

EVALUATION SPECIES:
Brown Thrasher
Carolina Chickadee
Eastern Cottontail
Eastern Turkey

Evergreen Forest

Evergreen forests also meet the requisites of upland forests, being dominated by trees of at least 5 meters in height with a minimum tree canopy closure of 25 percent. Upland forests in which at least 50 percent of the tree canopy cover is composed of trees that retain their green foliage year-round are designated as evergreen forest (USFWS 1980c). Evergreen forests in the project area have a tree canopy with very few deciduous trees and with little understory. The evergreen forest cover type makes up approximately 228 acres of the proposed Lower Bois d'Arc Creek Reservoir.

These forests are dominated by the evergreen eastern red cedar *(Juniperus virginiana*) mixed with deciduous tree species including red oak (*Quercus falcata*), post oak (*Q. stellata*), and blackjack oak (*Q. marilandica*). Average tree canopy closure equals approximately 70 percent, with evergreens comprising 98 percent of the tree canopy on average.

Shrub and herbaceous cover is sparse in these areas, averaging about 5 and 8 percent, respectively. Shrub and vine species occurring in these forests include coral berry (*Symphoricarpos orbiculatus*), greenbrier (*Smilax* spp.), gum bumelia (*Sideroxylon* (syn. *Bumelia*) *lanuginosum*), and possumhaw holly (*Ilex decidua*). Herbaceous species include Cherokee sedge (*Carex cherokeensis*), panicgrass (*Dichanthelium* sp.), johnsongrass (*Sorghum halepense*), and KR bluestem (*Bothriochloa ischaemum* var. *songarica*). Details of the HEP field measurements for this cover type are shown in Table 3.

Wildlife observed in the evergreen forests of the project area include tufted titmouse (*Baeolophus bicolor*), northern cardinal (*Cardinalis cardinalis*), painted bunting (*Passerina ciris)*, Carolina chickadee (*Poecile carolinensis*), pileated woodpecker (*Dryocopus pileatus*), and American crow (*Corvus brachyrhynchos*).

Table 3. HEP Field Data Summary:
Habitat Variable Measurements at Evergreen Forest Sites

Cover Type: Evergreen Forest			
Species: Brown Thrasher, Carolina Chickadee, Eastern Cottontail, Eastern Turkey			
Habitat Variable	**Sample Site Number**		
	1	**3**	**20**
% tree canopy closure	80	80	50
# per hectare of hard mast producing trees >10" dbh	1	0	0
% tree canopy closure of soft mast producing trees	80	80	0
Average dbh of overstory trees (in)	6	6	4
% shrub crown cover	5	10	0
% canopy cover of persistent herb vegetation	5	5	5
# per hectare of woody stems >1 m tall	450	1,284	1,729
Average dbh of hard mast producing trees that are >10" dbh (in)	0	0	0
% of shrub crown cover comprised of soft mast producing shrubs	3	100	0
% of forest canopy comprised of evergreens	99	95	100
% ground surface covered by litter >0.4" deep	40	10	20
% canopy closure deciduous trees in stand	5	5	0
Average height of overstory trees (ft)	20	30	30
# per acre snags <10" dbh	20	20	0
% herbaceous canopy cover in summer	10	5	10
Average height of herbaceous canopy in summer (in)	6	6	0

Tree Savanna

In tree savannas, trees taller than 5 meters make up a sparser canopy – between 5 to 25 percent – than in upland forests. Total canopy cover of all vegetation in this cover type is at least 25 percent (USFWS 1980c). Tree savannas in the project site have sparse tree and shrub canopies and abundant herbaceous cover. This cover type makes up about 132 acres of the proposed Lower Bois d'Arc Creek Reservoir.

TREE SAVANNA

Tree canopy cover 5-25%. Vegetation canopy cover at least 25%.

EVALUATION SPECIES:
American Kestrel
Eastern Cottontail
Eastern Meadowlark
Scissor-tailed Flycatcher

Tree canopy cover within this cover type averages 12 percent and primarily consists of large lone trees. These trees are most often cedar elms (*Ulmus crassifolia*), bois d'arc (*Maclura pomifera*), or eastern red cedars (*Juniperus virginiana*). Shrub canopy cover is also low in these areas, averaging about 9 percent. The shrub and vine species commonly seen in these areas include gum bumelia (*Sideroxylon* (syn *Bumelia*) *lanuginosum*), coralberry (*Symphoricarpos orbiculatus*), greenbrier (*Smilax* spo.), poison ivy (*Toxicodendron radicans*), and southern dewberry (*Rubus trivialis*).

Herbaceous cover in tree savannas within the project area is both diverse and abundant, averaging 89 percent cover. Species frequently occurring in the herbaceous layer include ironweed (*Vernonia* spp.), western ragweed (*Ambrosia psilostachya*), sedge (*Carex* spp.), flatsedge (*Cyperus* spp.), bermudagrass (*Cynodon dactylon*), panicgrass (*Dichanthelium* spp.), KR bluestem (*Bothriochloa ischaemum* var. *songarica*), indian plantain (*Arnoglossum* spp.), prairie plantain (*Plantago* sp.), croton (*Croton* spp.), and dock (*Rumex* spp.). Complete habitat variable measurements for this cover type are shown in Table 4.

Bird species observed in tree savannas include the Carolina chickadee, yellow-billed cuckoo, painted bunting, white-eyed vireo (*Vireo griseus*), northern cardinal, brown-headed cowbird, and downy woodpecker.

Table 4. HEP Field Data Summary:
Habitat Variable Measurements at Tree Savanna Sites

Cover Type: Tree Savanna				
Species: American Kestrel, Eastern Cottontail, Eastern Meadowlark, Scissor-tailed Flycatcher				
Habitat Variable	**Sample Site Number**			
	1	2	3	4
% herbaceous canopy cover	95	97	75	90
Average height of herbaceous canopy in spring (in)	16	12	12	12
Distance to perch sites: trees, forest edge, fence post, wire, etc (yd)	10	1.7	3.3	0
% herbaceous canopy cover that is grass	50	90	30	80
% shrub canopy cover	1	25	3	5
% tree canopy closure	1	25	15	5
# per acre of deciduous trees	10	150	20	1
Distance to nearest deciduous trees, clumps, forest edge, wing breaks, isolated trees, etc (yd)	10	15	3.3	13.3
% herbaceous canopy <12" tall	80	90	75	90
Availability of large lone trees >12" dbh or groves <1 ac in size containing large trees within 1 mi: A) Abundant: >10 B) Moderate: 4-9 C) Few to None: 0-1	A	A	A	A
Availability of cliff ledges, earth banks, or old abandoned buildings within 1 mi: A) Abundant B) Moderate C) Few to None	C	C	C	B
% canopy cover of persistent herbaceous vegetation (non-woody vegetation that remains after growing season, i.e. over-winter crop)	50	75	30	5

SHRUBLAND

Dominated by shrubs (including small trees < 5 meters tall)

Shrub canopy cover of at least 25 percent

EVALUATION SPECIES:
Eastern Cottontail
Field Sparrow
Racer

Shrubland

Shrublands are defined as upland areas that are dominated by a shrub layer, which may be composed of shrub species and/or small trees shorter than 5 meters. This covertype should have a shrub canopy cover of at least 25 percent (USFWS 1980c).

Shrublands in the project area represent a midpoint in the successional transition from upland old fields to forests, with a shrub layer dominated by tree species such as green ash (*Fraxinus pennsylvanica*), bois d'arc and eastern red cedar. Shrub species also within this layer include honey locust, persimmon (*Diospyros* sp.), and coralberry. Shrub canopy cover averages approximately 44 percent, while tree canopy cover averages about 3 percent. The diverse herbaceous layer was dominated by cherokee sedge, goldenrod (*Solidago* spp.), johnsongrass, silver bluestem (*Bothriochloa laguroides*), wild pea (*Lathyrus* spp.), and snow on the prairie (*Euphorbia bicolor*). The herbaceous cover is abundant, averaging approximately 89 percent. Complete results of HEP habitat measurements for this cover type are shown in Table 5. There are approximately 63 acres of shrubland within the proposed Lower Bois d'Arc Creek Reservoir.

Shrubland bird species observed in the project area include the northern cardinal, painted bunting, American crow, bluejay (*Cyanocitta cristata)*, and white-eyed vireo. The racer snake and garden orbweaver spider (*Argiope aurantia*) was also observed.

Table 5. HEP Field Data Summary:
Habitat Variable Measurements at Shrubland Sites

Cover Type: Shrubland

Species: Eastern Cottontail, Field Sparrow, Racer

Habitat Variable	Sample Site Number			
	1	**2**	**3**	**5**
% herbaceous canopy cover	90	100	95	70
% shrub canopy cover	40	75	35	25
# per acre of refuge sites	30	100	10	40
Average height of herbaceous vegetation (in)	15	36	36	8
Distance to shrubby edges or shrub thickets (ft)	20	300	0	20
% of total shrubs that are <4.9' tall	15	50	15	30
% canopy cover of grasses	20	40	75	90
% tree canopy closure	10	0	0	0
% canopy cover of persistent herbaceous vegetation (non-woody vegetation that remains after growing season, i.e. over-winter crop)	75	50	60	50

Cropland

CROPLAND

Annually planted and harvested uplands.

EVALUATION SPECIES:
American Kestrel
Eastern Cottontail
Scissor-tailed Flycatcher

Croplands are defined as agricultural uplands which are planted and harvested annually with agricultural crops; pasture and hayland are excluded from this covertype (USFWS 1980c). The croplands in the project area are primarily planted with oats (*Avena sativa*), soybeans, and hay crops, often alternated with winter wheat (*Triticum aestivum*) cover. Trees and shrubs are excluded from these areas, but are often present in adjacent fencerows. This cover type makes up about 1,757 acres of the proposed Lower Bois d'Arc Creek Reservoir.

Fallow fields are dominated by johnsongrass (*Sorghum halepense*), but also often include panicgrass, knotroot bristlegrass (*Setaria parviflora*), tall fescue (*Lolium arundinaceum)*, and bermudagrass. Forbs are also common in the herbaceous layer, including dock (*Rumex* spp.), pigweed (*Amaranthus* spp.), spurge (*Euphorbia* spp.), morning glory (*Ipomoea* sp.), and black-eyed susan (*Rudbeckia hirta*). This herbaceous cover stands at an average of 22 inches in the spring, with an average canopy cover of approximately 47 percent. Complete results of habitat variable field measurements are shown in Table 6.

Croplands support wildlife populations primarily by providing food sources, and are especially valuable when located adjacent to tree or shrub cover. Bird species observed in the croplands of the project area include the wild turkey (*Meleagris gallopavo*), northern cardinal, painted bunting, white-eyed vireo, tufted titmouse, and blue-gray gnatcatcher.

