Mississippi Valley Division,
Regional Planning and Environment Division South

Yazoo Backwater Area Water Management Project

APPENDIX F-5 - Waterfowl

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APPENDIX D

WATERFOWL

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ABSTRACT

Construction and implementation of the pump station for the 2024 Yazoo Backwater Area Pump Project Final Environmental Impact Statement (FEIS), hereinafter referred to as the 2024 FEIS of the Yazoo Basin, Yazoo Backwater, Mississippi, Project will result in changes to available wintering waterfowl habitat within the Mississippi Alluvial Valley (MAV). To determine the impacts of the Water Management Plan, an index for determining the number of days a single individual duck could be supported based on the food resources available in that area is calculated. This index is referred to as a duck-use- day (DUD) and it requires knowledge of the current land use and winter food availability within an area, hydrologic data, energy of food items, deterioration rates of food items, and the energy requirements of waterfowl.

The Water Management Plan incorporates both a No Action and two Action Alternatives according to the implementation of a 25,000 cubic feet per second pump station that is operational once water levels reach 93 feet NGVD during the non-crop season (Oct 15-March 25/15). The No Action, Action Alternative 1 (Alt 1; crop season March 25-October 15), and Action Alternative 2 (Alt 2; March 15-October 15) will result in an average of 6,571,178 DUD, 6,374,530 DUD, and 6,368,380 DUD, respectively, during the annual winter waterfowl period. A reduction in flooded area will result from the operation of the pump station which will result in a decrease in annual DUDs by 196,648 for Alt 1 and 202,798 for Alt 2 on average. Forested habitats will be the primary habitat impacted by changes in hydrology between the alternatives; however, all habitat types will experience some level of reduced flooding at desirable waterfowl feeding depths (i.e. ≤ 18 inches).

The potential for creating moist-soil management units using structural means or green-tree reservoirs along with enhancing bottomland hardwood forests (BLH) will more than offset the loss of foraging habitat to wintering waterfowl in the Yazoo Basin with proper mitigation to compensate for the loss of DUD under the Water Management Plan. Long-term impacts to wintering waterfowl are likely to be improved by incorporating mitigation recommendations from this report in addition to following guidelines from the Lower Mississippi Valley Joint Venture.

Improved forest management will not only benefit waterfowl during the winter period, but also greatly improve habitat conditions year-round for the majority of wildlife species that inhabit BLH.

TABLE OF CONTENTS

INTRODUCTION

Construction and implementation of the 25,000 cubic feet per second (cfs) pump station, as part of the Water Management Plan, within the Yazoo Backwater Area (YBA) will result in changes to available wintering waterfowl habitat within the Mississippi Alluvial Valley (MAV). To determine the impacts of the pump operation, a standard practice is to conduct a landscape analysis that provides an index of how many waterfowl an area can support according to food resources that are present within a particular habitat. This index refers to the number of duck-use-days (DUDs) or simply the number of days a single individual duck could be supported based on the food resources available in that area. The most basic representation for a DUD is the formula:

$$Species_{1...m}DUD = \frac{\sum(F_{1..j})(T_{1...l})}{D_{1...m}}$$

Where,

F = the potential food yield (g/ha) for food types $_{i...j}$ in the habitat type $_{1...k}$

T = TME[1] (kcal/g) of specific food types $_{1...l}$

D = DEE[2] of Species $_{1...m}$ in kcal/day and is 4x RMR

RMR[3] = $100.7W^{0.74}$

And, W = weighted body mass of species $_{1...m}$ in kg

True metabolizable energy (TME) is the amount of energy available to waterfowl from their diet

[2] Daily existence energy (DEE) is the number of kilocalories (kcal) an individual duck needs for one day

[3] Resting Metabolic Rate (RMR) accounts for conditions under which data are obtained from test animals, rather than implying a true basal rate of energy use

DUD calculations for the Yazoo Basin, Yazoo Backwater, Mississippi, Project are based on data and formulas within "A manual for calculating duck-use-days to determine habitat resource values and waterfowl population energetic requirements in the Mississippi Alluvial Valley," hereafter referred to as DUD manual (Heitmeyer 2010). This method has been used on U.S. Army Corps of Engineers (USACE) flood control projects to quantify the impact of altering hydrology on traditional waterfowl wintering areas and for designing appropriate mitigation measures (Heitmeyer et al. 2011; USACE 2013, 2020). The model for calculating DUD has been certified by USACE.

By converting to DUDs, units are comparable across habitat types which facilitates both mitigation efforts and management decisions. This is particularly useful when the loss of one habitat must be mitigated with another habitat type due to practical constraints or the need to meet multiple ecosystem management goals. DUDs provide an objective index of the relative value of different habitats for dabbling ducks as winter foraging habitats.

Historical Perspective

Historically, the MAV was composed of mostly bottomland hardwood forests (BLH), swamps, and bayous, including the largest forested wetland in North America (25 million acres) extending approximately from southeastern Missouri to southern Louisiana. Conversion of forest to agricultural land has resulted in over 80 percent of the forest in this region cleared. Historically, most of the MAV was subject to periodic flooding by the Mississippi River and its tributaries; however, following the Flood Control Act of 1941, hydrologic relationships in the MAV were altered by federally funded water resource developments for flood control (Reinecke et al. 1988, King et al. 2006, Remo et al. 2018). The construction of 1,500 miles of mainline levees along both banks of the Mississippi River under the Mississippi River and Tributaries (MR&T) Project, enabled thousands of acres of BLH to be cleared for agricultural production. The most productive agriculture lands within the Yazoo Basin were those that generally were higher in elevation with well-drained soils.

Following the completion of interior flood control projects within the MAV, the period from 1950 through the 1970's saw the expansion of agriculture into the lower, wetter, flood prone land. During this time period, approximately 3.5 million acres of wooded wetlands were converted to agriculture production (MacDonald et al. 1979, Oswalt 2013). The futility of farming marginal, floodprone land was made evident during the devastating floods that occurred from 1973 through 1993, despite the occasional periods of drought. As the result of this extended period of flooding, Congress enacted legislation to protect and restore wetlands (marginal, flood prone agricultural land brought into production during the period from 1950-1970): the 1985 Farm Bill, the Emergency Wetlands Protection Act of 1986, the Water Resources Development Act of 1986, the Agriculture Credit Act of 1987, the Conservation Reserve Program, the 1990 Farm Bill, the Food Security Act of 1992, the Wetlands Reserve Program (WRP), and the Federal Agriculture Improvement and Reform Act of 1996. For example, under the provisions of WRP, the federal government pays land owners fair market value for marginal cropland (farmed wetlands) and assists in replanting these areas in bottomland hardwood species. Today, the trend of Federal policy is decidedly favorable toward (1) wetland restoration that will benefit waterfowl and other wildlife dependent on wetland habitat, and (2) sound floodplain management. Both WRP and the U.S. Fish and Wildlife (USFWS) Partners for Fish and Wildlife Program have demonstrated that these federal wetland restoration programs have successfully met project goals by providing habitat to species of greatest conservation need and to other wetland associated wildlife (Benson et al. 2018).

