APPENDIX F-6: TERRESTRIAL

APPENDIX F-6: TERRESTRIAL HABITAT EVALUATION PROCEDURES

1.0 INTRODUCTION

This appendix will update the 2007 Final Supplement No. 1 to the 1982 Yazoo Area Pump Project Final Environmental Impact Statement (FSEIS), hereinafter referred to as the 2007 FSEIS (U.S. Army Corps of Engineers (USACE) 2007), for Habitat Evaluation Procedure (HEP) (U.S. Fish and Wildlife Service [USFWS] 1980a) analyses. The U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL) quantified potential impacts and changes to existing terrestrial habitat resulting from construction and operation of the 14,000 cfs pump station as part of the Proposed Plan. Data for variables associated with Habitat Suitability Index (HSI) models were collected by the ERDC-EL Wildlife Team during field work in July 2020 and were used to generate outputs to compare the Proposed Plan and the No Action Alternative.

2.0 BACKGROUND

Terrestrial habitat types within the Yazoo Study Area primarily include agricultural land or woody wetlands (Table 1). Agricultural lands and developed areas provide limited terrestrial habitat for a small number of species, with the exception of waterfowl (see Waterfowl Appendix). Bottomland hardwoods (BLH) are the predominant terrestrial habitat within the Mississippi Alluvial Valley (MAV), and therefore are the habitat most likely to be impacted by the construction and operation of the Proposed Plan (Table 2). The two dominant BLH communities are riverfront BLH and mixed BLH. Dominant species of the riverfront BLH communities include Cottonwood *(Populus deltoides)*, Sycamore *(Platanus occidentalis)*, and Black Willow (*Salix nigra)* while dominant mixed BLH species include Pecan (*Carya* spp.), Green Ash *(Fraxinus pennsylvanica)*, Sugarberry *(Celtis laevigata)*, Hackberry *(C. occidentalis)*, Oaks *(Quercus* spp.), and Elm *(Ulmus* spp.).

The impacts of the Proposed Plan to wildlife include direct impacts from project construction, and indirect impacts from the long-term hydrologic changes to the landscape within the Yazoo Study Area. The objectives for this analysis were to (1) collect data using targeted field sampling to generate inputs for HSI model variables of four avian and two mammalian species, and (2) use HEP to evaluate direct and indirect impacts from the construction and operation of the Proposed Plan. The baseline conditions for habitat suitability of the six target species associated with the No Action Alternative was determined and then used to estimate impacts to habitat associated with the Proposed Plan. The reduction of habitat between the No Action and Proposed Plan; requires mitigation to replace habitat altered directly by removal, or indirectly by a reduction in the frequency and duration of inundation.

2.1 Overview and Justification for Using HEP

HEP provides a means to quantify habitat availability for wildlife species under various management alternatives. HSI model input variables are derived from species-specific habitat requirements for a defined area. HSI models rate the quality of available habitat using a scale of 0 (unsuitable) to 1.0 (optimal). Land cover types in a defined area are mapped, and target species that utilize specific land cover types are then selected. Target species may include rare or sensitive species, but may also reflect economic, recreational, or ecological considerations (Roberts and O'Neil 1985, O'Neil 1993).

The HEP approach has historically been the standard procedure to estimate impacts on various species and their habitats (USFWS 1980a,b,c). The estimated loss or degradation of habitat, as measured by HEP, can be used to determine the amount of habitat needed to be protected or restored to mitigate for lost habitat, especially for sensitive or rare species (Wakeley 1988, Kellner et al. 1992).

Once target species have been selected, cover types mapped, and habitat variables collected, HSI models are then used to generate indices for each target species in each defined area. An initial number of habitat units (HUs) for each species are based on the amount of cover types available and individual HSI model results for each species. Usually, one HU is equal to 1 acre (0.40 ha) of optimum habitat available for a species. Then, the amount of acreage available for a species is calculated as the number of available acres (alternatively hectares) multiplied by the HSI value (HU = HSI x available acres/hectares) in the study area.

HEP is the preferred approach developed and recommended by the USFWS, the federal agency responsible for regulating impacts on wildlife species and their habitats (USFWS 1980a,b,c; Wakeley and O'Neil 1988; O'Neil 1993). In a typical HEP study, a number of evaluation species are chosen for each area which meets a specified standard of homogeneity (i.e., cover type) of interest in the project area. Our focal species were chosen because of their presence and dependency on BLH habitat within the MAV and to be consistent with the suite of species used in the 2007 FSEIS (USACE 2007).

Impacts on target species during the construction and operation of the pump station associated with the Proposed Plan were estimated by calculating the mean number of HUs in the No Action Alternative with the estimated loss of HUs associated with the Proposed Plan. This value is referred to as the difference in average annual habitat units (AAHUs). AAHUs reflect the values of habitat quality, acres, and time before and after project implementation; they may also estimate HUs gained or lost in comparisons between the alternative options (Wakeley and O'Neil 1988). The amount of HUs determined to be lost or gained during planning and prior to project implementation allows project managers to estimate whether there is a need to mitigate or restore lost habitat.

2.2 Species Selection

The selected species represent the wildlife community that uses BLH and may be directly or indirectly impacted by the Proposed Plan. These species included the Barred Owl (BADO; *Strix varia*), Gray Squirrel (GRSQ; *Sciurus carolinensis*), Carolina Chickadee (CACH; *Poecile carolinensis*), Pileated Woodpecker (PIWO; *Dryocopus pileatus*), Wood Duck (WODU; *Aix sponsa*), and Mink (*Mustela vison*). The USACE National Ecosystem Restoration Planning

Center of Expertise has certified all HSI models (Allen 1986, 1987a,b; Schroeder 1983a,b; Sousa and Farmer 1983) used in the Yazoo Study Area.

3.0 METHODS

3.1 Selection of Field Sites

ArcGIS layers of hydrologic conditions under the No Action Alternative for species reliant on inundated conditions (i.e., Wood Duck and Mink) were used to inform selection of sampling areas for HEP. Using these layers, sites were selected according to accessibility (e.g., roads) to suitable habitat (i.e., forested habitat with proper hydrology) for Wood Duck or Mink, with sampling locations generally spaced at least 250 meter apart. Forested sites were prioritized for Wood Duck and Mink, as Pileated Woodpecker, Barred Owl, Carolina Chickadee, and Gray Squirrel would not be expected to be impacted to the same degree with altered hydrology on the landscape. However, sites selected within forested habitats at the pump station site would be directly impacted by clearing of forested areas that will eliminate habitat for all terrestrial species.

3.2 Field Methods for Quantifying Habitat Characteristics

Using multiple two-person teams of ERDC-EL biologists, all points and reaches were sampled during July 2020; conducting field work earlier in the season was hampered by late-spring flooding in the Yazoo Study Area. Field equipment required for this effort included GPS units, clipboards, datasheets, two 50 meter tape measures, range finder with built-in clinometer, densiometer, metric tree calipers, and binoculars (for facilitating identification of tree cavities). Field personnel used a hand-held GPS units to locate all sampling points within the Yazoo Study Area, and had the latitude to move a point away from conditions that were too flooded to sample, or into areas more suitable for forest habitat if conditions were not appropriate (e.g., when tree harvest or other activity had impacted the area). Universal Transverse Mercator (UTM) coordinates were recorded at each sampling point to ensure that points matched established sampling locations, or to document when an original point was moved. Seventeen HSI model variables were measured on 53 randomly placed 0.1-acre plots within the Yazoo Study Area (Figure 1), and data were used to calculate four variables using ArcGIS (ESRI Inc. 2018).

For Mink, in place of calculating the percent of the year water was present on a plot, observations of permanent water sources occurring within 100 meters of each HEP sampling plot were recorded. If permanent water was present, other Mink HSI variables were measured at the plot to generate a Mink HSI score. This approach is considered to be more representative in calculations of a HSI score for Mink as water must be present for habitat utilization; this approach was later applied when assigning HUs to forested areas for Mink that contained permanent water sources within 100 meters of forested blocks. A composite of 21 variables (Table 3) was generated from HSI models for the six target species. References for these models can be found in Allen (1986, 1987a,b), Schroeder (1983a, b), and Sousa and Farmer (1983). The HSI model for the Black-capped Chickadee (*Poecile atricapillus*) (Schroeder 1983a) was modified for the Carolina Chickadee as described in a Memo from U.S. Geological Survey, Biological Resources Division, Fort Collins, Colorado to USFWS, Vicksburg, Mississippi (Farmer 1989).