Table 6. HEP Field Data Summary:
Habitat Variable Measurements at Cropland Sites

Cover Type: Cropland

Species: American Kestrel, Eastern Cottontail, Scissor-tailed Flycatcher

Habitat Variable	Sample Site Number		
	1	**4**	**20**
% herbaceous canopy cover	20	95	25
Average height of herbaceous canopy in spring (in)	18	36	12
Distance to perch sites: trees, forest edge, fence post, wire, etc (yd)	50	109	100
% shrub canopy cover	0	0	0
% tree canopy closure	0	0	0
# per acre of deciduous trees	0	0	0
Distance to nearest deciduous trees, clumps, forest edge, wind breaks, isolated trees, etc (yd)	50	109	100
% canopy cover of persistent herbaceous vegetation (non-woody vegetation that remains after growing season, i.e. over-winter crop)	40	90	10
Availability of large lone trees >12" dbh or groves <1 ac in size containing large trees within 1 mi: A) Abundant: >10 B) Moderate: 4-9 C) Few to None: 0-1	A	A	A
Availability of cliff ledges, earth banks, or old abandoned buildings within 1 mi: A) Abundant: >10 B) Moderate: 4-9 C) Few to None: 0-3	C	C	C
Availability of fence rows, roadside ditches, and grassy-uncultivated areas: A) Abundant B) Moderate C) Scarce to None	A	A	A

GRASSLAND

Dominated by grasses & non-woody vegetation. Canopy cover of at least 25 percent.

EVALUATION SPECIES:
American Kestrel
Eastern Cottontail
Eastern Meadowlark
Racer
Scissor-tailed Flycatcher

Grassland / Old Field

The grassland / old field cover type consists of upland areas with at least a 25 percent canopy cover of predominantly non-woody vegetation in which grasses, whether native or introduced, are dominant. This cover type includes mostly prairies and rangeland (USFWS 1980c). The grassland/old fields in the project area are generally upland improved pastures and are typically the result of forest clearing. These areas may be currently or recently grazed or thickly grown over by grasses and forbs. Grassland in the proposed Lower Bois d'Arc Creek Reservoir covers an area of approximately 4,761 acres.

Dominant grass species include tall fescue, perennial rye (*Lolium perenne*), bahia grass (*Bahia absinthifolia*), bermudagrass, Texas wintergrass (*Nassella leucotricha*), and dallisgrass (*Paspalum dilatatum*). Common forbs include western ragweed, ironweed), dock, vetch (*Vicia* spp.), and wild pea (*Lathyrus* spp.). Herbaceous canopy cover averages approximately 87 percent, while the herbaceous canopy height in spring averages about 13 inches. Complete results of HEP field measurements for this cover type are shown in Table 7.

Bird species observed in grassland/old field areas include the downy woodpecker, yellow-billed cuckoo, tufted titmouse, Carolina chickadee, northern cardinal, white-eyed vireo, painted bunting, great blue heron, and American crow. Turtle eggs (Order: Testudines) were also observed in this covertype.

Table 7. HEP Field Data Summary:
Habitat Variable Measurements at Grassland/Old Field Sites

Cover Type: Grassland / Old Field

Species: American Kestrel, Eastern Cottontail, Eastern Meadowlark, Racer, Scissor-tailed Flycatcher

Habitat Variable	Sample Site Number															
	CR 2	CR 3	1	2	3	4	5	6	7	8	11	12	13	14	15	16
% herbaceous canopy cover	75	90	90	90	100	60	95	95	97	98	100	90	30	98	95	90
Average height of herbaceous canopy in spring (in)	12	24	6	12	24	8	12	12	8	8	24	16	12	12	8	16
Distance to perch sites: trees, forest edge, fence post, wire, etc (yd)	29	50	30	25	61	70	58	39	100	13	17	42	50	5.67	76	63
% herbaceous canopy cover that is grass	99	25	88	80	75	5	90	95	98	80	10	40	80	92	95	20
% shrub canopy cover	0	1	0	0	0	0	0	0	0	0	15	0	0	2	0	0
% tree canopy closure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# per acre of deciduous trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distance to nearest deciduous trees, clumps, forest edge, wing breaks, isolated trees, etc (yd)	29	130	30	25	61	70	58	64	100	27	17	42	50	40	103	63
Distance to shrubby edge or thickets (ft)	825	537	600	75	100	810	450	321	300	100	50	120	150	273	500	200
# per acre of refuge sites: ground crevice, brush piles, wind throws, etc	0	0	0	10	0	0	0	0	0	0	100	0	10	0	0	0
% herbaceous canopy <12" tall	90	90	90	88	100	0	90	95	97	85	100	85	100	92	95	50
Availability of large lone trees >12" dbh or groves <1 ac in size containing large trees within 1 mi: A) Abundant: >10 B) Moderate: 4-9 C) Few to None: 0-1	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Availability of cliff ledges, earth banks, or old abandoned buildings within 1 mi: A) Abundant B) Moderate C) Few to None	C	C	C	C	C	C	C	C	C	C	C	C	B	C	C	C
% canopy cover of persistent herbaceous vegetation (non-woody vegetation that remains after growing season, i.e. over-winter crop)	0	90	0	50	100	25	35	75	30	70	75	25	10	40	5	80

Riparian Woodland / Bottomland Hardwood Forest

RIPARIAN WOODLAND / BOTTOMLAND HARDWOOD FOREST

Wetland areas dominated by trees. Vegetation cover greater than 30%.

EVALUATION SPECIES:
Barred Owl
Downy Woodpecker
Fox Squirrel
Racoon
Wood Duck

The riparian woodland / bottomland hardwood cover type includes wetland areas dominated by woody vegetation at least 6 meters tall, with a total vegetation cover of more than 30 percent; this designation is synonymous with the Forested Wetland covertype described in ESM 103 (USFWS 1980c). The riparian woodland / bottomland hardwood cover type in the project area includes the predominantly deciduous forests of riparian zones and wetlands, and is associated with the floodplains of Lower Bois d'Arc Creek and Honey Grove Creek. The condition of the forest floors in these areas varied from standing water to dry, cracking mud. Average tree canopy cover equals approximately 68 percent, while the shrub cover equals approximately 19 percent. There are approximately 6,330 acres of riparian woodland / bottomland hardwood forest in the proposed Lower Bois d'Arc Creek Reservoir pool area.

Dominant trees include black willow (*Salix nigra*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and cedar elm (*Ulmus crassifolia*). Average diameter at breast height (dbh) of overstory trees equals approximately 9 inches and basal area in the forest averages 97 square feet per acre. Dominant shrubs are often small trees of the species listed above, as well as honey locust, poison ivy, coralberry, buttonbush *(Cephalanthus occidentalis)*, and Virginia creeper. Common herbaceous plants in the bottomland hardwood forest include baccharis (*Baccharis* spp.), cherokee sedge, ragweed (*Ambrosia* spp.), and Virginia wildrye (*Elymus virginicus*). Complete results of HEP field measurements for this cover type are shown in Table 8.

Common avian species observed in the area include the indigo bunting (*Passerina cyanea*), white-eye vireo, yellow-billed cuckoo, American crow, Carolina wren (*Thryothorus ludovicianus)*, barred owls, egret (Family: Ardeidae), Carolina chickadee, and northern cardinal. Evidence of mammalian residents included racoon tracks, hog tracks, and beaver chew marks on trees. Reptiles such as the ornate box turtle (*Terrapene ornata*) and unidentified frogs (Order: Anura) were also found in these forests, as were numerous invertebrate species, including crayfish (Family: Cambaridae) and land snails (Class: Gastropoda).

Table 8. HEP Field Data Summary:
Habitat Variable Measurements at Riparian Woodland/Bottomland Hardwood Forest Sites

Cover Type: Riparian Woodland															
Species: Barred Owl, Downy Woodpecker, Fox Squirrel, Racoon, Wood Duck															
Habitat Variable	**Sample Site Number**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**11**	**12**	**14**	**15**	**20**	**30**
% tree canopy closure	60	85	90	50	10	80	95	80	85	50	80	60	70	70	60
% tree canopy closure of hard mast producers >10" dbh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average dbh of overstory trees (in)	8	8	8	9	8	4	5	8	8	15	10	8	12	20	5
Overstory forest size class A) <6" dbh B) 6-10" dbh C) 10-20" dbh D) >20" dbh	B	B	B	B	B	A	A	B	B	C	B	B	C	C	A
# per acre of snags >6" dbh	40	120	20	20	30	0	10	0	10	30	1	0	40	30	0
% shrub crown cover	10	5	5	5	80	5	10	20	10	60	10	10	10	25	15
# per acre of refuge sites	10	10	70	3	60	20	120	30	100	20	20	0	20	40	0
Distance to water (yd)	0	467	17	40	3	100	67	100	133	0	100	567	33	3	200
Water regime: A) Permanent B) Semi-permanent: 3 mo Apr-Sept C) Semi-permanent: 3-5 mo Apr-Sept D) None or Ephemeral	B	B	B	B	B	B	B	B	A	C	B	B	B	B	B
# per acre of potential nest cavities	0	0	0	1	0	0	30	20	0	40	10	0	0	20	0
% water area covered by logs, trees limbs, shrub cover or herbaceous vegetation (live or dead & overhanging within 1 m of surface) in summer	15	0	5	0	10	15	5	25	5	80	10	5	5	5	10
% water surface covered by logs, tree or shrub overhangs, etc in winter (persistent)	8	0	3	0	10	15	5	15	5	65	8	5	5	5	10
# per acre of trees >20" dbh	0	10	0	10	0	0	0	10	0	20	0	0	0	0	0
Basal Area: area of exposed woody stems if cut horizontally at 4.5 ft height (ft^2/ac)	120	170	180	120	10	80	50	90	2	150	60	150	150	20	110
Distance to grain (yd)	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
% canopy closure of overstory trees	50	60	60	20	10	75	80	80	40	40	75	55	40	30	60

Shrub Wetland

SHRUB WETLAND

Vegetation dominated by shrubs; includes shrub-dominated riparian zones

EVALUATION SPECIES:
Green Heron
Racoon
Swamp Rabbit
Wood Duck

Shrub (or shrub-scrub) wetlands are defined as areas dominated by woody vegetation that is less than 5 meters tall, with greater than 30 percent total vegetation cover. Shrub-dominated riparian zones are included in this cover type (USFWS 1980c). Shrub wetlands in the study area can be considered wetlands in successional transition between herbaceous wetlands and bottomland hardwood forests. Approximately 49 acres of the proposed Lower Bois d'Arc Creek Reservoir consist of the shrub wetland cover type.

The shrub layer is dominated by small trees such as green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and cedar elm (*Ulmus crassifolia*), as well as shrub species such as honey locust (*Gleditsia triacanthos*) and baccharis (*Baccharis* spp.). Shrub canopy cover averages approximately 48 percent. Dominant herbaceous plants include sedge (*Carex* spp.), ragweed (*Ambrosia* spp.), ironweed (*Vernonia* spp.), goldenrod (*Solidago* spp.), evening primrose (*Oenothera speciosa*), round-leaf groundsel (*Packera obouta*), trumpet vine (*Campsis radicans*), and wild pea (*Lathyrus* spp.). Herbaceous canopy cover averages about 66 percent. Complete results of HEP field measurements for this cover type are shown in Table 9.