The BLH that remain along the Mississippi River are among the nation's most important wetlands. These forested wetlands fulfill special waterfowl habitat requirements not provided by open lands. Wooded habitats produce nutritious foods for waterfowl and provide secure roosting areas, cover during inclement weather, loafing sites, protection from predators, and isolation for pair formation. Despite changes to the landscape and hydrology in the MAV, it remains a critical ecoregion for North American waterfowl and other wildlife (Kaminski 1999, Elliott et al 2020). Approximately 40 percent of the Mississippi Flyway's waterfowl and 60 percent of all U.S. bird species either migrate through or winter in the MAV (LMVJV 2015). The MAV is considered the most important wintering location for Mallard (*Anas platyrhynchos*) and Wood Duck (*Aix sponsa*) populations as well as wintering significant numbers of Green-winged Teal

(*Anas crecca*), Northern Shoveler (*Spatula clypeata*), and Gadwall (*Mareca strepera*) (LMVJV 2015).

Habitat Requirements

The loss and degradation of habitat has been identified as the major waterfowl management problem in North America (USFWS and Canadian Wildlife Service 1986). Habitat requirements for wintering waterfowl include three components: availability, utilization, and suitability in meeting social behavioral requirements. Size of the migratory waterfowl population in the MAV is a direct function of these three components. Managed and unmanaged wintering waterfowl habitats are present in the MAV. Managed habitats, using structural measures and vegetation manipulation, are primarily found on federal and state lands, and represent the core wintering habitat during dry (below normal rainfall) years. Temporary and seasonal wetlands tend to be large producers of waterfowl food supplies. Unmanaged winter habitat provides important foraging habitat to wintering waterfowl during years of normal or above normal rainfall. The increased availability of wintering habitat also affects the distribution of wintering waterfowl in the MAV (Hagy et al. 2014). Proportionately more waterfowl have been found to winter in the MAV during periods of above normal rainfall and cold winters (Nichols et al. 1983, Reinecke et al. 1987). However, unmanaged and flood susceptible habitats within the MAV, which are important to wintering waterfowl, have long been subject to federal flood control drainage projects that have altered the historic flood events.

Relationships exist between the availability of wetland habitat and food during winter, and waterfowl physiological, behavioral, and population responses (Kaminski 1999). Hydrology and resulting wetland habitat as well as intrinsic resources are critical proximate factors related to waterfowl use of alluvial environments like the MAV (Fredrickson and Heitmeyer 1988). Increased wetland availability during the winter likely improves foraging opportunities and food availability for Mallards and other waterfowl (Wright 1961, Delnicki and Reinecke 1986, Reinecke et al 1988, Wehrle et al 1995). These improved opportunities and availability are related to increased body weights in Mallards (Delnicke and Reinecke 1986), earlier prebasic molt and acquisition of basic (breeding) plumage in female Mallards (Heitmeyer 1987, Richardson and Kaminski 1992), and increased Mallard survival (Reinecke et al. 1987) and reproductive rates (Heitmeyer and Fredrickson 1981, Kaminski and Gluesing 1987).

Population Status

Within North America, several species of waterfowl, including Mallards, are showing signs of recovery approaching or exceeding the population levels recorded in the 1950's according to the USFWS Waterfowl Breeding Population and Habitat Survey which is conducted on an annual basis (USFWS 2023). Total estimated duck abundance in 2023 was 32.3 million birds, a 23% decline from the long-term average from 1955-2022 (USFWS 2023). Long-term trends generally display stable populations for Mallard, American Wigeon (*Mareca americana*), and Canvasback (*Aythya valisineria*), while Gadwalls, Green-winged Teal, Blue-winged Teal (*Spatula discors*), Northern Shoveler, and Redheads (*Aythya americana*) appear to be on an increasing population trend (Figure 1). Northern Pintails (*Anas acuta*) and Scaup (*Aythya* spp.) have yet to recover from long-term averages (Figure 1).

While the annual breeding duck surveys are the most reliable estimates of waterfowl populations, population estimates are also available from extensive surveys of wintering ducks as well as waterfowl harvest data. The midwinter waterfowl survey for the Mississippi Flyway, conducted by the USFWS and the states, is an attempt to count the total number of ducks of each species (Fronczak 2022). Total duck abundance in 2022 was 5.9 million birds, a decrease of 12 percent over the long-term average (1955-2022). However, the midwinter average population estimate for the past decade (2011-2020) was approximately 7.5 million ducks, an increase of nearly 10 percent over the long-term average (Table 1; Fronczak 2022). Caution must be taken when considering midwinter counts as these population estimates are not considered reliable for measuring trends in abundance of most duck species because of the large area which must be surveyed, and the difficulty of counting birds, especially in wooded habitats, and the lack of a valid statistical sampling scheme. However, these surveys do provide useful, general information on wintering waterfowl population levels.

The Lower Mississippi Valley Joint Venture (LMVJV) has taken the lead on establishing population and habitat objectives for most birds in the MAV. For wintering waterfowl, these objectives include targets for American Black Duck (*Anas rubripes*) (53,000), American Wigeon (288,000), Canvasback (43,000), Gadwall (430,000), Scaup (1,354,000), Green-winged Teal (476,000), Mallard (3,239,000), Northern Pintail (329,000), Northern Shoveler (89,000), Redhead (60,000), Ring-necked Duck (*Aythya collaris*) (277,000), Ruddy Duck (*Oxyura jamaicensis*) (55,000) and Wood Duck (1,622,000). Estimates for dabbling ducks in the Mississippi Flyway during 2018 were among the highest on record with approximately 6.8 million dabbling ducks; however, that number declined to 4.3 million dabbling ducks in 2022 (Fronczak 2022). Recovery of waterfowl populations can be attributed to many conservation efforts including extensive funding to restore both breeding and wintering habitat. Expansion of the USFWS National Wildlife Refuge system, creation of the duck stamp to fund wetland restoration, and large-scale participation with non-governmental organizations such as Ducks Unlimited and Delta Waterfowl have and will continue to play a key role in sustaining waterfowl populations. Legislation such as the Migratory Bird Treaty Act and North American Wetlands Conservation Act have provided critical protection for waterfowl (Anderson et al. 2018). However, habitat loss as well as factors such as climate change continue to be significant threats to wildlife populations including waterfowl (Mantyka-Pringle et al. 2012). Therefore, it remains critical to protect the resources on which waterfowl are dependent.