3.3 Plot Sampling

Within each 0.1 acre plot, canopy cover was measured with a hand-held densiometer, taking five measurements of the tree layer (all woody plants > 6.0 meters tall, excluding vines), at plot center, and at 10 meters from plot center in each of the four cardinal direction. ERDC-EL estimated midstory cover visually from plot center in each of four quadrants; midstory consisted of woody plants (trees and shrubs combined) 1.0 to 6.0 meters tall, including vines. Herbaceous cover was estimated using the same method as for midstory cover; this included cover of living plants < 1.0 meter tall. The diameter at breast height (DBH) of each living trees and snag was measured to the nearest centimeter, and identified all live trees to species. Snags were defined as standing dead trees > 10.0 centimeters in diameter and ≥ 2.0 meters tall, and included live trees from which > 50 percent of the branches had fallen or were present but no longer producing foliage. The height of a tree that was representative of the average canopy height within the plot was measured with a clinometer. Oaks (*Quercus* spp.) and hickories (*Carya* spp.) were the only hard-mast genera in our sampling plots. The percent hard-mast canopy was calculated as the proportion of these species from all trees and then multiplied this percentage by the total estimated canopy cover. All trees > 25 centimeters DBH were considered as contributing to canopy cover for this variable.

ERDC-EL visually counted the number of trees within a plot that contained cavities suitable for use by Carolina Chickadee, and counted the number of cavity openings measuring at least 7.6 x 10.0 centimeters, and the number of nest boxes within the plot, for Wood Duck. ERDC-EL then counted the number of downed logs (> 18 centimeters in diameter) and tree stumps (> 0.3 meters tall; > 18 centimeters in diameter) within the plot.

For plots within 100 meters of permanent water (Mink model), three additional variables were collected: 1) an estimate of the percent of shoreline cover that included the structural complexity consisting of cover provided by overhanging or emergent vegetation, undercut banks, logjams, debris, exposed roots, boulders, or rock crevices within 1 meter from water's edge; 2) the percent canopy cover of trees and shrubs within 100 meters of the water body; and 3) the level of disturbance to the body of water as a categorical variable (Devendorf and Yager 2013). This last variable was not included in the original HSI for Mink, but represents an updated method for calculating the HSI of riverine habitats (Devendorf and Yager 2013).

Mink require terrestrial environments near water. The 50 percent exceedance elevation was used to represent areas inundated for 180 days during the year. Thus the 50 percent duration for the period of record (POR) at each gage was used to represent available mink habitat. The Flood Event Simulation Model (FESM) tool was used to determine the extent of flooding across the landscape for the 180-day duration flood. The 180-day duration elevation was less than the minimum elevation at most gage locations; therefore, the minimum elevation in the Digital Elevation Model (DEM) at each gage was used instead of the 180-day duration. This FESM output provided the minimum water surface of the major rivers in the Yazoo Study Area, but mink primarily inhabit areas adjacent to the rivers. The FESM output from the mink model analysis was incorporated into ArcMap and converted into a polygon coverage. There was very little difference in inundated habitat between the No Action and Proposed Plan for the 180-day duration surfaces. Both elevations were less than the minimum water surface elevation in the

DEM, and therefore the No Action and Proposed Plan for suitable Mink habitat were the same. Therefore, the only projected impacts to Mink would be within areas where habitat (i.e., forested tracts) was directly removed for project construction. To address this, using ArcGIS, 100 meter buffers were created around permanent water sources within the areas directly impacted by construction activities in the Proposed Plan. Within these buffer areas, only the forested areas were deemed suitable as Mink habitat and used to generate the HUs that would be lost for Mink.

For Wood Duck, four variables were calculated (Variables 16-19; Table 3) with ArcGIS using hydrologic layers provided by U.S. Army Corps of Engineers, Vicksburg District (MVK) and land cover from the 2018 NASS Cropscape layer, and used to generate HSI scores for nesting and brood-rearing metrics (i.e., Variables 4-8 in Wood Duck HSI bluebook). Using the nearest neighbor tool in ArcGIS distance (in miles) between nesting and brood-rearing cover types was measured to determine the interspersion component for Variable 6 of the Wood Duck HSI model (Variable 17 in Table 3). Because all distances between life requisites types (i.e., nesting and brood-rearing) were less than 0.5 miles (1.0 HSI) within the buffered areas around all of our HEP plots, scores were not reduced according to the juxtaposition factor in the Wood Duck HSI Model (Variable 6; Sousa and Farmer 1983).

The Wood Duck breeding season is during the spring, primarily March-May. Wood Duck duckling survival is highly correlated with proximity to suitable brood-rearing habitat once ducklings leave the nest (Sousa and Farmer 1983). MVK modeled Wood Duck brood-rearing habitat as the 46-day duration (50 percent exceedance) elevation during the spring (March-May). MVK then calculated the median spring duration for each of the six Hydrologic Unit Maps (HUCs) for each year in the POR.

Wood Duck broods primarily feed on invertebrates. Ducklings can feed in shallow water ($\leq$12 inches) or on the forest floor in shallowly-inundated soils. They require dense shrubby understory nearby for refuge and resting during the night. The NASS Crop Data Layer (2018) was condensed into four land-use categories (cleared, forested, permanent water, and developed land), and these land cover layers were added to the stage-area curve to produce a new coverage that contained the available acres of the four categories from elevations 75 through 108 feet, NGVD. The stage-area curve was developed in one foot intervals. The area in each interval was sub-divided into 0.1 foot intervals by linear interpolation. This revised forest stage-area curve in 0.1 foot intervals was used to calculate the median annual acres for Wood Duck brood-rearing. The number of impacted acres was calculated by subtracting the Proposed Plan brood-rearing acres from the No Action Alternative brood-rearing acres (Tables 4 - 6).

The WETSORT program, used to calculated the annual 7, 14, 21, 28, and 35 consecutive days of inundation during the growing season (1 February to 27 November), was modified to provide the 25 and 50 percent (30 and 60 days respectively) duration elevation during the Wood Duck nesting and early brood-rearing life stages (1 February to 31 May). The program returns the annual 30 or 60-day duration elevation and the starting and ending dates of that period (Table 7). It also calculates the mean elevation for the POR.

3.4 Calculating Baseline Habitat Conditions/Habitat Suitability Model Inputs

HSI scores were generated using the EcoRest package (McKay and Hernandez-Abrams 2020) implemented in the R-statistical environment (R Core Team 2018) for five of the six focal species. For the Wood Duck, HSI values were manually calculated as this model involves more complex formulas which require certain variables to be integrated into subsequent variables (i.e., optimum nesting or brood-rearing habitat; Sousa and Farmer 1983) to acquire the final HSI score, and correct formulas within the EcoRest package are still being developed for that species. For all field metrics, an average across all plots within the Yazoo Study Area were used to calculate an overall HSI for each species.

3.5 Calculating Average Annual Habitat Units

The overall effects of the Proposed Plan were estimated by calculating the net change in AAHUs between the No Action Alternative and the Proposed Plan for each of the six evaluation species. It was assumed that all land proposed for clearing during construction (e.g., access to and footprint of the pump station in addition to borrow areas and right-of-ways) would remain in a cleared condition over the life of the project. For the borrow area and pump station sites that were directly sampled, the average of each variable among all plots within the site was calculated to develop a HSI score within the EcoRest package. For forested areas directly impacted by construction of the supplemental low flow groundwater wells, we averaged data for each variable from all 53 plots within the Yazoo Study Area and applied those scores. The only species within the Yazoo Study Area indirectly impacted by alterations from hydrology was the Wood Duck. Nesting habitat was assumed to remain unchanged between the No Action and Proposed Plan; however, brood-rearing habitat would be impacted with the Proposed Plan in years when inundation occurs above elevation 87 feet, NGVD. Therefore, HSI scores for the Wood Duck were applied to acres of brood-rearing habitat based on an average HSI generated for this species from data collected across the entire Yazoo Study Area.

3.6 Determining Mitigation Recommendations

AAHUs were calculated by generating spreadsheets in Microsoft Excel based on gains in habitat through reestablishment of BLH on a hypothetical 100 acres of cleared land under various management scenarios (Table 8). The benefits of management plans for selected target years over a 50-year period of analysis were estimated using models developed by consensus of prior HEP Teams in the MAV (i.e., Steele Bayou Project and Upper Yazoo Project HEP Teams (Figure 2; Wakeley and Marchi 1991, 1992). In the absence of any other available modeling, annualized benefits of the management plans were applied over a 50 year expected project life.