Birds observed in the shrub wetlands of the project area included northern cardinal, painted bunting, American crow, great egret (*Ardea alba*), solitary warbler (Family: Parulidae), common yellow throat (*Geothlypis trichas*). Evidence of mammalian residents includes tracks of the raccoon and bite marks of beaver (*Castor canadensis*). The southern leopard frog (*Rana sphenocephala*) and crayfish (Family: Cambaridae) were also observed in the shrub wetlands.

Table 9. HEP Field Data Summary:
Habitat Variable Measurements at Shrub Wetland Sites

Cover Type: Shrub Wetland					
Species: Green Heron, Racoon, Swamp Rabbit, Wood Duck					
Habitat Variable	**Sample Site Number**				
	1	**2**	**3**	**4**	**5**
Distance to water (yd)	567	3	0	200	50
Water regime: A) Permanent water B) Semi-permanent water C) None or ephemeral flooding	B	B	B	A	B
Water Regime: 1) Permanent 2) Intermittently exposed 3) Semi-permanent 4) Seasonally flooded 5) None or ephemeral	4	3	3	4	3
Water Current: A) Still or Slow B) Moderately slow C) Moderately fast D) Fast	A	A	A	A	A
# per acre of refuge sites	0	0	30	0	50
% water area <10" deep in average summer conditions	100	100	100	100	100
% emergent herbaceous cover in littoral zone	25	60	100	60	0
% water area covered by logs, trees limbs, shrub cover or herbaceous vegetation (live or dead & overhanging within 1 m of surface) in summer	25	0	95	50	40
% water surface covered by logs, tree or shrub overhangs, etc in winter (persistent)	25	0	60	25	40
Aquatic substrate composition: A) Muddy B) Sandy C) Rocky	A	A	A	A	A
# per acre of potential nest cavities	0	0	0	0	0
% shrub crown closure	65	60	45	90	40
% herbaceous canopy cover	10	67	100	60	100

Emergent / Herbaceous Wetland

Herbaceous wetlands are defined as wetland areas with a total vegetation cover of greater than 30 percent that is dominated by hydrophytic plants growing on or below the water surface (USFWS 1980c). The "emergent wetlands" of Cowardin et al. (1979) are included in this cover type. There are approximately 1,223 acres of herbaceous wetland within the proposed Lower Bois d'Arc Creek Reservoir site.

EMERGENT / HERBACEOUS WETLAND

Vegetative cover >30% dominated by hydrophytic plants.

EVALUATION SPECIES:
Green Heron
Raccoon
Wood Duck

Emergent wetlands in the project area are dominated by an herbaceous layer made up of wetland obligates such as rushes, sedges, smartweed, and redstem (*Ammannia* sp.). The shrub layer is primarily made up of black willow, green ash, baccharis, swampprivet (*Forestiera* sp.), buttonbush, honeylocust, cocklebur (*Xanthium strumarium*), and desert false indigo (*Amorpha fruticosa*). The herbaceous canopy includes numerous grass species, such as barnyard grass (*Echinochloa crus-galli*), crowngrass (*Paspalem* sp.), and eastern gammagrass (*Tripsacum dactyloides*). Other plants found in the herbaceous wetlands include rushes (*Juncus* spp.), blue sedge (*Carex glaucodea*), spikerush (*Eleocharis* spp.), flatsedge (*Cyperus* spp.), smartweed (*Polygonum* spp.), sumpweed (*Iva annua*), frog fruit (*Phyla* spp.), water primrose (*Ludwigia* sp.), balloon vine (*Cardiospermum halicacabum*), dock (*Rumex* spp.), and buttercup (*Ranunculus* spp.). Complete results of HEP field measurements for this cover type are shown in Table 10.

Many species of birds were found in the herbaceous wetlands, including the northern cardinal, American crow, indigo bunting, tufted titmouse, great blue heron, great egret, red-tailed hawk (*Buteo jamaicensis*), and northern harrier (*Circus cyaneus*). Other wildlife resident in the areas include several mammals, such as raccoon (*Procyon lotor*), beaver (*Castor canadensis*), feral hog (*Sus scrofa*), and white-tailed deer (*Odocoileus virginianus*); aquatic species including frogs (Order: Anura), mosquitofish (*Gambusia affinis*), crayfish (Family: Cambaridae), and clams (Class: Bivalvia); and plentiful flying insects such as butterflies (Order: Lepidoptera), bees (Order: Hymenoptera) and dragonflies (Order: Odonata).

Table 10. HEP Field Data Summary:
Habitat Variable Measurements at Herbaceous Wetland Sites

Cover Type: Emergent Wetlands

Species: Green Heron, Raccoon, Wood Duck

Habitat Variable	Sample Site Number					
	1	**2**	**3**	**4**	**5**	**6**
Distance to water (yd)	0	0	10	0	0	0
Water regime: A) Permanent water B) Semi-permanent water C) None or ephemeral flooding	B	B	B	C	B	A
Water Current: A) Still or Slow: <6" per sec B) Moderately slow: 6-24" per sec C) Moderately fast: 24-40" per sec D) Fast: >40" per sec	A	A	A	A	A	A
# per acre of refuge sites	0	0	0	20	50	0
% water area <10" deep in average summer conditions	100	100	100	100	25	15
% emergent herbaceous cover in littoral zone	75	90	50	95	50	20
% water area covered by logs, trees limbs, shrub cover or herbaceous vegetation (live or dead & overhanging within 1 m of surface) in summer	75	90	0	2	15	5
% water surface covered by logs, tree or shrub overhangs, etc in winter (persistent)	20	75	0	2	15	5
Aquatic substrate composition: A) Muddy B) Sandy C) Rocky	A	A	A	A	A	A
Distance to forested/shrub wetland, i.e. large trees (yd)	80	214	47	75	40	17
# per acre of potential nest cavities	0	0	0	10	0	0

3.2 Baseline Habitat Suitability Indices

After species selection, cover types were sampled for the appropriate habitat variables required for each species' HSI model. The sampling site locations illustrated relative to cover types is shown in Figure1, and on color IR aerial imagery in Figure 2.

Calculation of HSI values were performed according to standard models developed for each evaluation species. Exceptions and assumptions for each species model and the specific HSI calculations for each species evaluated by cover type are described in Appendix A. To compute the HSI for a cover type, site measurements for each variable were averaged for each cover type and then were used in the HSI model for each species. The HSI for each cover type was calculated as the arithmetic mean of all the individual species' HSIs (Table 11).

Table 11. Habitat Suitability Indices by Cover Type

	Cover Types								
Species	**Upland Deciduous Forest**	**Evergreen Forest**	**Tree Savanna**	**Shrubland**	**Cropland**	**Grassland / Old Field**	**Riparian Woodland / Bottomland Hardwood**	**Shrub Wetland**	**Emergent / Herbaceous Wetland**
American kestrel	--	--	1.00	--	1.00	1.00	--	--	--
Barred owl	0.20	--	--	--	--	--	0.14	--	--
Brown thrasher	--	0.02	--	--	--	--	--	--	--
Carolina chickadee	0.75	0.40	--	--	--	--	--	--	--
Downy wood-pecker	0.29	--	--	--	--	--	0.34	--	--
Eastern cottontail	--	0.31	0.31	0.31	0.31	0.31	--	--	--
Eastern meadowlark	--	--	0.59	--	--	0.53	--	--	--
Eastern turkey	0.68	0.68	--	--	--	--	--	--	--
Field sparrow	--	--	--	0.43	--	--	--	--	--
Fox squirrel	0.42	--	--	--	--	--	0.03	--	--
Green heron	--	--	--	--	--	--	--	0.81	0.87
Raccoon	--	--	--	--	--	--	0.52	0.28	0.17
Racer	--	--	--	0.98	--	0.18	--	--	--
Scissor-tailed flycatcher	--	--	1.00	--	0.83	0.98	--	--	--
Swamp rabbit	--	--	--	--	--	--	--	0.52	--
Wood duck	--	--	--	--	--	--	0.22	0.22	0.22
Average HSI Values	**0.47**	**0.35**	**0.73**	**0.57**	**0.72**	**0.60**	**0.25**	**0.46**	**0.42**

3.3 Baseline Habitat Units

Baseline Habitat Units (HUs) were calculated for each cover type within the Lower Bois d'Arc Creek Reservoir project area by multiplying the average cover type Habitat Suitability Index (HSI) values (Table 10) by the cover type acreage (Table 12).

Table 12. Baseline Habitat Units by Cover Type.

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Upland Deciduous Forest	0.47	2,216	1,042
Evergreen Forest	0.35	228	80
Tree Savanna	0.73	132	96
Shrubland	0.57	63	36
Cropland	0.72	1,757	1,265
Grassland / Old Field	0.60	4,761	2,857
Riparian Woodland / Bottomland Hardwood	0.25	6,330	1,583
Shrub Wetland	0.46	49	23
Emergent / Herbaceous Wetland	0.42	1,223	514
TOTAL HABITAT UNITS			**7,494**

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Appendix A

Determination of HSI Values for HEP Analyses

Table A-1. HSI Calculation: Upland Deciduous Forest Cover Type								
Cover Type: Upland Deciduous Forest Species: Barred Owl, Carolina Chickadee, Downy Woodpecker, Eastern Turkey, Fox Squirrel								
Variable		**Area / Site Number**						
		1	**2**	**3**	**4**	**5**	**20**	
Barred Owl								
Variable name	#	Value	Value	Value	Value	Value	Value	
Number of trees >20" dbh/acre	**V1**	0	0	30	0	0	0	
Average dbh of overstory trees (in)	**V2**	15	12	18	8	15	16	
Percent canopy cover of overstory trees	**V3**	40	40	35	85	70	50	
		SI	SI	SI	SI	SI	SI	
	SI1	0.1	0.1	1.0	0.1	0.1	0.1	
	SI2	0.7	0.5	0.9	0.2	0.7	0.7	
	SI3	0.5	0.5	0.4	1.0	1.0	0.8	Average
HSI = Reproductive Suitability Index $= (SI1 \times SI2)^{1/2} \times SI3$	**HSI =**	0.13	0.11	0.35	0.14	0.26	0.20	**0.20**
Carolina Chickadee								
Variable name	#	Value	Value	Value	Value	Value	Value	
Average height of overstory trees (m)	**V1**	9.1	10.7	10.7	10.7	18.3	18.3	
Percent tree canopy closure	**V2**	85	50	45	85	95	50	
Percent canopy closure of deciduous trees in stand	**V3**	85	25	45	85	80	50	
Number of snags < 25 cm (10 in) dbh per 0.4 ha (1 acre)	**V4**	200	3	90	10	10	1	
		SI	SI	SI	SI	SI	SI	
	SI1	0.6	0.7	0.7	0.7	1.0	1.0	
	SI2	1.0	0.7	0.6	1.0	1.0	0.7	
	SI3	0.8	0.9	1.0	0.8	0.9	1.0	
Reproduction Value	**SI4**	1.0	1.0	1.0	1.0	1.0	0.4	
Cover Value $= (SI1 \times SI2 \times SI3)^{1/3}$		0.8	0.8	0.7	0.8	1.0	0.9	Average
Lowest Life Requisite Value	**HSI=**	0.78	0.77	0.75	0.84	0.95	0.43	**0.75**
Downy woodpecker								
Variable name	#	Value	Value	Value	Value	Value	Value	
Basal area (ft^2 per acre)	**V1**	120	140	60	80	5	160	
Number of snags >6 in dbh/acre	**V2**	40	3	0	2	0	1	
		SI	SI	SI	SI	SI	SI	
Food Value	**SI1**	0.6	0.5	1.0	1.0	0.1	0.5	
Reproduction Value	**SI2**	1.0	0.6	0.0	0.4	0.0	0.2	Average
Lowest Life Requisite Value	**HSI=**	0.62	0.50	0.00	0.40	0.00	0.20	**0.29**