METHODS

The information requirements to estimate DUDs are: (1) current land use, including crop type; (2) extent, duration, and depth of flooding; (3) amount of winter food present by land use; (4) energy of food items; (5) deterioration rates of food items; and (6) energy requirements of waterfowl. To facilitate calculation, food item densities, deterioration/resource availability rates (by month), and energy values were aggregated within a given habitat type. The aggregated values for each habitat condition were formulated within a spreadsheet so that a final estimate of DUDs could be generated based on acreage.

The U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL) calculated hectares of 11 habitat categories used by wintering waterfowl within the Yazoo Study Area that flooded less than 18 inches during the period of 1 November to 28 February according to the ENVIRO-DUCK hydrological model developed by the U.S. Army Corps of Engineers, Vicksburg District (MVK). The Enviro-Duck Program calculates area by acres; however, DUDs are calculated according to hectares within the DUD manual. Therefore, ERDC-EL converted between the two units as necessary. For example, acres from the Enviro-Duck Program were converted to hectares prior to energetic calculations within the DUD manual. For ease of use within this Appendix, ERDC-EL also reports acres as it relates to mitigation requirements. Habitat categories were: 1) Corn, 2) Rice, 3) Soybeans, 4) Sorghum/Milo, 5) BLH naturally forested areas with average density of small, medium, and large trees containing 5 percent canopy gaps, 6) BLH naturally forested areas with average density of small, medium, and large trees containing 10% canopy gaps, 7) BLH naturally forested areas with average density of small, medium, and large trees containing 20+ percent canopy gaps , 8) Grassland/Seasonal Herbaceous Wetland (SHM passively unmanaged), 9) Open Water/Aquatic (OW-AQ), 10) Shrub/Scrub, and 11) Wheat. Other land cover types in the Yazoo Study Area included developed lands (e.g., roads, residences, building sites, cities) and other agricultural lands that primarily include cotton or other crops not contributing energetics to waterfowl. ERDC-EL did not analyze these latter land cover categories for DUD because they do not provide significant available waterfowl food sources (e.g., cotton, developed lands) or they do not require flooding for waterfowl use.

ERDC-EL determined food and energy values for the 11 habitat categories, by specified time period (month) from the DUD manual (Heitmeyer 2010; Table 2 and 3). These energy values were related to a daily existence energy (DEE) for a Mallard (1 Mallard DEE = 452.44 kcal/day) and divided by the number of hectares of each flooded habitat to determine the potential DUDs/hectare/specified time period (Table 2). ERDC-EL incorporated aerial winter waterfowl surveys conducted by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) in the Mississippi Delta (Figure 2) for estimating the percentage of each waterfowl species within the study area. The MDWFP's November, December, and January survey reports specified long-term averages from 2007-2022 for Mallard and "Other Dabblers" (Table 4). ERDC-EL incorporated these percentages into the DUD spreadsheet to account for multiple species of waterfowl beyond only Mallard which has been used as the sole species to represent all waterfowl in previous DUD calculations (USACE 2020). Since surveys were not conducted for waterfowl in February, ERDC-EL incorporated January estimates for this time period. The MDWFP did not separate waterfowl into individual species except for Mallard; however, MDWFP did differentiate between other waterfowl groups (i.e. dabblers vs. divers). Therefore, two categories within the DUD spreadsheet were generated, one directly related to the Mallard and the other category for "Other Dabblers". ERDC-EL generated DUDs/hectare using the same methods as the Mallard for Northern Pintail, Gadwall, American Wigeon, Wood Duck, Northern Shoveler, Green-winged Teal, and Blue-winged Teal as defined in Heitmeyer (2010). ERDC-EL averaged these duck species DUDs/ha values for each habitat to generate one set of DUDs for "Other Dabblers" that was used in the DUD spreadsheet (Table 3).

The amount of food available on a unit area was determined from tables within the DUD manual (Heitmeyer 2010). For this waterfowl section, the methodology was further refined to include information on seed deterioration rates, seed availability/abundance, and invertebrate availability/abundance that was incorporated into energetic formulas (Heitmeyer 2010; Table 5).

Waterfowl foraging habitat, regardless of food value, is only of use if available. Food availability is dependent on extent, duration, and depth of flooding. Dabbling ducks use relatively shallow water areas, 18 inches or less, for feeding. Using extensive hydrological data for the period-of- record (POR; 1978-2020), CEMVK estimated seasonal acres flooded 18 inches or less for the wintering season using the ENVIRO-DUCK model. This analysis within the model uses two types of wintering waterfowl habitat: resting and feeding. Resting habitat consists of large bodies of water with more than two feet of depth. Feeding habitat is represented by lands flooded less than or equal to 18 inches in depth, from November through February. During the winter waterfowl season the river stages are typically on a gradual rise, which provides new inundated habitat and feeding areas as the period progresses. The daily acres of feeding habitat were calculated using stage-area curves. The resting habitat is simply all areas inundated each day. The feeding habitat is calculated by finding the difference between the resting area and the aerial extent of a water surface inundated 18 inches or less.

The ENVIRO-DUCK program calculates the resting and feeding acres for each day, sums them for each year, and calculates the annual mean daily acres. The program provides two output files. The first has the daily data, with the stage, resting and feeding area for each day of the waterfowl season. The second output file provides an annual summary of the daily output. The annual summary also provides an overall mean for the study period.

The stage area curves were developed in ArcMap, using flood extents determined by a flood mapping tool (Flood Event Simulation Model, FESM). A series of flood events for elevations 75 through 108 feet, NGVD were modeled in FESM. The FESM mapping tool produces a geo-TIFF file, which is then incorporated into ArcMap. ArcMap (Spatial Analyst-zonal tabulation) was then used to determine the aerial extent of flooding for each of those events. The tabulation was imported into Microsoft Excel, and the stage-area curves were constructed in Excel. ArcMap was also used to determine the area associated with each river/stream gage location. The 12 digit Hydrologic Units (HUC-12) from the Yazoo Basin were used for these calculations (Figure 3).

The Statistical Analysis System (SAS) Procedure Univariate was used to calculate the duration. SAS calculated the 1, 5, 10, 25, 50, 75, 90, 95 and 99th percentile of the POR stage data. The data was sorted by season and the 75th percentile of the winter season was used for determining areas that typically are suitable for foraging by waterfowl in the Yazoo Study Area during the POR (Figure 4).