It was assumed that mitigation by direct reforestation of existing cleared land is the preferred means of restoring wildlife habitat impacted by the project. Wakeley (2006) provided a summary of how habitat benefits of establishing new forest vary with site characteristics. The four generalist species – Barred Owl, Gray Squirrel, Carolina Chickadee, and Pileated Woodpecker, eventually will benefit from forests of nearly any age so long as sufficient time is allowed for forest succession and tracts generally are ≥ 10 acres in size. Mink will use forested wetlands that are flooded > 25 percent of the year; they will also benefit from the establishment of forest cover adjacent to streams or lakes, as long as streambank or shoreline vegetation is allowed to develop, or other foraging cover is provided (Wakeley 2006). Wood Ducks require mature trees with large cavities for nesting (which can be offset in mitigation sites with nest boxes), as well as proximal shallow surface water with overhead vegetation cover at least during the brood-rearing period.

4.0 RESULTS

The Proposed Plan will result in up to 112 acres of direct BLH loss for all of the targeted species within the HEP analyses through deforestation associated with construction (i.e., pump station, borrow areas, and supplemental low flow groundwater wells). Likewise, the Proposed Plan may indirectly impact forested habitats through intermittent alterations in hydrology from late winter to early summer in years when water elevations would have exceeded 87 feet, NGVD, under the No Action Alternative.

HSI values for the No Action Alternative suggested moderate, and in some cases high, habitat value for our focal species (Table 9). HSI values ranged from 0.33-0.70 for Carolina Chickadee, 0.51-0.79 for Barred Owl, 0.0-0.34 for Pileated Woodpecker, 0.23-0.60 for Gray Squirrel, 0.21-0.74 for Wood Duck, and 0.42-0.67 for Mink. The HEP sampling locations within the footprint of the borrow area and pump station generally had lower HSI values when compared to other areas within the Yazoo Study Area (Table 9).

Carolina Chickadee, Barred Owl, and Gray Squirrel would be most affected by the direct impacts of deforestation due to construction activities associated with the Proposed Plan, while Wood Duck and Mink would experience moderate impacts, and Pileated Woodpecker experiencing low impacts (Table 10). Overall, the Proposed Plan will result in the loss of 267.6 HUs when considering direct impacts to all six target species.

While direct impacts are relatively low for the Proposed Plan, changes in hydrologic regimes may result in further impacts to wildlife. The Proposed Plan would result in an estimated annual mean loss of 1,330.2 acres of Wood Duck brood-rearing habitat across the entire POR in indirect impacts. For the Proposed Plan, the reduction of brood-rearing habitat for Wood Ducks when considered across the entire POR resulted in loss of 984 HUs. Changes in hydrology are not anticipated to indirectly impact Mink, Carolina Chickadee, Barred Owl, Pileated Woodpecker, or Gray Squirrel; therefore, no indirect losses of HUs were calculated for these species.

4.1 Mitigation

AAHU values from Wakeley (2006), generated from past mitigation planning in the MAV that could be gained by reestablishing BLH forest on a hypothetical 100 acres of existing cleared land under various management plans, were used (Table 8). The Steele Bayou Project and Upper Yazoo Project HEP Teams determined the benefits of different management plans that were estimated for selected target years over a 50-year period of analysis using models developed by consensus of Wakeley and Marchi (1991, 1992) in the MAV. Values from the various management plans were annualized over 50 years to be comparable with estimates of project feature impacts.

For the Proposed Plan, 97.5-199.5 acres will require reforestation according to mitigation plans 1 - 6 (Table 8) in order to restore habitat directly lost from construction. Additional mitigation will be required to address indirect impacts (i.e., changes in frequency and duration of inundation) associated with lost HUs necessary for brood-rearing by the Wood Duck. Using hydrologic data for the POR from MVK, maximum water depths for Wood Duck brood-rearing habitat were set at ≤ 12 inches, and included historical hydrologic changes from all 42 years within the POR. Under this scenario, 1,330.2 acres would no longer receive intermittent inundation. This would require in-kind mitigation to restore 984.6 HUs that no longer receive inundation. ERDC-EL used the mitigation value from Table 8 that is specific to the Wood Duck (i.e., 62.7 AAHU) and determined that 1,569.9 acres of suitable habitat with proper hydrology would be required to offset these losses.

5.0 DISCUSSION

All six of the target wildlife species we investigated would experience direct loss of suitable forested habitat associated with the Proposed Plan. To properly mitigate for the loss of BLH habitat, it is recommended that a focus on Mitigation Plan 5 or 6 within Table 8 be used to obtain the necessary number of AAHU's to be applied for determining the acres of reforestation. Mitigation Plans 5 and 6 include active replanting of non-forested land with mast-producing species to include oaks and hickories, as well as ensuring that hydrology that also benefits Mink and Wood Duck is present. Specific tree species to be planted will depend on locations and site conditions of mitigation lands. If mitigation sites selected for reforestation are within areas projected to flood during the winter, we recommend that tree planting follow the recommendations within the Waterfowl Appendix. A mixture of red and white oaks, as well as several species of hickories will provide food resources for Gray Squirrel and other fauna that rely on hard mast. In addition to hard-mast trees, other species of trees that are prone to form cavities, such as Sycamore, should be planted to benefit Wood Duck, Pileated Woodpecker, Carolina Chickadee, Barred Owls, and other cavity-nesting species. All tree plantings should include species that are native to the MAV. By incorporating a diversity of tree species into the landscape during reforestation, the long-range benefits and habitat value of this forest community eventually will likely exceed those of the current floodplain and riverfront forest that will be impacted by construction activities.

Impacts other than those related to construction associated with the Proposed Plan are associated with alterations in hydrology which will result in lost HUs for the Wood Duck. Preferred Wood Duck brood-rearing habitat includes specific vegetated cover components that are inundated for varying intervals and depths across the landscape. The MVK provided ERDC-EL with data related to habitat inundated ≤ 12 inches in depth, to serve as optimal conditions for ducklings during brood-rearing. ERDC-EL incorporated these data into HEP models which generated an additional 984.6 HU averaged across the POR, which will require 1,570 acres of mitigation.

It is critical that proper hydrology exists on any proposed in-kind mitigation lands to fulfill life requisites for the Wood Duck throughout all seasons. Other studies have indicated that water depths deeper than 12 inches are important to Wood Duck ducklings prior to fledging (Bellrose and Holm 1994), with ideal brood-rearing habitat being comprised of approximately 25% of area in depths 1 to 12 inches, 50 percent in depths 12 to 36 inches, and 25 percent in depths 36 to 72 inches (McGilvrey 1968). Therefore, it is ERDC-EL recommendations that other depths of inundation also be considered in analyses when addressing life-history requirements of the Wood Duck, especially as it relates to brood-rearing habitat.

Tables:

Table 1. The 2018 NASS Cropscape land cover classification for the Yazoo Study Area.

Land Cover	Acres	% Land Cover
Aquaculture	1,204.9	0.1
Barren	58.7	0.0
Corn	78,919.5	8.5
Cotton	53,441.9	5.8
Deciduous Forest	78.7	0.0
Developed/High Intensity	110.4	0.0
Developed/Low Intensity	2,520.4	0.3
Developed/Med Intensity	1,309.7	0.1
Developed/Open Space	20,183.3	2.2
Double Crop Soybeans/Oats	2.2	0.0
Double Crop Winter Wheat/Cotton	171.6	0.0
Double Crop Winter Wheat /Soybeans	805.5	0.1
Evergreen Forest	44.8	0.0
Fallow/Idle Cropland	7,091.6	0.8
Grassland/Pasture	96.7	0.0
Herbaceous Wetlands	1,307.9	0.1
Mixed Forest	46.3	0.0
Oats	0.3	0.0
Open Water	30,548.0	3.3
Other Hay/Non Alfalfa	502.0	0.1
Peanuts	396.5	0.0
Peas	0.2	0.0
Pecans	1,523.5	0.2
Rice	8,655.2	0.9
Shrubland	3,336.6	0.4
Sod/Grass Seed	29.3	0.0
Soybeans	425,893.7	46.0
Sunflower	4.8	0.0
Sweet Potatoes	438.8	0.0
Winter Wheat	1,965.5	0.2
Woody Wetlands	284,689.8	30.8
Total	**925,378.3**	

Table 2. Land cover acreage and percent cover for project features associated with the Proposed Plan of the Yazoo Basin, Yazoo Backwater, Mississippi, Project.