(Table A-1. HSI Calculation: Upland Deciduous Forest Cover Type, Continued)

Cover Type: Upland Deciduous Forest

Species: Barred Owl, Carolina Chickadee, Downy Woodpecker, Eastern Turkey, Fox Squirrel

Variable		Area / Site Number						
		1	2	3	4	5	20	
Eastern Wild Turkey								
Variable name	#	Value	Value	Value	Value	Value	Value	
Percent herbaceous canopy cover	**V1**	95	25	15	60	0	30	
Average height of herbaceous canopy in summer (cm)	**V2**	45.7	30.5	30.5	35.6	0	15.2	
Average dbh of hard mast producing trees ≥25.4 cm (cm)	**V4a**	0	0	45.7	0	101.6	40.6	
Number of hard mast producing trees/ha that are ≥25.4 cm (# / ha)	**V4b**	0	0	123.5	0	99	8	
Percent canopy closure of soft mast producing trees	**V5**	60	50	10	90	20	5	
Percent shrub crown cover	**V6 & V7**	20	20	15	5	90	45	
Percent shrub crown cover comprised of soft mast producing shrubs	**V8**	100	5	90	100	15	30	
Percent tree canopy closure	**V11**	85	50	45	85	95	50	
Average dbh of overstory trees (in)	**V12**	15	12	18	8	15	16	
Percent of forest canopy comprised of evergreens	**V13**	0	25	0	2	20	0	
Deciduous Forest Model		SI	SI	SI	SI	SI	SI	
	SI1	0.6	0.1	0.0	1.0	0.0	0.3	
	SI2	1.0	1.0	1.0	1.0	0.0	0.7	
	SI4	0.0	0.0	1.0	0.0	0.8	0.1	
	SI5	1.0	1.0	0.3	1.0	0.5	0.1	
	SI6	1.0	1.0	0.8	0.3	1.0	1.0	
	SI7	1.0	1.0	1.0	1.0	0.0	0.9	
	SI8	1.0	0.4	0.9	1.0	0.5	0.6	
	SI11	1.0	1.0	0.9	1.0	1.0	1.0	
	SI12	1.0	1.0	1.0	0.5	1.0	1.0	
	SI13	1.0	1.0	1.0	1.0	1.0	1.0	Average
Summer Food/Brood Value *= (SI1 × SI2)$^{1/2}$*		0.8	0.4	0.0	1.0	0.0	0.4	**0.43**
Fall/Winter/Spring Food Value *= ([(SI4 + SI5) + (SI6 × SI8)] ÷ 2) × SI7*		1.0	0.7	0.9	0.6	0.0	0.3	**0.59**
Cover Value *= SI11 × SI12 × SI13*		1.0	1.0	0.9	0.5	1.0	1.0	**0.89**
See Eastern Wild Turkey Multi-cover Type Worksheet	**HSI=**							**0.68**
Fox Squirrel								
Variable name	#	Value	Value	Value	Value	Value	Value	
Percent canopy closure of trees that produce hard mast >10 in dbh	**V1**	0	0	35	10	70	50	
Distance to available grain (yd)	**V2**	660	660	660	660	660	660	
Average dbh of overstory trees (in)	**V3**	15	12	18	8	15	16	
Percent tree (>16.5 ft height) canopy closure	**V4**	85	50	45	85	95	50	
Percent shrub (<16.5 ft height) crown cover	**V5**	20	20	15	5	90	45	
		SI	SI	SI	SI	SI	SI	
	SI1	0.0	0.0	0.9	0.3	0.9	1.0	
	SI2	0.1	0.1	0.1	0.1	0.1	0.1	
	SI3	1.0	0.6	1.0	0.1	1.0	1.0	
	SI4	0.7	1.0	1.0	0.7	0.6	1.0	
	SI5	1.0	1.0	1.0	1.0	0.1	0.7	
Winter Food Value *= (3 × SI1 + SI2) ÷ 3*		0.0	0.0	0.9	0.3	0.9	1.0	
Cover/Reproduction Value *= (SI3 × SI4 × SI5)$^{1/3}$*		0.9	0.8	1.0	0.4	0.4	0.9	Average
Lowest Life Requisite Value	**HSI=**	0.03	0.03	0.91	0.28	0.36	0.90	**0.42**

Table A-2. HSI Calculation: Evergreen Forest Cover Type					
Cover Type: Evergreen Forest Species: Brown Thrasher, Carolina Chickadee, Eastern Cottontail, Eastern Turkey					
Variable		**Area / Site Number**			
		1	**3**	**20**	
Brown Thrasher					
Variable name	#	Value	Value	Value	
Density of wood stems ≥ 1.0m (3.3 ft) tall (1000s/ha)	**V1**	0.5	1.3	1.7	
Percent canopy cover of trees	**V2**	80	80	50	
Percent of ground surface covered by litter ≥ 1 cm (0.4 in) deep	**V3**	40	10	20	
		SI	SI	SI	
	SI1	0.1	0.2	0.3	
	SI2	0.4	0.4	0.7	
	SI3	0.4	0.1	0.1	Average
HSI = Food/Cover/Reproduction Value *= SI1 × SI2 × SI3*	**HSI=**	0.02	0.01	0.02	**0.02**
Carolina Chickadee					
Variable name	#	Value	Value	Value	
Average height of overstory trees (m)	**V1**	6.1	9.1	9.1	
Percent tree canopy closure	**V2**	80	80	50	
Percent canopy closure of deciduous trees in stand	**V3**	5	5	0	
Number of snags < 25 cm (10 in) dbh per 0.4 ha (1 acre)	**V4**	20	20	0	
		SI	SI	SI	
	SI1	0.2	0.6	0.6	
	SI2	1.0	1.0	0.7	
	SI3	0.7	0.7	0.6	
Reproduction Value	**SI4**	1.0	1.0	0.0	
Cover Value *= $(SI1 \times SI2 \times SI3)^{1/3}$*		0.5	0.7	0.6	Average
Lowest Life Requisite Value	**HSI =**	0.47	0.73	0.00	**0.40**
Eastern Cottontail					
Variable name	#	Value	Value	Value	
Percent shrub (<16.5 ft height) crown cover	**V1**	5	10	0	
Percent tree (>16.5 ft height) canopy closure	**V2**	80	80	50	
Percent canopy closure of persistent herbaceous vegetation	**V3**	5	5	5	
		SI	SI	SI	
	SI1	0.3	0.5	0.0	
	SI2	0.5	0.5	1.0	
	SI3	0.0	0.0	0.0	Average
Winter Cover / Food Index = WCFI *= ((4 × SI1 + SI2) ÷ 5) + SI3*		0.3	0.5	0.2	**0.37**
See Eastern Cottontail Multi-cover Type Worksheet	**HSI =**				**0.31**
Eastern Wild Turkey					
Variable name	#	Value	Value	Value	
Average dbh of hard mast producing trees ≥25.4 cm (cm)	**V4a**	0	0	0	
Number of hard mast producing trees per hectare ≥25.4 cm dbh (# / ha)	**V4b**	1	0	0	
Percent canopy closure of soft mast producing trees	**V5**	80	80	0	
Percent shrub crown cover	**V6 & V7**	5	10	0	
Percent shrub crown cover of soft mast producing shrubs	**V8**	3	100	0	
Percent tree canopy closure	**V11**	80	80	50	
Average dbh of overstory trees (in)	**V12**	6	6	4	
Percent of forest canopy comprised of evergreens	**V13**	99	95	100	
		SI	SI	SI	
	SI4	0.0	0.0	0.0	
	SI5	1.0	1.0	0.0	
	SI6	0.3	0.5	0.0	
	SI7	1.0	1.0	1.0	
	SI8	0.4	1.0	0.4	
	SI11	1.0	1.0	1.0	
	SI12	0.2	0.2	0.1	
	SI13	0.2	0.3	0.2	Average
Fall/Winter/Spring Food Value *= ([(SI4 + SI5) + (SI6 × SI8)] ÷ 2)*		0.6	0.8	0.0	**0.43**
Cover Value *= SI11 × SI12 × SI13*		0.0	0.1	0.0	**0.04**
See Eastern Wild Turkey Multi-cover Type Worksheet	**HSI=**				**0.68**