In order to meet the above requirements for calculating DUDs, ERDC-EL determined habitat type and associated food resources within those habitats by acquiring spatial layers of land cover within the Yazoo Study Area. ERDC-EL acquired the spatial extent of the Yazoo Study Area within a geodatabase in ArcGIS from MVK. ERDC-EL used this spatial boundary to determine land classification and features for subsequent analyses. ERDC-EL acquired the USDA National Agriculture Statistics Service (NASS) Cropscape that determines annual crop production (USDA NASS Cropland Data Layer). The Cropscape land cover provides classifications for crop production (e.g., corn, soybean, rice, cotton) as well as other general habitat types (e.g., deciduous forest, shrubland, woody or herbaceous wetlands). The primary categories within the Yazoo Study Area for production years 2018-2022 included cotton, corn, soybean, sorghum/milo, rice, and agricultural browse.

ERDC-EL further refined the forest classification according to canopy cover that was determined using the 2021 U.S. Forest Service Tree Canopy spatial layer (Multi-resolution Land Characteristics Consortium 2021). ERDC-EL created three categories (5 percent, 10 percent, 20+ percent) according to percentage of canopy gaps within the forest cover layer. The forest canopy gap layer was used to inform the model based on Table 10 from the DUD manual which standardizes average herbaceous seed production from percentage of canopy gaps within forests (Heitmeyer 2010). ERDC-EL grouped all cover types referenced as "fallow/idle cropland, grass/pasture, or herbaceous wetlands" into one broader classification of SHM-Passively Unmanaged for incorporation into the DUD manual. One classification with reference to "shrubland" was categorized as Shrub-scrub. Open water/aquatic areas were direct inputs into Table 10 of the DUD manual (Heitmeyer 2010). ERDC-EL classified the remaining land cover groups which contained "developed" land, "barren", or crops that would not contribute as energy for waterfowl as "Other Crop"; these groups were not considered within the DUD model.

Heitmeyer (2010) designated six forest types according to forest composition/major food types which include: BLH-Naturally Flooded (BLH-NF), BLH-Greentree Reservoirs (BLH-GTR), Cypress (*Taxodium distichum*)-Tupelo (*Nyssa sylvatica*), Floodplain Forests, Riverfront Forest, and Dead Timber. ERDC-EL conducted Habitat Evaluation Procedures (HEP) sampling during July 2020 at 53 plots across the Yazoo Study Area. The HEP sampling plots revealed numerous forest types that ranged from young forest stands replanted predominantly in oak species to more mature forests containing a wider diversity of BLH tree species. Heitmeyer (2010) described floodplain forest as the transition zone between riverfront forest and BLH that generally occurs within the 1-2 year flood frequency zone. Floodplain forest are dominated by Elm (*Ulmus* spp.), Ash (*Fraxinus* spp.), Sweetgum (*Liquidambar styraciflua*), Sugarberry/Hackberry (*Celtis* spp.), and Box Elder (*Acer negundo*). Tree species within our HEP sample plots are consistent with the dominant species in floodplain forest; however, oaks did comprise approximately 24 percent of the forest community 10 centimeters diameter at breast height (dbh) or greater. Riverfront forest is characterized by more early successional species such as Willow (*Salix* spp.) and Silver Maple (*Acer saccharinum*) and are associated more within the 1-year flood frequency. Plots that also were consistent with that of riverfront forest were sampled, but these habitats were less frequent. Therefore, all forested areas were conservatively categorized as naturally forested BLH with average density of small, medium, and large trees with 5, 10, or 20+ percent canopy gaps for this analysis. This represents a conservative choice as this category over-represents oak production compared to the actual composition of oaks within our sampled forest plots within the Yazoo Study Area. ERDC-EL was unable to determine if dead timber stands occurred within the project areas based on the spatial layers that were obtained and none were observed within the HEP sample plots. The USDA Cropscape layer was used to define areas containing agricultural resources for waterfowl (i.e., corn, milo/sorghum, rice, soybean or wheat; Figure 5).

The flooded acres of each habitat category were compiled across the five most recent years (2018-2022) according to Heitmeyer (2010) and incorporated them into the 75th percentile hydrologic zone of 18 inches or less within each of the HUCs to determine the percentage of each habitat category available throughout the winter waterfowl period (Figure 4). The percentages of each habitat category within the 75th percentile hydrologic zone were then used to determine the acres of suitable habitat flooded ≤ 18 inches according to the acres generated each month within the Enviro-Duck program. These acreages along with energetic values from

Heitmeyer (2010) were incorporated into the spreadsheet (see Supplemental Material in administrative record at MVK) to calculate DUDs for hydrologic conditions comparing the No Action and Action Alternatives. The five- year period was incorporated into the model to account for yearly variability in agricultural crop production, or in some cases areas that remained fallow (e.g., 2019 agricultural production season; Figure 5). In order to factor resource availability during the wintering waterfowl period (1 November- 28 February), each month separately was averaged across the four months to determine the average DUD value during the winter period; this procedure was also used to calculate DUD for mitigation lands to be reforested as BLH forest or SHM-passively managed moist-soil management (MSM) units.

Mitigation values for DUDs were generated by incorporating mitigation recommendations from the USFWS for different successional habitat types over the 50-year bottomland hardwood restoration period into the current DUD model's habitat categories (Heitmeyer 2010). ERDC-EL calculated each habitat's contribution to DUDs according to 1 hectare (2.47 acres), and then calculated the contribution of that hectare across a 50-year period. Mitigation was based on restoring existing cropland within the 2022 NASS land cover to BLH forest consisting of at least 50 percent red oaks or developing MSM units (i.e. SHM-passively unmanaged). For the BLH restoration, the first five years after planting were given values according to SHM-passively unmanaged as this period will primarily consist of herbaceous growth. The following 15 years (Year 6-20) were not assigned any value towards DUDs as this period will consist of dense woody vegetation that will likely be unsuitable as foraging habitat to wintering waterfowl. Once trees reach the age of 20, oaks begin producing hard mast which contributes to energy resources and were given the category of "BLH-NF, 5% tree gaps and canopy openings, average density, small trees" for 15 years (Year 21-35). The last 15 years (Year 36-50) were assigned "BLH-NF, 5% tree gaps and canopy openings, average density, medium trees". These DUD values for BLH forest were totaled for the 50-year period to determine the amount of mitigation needed to replace flooded habitats used by wintering waterfowl (Mallard, Table 6; Other Dabblers, Table 7). Moist-soil impoundments focus on encouraging growth of seed-producing native wetland plants by mimicking the seasonal wet and dry cycles of natural wetlands (Strader and Stinson 2005). These habitats typically are wet in spring, dry in summer, and wet again in fall and winter. The energetic contribution of MSM units is expected to remain constant each year; therefore, the average annual energetic contribution for MSM units is the same over the 50-year project life.