Project Feature	Land Cover	Total Acres	Percent Cover
Borrow Area	Corn	3.7	8.1
	Developed/Low Intensity	0.2	0.5
	Developed/Open Space	0.9	2.0
	Fallow/Idle Cropland	4.5	9.9
	Grassland/Pasture	3.8	8.3
	Herbaceous Wetlands	0.6	1.4
	Mixed Forest	0.0	0.1
	Open Water	0.9	2.0
	Other Hay/Non Alfalfa	0.0	0.0
	Pecans	0.4	1.0
	Rice	0.0	0.1
	Shrubland	0.2	0.5
	Soybeans	16.0	35.1
	Woody Wetlands	14.2	31.1
Borrow Area Total		45.7	
Pump Station	Aquaculture	0.2	0.1
	Corn	4.4	1.8
	Cotton	0.4	0.2
	Dbl Crop WinWht/Soybeans	0.7	0.3
	Deciduous Forest	0.1	0.0
	Developed/Med Intensity	0.0	0.0
	Developed/Open Space	26.7	10.8
	Fallow/Idle Cropland	1.4	0.6
	Grassland/Pasture	0.7	0.3
	Herbaceous Wetlands	0.2	0.1
	Mixed Forest	0.6	0.3
	Open Water	7.4	3.0
	Other Hay/Non Alfalfa	0.4	0.2
	Pecans	0.1	0.1
	Shrubland	2.5	1.0
	Soybeans	112.7	45.6
	Woody Wetlands	88.9	35.9
Pump Station Total		247.4	
Well Access Road	Corn	0.0	0.0
	Cotton	0.3	2.1
	Dbl Crop WinWht/Soybeans	0.0	0.2
	Developed/Low Intensity	0.3	2.4
	Developed/Med Intensity	0.1	1.0
	Developed/Open Space	2.5	20.8
	Fallow/Idle Cropland	0.0	0.0
	Herbaceous Wetlands	0.0	0.2
	Open Water	0.0	0.0

	Soybeans	8.5	70.0
	Woody Wetlands	0.4	3.3
Well Access Road Total		12.2	
Well Areas	Corn	0.5	1.5
	Cotton	0.5	1.5
	Dbl Crop WinWht/Soybeans	0.2	0.8
	Developed/Low Intensity	0.2	0.7
	Developed/Open Space	3.2	10.3
	Fallow/Idle Cropland	0.2	0.6
	Herbaceous Wetlands	0.1	0.4
	Open Water	0.0	0.2
	Pecans	0.1	0.5
	Rice	0.2	0.7
	Soybeans	17.8	57.8
	Winter Wheat	0.3	0.9
	Woody Wetlands	7.5	24.3
Well Areas Total		30.9	
Grand Total		336.1	

Table 3. Habitat variables collected and the species for which the data contributed to individual HSI models.

No.	Variables	Species
1	Overall canopy closure (%) for entire plot	Carolina Chickadee, Gray Squirrel, Mink, Pileated Woodpecker
2	Overall midstory canopy closure (%) for entire plot	Mink
3	Overall herbaceous cover for entire plot	Mink
4	Canopy closure (%) of hard mast trees	Gray Squirrel
5	Canopy height (average height of overstory trees, $\geq$80% of tallest trees)	Carolina Chickadee
6	# of trees with DBH[a] ≥ 51 cm	Barred Owl, Pileated Woodpecker
7	Average DBH of overstory trees ($\geq$80% of tallest trees)	Barred Owl, Gray Squirrel
8	# of snags or dying trees $\geq$38 cm DBH[a]	Pileated Woodpecker
9	Average DBH of snags $\geq$38 cm DBH[a]	Pileated Woodpecker
10	Combined # of trees and snags with $\geq$1 cavity (trees $\geq$10 cm DBH[a])	Carolina Chickadee
11	# of tree cavities with dimensions of 7.6 x 10.0 cm (in live trees or snags).	Wood Duck
12	# of tree stumps; # of log	Pileated Woodpecker
13	# of artificial nest boxes	Wood Duck
14	% of the terrestrial ground surface within 100 m of a wetland's edge that is shaded by vertical projection of woody vegetation canopy	Mink
15	% of the vegetation/structural complexity at the water/land interface ($\leq$1 m from water's edge)	Mink
16	% water surface covered by brood cover	Wood Duck
17	Distance (m) between nesting and brooding-rearing habitat	Wood Duck
18	% area of optimum nesting habitat	Wood Duck
19	% area of optimum brood-rearing habitat	Wood Duck
20	Number of hard mast tree species	Gray Squirrel
21	Stream condition (level of disturbance)	Mink

[a] Diameter at breast height (DBH) is a standard method of expressing the diameter of the trunk or bole of a standing tree

Table 4. Elevation and acreage inundated less than 12 inches in depth during March-May that represents brood-rearing habitats in forested habitats for the No Action Alternative within the six HUCs of the Yazoo Study Area. Hydrologic data for elevation and brood-rearing acres provided by MVK.

	Callao		Anguilla		Holly Bluff		Little Sunflower		Steele Grace		Steele Bayou	
Year	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres
1978	84.8	61.7	80.7	33.6	80.7	35.7	82.6	475.4	87.1	223.5	80.0	612.9
1979	96.3	361.7	95.0	196.6	93.5	4,536.2	92.1	8,969.5	91.5	203.9	91.6	6,010.3
1980	93.8	258.3	91.8	93.6	90.5	889.4	85.2	2,412.1	90.4	123.2	80.7	1,547.6
1981	83.6	52.2	75.6	0.9	70.0	0.0	69.4	0.0	86.2	114.0	68.8	0.0
1982	84.5	59.5	81.3	39.2	80.8	35.1	79.9	276.6	86.7	188.8	78.6	414.3
1983	91.3	175.7	91.0	79.8	89.9	665.7	87.4	7,779.7	90.1	90.2	86.8	5,180.0
1984	92.0	187.0	90.9	76.8	89.9	665.7	89.1	13,525.0	90.6	86.2	89.1	4,968.9
1985	85.9	85.8	85.7	56.8	85.7	88.3	85.2	2,412.1	86.0	84.1	85.1	4,755.1
1986	83.3	49.4	74.5	0.0	72.1	0.0	71.0	0.0	85.8	97.8	70.2	0.0
1987	85.6	78.2	79.9	19.9	78.8	59.7	77.0	497.3	86.8	203.8	76.1	679.7
1988	84.0	55.8	75.2	0.9	73.8	0.0	72.1	0.0	86.2	114.0	70.7	0.0
1989	89.3	135.4	87.6	56.4	86.1	99.7	85.0	1,833.8	87.6	172.6	83.9	3,662.9
1990	87.4	105.7	86.5	57.6	85.5	83.8	84.9	1,761.4	86.8	203.8	84.7	4,403.2
1991	100.2	636.7	96.6	599.6	93.5	4,536.2	89.8	15,203.9	90.0	79.2	87.9	6,098.6
1992	84.2	57.3	75.3	0.9	73.6	0.0	72.5	0.0	86.2	114.0	71.6	0.0
1993	91.5	178.9	91.3	85.1	90.9	1,032.4	89.6	14,724.2	91.0	189.3	89.2	5,051.9
1994	91.3	175.7	90.9	76.8	90.8	996.7	90.3	15,117.4	90.6	145.2	90.2	6,088.9
1995	85.1	65.7	83.4	40.4	83.0	44.9	81.8	274.3	87.5	182.8	80.2	880.0
1996	84.2	57.3	81.9	39.3	79.1	51.2	77.7	317.6	86.3	129.0	76.7	600.2
1997	93.2	233.9	92.8	128.7	91.6	2,253.8	89.0	13,285.1	91.0	189.3	88.2	5,946.4
1998	88.4	124.2	87.8	56.8	86.4	113.9	85.3	2,701.3	87.2	152.2	85.2	4,845.9
1999	85.4	73.2	83.8	39.3	82.2	40.8	80.5	230.2	86.5	158.9	79.7	552.1
2000	85.3	70.7	78.5	18.2	75.9	31.1	73.2	0.0	86.3	129.0	70.4	0.0
2001	84.2	57.3	78.2	21.2	77.0	0.0	75.3	86.6	86.5	158.9	74.6	0.0
2002	88.8	128.3	87.8	56.3	87.4	143.8	85.0	1,833.8	86.8	203.8	84.8	4,490.3
2003	86.9	95.3	83.6	39.9	80.3	37.9	77.8	292.0	86.6	173.9	76.2	666.5
2004	84.5	75.7	79.7	18.5	79.0	52.5	76.8	417.4	86.2	114.0	75.1	744.5