Table A-3. HSI Calculation: Tree Savanna Cover Type						
Cover Type: Tree Savanna Species: American Kestrel, Eastern Cottontail, Eastern Meadowlark, Scissor-tailed Flycatcher						
Variable		**Area / Site Number**				
		1	**2**	**3**	**4**	
American Kestrel						
Variable name	#	Value	Value	Value	Value	
Percent herbaceous canopy cover	**V1**	95	97	75	90	
Percent herbaceous canopy cover ≤ 30 cm (12 in) tall	**V2**	80	90	75	90	
Distance to nearest trees, fence post or utility poles/lines (km)	**V4**	0	0	0	0	
Availability of large lone trees (≥30 dbh) or groves (≤ 0.4 ha in size) containing large trees within a diameter of 1.6 km: A) Abundant: >10, B) Moderate: 4-9, C) Few to None: 0-1	**V7**	A	A	A	A	
Availability of cliff ledges, earth banks, or abandoned buildings within 1.6 km (1.0 mi): A) Abundant, B) Moderate, or C) Few to None	**V8**	C	C	C	B	
Herbland / Savanna Model		SI	SI	SI	SI	
	SI1	0.9	0.9	1.0	0.9	
	SI2	1.0	1.0	1.0	1.0	
	SI4	1.0	1.0	1.0	1.0	
	SI7	1.0	1.0	1.0	1.0	
	SI8	0.1	0.1	0.1	0.5	Average
Food Value *= (SI1 × SI2 × SI4)* $^{1/3}$		1.0	1.0	1.0	1.0	**0.98**
Reproduction Value *= SI7 + SI8 (max = 1.0)*		1.0	1.0	1.0	1.0	**1.00**
See American Kestrel Multi-cover Type Worksheet	**HSI =**					**1.00**
Eastern Cottontail						
Variable name	#	Value	Value	Value	Value	
Percent shrub (<16.5 ft height) crown cover	**V1**	1	25	3	5	
Percent tree (>16.5 ft height) canopy closure	**V2**	1	25	15	5	
Percent canopy closure of persistent herbaceous vegetation	**V3**	50	75	30	5	
		SI	SI	SI	SI	
	SI1	0.1	1.0	0.2	0.3	
	SI2	0.0	1.0	0.6	0.2	
	SI3	0.3	0.5	0.2	0.0	Average
Winter Cover / Food Index = WCFI *= ((4 × SI1 + SI2) ÷ 5) + SI3 [max=1.0]*		0.3	1.0	0.4	0.3	**0.51**
See E. Cottontail Multi-cover Type Worksheet	**HSI =**					**0.31**
Eastern Meadowlark						
Variable name	#	Value	Value	Value	Value	
Percent herbaceous canopy cover	**V1**	95	97	75	90	
Proportion of herbaceous canopy cover that is grass	**V2**	50	90	30	80	
Average height of herbaceous canopy (spring conditions) (cm)	**V3**	40.6	30.5	30.5	30.5	
Distance to perch site (m)	**V4**	9.1	1.5	3	0	
Percent shrub (<16.5 ft height) crown cover	**V5**	1	25	3	5	
		SI	SI	SI	SI	
	SI1	1.0	1.0	0.8	1.0	
	SI2	0.5	1.0	0.2	1.0	
	SI3	0.9	1.0	1.0	1.0	
	SI4	1.0	1.0	1.0	1.0	
	SI5	1.0	0.3	1.0	1.0	Average
HSI = Food / Reproduction *= (SI1 × SI2 × SI3 × SI4)* $^{1/2}$ *× SI5*	**HSI=**	0.66	0.33	0.36	1.00	**0.59**
Scissor-tailed flycatcher						
Variable name	#	Value	Value	Value	Value	
Percent herbaceous canopy cover	**V1**	95	97	75	90	
Average height of herbaceous vegetation (cm)	**V2**	40.6	30.5	30.5	30.5	
Number of deciduous trees per acre (#/acre)	**V3**	10	150	20	1	
Distance to nearest deciduous trees (m)	**V4**	9.1	13.7	3.0	12.2	
Model developed for Herbland/Savanna		SI	SI	SI	SI	
	SI1	1.0	1.0	1.0	1.0	
	SI2	1.0	1.0	1.0	1.0	
	SI3	1.0	1.0	1.0	0.3	
	SI4	1.0	1.0	1.0	1.0	
Food Value *= (SI1 × SI2)* $^{1/2}$		1.0	1.0	1.0	1.0	
Cover and Reproduction Value *= SI3 + SI4 (max = 1.0)*		1.0	1.0	1.0	1.0	Average
Lowest Life Requisite Value	**HSI=**	1.00	1.00	1.00	1.00	**1.00**

Table A-4. HSI Calculation: Shrubland Cover Type						
Cover Type: Shrubland Species: Eastern Cottontail, Field Sparrow, Racer						
Variable		**Area / Site Number**				
		SH 1	**SH 2**	**SH 3**	**SH 5**	
Eastern Cottontail						
Variable name	#	Value	Value	Value	Value	
Percent shrub (<16.5 ft height) crown cover	**V1**	40	75	35	25	
Percent tree (>16.5 ft height) canopy closure	**V2**	10	0	0	0	
Percent canopy closure of persistent herbaceous vegetation	**V3**	75	50	60	50	
		SI	SI	SI	SI	
	SI1	1.0	0.8	1.0	1.0	
	SI2	0.4	0.0	0.0	0.0	
	SI3	0.5	0.3	0.4	0.3	Average
Winter Cover / Food Index = WCFI *= ((4 × SI1 + SI2) ÷ 5) + SI3 [max=1.0]*		1.0	0.9	1.0	1.0	**0.99**
See Eastern Cottontail Multi-cover Type Worksheet	**HSI =**					**0.31**
Field Sparrow						
Variable name	#	Value	Value	Value	Value	
Percent shrub crown cover	**V1**	40	75	35	25	
Percent of total shrubs that are less than 1.5 m (4.9 ft) tall	**V2**	15	50	15	30	
Percent canopy cover of grasses	**V3**	20	40	75	90	
Average height of herbaceous canopy in spring (cm)	**V4**	38.1	91.4	91.4	20.3	
		SI	SI	SI	SI	
	SI1	0.9	0.0	1.0	1.0	
	SI2	0.4	1.0	0.4	0.7	
	SI3	0.4	0.8	1.0	1.0	
	SI4	0.6	0.5	0.5	1.0	Average
HSI = Cover/Reproduction Value *= [Min(SI1,SI2) × Min(SI3,SI4)]* $^{1/2}$	**HSI =**	0.42	0.00	0.47	0.82	**0.43**
Racer						
Variable name	#	Value	Value	Value	Value	
Percent herbaceous canopy cover	**V1**	90	100	95	70	
Average height of herbaceous canopy (meters)	**V2**	0.4	0.9	0.9	0.2	
Distance to shrubby edges or shrub thickets (feet)	**V3**	20	300	0	20	
Number of refuge sites per acre (#/acre)	**V4**	30	100	10	40	
		SI	SI	SI	SI	
	SI1	1.0	1.0	1.0	1.0	
	SI2	0.3	0.8	0.8	0.2	
	SI3	1.0	1.0	1.0	1.0	
Winter Cover Value	**SI4**	1.0	1.0	1.0	1.0	
Food Value *= [2 × (SI1 × SI2)* $^{1/2}$ *+ SI3] ÷ 2*		1.0	1.0	1.0	0.9	Average
Lowest Life Requisite Value	**HSI=**	1.00	1.00	1.00	0.92	**0.98**

Table A-5. HSI Calculation: Cropland Cover Type					
Cover Type: Cropland Species: American Kestrel, Eastern Cottontail, Scissor-tailed Flycatcher					
Variable		**Area / Site Number**			
		1	**4**	**20**	
American Kestrel					
Variable name	#	Value	Value	Value	
Distance to nearest trees, forest edge, fence post or utility poles and lines (km)	**V4**	0.0	0.1	0.1	
Availability of fence rows, roadside ditches, and grassy-uncultivated areas: A) Abundant, B) Moderate, C) Scarce to None	**V5**	A	A	A	
Availability of large lone trees (≥30 dbh) or groves (≤ 0.4 ha in size) containing large trees within a diameter of 1.6km: A) Abundant: >10, B) Moderate: 4-9, C) Few to None: 0-1	**V7**	A	A	A	
Availability of cliff ledges, earth banks, or abandoned buildings w/in 1.6 km (1. mi): A) Abundant, B) Moderate, C) Few to None	**V8**	C	C	C	
		SI	SI	SI	
	SI4	1.0	1.0	1.0	
	SI5	1.0	1.0	1.0	
	SI7	1.0	1.0	1.0	
	SI8	0.1	0.1	0.1	Average
Food Value *= 0.5 × (SI4 + SI5) ÷ 2*		0.5	0.5	0.5	**0.50**
Reproduction Value *= SI7 + SI8 (max = 1.0)*		1.0	1.0	1.0	**1.00**
See American Kestrel Multi-cover Type Worksheet	**HSI =**				**1.00**
Eastern Cottontail					
Variable name	#	Value	Value	Value	
Percent shrub (<16.5 ft height) crown cover	**V1**	0	0	0	
Percent tree (>16.5 ft height) canopy closure	**V2**	0	0	0	
Percent canopy closure of persistent herbaceous vegetation	**V3**	40	90	10	
		SI	SI	SI	
	SI1	0.0	0.0	0.0	
	SI2	0.0	0.0	0.0	
	SI3	0.2	0.5	0.1	Average
Winter Cover / Food Index = WCFI *= ((4 × SI1 + SI2) ÷ 5) + SI3 [max=1.0]*		0.2	0.5	0.1	**0.28**
See E. Cottontail Multi-cover Type Worksheet	**HSI =**				**0.31**
Scissor-tailed flycatcher					
Variable name	#	Value	Value	Value	
Percent herbaceous canopy cover	**V1**	20	95	25	
Average height of herbaceous vegetation (cm)	**V2**	45.7	91.4	30.5	
Number of deciduous trees per acre (#/acre)	**V3**	0	0	0	
Distance to nearest deciduous trees (m)	**V4**	45.7	99.7	91.4	
		SI	SI	SI	
	SI1	0.5	1.0	0.6	
	SI2	1.0	1.0	1.0	
	SI3	0.0	0.0	0.0	
	SI4	1.0	1.0	1.0	
Food Value *= $(SI1 \times SI2)^{1/2}$*		0.7	1.0	0.8	
Cover and Reproduction Value *= SI3 + SI4 (max = 1.0)*		1.0	1.0	1.0	Average
Lowest Life Requisite Value	**HSI=**	0.71	1.00	0.79	**0.83**

Table A-6. HSI Calculation: Grassland / Old Field Cover Type

Cover Type: Grassland / Old Field

Species: American Kestrel, Eastern Cottontail, Eastern Meadowlark, Racer, Scissor-tailed Flycatcher