RESULTS

The Water Management Plan incorporates a No Action and two Action Alternatives according to the implementation of a 25,000 cfs pump station that is operational once water levels reach 93 feet NGVD. The No Action, Alternative 2, and Alternative 1 will result in an average of 6,571,178 DUDs (Mallard Table 8 and Other Dabblers Table 9), 6,368,380 DUDs (Mallard Table 10 and Other Dabblers Table 11), and 6,374,530 DUDs (Mallard Table 12 and Other Dabblers Table 13), respectively, during the winter waterfowl period. A reduction in flooded area will result from construction and operation of the pump station which will result in a decrease in annual DUDs by 202,798 for Alt 2 (Table 14) and 196,648 for Alt 1 (Table 15), on average. Forested habitats will be the most impacted by changes in hydrology between the two alternatives; however, all habitat types will experience some level of reduced flooding at desirable waterfowl feeding depths (i.e., ≤ 18 inches).

Construction and operation of the 25,000 cfs pump station in the Yazoo Study Area is expected to alter hydrology and flooded acreage suitable for wintering waterfowl foraging (flooded 18 inches in depth or less) by a reduction of between 188-846 acres for Alt 2 (Table 16) and between 183-849 for Alt 1 (Tables 17) depending on the month during the winter season.

Eleven habitat categories that vary in energetic value based on type of food source contribute to a loss of 10,143,559 DUD for Alt 2 and 9,836,072 DUD for Alt 1 from the loss of foraging habitats during November through February over a 50-year project life. Therefore, conversion of habitats from lower to higher quality foraging habitats will be required to offset these losses. For instance, croplands currently planted with soybeans and that are flooded at proper depths during the winter season currently provide food resources to waterfowl. If these areas are to be converted to BLH forest than the loss of energetics from soybeans must be taken into account for determining final mitigation values. Mitigation lands that are reforested with a minimum of 50 percent desirable red oak plantings for waterfowl will contribute 56,203 and 97,834 DUD/hectare over a 50-year project life for the Mallard and Other Dabblers, respectively (Table 6 and 7). Lands that are converted to MSM units for waterfowl will contribute 84,550 and 254,700 DUD/hectare over a 50-year project life for Mallard and Other Dabblers, respectively. Management strategies that implement MSM units or GTRs through structural components that previously did not flood to proper waterfowl foraging depths will result in 100 percent gains in energetic values to waterfowl. MSM units and GTRs use structural components typically consisting of small levees with a water control structure (e.g., stop-log or gate) to control water levels, in areas that historically did not flood or flooded for only a short duration.

In order to mitigate for the reduction in DUDs between the No Action and Alternative 2, 121 hectares (299 acres) of BLH over a 50-year project life would be required with this approach. Using the same approach, 117 hectares (290 acres) of BLH would be required to offset DUD losses between the No Action and Alternative 1. However, if currently flooded croplands are to be converted to BLH as mitigation, the loss of DUDs for that acreage must be considered as a loss. Therefore, to fully mitigate for the conversion of a lower quality habitat (i.e. croplands assumed to be in soybean production) to a higher quality BLH forest, additional mitigation credits must be calculated. For example, the conversion of 121 hectares (299 acres) of soybeans under Alternative 2 that currently provide energetic value to Mallard (223 DUD/hectare/year) and other dabblers (386 DUD/hectare/year) would require an additional 20 hectares (48 acres) of BLH to fully mitigate over a 50-year project life. This results in a total of 141 hectares (347 acres) of mitigation to convert soybean fields currently flooded during winter months to BLH forest over a 50-year project life. A different scenario where MSM units (SHM- passively unmanaged) are implemented on the landscape would require less mitigation because of the higher energetic value of seeds produced from herbaceous plants every year within this habitat type. Under a scenario where MSM units are created as mitigation, 58 hectares (143 acres) of SHM are required to achieve the loss of DUDs associated with the reduction of hydrology once the pump station is operational under Alternative 2. The conversion of 58 hectares (143 acres) of soybeans that currently provide energetic value to wintering waterfowl would require an additional 12 hectares (32 acres) of SHM to fully mitigate for additional losses of flooded soybean fields. This results in a total of 70 hectares or 173 acres of mitigation to convert soybean fields currently flooded during winter months to SHM-passively unmanaged MSM units for the 50-year project life.

DISCUSSION

The construction and implementation of the Proposed Plan, which includes a 25,000 cfs pump station to reduce flooding within the Yazoo Study Area will result in a loss of waterfowl habitat acreage. Flooding within the Yazoo Basin is expected to be low in years where the Mississippi River remains below the critical level required to close the Steele Bayou water control structure which allows the Yazoo Basin to drain into the Mississippi River near Vicksburg, Mississippi. However, in years with high precipitation throughout the Mississippi River watershed, the gates of the water control structure will be closed resulting in "backwater" accumulating in the Yazoo Basin. Depending on local precipitation in the basin, significant flooding may occur even with the implementation of the pump station. Therefore, estimates given in this report are considered to be conservative (i.e., over-estimated loss of DUDs) and do not take into account additional acres that may be receiving significant additional hydrologic inputs in some years.

Conservative approaches were used for classifying forests as suitable foraging habitat for waterfowl within the Yazoo Study Area. All forest types within the Yazoo Study Area were classified according to the DUD manual (Heitmeyer 2010) as "BLH naturally forested areas with an average density of small, medium, and large trees (combined)." Other areas, such as along river corridors, are more characteristic of either riverfront or cypress forest, both of which only contribute a fraction of the energetic value as that of oak-dominated BLH. Forest stand age for many tracts within the Yazoo Study Area were unable to be verified; therefore, the most conservative approach was taken by calculating all forests to be of a higher energetic contribution for foraging waterfowl than what likely occurs throughout the Yazoo Basin. Many areas have been reforested in BLH on public lands (e.g., Theodore Roosevelt National Wildlife Refuge), but are still many years from producing hard-mast that could be utilized by wintering waterfowl.

Water levels at or below 93 feet NGVD will continue to support wintering waterfowl regardless of the operation of the pump station. Foraging habitat within any watershed that experiences fluctuations in water levels due to precipitation events are dynamic across the landscape. This is also true for the floodplains within the Yazoo Basin in that as water levels rise or fall, some areas will become unsuitable as water depths exceed the necessary 18 inch threshold while others become suitable as foraging habitat. Therefore, implementation of the pump station will reduce the area suitable for foraging waterfowl; however, large areas of foraging habitats will still be available with the Proposed Plan. Furthermore, it is important to note that during the POR (1978-2020), only during January and February of 2020 would the pumps have been utilized during the winter waterfowl period (pers comm. Dave Johnson) as elevation 93 is rarely exceeded prior to spring precipitation events.