2005	84.4	58.8	76.3	0.0	74.2	0.0	73.9	0.0	86.4	143.9	73.6	0.0
2006	84.7	61.0	75.4	0.9	73.3	0.0	71.5	0.0	86.4	143.9	70.5	0.0
2007	83.6	52.2	76.7	0.0	76.6	0.0	76.4	257.8	86.0	84.1	76.4	636.9
2008	91.4	177.3	91.2	83.4	91.2	1,463.4	90.4	14,928.6	90.8	167.2	90.2	6,088.9
2009	87.5	108.1	85.1	50.8	84.7	69.1	84.1	1,182.1	86.6	173.9	84.0	3,793.8
2010	84.1	56.6	81.9	39.3	81.1	34.6	80.4	240.1	86.3	129.0	80.2	880.0
2011	86.9	95.3	86.4	245.4	86.4	113.9	86.0	4,725.3	87.0	233.7	85.9	5,481.0
2012	83.8	54.0	74.4	0.0	72.3	0.0	71.6	0.0	86.1	99.0	71.2	0.0
2013	91.7	182.2	87.5	56.3	86.2	104.4	83.3	748.6	87.9	142.1	82.7	2,409.2
2014	85.1	65.7	79.4	16.3	79.4	47.3	78.2	242.1	86.5	158.9	77.8	448.3
2015	91.4	177.3	89.4	51.4	88.6	214.5	87.2	6,813.6	88.4	117.8	86.4	5,375.9
2016	87.9	117.7	86.5	57.6	86.0	95.0	85.5	3,279.6	87.2	213.4	83.7	3,401.1
2017	84.4	58.8	82.5	40.5	82.1	40.3	80.7	210.3	86.5	158.9	80.7	1,547.6
2018	95.9	317.2	94.3	156.4	93.3	4,507.9	92.1	8,969.5	92.1	212.7	91.4	6,533.6
2019	100.4	652.6	98.3	1,133.2	97.6	2,508.6	97.1	1,910.3	97.4	1,385.7	96.3	5,216.8
Average	**88.1**	**141.2**	**84.6**	**92.0**	**83.4**	**611.8**	**82.0**	**3522.3**	**87.9**	**180.7**	**81.1**	**2,619.4**

Table 5. Elevation and acreage inundated less than 12 inches in depth during March-May that represents brood-rearing habitats in forested habitats for the Proposed Plan within the six HUCs of the Yazoo Study Area. Hydrologic data for elevation and brood-rearing acres provided by MVK.

	Callao		Anguilla		Holly Bluff		Little Sunflower		Steele Grace		Steele Bayou	
Year	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres
1978	84.8	7.7	80.7	33.6	80.7	35.7	82.6	475.4	87.1	223.5	80.0	612.9
1979	95.5	32.4	93.9	138.9	91.4	1858.6	89.0	13,285.1	90.8	167.2	88.7	5,283.6
1980	93.1	38.9	91.0	79.8	89.4	440.4	84.8	1,689.0	89.7	84.4	80.7	1,547.6
1981	83.6	7.8	74.9	0.0	69.4	0.0	69.4	0.0	86.0	84.1	68.8	0.0
1982	84.1	8.9	80.8	35.4	80.0	39.6	79.9	276.6	86.2	114.0	78.6	413.3
1983	90.1	17.6	89.0	52.7	87.9	145.5	87.0	5,847.5	88.7	107.3	86.6	5,277.9
1984	90.1	17.6	88.7	54.0	88.1	157.3	87.1	6,330.6	88.8	103.8	87.1	5,195.0
1985	85.7	19.8	84.7	46.5	85.0	72.7	85.2	2,412.1	85.6	111.5	84.9	4,577.3
1986	83.3	6.8	74.2	0.0	71.7	0.0	71.0	0.0	85.7	104.6	70.2	0.0
1987	85.5	16.2	79.2	14.8	78.0	88.7	76.9	457.3	86.4	143.9	76.0	693.0
1988	84.0	9.1	75.2	0.9	73.8	0.0	72.1	0.0	86.2	114.0	70.7	0.0
1989	88.4	18.5	87.1	55.6	85.9	92.7	84.8	1,689.0	87.4	193.0	83.8	3,532.0
1990	87.4	14.3	86.3	58.5	85.3	79.4	84.9	1,761.4	86.7	188.8	84.6	4,316.1
1991	100.2	72.1	96.5	559.2	93.2	4,493.7	89.0	13,285.1	89.4	89.7	87.3	5,420.9
1992	84.2	9.8	75.2	0.9	73.4	0.0	72.5	0.0	86.2	114.0	71.6	0.0
1993	89.5	13.6	88.5	54.9	88.0	145.9	87.1	6,330.6	88.3	121.3	87.0	5,082.1
1994	89.0	10.2	88.2	56.3	87.8	145.2	87.1	6,330.6	88.1	128.4	87.0	5,082.1
1995	85.1	9.1	83.4	40.4	82.9	44.4	81.8	274.3	87.1	223.5	80.1	746.4
1996	84.2	8.8	81.8	39.3	78.9	59.7	77.6	343.3	86.2	114.0	76.7	600.2
1997	90.8	22.2	89.7	50.4	88.8	237.3	87.0	5,847.5	89.5	88.0	87.0	5,082.1
1998	87.0	7.8	86.4	58.0	86.1	99.7	85.3	2,701.3	86.5	158.9	85.2	4,845.9
1999	85.3	12.7	83.8	39.3	81.9	39.2	80.5	230.2	86.5	158.9	79.7	552.1
2000	85.3	12.7	78.4	19.2	75.8	31.1	73.2	0.0	86.2	114.0	70.4	0.0
2001	84.2	9.8	78.2	21.2	76.9	0.0	75.3	86.6	86.5	158.9	74.5	0.0
2002	88.6	15.7	87.2	55.7	86.6	123.4	84.9	1,761.4	86.5	158.9	84.6	4,316.1
2003	86.8	11.3	83.4	40.4	80.2	38.5	77.7	317.6	86.5	158.9	76.2	666.5
2004	84.5	8.2	79.6	17.7	78.9	56.1	76.8	417.4	86.2	114.0	75.1	744.5

2005	84.4	8.4	76.2	0.0	74.1	0.0	73.9	0.0	86.4	143.9	73.6	0.0
2006	84.7	7.9	75.3	0.9	73.2	0.0	71.5	0.0	86.3	129.0	70.5	0.0
2007	83.6	7.8	76.7	0.0	76.5	0.0	76.4	257.8	85.9	90.9	76.4	639.9
2008	89.7	14.9	88.5	54.9	88.1	157.3	87.2	6,813.6	87.7	162.4	87.0	5,082.1
2009	87.4	14.3	84.6	45.4	84.3	64.2	84.1	1,182.1	86.3	129.0	84.0	3,793.8
2010	84.0	9.1	81.5	39.3	80.6	36.2	80.4	240.1	86.1	99.0	80.2	880.0
2011	86.9	9.5	86.3	58.5	86.1	99.7	86.0	4,725.3	86.2	114.0	85.9	5,481.0
2012	83.8	8.5	74.2	0.0	72.0	0.0	71.6	0.0	86.0	84.1	71.2	0.0
2013	90.6	20.9	87.5	56.3	86.2	104.4	83.3	748.6	87.5	182.8	82.7	2,409.2
2014	85.0	7.3	79.1	14.1	79.0	52.5	78.1	241.4	86.2	114.0	77.8	448.3
2015	90.5	20.2	88.0	57.2	87.2	143.0	86.4	5,174.2	87.2	213.4	85.7	5,299.6
2016	87.7	19.1	86.2	58.9	85.7	88.3	85.3	2,701.3	86.9	218.8	83.3	2,877.6
2017	84.4	8.4	82.4	40.3	81.9	39.2	80.7	210.3	86.2	114.0	80.7	1,547.6
2018	94.6	34.2	93.0	136.5	92.1	3,186.4	90.9	13,984.9	91.4	201.0	89.8	5,550.1
2019	99.3	81.5	96.4	519.5	94.8	4,710.9	93.8	6,932.0	95.0	189.0	93.2	4,748.3
Average	**87.5**	**16.9**	**83.9**	**64.4**	**82.6**	**409.7**	**81.4**	**2,746.7**	**87.3**	**138.7**	**80.6**	**2,460.6**

Table 6. The difference in elevation and acreage inundated less than 12 inches in depth during March-May that represents brood-rearing habitats in forested habitats between the No Action Alternative and the Proposed Plan within the six HUCs of the Yazoo Study Area. Hydrologic data for elevation and brood-rearing acres provided by MVK.