Variable		Area / Site Number																
		CR2	CR3	1	2	3	4	5	6	7	8	11	12	13	14	15	16	
American Kestrel																		
Variable name	#	Field Variable Values																
Percent herbaceous canopy cover	V1	75	90	90	90	100	60	95	95	97	98	100	90	30	98	95	90	
Percent herbaceous canopy cover ≤ 12 in tall	V2	90	90	90	88	100	0	90	95	97	85	100	85	100	92	95	50	
Distance to nearest trees, forest edge, fence post or utility poles and lines (km)	V4	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	
Availability of large lone trees (≥30 dbh) or groves (≤ 0.4 ha in size) with large trees within 1.6 km: A) Abundant: >10, B) Moderate: 4-9, or C) Few to None: 0-1	V7	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
Availability of cliff ledges, earth banks, or old abandoned buildings within 1.6 km (1.0 mi): A) Abundant, B) Moderate, or C) Few to None	V8	C	C	C	C	C	C	C	C	C	C	C	C	B	C	C	C	
Herbland / Savanna Model		SI Values																
	SI1	1.0	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.4	0.9	0.9	0.9	
	SI2	1.0	1.0	1.0	1.0	1.0	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	
	SI4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	SI7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	SI8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1	0.1	0.1	Average
Food Value *= (SI1×SI2×SI4)$^{1/3}$*		1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0	0.8	**0.93**
Reproduction Value *= SI7 + SI8 (max = 1.0)*		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.00**
	HSI =	*See American Kestrel Multi-cover Type Worksheet*																**1.00**
Eastern Cottontail																		
Variable name	#	Field Variable Values																
Percent shrub (<16.5 ft height) crown cover	V1	0	1	0	0	0	0	0	0	0	0	15	0	0	2	0	0	
Percent tree (>16.5 ft height) canopy closure	V2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Percent canopy closure of persistent herbaceous vegetation	V3	0	90	0	50	100	25	35	75	30	70	75	25	10	40	5	80	
		SI Values																
	SI1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.1	0.0	0.0	
	SI2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	SI3	0.0	0.5	0.0	0.3	0.6	0.2	0.2	0.5	0.2	0.4	0.5	0.2	0.1	0.2	0.0	0.5	Average
Winter Cover / Food Index (WCFI) *= ((4 × SI1 + SI2) ÷ 5) + SI3 [max=1.0]*		0.0	0.6	0.0	0.3	0.6	0.2	0.2	0.5	0.2	0.4	1.0	0.2	0.1	0.3	0.0	0.5	**0.31**
	HSI =	*See Eastern Cottontail Multi-cover Type Worksheet*																**0.31**
Eastern Meadowlark																		
Variable name	#	Field Variable Values																
Percent herbaceous canopy cover	V1	75	90	90	90	100	60	95	95	97	98	100	90	30	98	95	90	
Proportion of herbaceous cover that is grass	V2	99	25	88	80	75	5	90	95	98	80	10	40	80	92	95	20	
Average height of herbaceous canopy in spring conditions (cm)	V3	30.5	61.0	15.2	30.5	61.0	20.3	30.5	30.5	20.3	20.3	61.0	40.6	30.5	30.5	20.3	40.6	
Distance to perch site (m)	V4	26.5	45.7	27.4	22.9	55.8	64.0	53.0	35.7	91.4	12.2	15.2	38.4	45.7	5.2	69.5	57.6	
Percent shrub (<16.5 ft height) crown cover	V5	0	1	0	0	0	0	0	0	0	0	15	0	0	2	0	0	
		SI Values																
	SI1	0.8	1.0	1.0	1.0	1.0	0.6	1.0	1.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0	1.0	
	SI2	1.0	0.1	1.0	1.0	0.9	0.0	1.0	1.0	1.0	1.0	0.0	0.3	1.0	1.0	1.0	0.0	
	SI3	1.0	0.4	1.0	1.0	0.4	1.0	1.0	1.0	1.0	1.0	0.4	0.9	1.0	1.0	1.0	0.9	
	SI4	1.0	0.6	1.0	1.0	0.3	0.2	0.4	0.8	0.2	1.0	1.0	0.8	0.6	1.0	0.2	0.3	
	SI5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	Average
HSI = Food / Reproduction *= (SI1 × SI2 × SI3 × SI4)$^{1/2}$ × SI5*	**HSI=**	0.89	0.13	1.00	1.00	0.32	0.00	0.62	0.92	0.45	1.00	0.00	0.47	0.29	1.00	0.45	0.00	**0.53**

(Table A-6. HSI Calculation: Grassland / Old Field Cover Type, Continued)

Cover Type: Grassland / Old Field

Species: American Kestrel, Eastern Cottontail, Eastern Meadowlark, Racer, Scissor-tailed Flycatcher

Variable		Area / Site Number																
		CR2	CR3	1	2	3	4	5	6	7	8	11	12	13	14	15	16	
Racer																		
Variable name	#	Field Variable Values																
Percent herbaceous canopy cover	**V1**	75	90	90	90	100	60	95	95	97	98	100	90	30	98	95	90	
Average height of herbaceous canopy (m)	**V2**	0.3	0.6	0.2	0.3	0.6	0.2	0.3	0.3	0.2	0.2	0.6	0.4	0.3	0.3	0.2	0.4	
Dist. to shrubby edges or shrub thickets (ft)	**V3**	825	537	600	75	100	810	450	321	300	100	50	120	150	273	500	200	
Number of refuge sites per acre (#/acre)	**V4**	0	0	0	10	0	0	0	0	0	0	100	0	10	0	0	0	
		SI Values																
	SI1	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	
	SI2	0.3	0.5	0.1	0.3	0.5	0.2	0.3	0.3	0.2	0.2	0.5	0.4	0.3	0.3	0.2	0.4	
	SI3	0.5	0.8	0.7	1.0	1.0	0.5	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	1.0	
Winter Cover Value	**SI4**	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	
Food Value *= [2 × (SI1 × SI2)$^{1/2}$ + SI3] ÷ 2*		0.8	1.0	0.7	1.0	1.0	0.7	1.0	1.0	0.9	0.9	1.0	1.0	0.9	1.0	0.8	1.0	Average
Lowest Life Requisite Value	**HSI=**	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.86	0.00	0.00	0.00	**0.18**
Scissor-tailed flycatcher																		
Variable name	#	Field Variable Values																
Percent herbaceous canopy cover	**V1**	75	90	90	90	100	60	95	95	97	98	100	90	30	98	95	90	
Average height of herbaceous vegetation (cm)	**V2**	30.5	61.0	15.2	30.5	61.0	20.3	30.5	30.5	20.3	20.3	61.0	40.6	30.5	30.5	20.3	40.6	
Number of deciduous trees per acre (#/acre)	**V3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Distance to nearest deciduous trees (m)	**V4**	26.5	118.9	27.4	22.9	55.8	64.0	53.0	58.5	91.4	24.4	15.2	38.4	45.7	36.6	94.2	57.6	
Model developed for Herbland/Savanna		SI Values																
	SI1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0	1.0	
	SI2	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	SI3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	SI4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Food Value *= (SI1 × SI2)$^{1/2}$*		1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	
Cover and Reproduction Value *= SI3 + SI4 (max = 1.0)*		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	Average
Lowest Life Requisite Value	**HSI=**	1.00	0.96	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.87	1.00	1.00	1.00	**0.98**

Table A-7. HSI Calculation: Riparian Woodland Cover Type

Cover Type: Riparian Woodland

Species: Barred Owl, Downy Woodpecker, Fox Squirrel, Racoon, Wood Duck

Variable		Area / Site Number															
		1	2	3	4	5	6	7	8	9	11	12	14	15	20	30	
Barred Owl																	
Variable name	#	Field Variable Values															
Number of tree >20'' dbh/acre	**V1**	0	10	0	10	0	0	0	10	0	20	0	0	0	0	0	
Average dbh of overstory trees (in)	**V2**	8	8	8	9	8	4	5	8	8	15	10	8	12	20	5	
Percent canopy cover of overstory trees	**V3**	50	60	60	20	10	75	80	80	40	40	75	55	40	30	60	
		SI Values															
	SI1	0.1	1.0	0.1	1.0	0.1	0.1	0.1	1.0	0.1	1.0	0.1	0.1	0.1	0.1	0.1	
	SI2	0.2	0.2	0.2	0.3	0.2	0.0	0.0	0.2	0.2	0.7	0.3	0.2	0.5	1.0	0.0	
	SI3	0.8	1.0	1.0	0.0	0.0	1.0	1.0	1.0	0.5	0.5	1.0	0.9	0.5	0.3	1.0	Average
HSI = Repro. Suitability Index $= (SI1 \times SI2)^{1/2} \times SI3$	**HSI =**	0.11	0.45	0.14	0.00	0.00	0.00	0.00	0.45	0.07	0.41	0.18	0.12	0.11	0.08	0.00	**0.14**
Downy Woodpecker																	
Variable name	#	Field Variable Values															
Basal area (ft^2 per acre)	**V1**	120	170	180	120	10	80	50	90	2	150	60	150	150	20	110	
Number of snags >6 in dbh/acre	**V2**	40	120	20	20	30	0	10	0	10	30	1	0	40	30	0	
		SI Values															
Food Value	**SI1**	0.6	0.5	0.5	0.6	0.2	1.0	1.0	1.0	0.0	0.5	1.0	0.5	0.5	0.5	0.7	
Reproduction Value	**SI2**	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	1.0	0.2	0.0	1.0	1.0	0.0	Average
Lowest Life Requisite Value	**HSI=**	0.62	0.50	0.50	0.62	0.23	0.00	1.00	0.00	0.05	0.50	0.20	0.00	0.50	0.45	0.00	**0.34**
Fox Squirrel																	
Variable name	#	Field Variable Values															
Percent canopy closure of trees that produce hard mast >10 in dbh	**V1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Distance to available grain (yd)	**V2**	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660	
Average dbh of overstory trees (in)	**V3**	8	8	8	9	8	4	5	8	8	15	10	8	12	20	5	
Percent tree (>16.5 ft height) canopy closure	**V4**	60	85	90	50	10	80	95	80	85	50	80	60	70	70	60	
Percent shrub (<16.5 ft height) crown cover	**V5**	10	5	5	5	80	5	10	20	10	60	10	10	10	25	15	
		SI Values															
	SI1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	SI2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
	SI3	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.1	0.1	1.0	0.3	0.1	0.6	1.0	0.0	
	SI4	1.0	0.7	0.6	1.0	0.5	0.8	0.6	0.8	0.7	1.0	0.8	1.0	0.9	0.9	1.0	
	SI5	1.0	1.0	1.0	1.0	0.2	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	
Winter Food $= (3 \times SI1 + SI2) \div 3$		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cover/Reproduction Value $= (SI3 \times SI4 \times SI5)^{1/3}$		0.4	0.4	0.3	0.6	0.2	0.0	0.0	0.4	0.4	0.8	0.6	0.4	0.8	1.0	0.0	Average
Lowest Life Requisite Value	**HSI=**	0.03	0.03	0.03	0.03	0.03	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.00	**0.03**

(Table A-7. HSI Calculation: Riparian Woodland Cover Type, Continued)