Restoration of BLH forests and/or the construction of GTRs or MSM units that are managed each year to provide the proper flooding regimes should more than offset losses to wintering waterfowl within the Yazoo Study Area following actions within the Proposed Plan. Cropland that are to be converted to BLH forest using prescribed methods from Table 4 of this appendix should ensure the proper hydrological parameters (i.e., 18 inches in depth or less) are met. If insufficient cropland is available to meet hydrological requirements for feeding by waterfowl, construction of GTRs can be used to complete mitigation requirements.
Planting a variety of red oak species producing smaller-sized acorns and tolerable of periodic flooding, such as Pin Oak (*Quercus palustris*), Water Oak (*Q. nigra*), Willow Oak, (*Q. phellos*), Cherrybark Oak (*Q. falcate*), and Nutall Oak (*Q. texana*) will be most beneficial to wintering waterfowl in the MAV. Actions that are undertaken to mitigate for the loss of DUDs will be coordinated with the local USFWS Ecological Service Field Office to ensure that proper

management for wintering waterfowl occurs within the Yazoo Basin. Post-project monitoring should also be conducted at mitigation sites to ensure that adequate conditions are present for the continued use of the area as winter foraging sites for waterfowl in the YBA.

TABLES

Table 1. Number of dabbling ducks observed during the midwinter waterfowl survey of the Mississippi flyway. Original table from Waterfowl Harvest and Population Survey Data (Fronczak 2022).

NUMBERS OF DUCKS OBSERVED DURING THE MIDWINTER WATERFOWL SURVEY IN THE MISSISSIPPI FLYWAY

YEAR	MN[2]	WI[3]	MI	IA	IL	IN	OH	MO	KY	AR	TN	LA	MS	AL	MFTOTAL
	Continued from previous page														
2001	30,056	50,147	78,321	9,087	98,580	15,812	101,200	85,701	113,679	604,240	481,138	5,818,758	180,932	114,882	7,782,533
2002	33,262	94,388	176,482	117,790	189,147	71,795	118,656	589,454	118,139	1,143,044	467,408	3,644,897	353,936	112,436	7,230,834
2003	27,691	165,093	101,379	119,353	159,660	10,274	71,265	300,014	43,827	553,397	344,658	3,129,665	209,799	88,522	5,324,597
2004	40,984	NS	185,287	34,095	216,950	9,904	85,324	641,185	35,163	298,149	256,290	3,852,088	188,831	86,963	5,931,213
2005	31,792	101,645	85,300	25,448	286,821	6,505	53,219	691,470	85,076	567,243	397,019	3,105,093	124,133	76,685	5,637,449
2006*	22,983	129,952	63,865	28,414	358,372	25,870	95,775	572,741	104,307	267,928	792,506	3,213,419	336,635	94,721	6,107,488
2007	12,426	79,658	155,827	161,241	177,152	19,448	102,179	530,455	65,648	485,502	376,254	4,737,227	144,977	68,895	7,116,889
2008	15,105	119,249	94,809	24,439	150,794	9,890	61,275	394,515	138,863	668,129	874,307	2,148,068	540,562	104,499	5,344,504
2009	28,238	69,340	105,262	19,820	127,225	23,655	94,758	367,441	101,679	910,353	518,139	2,011,575	546,561	117,771	5,041,817
2010[1]	25,985	77,473	157,401	21,787	148,917	14,533	48,561	147,468	107,027	3,013,623	850,266	3,434,357	934,140	65,152	9,046,690
2011	28,768	89,410	92,755	35,946	198,357	60,184	73,995	709,861	77,359	1,227,393	743,307	3,900,893	676,670	85,694	8,000,592
2012	30,465	119,522	NS	67,471	451,645	83,266	100,413	681,265	90,740	1,133,622	794,602	3,514,313	663,054	81,177	7,811,555
2013	14,940	80,825	NS	77,972	446,043	23,845	119,592	621,976	116,205	562,237	695,984	3,133,372	508,637	96,397	6,498,025
2014	16,091	45,423	101,858	68,830	150,906	30,062	79,816	396,079	108,410	1,017,246	717,302	4,054,418	1,281,276	81,264	8,148,981
2015	19,785	49,872	193,784	40,527	457,620	23,659	173,060	638,919	122,178	1,312,653	630,529	3,825,167	679,465	84,516	8,251,734
2016	24,730	127,902	209,411	61,314	796,235	36,014	114,061	753,452	52,777	1,065,338	862,482	2,485,532	537,911	60,684	7,187,843
2017	19,028	60,243	148,477	53,620	437,325	29,169	67,778	809,885	81,416	867,124	1,108,626	2,782,208	1,446,429	77,717	7,989,045
2018	9,856	64,125	105,241	45,498	358,629	42,248	104,427	492,877	100,258	1,241,709	787,519	3,499,143	1,150,947	82,063	8,084,540
2019		51,873	117,489	57,793	493,131	18,230	43,221	854,067	50,767	1,092,133	86,347	2,502,078	371,834	21,990	5,760,953
2020			103,396	53,428	172,556	13,379	159,404	511,181	45,661	1,287,526	322,131	2,814,247	613,351	34,579	6,130,839
2021			135,622	33,388	402,300	5,294	158,005	650,252	58,879	1,112,901	393,700	2,261,313	477,764	52,776	5,742,194
2022			62,043	27,434	238,698	10,311	186,068	773,737	41,556	990,573	462,362	2,372,104	687,228	60,032	5,912,146
AVERAGES:															
55-60	15,867	42,433	138,717	91,567	976,433	556,067	101,283	368,100	156,983	1,328,217	390,117	2,271,283	159,567	89,867	6,686,500
61-70	11,670	35,020	49,410	138,830	400,670	61,510	94,560	322,950	57,510	1,289,020	404,080	4,934,590	244,480	106,130	8,150,430
71-80	25,890	20,640	42,540	114,190	411,960	37,380	64,780	312,380	42,330	931,690	395,680	3,798,880	400,600	96,030	6,694,970
81-90	26,428	35,632	47,265	56,290	222,754	26,340	62,768	195,680	32,286	1,005,389	374,195	3,077,005	262,650	79,514	5,504,197
91-00	16,902	49,389	110,141	28,234	195,650	32,347	126,204	388,455	49,833	891,267	445,882	3,506,333	222,893	91,048	6,143,563
01-10	26,852	98,549	120,393	56,147	191,362	20,769	83,221	432,044	91,341	851,161	535,799	3,509,515	356,051	93,053	6,456,401
11-20	20,458	76,577	134,051	56,240	396,245	36,006	103,577	646,956	84,577	1,080,698	674,883	3,251,137	792,957	70,608	7,386,411
Long-term	20,880	50,587	87,534	75,140	363,029	80,816	92,689	391,430	67,957	1,037,721	463,264	3,515,231	366,451	88,468	6,693,133