	Callao		Anguilla		Holly Bluff		Little Sunflower		Steele Grace		Steele Bayou	
Year	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres	Elevation	Acres
1978	0.0	-54.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1979	-0.8	-329.3	-1.1	-57.7	-2.0	-2,677.6	-3.0	4,315.6	-0.6	-36.7	-2.9	-726.7
1980	-0.6	-219.4	-0.8	-13.8	-1.0	-449.0	-0.4	-723.1	-0.8	-38.8	0.0	0.0
1981	-0.1	-44.4	-0.7	-0.9	-0.6	0.0	0.0	0.0	-0.1	-29.9	0.0	0.0
1982	-0.4	-50.6	-0.5	-3.8	-0.8	4.5	0.0	0.0	-0.5	-74.8	0.0	-1.0
1983	-1.2	-158.1	-2.0	-27.1	-2.0	-520.2	-0.3	-1,932.2	-1.3	17.1	-0.2	97.9
1984	-2.0	-169.4	-2.3	-22.8	-1.8	-508.4	-2.0	-7,194.4	-1.7	17.6	-2.0	226.1
1985	-0.3	-66.0	-0.9	-10.3	-0.7	-15.6	0.0	0.0	-0.4	27.4	-0.2	-177.8
1986	0.0	-42.6	-0.3	0.0	-0.5	0.0	0.0	0.0	0.0	6.8	0.0	0.0
1987	-0.1	-62.0	-0.7	-5.1	-0.7	29.0	0.0	-40.0	-0.3	-59.9	0.0	13.3
1988	0.0	-46.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	-0.8	-116.9	-0.5	-0.8	-0.2	-7.0	-0.2	-144.8	-0.2	20.4	-0.2	-130.9
1990	0.0	-91.4	-0.1	0.9	-0.1	-4.4	0.0	0.0	-0.1	-15.0	0.0	-87.1
1991	0.0	-564.6	-0.1	-40.4	-0.4	-42.5	-0.7	-1,918.8	-0.6	10.5	-0.6	-677.7
1992	0.0	-47.5	-0.1	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	-2.0	-165.3	-2.8	-30.2	-2.9	-886.5	-2.4	-8,393.6	-2.7	-68.0	-2.2	30.2
1994	-2.3	-165.5	-2.7	-20.5	-3.0	-851.5	-3.2	-8,786.8	-2.5	-16.8	-3.2	-1,006.8
1995	-0.1	-56.6	-0.1	0.0	-0.1	-0.5	0.0	0.0	-0.4	40.7	-0.1	-133.6
1996	0.0	-48.5	-0.1	0.0	-0.3	8.5	0.0	25.7	-0.1	-15.0	0.0	0.0
1997	-2.4	-211.7	-3.1	-78.3	-2.8	-2,016.5	-2.0	-7,437.6	-1.5	-101.3	-1.2	-864.3
1998	-1.4	-116.4	-1.4	1.2	-0.2	-14.2	0.0	0.0	-0.7	6.7	0.0	0.0
1999	-0.1	-60.5	0.0	0.0	-0.3	-1.6	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	-58.0	0.0	1.0	-0.1	0.0	0.0	0.0	-0.1	-15.0	0.0	0.0
2001	0.0	-47.5	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	-0.2	-112.6	-0.6	-0.6	-0.8	-20.4	-0.1	-72.4	-0.3	-44.9	-0.2	-174.2
2003	-0.1	-84.0	-0.1	0.5	-0.1	0.6	0.0	25.6	0.0	-15.0	0.0	0.0

2004	0.0	-67.5	-0.1	-0.8	-0.1	3.6	0.0	0.0	0.0	0.0	0.0	0.0
2005	0.0	-50.4	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2006	0.0	-53.1	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	-14.9	0.0	0.0
2007	0.0	-44.4	-0.1	0.0	-0.1	0.0	0.0	0.0	0.0	6.8	0.0	3.0
2008	-1.7	-162.4	-2.7	-28.5	-3.2	-1,306.1	-3.3	-8,115.0	-3.1	-4.8	-3.2	-1,006.8
2009	-0.1	-93.8	-0.5	-5.4	-0.4	-4.9	0.0	0.0	-0.3	-44.9	0.0	0.0
2010	-0.1	-47.5	-0.3	0.0	-0.5	1.6	0.0	0.0	-0.2	-30.0	0.0	0.0
2011	-0.1	-85.8	-0.1	-186.9	-0.2	-14.2	0.0	0.0	-0.8	-119.7	0.0	0.0
2012	0.0	-45.5	-0.1	0.0	-0.3	0.0	0.0	0.0	-0.1	-14.9	0.0	0.0
2013	-1.1	-161.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	40.7	0.0	0.0
2014	-0.1	-58.4	-0.3	-2.2	-0.4	5.2	-0.1	-0.7	-0.3	-44.9	0.0	0.0
2015	-0.9	-157.1	-1.3	5.8	-1.4	-71.5	-0.8	-1,639.4	-1.2	95.6	-0.7	-76.3
2016	-0.2	-98.6	-0.3	1.3	-0.3	-6.7	-0.1	-578.3	-0.3	5.4	-0.3	-523.5
2017	-0.1	-50.4	-0.1	-0.2	-0.2	-1.1	0.0	0.0	-0.3	-44.9	0.0	0.0
2018	-1.3	-283.0	-1.3	-19.9	-1.1	-1,321.5	-1.2	5,015.4	-0.7	-11.7	-1.6	-983.5
2019	-1.1	-571.1	-1.9	-613.7	-2.8	2,202.3	-3.3	5,021.7	-2.4	-1,196.7	-3.0	-468.5
Average	**-0.5**	**-124.3**	**-0.7**	**-27.6**	**-0.8**	**-202.1**	**-0.6**	**-775.6**	**-0.6**	**-42.0**	**-0.5**	**-158.8**

Table 7. The 30 day duration average elevation during the Wood Duck nesting and early rearing life stages (1 Feb to 31 May) that includes the beginning and end dates for the continuous period of inundation for the two HUCs containing the majority of Wood Duck habitat within the Yazoo Study Area. Hydrologic data for 30-day duration with start and end dates provided by MVK.