Cover Type: Riparian Woodland

Species: Barred Owl, Downy Woodpecker, Fox Squirrel, Racoon, Wood Duck

Variable		Area / Site Number															
		1	2	3	4	5	6	7	8	9	11	12	14	15	20	30	
Racoon																	
Variable name	#	Field Variable Values															
Distance to water (mi)	**V1**	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.3	0.0	0.0	0.1	
Water regime: A) Permanent water, B) Semi-permanent water, or C) No water or ephemeral flooding	**V2**	B	B	B	B	B	B	B	B	A	C	B	B	B	B	B	
Overstory forest size class: A) Saplings (<15cm dbh), B) Pole timber (≥ 15 cm to 25 cm dbh), C) Saw timber (≥ 25 cm to 50 cm dbh), or D) Mature trees (≥ 50 cm dbh).	**V3**	B	B	B	B	B	A	A	B	B	C	B	B	C	C	A	
Number of refuge sites per 0.4 ha (#/acre)	**V4**	10	10	70	3	60	20	120	30	100	20	20	0	20	40	0	
Deciduous Forested Wetlands Model		SI Values															
	SI 1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	SI 2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.1	0.5	0.5	0.5	0.5	0.5	
	SI 3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.7	0.2	0.2	0.7	0.7	0.1	
	SI 4	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	
Water Value *= (SI1 × SI2)* $^{1/2}$		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.0	0.3	0.7	0.7	0.7	0.7	0.7	
Cover Reproduction Value *= (SI3 + SI4) ÷ 2*		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.9	0.6	0.1	0.9	0.9	0.1	Average
Lowest Life Requisite Value	**HSI=**	0.60	0.60	0.60	0.55	0.60	0.55	0.55	0.60	0.60	0.32	0.60	0.10	0.71	0.71	0.05	**0.52**
Wood Duck																	
Variable name	#	Field Variable Values															
Number of potentially suitable tree cavities per acre (min entrance size of 7.6 × 10 cm)	**V1**	0	0	0	1	0	0	30	20	0	40	10	0	0	20	0	
Number of nest boxes per acre	**V2**																
Number of potential nest sites per acre = (0.18 × V1) + (0.95 × V2)	**V3**	0.0	0.0	0.0	0.2	0.0	0.0	5.4	3.6	0.0	7.2	1.8	0.0	0.0	3.6	0.0	
Percent of water surface covered by potential brood cover	**V4**	15	0	5	0	10	15	5	25	5	80	10	5	5	5	10	
Percent of water surface covered by potential winter cover	**V5**	8	0	3	0	10	15	5	15	5	65	8	5	5	5	10	
		SI Values															Average
Nesting Value	**SI3**	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.7	0.0	1.0	0.4	0.0	0.0	0.7	0.0	**0.26**
Brooding Value	**SI4**	0.3	0.0	0.1	0.0	0.2	0.3	0.1	0.5	0.1	0.8	0.2	0.1	0.1	0.1	0.2	**0.21**
Winter Cover Value	**SI5**	0.2	0.0	0.1	0.0	0.2	0.3	0.1	0.3	0.1	1.0	0.2	0.1	0.1	0.1	0.2	**0.19**
	HSI =	*See Wood Duck Multi-cover Type Worksheet*															**0.22**

Table A-8. HSI Calculation: Shrub Wetland Cover Type							
Cover Type: Shrub Wetland Species: Green Heron, Racoon, Swamp Rabbit, Wood Duck							
Variable		**Area / Site Number**					
		1	**2**	**3**	**4**	**5**	
Green Heron							
Variable name	#	Value	Value	Value	Value	Value	
Aquatic substrate composition in littoral zone: A) Muddy, B) Sandy, or C) Rocky	**V1**	A	A	A	A	A	
Percent water area <10 in deep	**V2**	100	100	100	100	100	
Percent emergent herbaceous canopy cover in littoral zone	**V3**	25	60	100	60	0	
Percent water surface obstruction	**V4**	25	0	95	50	40	
Water regime: A) Permanent water, B) Semi-permanent water, or C) No water or ephemeral flooding	**V5**	B	B	B	A	B	
Water current in summer: A) Still to slow (<6 in/sec), B) Moderately slow (2-24 in/sec), C) Moderately fast (24-40 in/sec), or D) Fast (>40 in/sec)	**V6**	A	A	A	A	A	
		SI	SI	SI	SI	SI	
	SI1	1.0	1.0	1.0	1.0	1.0	
	SI2	1.0	1.0	1.0	1.0	1.0	
	SI3	0.6	1.0	0.0	1.0	0.1	
	SI4	1.0	0.2	0.2	1.0	1.0	
	SI5	0.9	0.9	0.9	1.0	0.9	
	SI6	1.0	1.0	1.0	1.0	1.0	
Food Value *= (SI1 × SI2 × SI3)$^{1/3}$ + SI4*		1.0	1.0	0.2	1.0	1.0	
Water Value *= (SI5 × SI6)$^{1/2}$*		0.9	0.9	0.9	1.0	0.9	Average
Lowest Life Requisite Value	**HSI =**	0.95	0.95	0.20	1.00	0.95	**0.81**
Racoon							
Variable name	#	Value	Value	Value	Value	Value	
Distance to water (mi)	**V1**	0.3	0.0	0.0	0.1	0.0	
Water regime: A) Permanent water, B) Semi-permanent water, or C) No water or ephemeral flooding	**V2**	B	B	B	A	B	
Number of refuge sites per 0.4 ha (#/acre)	**V4**	0	0	30	0	50	
Deciduous Shrub Wetland Model		SI	SI	SI	SI	SI	
	SI 1	1.0	1.0	1.0	1.0	1.0	
	SI 2	0.5	0.5	0.5	1.0	0.5	
Cover / Reproduction Value	**SI 4**	0.0	0.0	1.0	0.0	1.0	
Water Value *= (SI1 × SI2)$^{1/2}$*		0.7	0.7	0.7	1.0	0.7	Average
Lowest Life Requisite Value	**HSI=**	0.00	0.00	0.71	0.00	0.71	**0.28**
Swamp Rabbit							
Variable name	#	Value	Value	Value	Value	Value	
Percent shrub crown closure	**V2**	65	60	45	90	40	
Percent herbaceous canopy cover	**V3 / V4**	10	67	100	60	100	
Water Regime: 1) Permanently flooded, 2) Intermittently exposed, 3)Semi-permanently flooded, 4) seasonally flooded, 5) Temporarily flooded, or 6) Intermittently flooded	**V6**	4	3	3	4	3	
Deciduous Shrub Wetland Model		SI	SI	SI	SI	SI	
	SI2	1.0	1.0	0.9	1.0	0.8	
	SI3 / SI4	0.1	0.9	1.0	0.8	1.0	
	SI6	0.8	0.5	0.5	0.8	0.5	
Food/Cover Value *= (SI1 + SI2) ÷ 2*		0.6	0.9	1.0	0.9	0.9	Average
HSI *= Food/Cover Index × SI6*	**HSI =**	0.45	0.47	0.48	0.72	0.46	**0.52**
Wood duck							
Variable name	#	Value	Value	Value	Value	Value	
Number of potentially suitable tree cavities per acre (min entrance size of 7.6 × 10 cm)	**V1**	0	0	0	0	0	
Number of nest boxes per acre	**V2**	0	0	0	0	0	
Number of potential nest sites per acre = (0.18 × V1) + (0.95 × V2)	**V3**	0	0	0	0	0	
Percent of water surface covered by potential brood cover	**V4**	25	0	95	50	40	
Percent of water surface covered by potential winter cover	**V5**	25	0	60	25	40	
		SI	SI	SI	SI	SI	Average
Nesting Value	**SI3**	0.0	0.0	0.0	0.0	0.0	**0.00**
Brooding Value	**SI4**	0.5	0.0	0.2	1.0	0.8	**0.50**
Winter Cover Value	**SI5**	0.5	0.0	1.0	0.5	0.8	**0.56**
See Wood Duck Multi-cover Type Worksheet	**HSI =**						**0.22**

Table A-9. HSI Calculation: Emergent Wetlands Cover Type

Emergent Wetlands
Species: Green Heron, Racoon, Wood Duck

Variable		Area / Site Number						
		1	2	3	4	5	75	
Green Heron								
Variable name	#	Value	Value	Value	Value	Value	Value	
Aquatic substrate composition in littoral zone A) Muddy, B) Sandy, or C) Rocky	V1	A	A	A	A	A	A	
Percent water area <10 in deep	V2	100	100	100	100	25	15	
Percent emergent herbaceous canopy cover in littoral zone	V3	75	90	50	95	50	20	
Percent water surface obstruction	V4	75	90	0	2	15	5	
Water regime (average summer conditions): A) No water or ephemeral flooding, B) Semi-permanent water, or C) Permanent water	V5	B	B	B	C	B	A	
Water current (average summer conditions): A) Still to slow (<6 in/sec), B) Moderately slow (2-24 in/sec), C) Moderately fast (24-40 in/sec), or D) Fast (>40 in/sec)	V6	A	A	A	A	A	A	
Distance to deciduous forested or deciduous shrub wetland (mi)	V7	0.0	0.1	0.0	0.0	0.0	0.0	
		SI	SI	SI	SI	SI	SI	
	SI1	1.0	1.0	1.0	1.0	1.0	1.0	
	SI2	1.0	1.0	1.0	1.0	0.5	0.3	
	SI3	1.0	0.4	1.0	0.2	1.0	0.5	
	SI4	1.0	0.4	0.2	0.3	0.7	0.4	
	SI5	0.9	0.9	0.9	0.3	0.9	1.0	
	SI6	1.0	1.0	1.0	1.0	1.0	1.0	
Reproduction Value	SI7	1.0	1.0	1.0	1.0	1.0	1.0	
Food Value $= (SI1 \times SI2 \times SI3)^{1/3} + SI4$		1.0	1.0	1.0	0.8	1.0	0.9	
Water Value $= (SI5 \times SI6)^{1/2}$		0.9	0.9	0.9	0.5	0.9	1.0	Average
Lowest Requisite Life Value	**HSI =**	0.95	0.95	0.95	0.55	0.95	0.87	**0.87**
Racoon								
Variable name	#	Value	Value	Value	Value	Value	Value	
Distance to water (mi)	V1	0	0	0	0	0	0	
Water regime: A) Permanent water, B) Semi-permanent water, or C) No water or ephemeral flooding	V2	B	B	B	C	B	A	
Number of refuge sites per 0.4 ha (#/acre)	V4	0	0	0	20	50	0	
Herbaceous Wetland Model		SI	SI	SI	SI	SI	SI	
	SI 1	1.0	1.0	1.0	1.0	1.0	1.0	
	SI 2	0.5	0.5	0.5	0.1	0.5	1.0	
Cover / Reproduction Value	SI 4	0.0	0.0	0.0	1.0	1.0	0.0	
Water Value $= (SI1 \times SI2)^{1/2}$		0.7	0.7	0.7	0.3	0.7	1.0	Average
Lowest Requisite Life Value	**HSI=**	0.00	0.00	0.00	0.32	0.71	0.00	**0.17**
Wood Duck								
Variable name	#	Value	Value	Value	Value	Value	Value	
Number of potentially suitable tree cavities per acre (min entrance size of 7.6 × 10 cm)	V1	0	0	0	10	0	0	
Number of nest boxes per acre	V2							
Number of potential nest sites per acre = (0.18 × V1) + (0.95 × V2)	V3	0	0	0	1.8	0	0	
Percent of water surface covered by potential brood cover	V4	75	90	0	2	15	5	
Percent of water surface covered by potential winter cover	V5	20	75	0	2	15	5	
		SI	SI	SI	SI	SI	SI	Average
Nesting Value	SI3	0.0	0.0	0.0	0.4	0.0	0.0	**0.06**
Brooding Value	SI4	1.0	0.4	0.0	0.0	0.3	0.1	**0.31**
Winter Cover Value	SI5	0.4	1.0	0.0	0.0	0.3	0.1	**0.31**
See Wood Duck Multi-cover Type Worksheet	**HSI =**							**0.22**