* - Incomplete survey. Estimates for the flyway and some states (IL, LA, 93; LA, MS, 97; MS, 06) are not comparable with other years. ** - NS = No survey DF 9/12/22

[1]-Arkansas 2010: switched to a transect survey in Zone 2 & 3 [2]-MN: 2019 discontinued survey [3] WI: 2020 discontinued survey

Table 2. The total number of DUDs for the Mallard within each habitat type by month and the final DUD value resulting from the sum of DUDs from November through February that are incorporated into the DUD formula with land acreage. These values are derived from Heitmeyer (2010), and are incorporated into a spreadsheet (see Supplemental Material in administrative record at MVK) that was certified by USACE for the DUD model.

Habitat	Nov	Dec	Jan	Feb	Nov-Feb Average
BLH-NF, 5% tree gaps and canopy openings, average density, Combined trees	1,583	1,784	1,684	1,552	1651
BLH-NF, 10% tree gaps and canopy openings, average density, Combined trees	1,682	1,872	1,760	1,617	1733
BLH-NF, 20+% tree gaps and canopy openings, average density, Combined trees	1,878	2,045	1,909	1,743	1894
Shrub/Scrub	738	694	727	722	720
SHM-Passively Unmanaged	1,987	1,774	1,598	1,404	1691
OW-AQ	15	31	77	108	58
Agricultural (corn)	983	747	517	520	692
Agricultural (soybeans)	302	236	177	179	223
Agricultural (milo)	529	406	290	293	379
Agricultural (rice)	529	406	290	293	379
Agricultural (wheat)	0	0	0	0	0

Table 3 The total number of DUDs for "Other Dabblers" within each habitat type by month and the final DUD value resulting from the sum of DUDs from November through February that are incorporated into the DUD formula with land acreage. These values are derived from Heitmeyer (2010), and are incorporated into a spreadsheet (see Supplemental Material in administrative record at MVK) that was certified by USACE for the DUD model.

Habitat	Nov	Dec	Jan	Feb	Nov-Feb Average
BLH-NF, 5% tree gaps and canopy openings, average density, Combined trees	2,389	2,696	2,556	2,364	2501
BLH-NF, 10% tree gaps and canopy openings, average density, Combined trees	2,532	2,820	2,661	2,450	2616
BLH-NF, 20+% tree gaps and canopy openings, average density, Combined trees	2,814	3,064	2,866	2,,617	2840
Shrub/Scrub	1,511	1,314	1,328	1,298	1363
SHM-Passively Unmanaged	6,251	5,439	4,719	3,968	5094
OW-AQ	665	447	422	423	489
Agricultural (corn)	1,700	1,290	894	898	1196
Agricultural (soybeans)	522	407	306	309	386
Agricultural (milo)	915	702	502	506	656
Agricultural (rice)	915	702	502	506	656
Agricultural (wheat)	722	1163	1615	1839	1335

Table 4. Estimate of waterfowl (Mallard and "Other Dabblers") according to long-term averages (2007-2022) obtained from the Mississippi Department of Wildlife, Fisheries, and Parks' Aerial Waterfowl Surveys Reports (Havens and Hardesty 2022ab; Havens and Hardesty 2023ab).

	Waterfowl Survey Abundance Estimate[a]			Percentage of Total Waterfowl (i.e. Dabblers)	
Month	Mallard	Other Dabblers	Total	Mallard	Other Dabblers
November	40,111	139,169	179,280	22.4	77.6
December	123,848	271,232	395,080	31.3	68.7
Early-January	233,557	370,567	604,124	38.7	61.3
Late-January	217,342	359,809	577,151	37.7	62.3
January (average)	225,450	365,188	590,638	38.2	61.8

[a] Data obtained from MDWFP Aerial Waterfowl Survey Reports (2022/2023)

Table 5. Estimated percent of maximum annual production of major food items available to wintering waterfowl in the MAV during November to February. Table obtained from Heitmeyer (2010; Table 14 of DUD manual).

Food Type	Nov	Dec	Jan	Feb
Herbaceous Seeds	70	60	50	40
Aquatic Seeds	70	50	30	20
Mast	80	90	80	70
Below-ground Tubers	90	90	90	90
Above-ground Browse	60	50	40	50
Aquatic Plants	40	20	20	20
Invertebrates	10	20	50	70
Agricultural Grains	40	30	20	20
Agricultural Browse	30	50	70	80

Table 6. Mitigation in terms of number of duck-use-days across the winter period for waterfowl (Mallard) for one hectare of land replanted with average density of oaks in a bottomland hardwood forest over the course of 50 years.

Habitat Type[a]	Project Life (Years)	Nov-Feb Average	Years	Total DUDs
SHM-Passively Unmanaged	1-5	1,691	5	8,454
Densely populated early-successional forest[b]	6-20	0	15	0
BLH-NF, 5% tree gaps and canopy openings, average density, small trees	21-35	1,533	15	22,989
BLH-NF, 5% tree gaps and canopy openings, average density, medium trees	36-50	1,651	15	24,760
Total number of DUD for mitigation across 50 years for 1 hectare (2.47 acres)			50	56,203

[a] Habitats descriptions and DUD values from Heitmeyer (2010).

[b] Habitat is deemed unsuitable for wintering waterfowl between years 6-20 as the reforested BLH stand transitions from herbaceous to an early, densely forested successional state.

Table 7. Mitigation in terms of number of duck-use-days across the winter period for waterfowl (Other Dabblers) for one hectare of land replanted with average density of oaks in a bottomland hardwood forest over the course of 50 years.

Habitat Type[a]	Project Life (Years)	Nov-Feb Average	Years	Total DUDs
SHM-Passively Unmanaged	1-5	5,094	5	25,472
Densely populated early-successional forest[b]	6-20	0	15	0
BLH-NF, 5% tree gaps and canopy openings, average density, small trees	21-35	2,323	15	34,844
BLH-NF, 5% tree gaps and canopy openings, average density, medium trees	36-50	2,501	15	37,518
Total number of DUD for mitigation across 50 years for 1 hectare (2.47 acres)			50	97,834

[a] Habitats descriptions and DUD values from Heitmeyer (2010).