Steele Bayou					Little Sunflower				
	No Action Alternative		Action Alternative			No Action Alternative		Action Alternative	
Elevation	Window Start	Window Stop	Window Start	Window Stop	Elevation	Window Start	Window Stop	Window Start	Window Stop
79.2	27-Mar-78	26-Apr-78	27-Mar-78	26-Apr-78	97.0	17-Mar-19	16-Apr-19	25-Apr-19	25-May-19
91.4	16-Apr-79	16-May-79	19-Apr-79	19-May-79	94.7	18-Apr-79	18-May-79	21-Apr-79	21-May-79
87.3	2-Apr-80	2-May-80	1-Apr-80	1-May-80	92.7	9-Mar-18	8-Apr-18	7-Mar-18	6-Apr-18
67.6	6-Apr-81	6-May-81	6-Apr-81	6-May-81	91.9	19-Mar-97	18-Apr-97	29-Apr-91	29-May-91
79.2	9-Feb-82	11-Mar-82	9-Feb-82	11-Mar-82	91.0	25-Apr-08	25-May-08	2-Apr-80	2-May-80
87.0	2-May-83	1-Jun-83	17-Apr-83	17-May-83	91.0	29-Apr-91	29-May-91	9-Mar-97	8-Apr-97
87.1	19-Apr-84	19-May-84	7-Apr-84	7-May-84	90.8	19-Apr-93	19-May-93	12-Mar-16	11-Apr-16
84.9	5-Mar-85	4-Apr-85	4-Mar-85	3-Apr-85	90.2	18-Apr-94	18-May-94	16-Feb-90	18-Mar-90
69.7	15-Mar-86	14-Apr-86	15-Mar-86	14-Apr-86	90.2	30-Apr-83	30-May-83	4-Mar-94	3-Apr-94
76.9	1-Mar-87	31-Mar-87	1-Mar-87	31-Mar-87	89.7	3-Apr-80	3-May-80	10-Apr-93	10-May-93
71.1	1-Feb-88	2-Mar-88	1-Feb-88	2-Mar-88	89.3	20-Apr-84	20-May-84	20-Apr-84	20-May-84
85.2	24-Feb-89	26-Mar-89	23-Feb-89	25-Mar-89	89.0	2-May-11	1-Jun-11	4-Apr-08	4-May-08
85.3	20-Feb-90	22-Mar-90	20-Feb-90	22-Mar-90	89.0	12-Mar-16	11-Apr-16	15-Apr-83	15-May-83
87.9	23-Apr-91	23-May-91	23-Apr-91	23-May-91	88.3	18-Feb-90	20-Mar-90	25-Apr-11	25-May-11
73.1	12-Mar-92	11-Apr-92	12-Mar-92	11-Apr-92	86.9	25-Feb-89	27-Mar-89	2-May-13	1-Jun-13
87.2	21-Apr-93	21-May-93	9-Apr-93	9-May-93	86.8	2-May-13	1-Jun-13	23-Feb-89	25-Mar-89
87.3	21-Apr-94	21-May-94	28-Feb-94	30-Mar-94	86.7	29-Apr-98	29-May-98	16-Mar-15	15-Apr-15
79.9	25-Apr-95	25-May-95	25-Apr-95	25-May-95	86.1	17-Mar-15	16-Apr-15	28-Apr-98	28-May-98
80.6	2-May-96	1-Jun-96	2-May-96	1-Jun-96	85.4	6-Mar-85	5-Apr-85	6-Mar-85	5-Apr-85
89.0	17-Mar-97	16-Apr-97	9-Mar-97	8-Apr-97	84.0	14-Apr-09	14-May-09	14-Apr-09	14-May-09
85.7	28-Apr-98	28-May-98	27-Apr-98	27-May-98	83.9	2-May-17	1-Jun-17	2-May-17	1-Jun-17
79.4	29-Apr-99	29-May-99	29-Apr-99	29-May-99	83.5	26-Mar-02	25-Apr-02	25-Mar-02	24-Apr-02
69.9	24-Mar-00	23-Apr-00	24-Mar-00	23-Apr-00	83.1	21-Feb-01	23-Mar-01	21-Feb-01	23-Mar-01
80.7	20-Feb-01	22-Mar-01	20-Feb-01	22-Mar-01	81.3	30-Apr-96	30-May-96	30-Apr-96	30-May-96
81.9	25-Mar-02	24-Apr-02	2-May-02	1-Jun-02	80.7	1-Feb-05	3-Mar-05	1-Feb-05	3-Mar-05

76.5	22-Feb-03	24-Mar-03	22-Feb-03	24-Mar-03	80.4	23-Apr-95	23-May-95	23-Apr-95	23-May-95
72.4	5-Mar-04	4-Apr-04	5-Mar-04	4-Apr-04	80.3	1-Mar-87	31-Mar-87	1-Mar-87	31-Mar-87
80.5	1-Feb-05	3-Mar-05	1-Feb-05	3-Mar-05	80.2	1-Feb-99	3-Mar-99	1-Feb-99	3-Mar-99
69.9	17-Apr-06	17-May-06	17-Apr-06	17-May-06	80.1	1-Feb-10	3-Mar-10	1-Feb-10	3-Mar-10
76.4	14-Apr-07	14-May-07	14-Apr-07	14-May-07	79.4	24-Mar-82	23-Apr-82	24-Mar-82	23-Apr-82
87.1	14-Apr-08	14-May-08	3-Apr-08	3-May-08	77.7	22-Feb-03	24-Mar-03	22-Feb-03	24-Mar-03
83.9	14-Apr-09	14-May-09	14-Apr-09	14-May-09	77.5	2-May-78	1-Jun-78	2-May-78	1-Jun-78
79.4	1-Feb-10	3-Mar-10	1-Feb-10	3-Mar-10	76.4	15-Apr-07	15-May-07	15-Apr-07	15-May-07
87.0	2-May-11	1-Jun-11	25-Apr-11	25-May-11	76.2	7-Apr-14	7-May-14	11-Mar-12	10-Apr-12
74.6	11-Mar-12	10-Apr-12	11-Mar-12	10-Apr-12	76.2	11-Mar-12	10-Apr-12	7-Apr-14	7-May-14
87.0	2-May-13	1-Jun-13	2-May-13	1-Jun-13	75.7	6-Feb-04	7-Mar-04	6-Feb-04	7-Mar-04
74.9	7-Apr-14	7-May-14	7-Apr-14	7-May-14	74.5	11-Mar-92	10-Apr-92	11-Mar-92	10-Apr-92
85.1	17-Mar-15	16-Apr-15	17-Mar-15	16-Apr-15	73.3	19-Mar-00	18-Apr-00	19-Mar-00	18-Apr-00
85.6	9-Mar-16	8-Apr-16	6-Mar-16	5-Apr-16	71.5	1-Feb-88	2-Mar-88	1-Feb-88	2-Mar-88
83.9	2-May-17	1-Jun-17	2-May-17	1-Jun-17	70.2	1-Feb-06	3-Mar-06	1-Feb-06	3-Mar-06
89.4	7-Mar-18	6-Apr-18	4-Mar-18	3-Apr-18	69.8	15-Mar-86	14-Apr-86	15-Mar-86	14-Apr-86
93.8	10-Mar-19	9-Apr-19	2-May-19	1-Jun-19	68.1	10-Feb-81	12-Mar-81	10-Feb-81	12-Mar-81

Table 8. From Wakeley (2006), "Estimated Benefits Of Establishment Of Bottomland Hardwood Forest Under Various Management Plans."

Management Plan[a]	Increase in Average Annual Habitat Units (AAHU) per 100 Acres						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
				Natural Succession			
MP 1	34.35	25.95	46.8	27.00	0.00	0.00	134.1
MP 2	34.35	25.95	46.8	27.00	62.7	44.55	241.35
MP 3	34.35	25.95	46.8	27.00	62.7	55.65	252.45
				Reforestation with Hard-Mast Trees			
MP 4	34.35	47.85	46.8	27.00	0.00	0.00	156.00
MP 5	34.35	47.85	46.8	27.00	62.7	44.55	263.25
MP 6	34.35	47.85	46.8	27.00	62.7	55.65	274.35

[a] Mitigation Plan (MP) 1 and MP 4 assume that the mitigation site floods less than 25% of the year, and is not located within 328 ft of a lake or stream that contains water more than 25% of the year. Thus, habitat benefits accrue only to the generalist species.

MP 2 and MP 5 apply to sites entirely within 328 ft of a lake or stream that contains water for 6 months per year, or the site is forested wetland flooded for 6 months per year. The site is shallowly flooded during the March-to-May wood duck brood-rearing period, abundant over-water brood cover is present, and well-maintained nest boxes are provided. If adjacent to a stream or lake, the streambank or shoreline is well vegetated providing ample cover for foraging mink.

MP 3 and MP 6 apply to sites entirely within 328 ft of a lake or stream that contains surface water >9 months per year, or the site is forested wetland shallowly flooded >9 months per year. Other requirements given under MP 2 and MP 5 apply.

Table 9. Habitat Suitability Index scores assigned for each target species selected to represent forest characteristics and species guild in BLH with scores assigned to individual sampled area or project feature.

Project Feature	Habitat Suitability Index					
	Carolina Chickadee	Barred Owl	Pileated Woodpecker	Gray Squirrel	Wood Duck	Mink
Pump Site	0.57	0.77	0.00	0.60	0.21	0.42
Borrow Area	0.33	0.51	0.24	0.23	0.20	0.55
Average HSI for Yazoo Study Area	0.70	0.79	0.34	0.31	0.74	0.67

Table 10. The overall loss of AAHU's as a result of the construction activities with project features for each target species. Mitigation acres to reforest the loss of BLH are calculated for six mitigation plans (MP). All values express a loss of AAHU's.