Table A-10. American Kestrel Multi-cover Type Worksheet

American Kestrel Relative Abundance of Cover Types	Cover Type Cropland	Grassland	Tree Savanna	Total
Area Used By Species (acres)	1757.0	4761.0	132.0	6650.00
Relative Area = Cover Type Area ÷ Total Area	0.3	0.7	0.0	1.00
Food Value Calculation				
Food Value 1 From Cover Type Worksheet	0.5	0.9	1.0	
Mean Distance to Covertype Providing Food (mi)	0.0	0.0	0.0	
Interspersion Index Value of Index at Distance	1.0	1.0	1.0	
Food Value 2 At Cover Type Providing Food Habitat	0.5	0.9	1.0	
Modified Food Value = Interspersion Index × Food Value 2	0.5	0.9	1.0	**Total**
% Food Support Provided = Modified Food Value × Relative Area	0.1	0.7	0.0	**0.82**

Reproduction Value Calculation

Reproduction Value 1 From Cover Type Worksheet	1.0	1.0	1.0	
Mean Distance to Covertype Providing Reproduction (mi)	0.0	0.0	0.0	
Interspersion Index Value of Index at Distance	1.0	1.0	1.0	
Reproduction Value 2 At Cover Type Providing Reproduction Habitat	1.0	1.0	1.0	
Modified Reproduction Value = Interspersion Index × Reproduction Value 2	1.0	1.0	1.0	**Total**
% Reproduction Support Provided = Modified Reproduction Value × Relative Area	0.3	0.7	0.0	**1.00**

Overall Life Requisite Calculation	**% Provided** Calculated Above	**Optimal %** Provided in Model	**Overall Life Requisite Value** = Provided ÷ Optimal
Food Value	0.8	0.6	1.0
Reproduction Value	1.0	0.1	1.0
HSI = Lowest Requisite Life Value			**1.00**

Table A-11. Wood Duck Multi-cover Type Worksheet

Wood Duck	**Cover Type**			
Relative Abundance of Cover Types	**Riparian Woodland**	**Shrub Wetland**	**Herbaceous Wetland**	**Total**
Area Used By Species (acres)	6330.0	49.0	1223.0	7602.0
Relative Area = Cover Type Area ÷ Total Area	0.8	0.0	0.2	1.0
Winter Cover Value Calculation				
Winter Cover Value (SI5) From Cover Type Worksheet	0.2	0.6	0.3	**Total**
Winter Cover Value Adjusted by Area = SI5 × Relative Area	0.2	0.00	0.0	**0.2**

Nesting Value Calculation

Nesting Value (SI3) From Cover Type Worksheet	0.3	0.0	0.1	
Interspersion Index for Nesting* =1 if Nesting Provided in Covertype or Within 0.5 mi	1.0	1.0	1.0	
Usable Relative Area = Relative Area × Interspersion Index	0.8	0.0	0.2	**Total**
Nesting Value Adjusted by Usable Area = SI3 × Usable Relative Area	0.2	0.0	0.0	0.2
% Area in Optimum Condition for Nesting (V7) = Sum of Adjusted Nesting Values × 100			**V7**	22.3
Overall Nesting Value (SI7) **=** Calculated for V7 from Model			**SI7**	**1.0**

Brooding Value Calculation

Brooding Value (SI4) From Cover Type Worksheet	0.2	0.5	0.3	
Interspersion Index for Brooding =1 if Brooding Provided in Covertype or Within 0.5 mi	1.0	1.0	1.0	
Usable Relative Area = Relative Area × Interspersion Index	0.8	0.0	0.2	**Total**
Brooding Value Adjusted by Area = SI4 × Relative Area	0.2	0.0	0.0	0.2
% Area in Optimum Condition for Brooding (V8) = Sum of Adjusted Brooding Values × 100			**V8**	22.5
Overall Brooding Value (SI8) **=** Calculated for V8 from Model			**SI8**	**0.2**

Year-Round HSI Calculation

Breeding Suitability Value **=** Lowest Life Requisite Value for Breeding (Nesting or Brooding)	0.2
Winter Cover Suitability Value = Sum of Adjusted Winter Cover Values	0.2
Highest Life Requisite Value = HSI =	**0.22**

Table A-12. Eastern Cottontail Multi-cover Type Worksheet

Eastern Cottontail **Winter Cover / Food Value Calculation**	**Cover Type**					
	Evergreen Forest	**Tree Savanna**	**Shrubland**	**Grassland**	**Cropland**	**Total**
Area Used By Species (acres)	228.0	132.0	63.0	4761.0	1757.0	6941.0
Relative Area = Cover Type Area ÷ Total Area	0.03	0.02	0.01	0.69	0.25	1.00
Winter Cover / Food Value (WCFI) From Cover Type Worksheet	0.37	0.51	0.99	0.31	0.28	**Total**
Weighted WCFI = WCFI × Relative Area	0.01	0.01	0.01	0.21	0.07	**0.31**
HSI = Weighted WCFI Total if all cover types provide WCFI						**0.31**

Table A-13. Eastern Wild Turkey Multi-cover Type Worksheet

Eastern Wild Turkey	Cover Type		
	Evergreen Forest	Upland Deciduous Forest	Totals
Area Used By Species (acres)	228.0	2216.0	2444.0
Relative Area = Cover Type Area ÷ Total Area	0.09	0.91	1.00
Summer Food / Brood Value (FBSI) From Cover Type Worksheet	0.00	0.43	**Total**
Adjusted FBSI = FBSI × Relative Area	0.00	0.39	**0.39**
Fall/Winter/Spring Food (FWSSI) Value From Cover Type Worksheet	0.43	0.59	**Total**
Adjusted FWSSI = FWSSI × Relative Area	0.04	0.53	**0.57**
Cover (CSI) Value From Cover Type Worksheet	0.04	0.89	**Total**
Adjusted CSI = CSI × Relative Area	0.00	0.81	**0.81**

% Area Providing Optimum Habitat for Life Requisite		
Summer Food/Brood = Sum of Adjusted FBSI	**V14**	**38.6**
Fall/Winter/Spring Food = Sum of Adjusted FWSSI	**V15**	**57.4**
Cover = Sum of Adjusted CSI	**V16**	**81.4**

Overall Life Requisite Values		
Summer Food/Brood Calculated for V14 from Model	**SI14**	**1.00**
Fall/Winter/Spring Food Calculated for V15 from Model	**SI15**	**0.68**
Cover Calculated for V16 from Model	**SI16**	**1.00**
Lowest Requisite Life Value	**HSI =**	**0.68**

Appendix B

Photographs of Evaluation Sites

Upland Deciduous Forest HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Post Oak, Water Oak, Red Oak, Cedar Elm, Sugarberry, Bois d'Arc, Green Ash, and Eastern Red Cedar

SHRUBS & VINES
Coralberry, Greenbrier, Honey Locust, Poison Ivy, Virginia Creeper, and Dogwood

HERBACEOUS
Carex Sedges, Flatsedges, Panicgrass, Corn Salad, Virginia Wildrye, Ironweed, Venus' Looking-Glass, and Wild Onion

Photo 1. Evaluation site UPDEC 2. Photo taken facing south in August 2007**.**

Photo 2. Evaluation site UPDEC 3. Photo taken facing south in August 2007.

Evergreen Forest HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Eastern Red Cedar, Red Oak, and Post Oak

SHRUBS & VINES
Coral Berry, Greenbrier, Gum Bumelia, and Possumhaw Holly

HERBACEOUS
Cherokee Sedge, Panicgrass, Johnsongrass, and KR Bluestem

Photo 3. Evaluation site EF 3. Photo taken facing north in August 2007**.**

Photo 4. Evaluation site EF 1. Photo taken facing east in June 2007.

Tree Savanna HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Cedar Elm, Bois d'Arc, and Eastern Red Cedar

SHRUBS & VINES
Gum Bumelia, Coralberry, Greenbrier, Poison Ivy, and Southern Dewberry

HERBACEOUS
Ironweed, Western Ragweed, Sedge, Flatsedge, Bermudagrass, Panicgrass, KR Bluestem, Indian Plantain, Prairie Plantain, Croton, and Dock.

Photo 5. Evaluation site TS 4. Photo taken facing east in August 2007.

Photo 6. Evaluation site TS 4. Photo taken facing north in August 2007.

Shrubland HEP Evaluation Sites

DOMINANT VEGETATION

IMMATURE TREES
Green Ash, Bois d'Arc, and Eastern Red Cedar

SHRUBS & VINES
Honey Locust, Persimmon, and Coralberry

HERBACEOUS
Cherokee Sedge, Goldenrod, Johnsongrass, Silver Bluestem, Wild Pea, and Snow-On-The-Prairie

Photo 7. Evaluation site SH 5. Photo taken facing east in August 2007.

Photo 8. Evaluation site SH 5. Photo taken facing north in August 2007.

Cropland HEP Evaluation Sites

DOMINANT VEGETATION

PLANTED FIELDS
Oats, Soybeans, Hay, and Winter Wheat

FALLOW FIELDS
Johnsongrass, Panicgrass, Knotroot Bristlegrass, Tall Fescue, Bermudagrass, Dock, Pigweed, Spurge, Morning Glory, and Black-Eyed Susan.

Photo 9. Evaluation site CROP 2. Photo taken facing east in August 2007.

Photo 10. Evaluation site CROP 2. Photo taken facing north in August 2007.

Grassland / Old Field HEP Evaluation Sites

DOMINANT VEGETATION

HERBACEOUS
Tall Fescue, Perennial Rye, Bahia Grass, Bermudagrass, Texas Wintergrass, Dallisgrass, Western Ragweed, Ironweed, Dock, Vetch, and Wild Pea

Photo 11. Evaluation site GOF 13. Photo taken facing north in August 2007.

Photo 12. Evaluation site GOF 16. Photo taken facing north in August 2007.

Riparian Woodland / Bottomland Hardwood HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Black Willow, Boxelder, Green Ash, Sugarberry, and Cedar Elm

SHRUBS & VINES
Honey Locust, Poison Ivy, Coralberry, Buttonbush, and Virginia Creeper

HERBACEOUS
Baccharis, Cherokee Sedge, Ragweed, and Virginia Wildrye

Photo 13. Evaluation site RWBH 1. Photo taken facing north in July 2007.

Photo 14. Evaluation site RWBH 15. Photo taken facing south in August 2007.

Shrub Wetland HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Green Ash, Sugarberry, and Cedar Elm

SHRUBS & VINES
Honey Locust and Baccharis

HERBACEOUS
Sedges, Ragweed, Ironweed, Goldenrod, Evening Primrose, Round-Leaf Groundsel, Trumpet Vine, and Wild Pea

Photo 15. Evaluation site SHWET 2. Photo taken facing north in July 2007.

Photo 16. Evaluation site SHWET 1. Photo taken facing west in August 2007.

Emergent / Herbaceous Wetland HEP Evaluation Sites

DOMINANT VEGETATION

HERBACEOUS
Rushes Blue Sedge, Spikerush, Flatsedge, Smartweed, Sumpweed, Frog Fruit, Water Primrose, Balloon Vine, Dock, Buttercup, Crowngrass, and Eastern Gammagrass

Photo 17. Evaluation site EHW 3. Photo taken facing east in July 2007.

Photo 18. Evaluation site EHW 1. Photo taken facing north in July 2007.