		Loss of AAHU from Impacts to Forested Habitat							Acres Needed for Mitigation Under Various Reforestation Plans					
Project Features	Forested Acres	CACH AAHU	BADO AAHU	PIWO AAHU	GRSQ AAHU	WODU AAHU	Mink AAHU	Total Combined Species AAHU	MP 1	MP 2	MP 3	MP 4	MP 5	MP 6
Borrow Area	14.3	4.7	7.3	3.4	3.3	3.2	6.0	27.8	20.7	11.5	11.0	17.8	10.6	10.1
Pump Station	89.6	51.4	69.2	0.0	54.1	20.9	20.8	216.3	161.3	89.6	85.7	138.7	82.2	78.8
Access Road	0.4	0.3	0.3	0.1	0.1	0.3	0.1	1.2	0.9	0.5	0.5	0.8	0.5	0.5
Well Area	7.5	5.3	5.9	2.6	2.3	5.7	0.5	22.2	16.6	9.2	8.8	14.2	8.4	8.1
Total	111.7	61.6	82.7	6.1	59.9	30.1	27.3	267.6	199.5	110.9	106.0	171.5	101.6	97.5

Figures

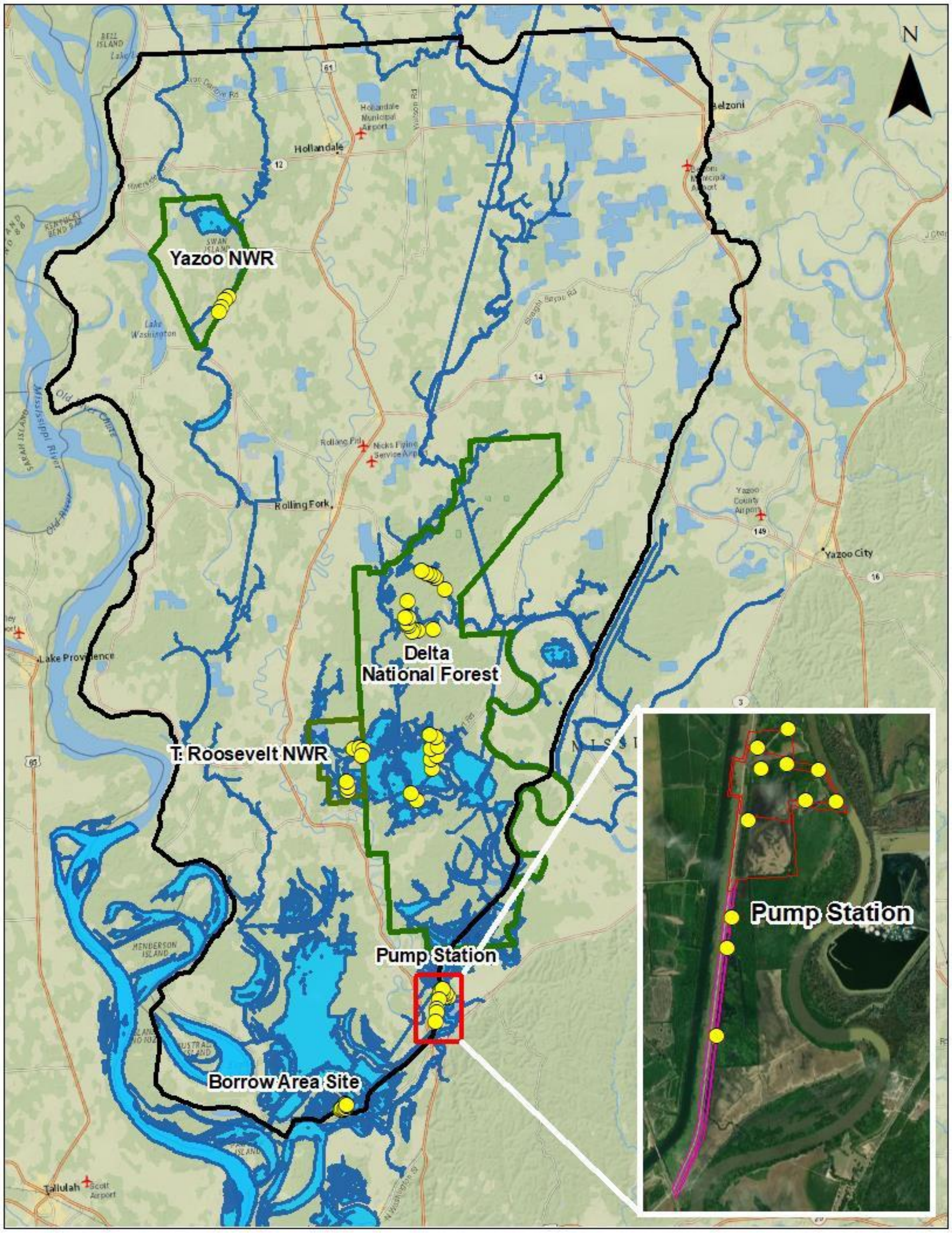

Figure 1. The locations 53 HSI plots conducted for the HEP analysis within the Yazoo Study Area during July 2020.

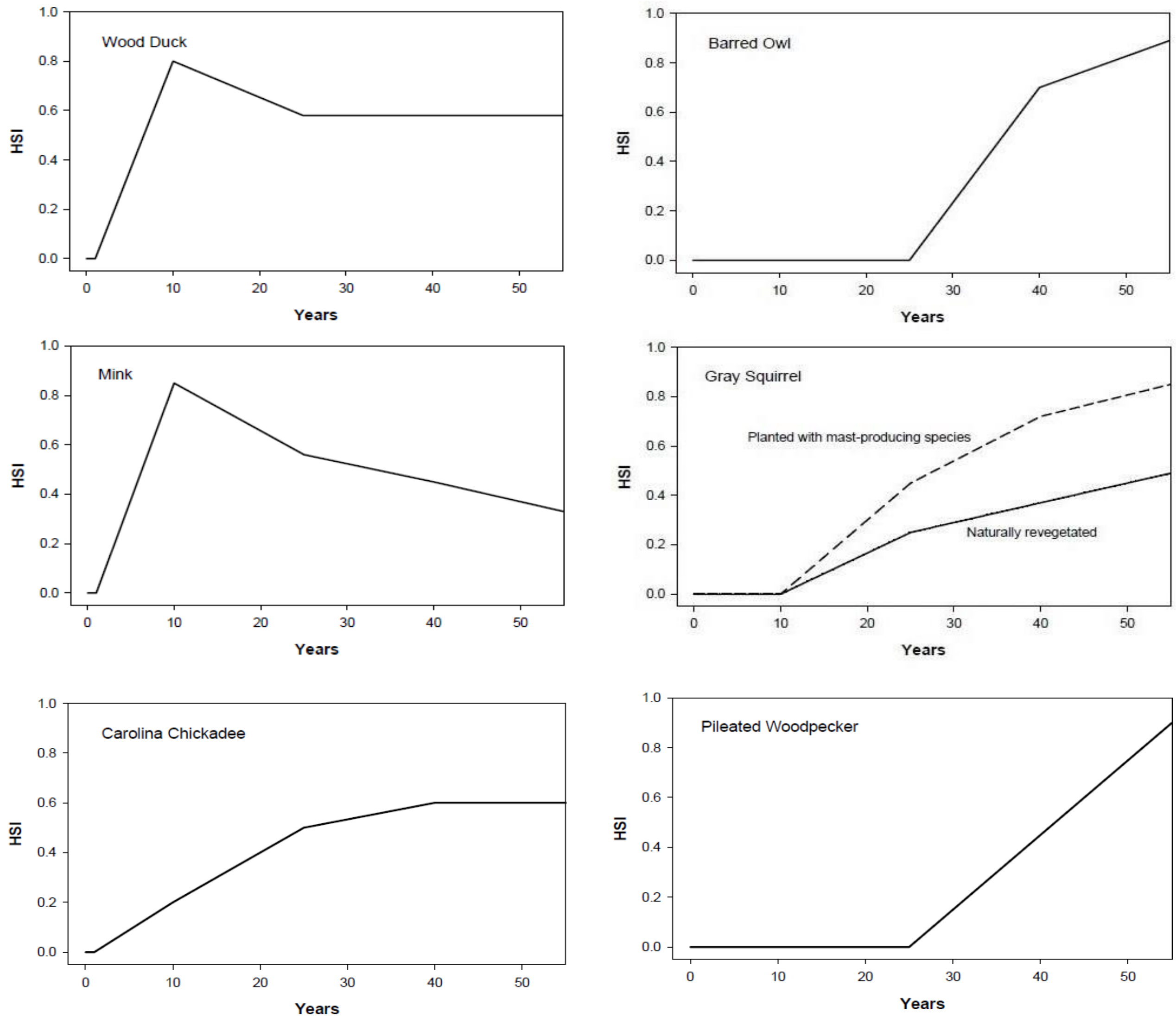

Figure 2. Models of habitat development for Wood Duck (upper-left), Barred Owl (upper-right), Mink (middle-left), Gray Squirrel (middle-right), Carolina Chickadee (lower-left) and Pileated Woodpecker (lower-right) following reforestation of existing cleared land (Wakeley and Marchi 1991).

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