[b] Habitat is deemed unsuitable for wintering waterfowl between years 6-20 as the reforested BLH stand transitions from herbaceous to an early, densely forested successional state.

Table 8. Number of duck-use-days for the Mallard associated with each habitat during the period 2018-2022 for the No Action Alternative averaged across the period-of-record (1978-2020).

	No Action Alternative-Total DUD (Nov-Feb)					
Habitat Type	2018	2019	2020	2021	2022	Average
Corn	921	205	196	560	587	494
Cotton	-	-	-	-	-	-
Forest-5%	121,318	121,424	121,695	121,623	121,873	121,587
Forest-10%	224,088	225,376	226,325	226,013	226,825	225,726
Forest-20+%	1,253,007	1,285,534	1,291,831	1,302,138	1,313,445	1,289,191
Milo	-	-	-	13	-	3
Open Water/Aquatic	4,188	2,719	2,897	2,623	2,492	2,984
Other	-	-	-	-	-	-
Rice	128	155	19	31	82	83
Scrub-shrub	1,219	5	144	28	13	282
SHM-Passively Managed	21,482	133,202	113,327	24,899	21,697	62,921
Soybeans	14,102	880	2,180	12,791	11,763	8,343
Wheat	-	-	-	-	-	-
Total	1,640,454	1,769,499	1,758,615	1,690,718	1,698,777	1,711,612

Table 9. Number of duck-use-days for "Other Dabblers" associated with each habitat during the period 2018-2022 for the No Action Alternative averaged across the period-of-record (1978-2020).

	No Action Alternative-Total DUD (Nov-Feb)					
Habitat Type	2018	2019	2020	2021	2022	Average
Corn	3,040	691	656	1,833	1,964	1,637
Cotton	-	-	-	-	-	-
Forest-5%	338,062	338,348	339,101	338,905	339,583	338,800
Forest-10%	613,348	616,855	619,484	618,615	620,826	617,825
Forest-20+%	3,404,017	3,491,711	3,509,195	3,536,461	3,566,904	3,501,658
Milo	-	-	-	41	-	8
Open Water/Aquatic	42,181	28,113	29,660	27,027	25,791	30,554
Other	-	-	-	-	-	-
Rice	436	518	67	106	277	281
Scrub-shrub	4,006	15	471	94	41	925
SHM-Passively Managed	117,048	722,603	613,386	134,109	116,778	340,785
Soybeans	45,701	2,933	7,244	41,446	38,140	27,093
Wheat	202	89	317	344	753	341
Total	4,568,040	5,201,876	5,119,581	4,698,979	4,711,056	4,859,906

Table 10. Number of duck-use-days for the Mallard associated with each habitat during the period 2018-2022 for Action Alternative 2 averaged across the period-of-record (1978-2020).

	Action Alternative 1-Total DUD (Nov-Feb)					
Habitat Type	2018	2019	2020	2021	2022	Average
Corn	819	197	192	616	439	453
Cotton	-	-	-	-	-	-
Forest-5%	117,288	117,391	117,687	117,652	117,382	117,480
Forest-10%	224,849	225,830	226,793	226,500	225,060	225,807
Forest-20+%	1,237,158	1,260,148	1,262,750	1,268,712	1,269,476	1,259,649
Milo	22	-	-	2	-	5
Open Water/Aquatic	2,606	2,502	2,403	2,367	2,574	2,490
Other	-	-	-	-	-	-
Rice	98	130	19	25	114	77
Scrub-shrub	1,350	-	181	18	447	399
SHM-Passively Managed	22,146	107,831	96,547	19,569	15,744	52,367
Soybeans	13,170	823	2,040	11,122	10,718	7,575
Wheat	-	-	-	-	-	-
Total	1,619,506	1,714,852	1,708,613	1,646,583	1,641,953	1,666,301

Table 11. Number of duck-use-days for "Other Dabblers" associated with each habitat during the period 2018-2022 for the Action Alternative 2 averaged across the period-of-record (1978-2020).

	No Action Alternative-Total DUD (Nov-Feb)					
Habitat Type	2018	2019	2020	2021	2022	Average
Corn	2,699	662	639	2,015	1,483	1,500
Cotton	-	-	-	-	-	-
Forest-5%	326,848	327,132	327,952	327,855	327,110	327,379
Forest-10%	614,941	617,613	620,285	619,465	615,525	617,566
Forest-20+%	3,359,024	3,420,987	3,428,591	3,444,220	3,446,078	3,419,780
Milo	-	-	-	5	-	1
Open Water/Aquatic	26,937	26,128	24,979	24,631	26,817	25,899
Other	-	-	-	-	-	-
Rice	408	435	67	88	376	275
Scrub-shrub	4,423	-	593	61	1,485	1,312
SHM-Passively Managed	119,872	585,889	522,511	105,694	84,973	283,788
Soybeans	42,628	2,737	6,771	36,029	34,733	24,580
Wheat	122	60	160	268	727	267
Total	4,497,902	4,981,644	4,932,548	4,560,331	4,539,308	4,702,347

Table 12. Number of duck-use-days for the Mallard associated with each habitat during the period 2018-2022 for the Action Alternative 1 averaged across the period-of-record (1978-2020).

	No Action Alternative-Total DUD (Nov-Feb)					
Habitat Type	2018	2019	2020	2021	2022	Average
Corn	820	197	192	617	439	453
Cotton	-	-	-	-	-	-
Forest-5%	117,404	117,507	117,803	117,767	117,498	117,596
Forest-10%	225,078	226,060	227,023	226,731	225,289	226,036
Forest-20+%	1,238,077	1,261,074	1,263,682	1,269,647	1,270,410	1,260,578
Milo	-	-	-	2	-	0
Open Water/Aquatic	2,607	2,503	2,404	2,368	2,575	2,491
Other	-	-	-	-	-	-
Rice	120	130	19	25	114	82
Scrub-shrub	1,350	-	181	18	447	399
SHM-Passively Managed	22,202	107,947	96,649	19,579	15,752	52,426
Soybeans	13,180	823	2,042	11,135	10,731	7,582
Wheat	-	-	-	-	-	-
Total	1,620,837	1,716,241	1,709,996	1,647,888	1,643,254	1,667,643

Table 13. Number of duck-use-days for "Other Dabblers" associated with each habitat during the period 2018-2022 for the Action Alternative 1 averaged across the period-of-record (1978-2020).

	No Action Alternative-Total DUD (Nov-Feb)					
Habitat Type	2018	2019	2020	2021	2022	Average
Corn	2,703	663	640	2,017	1,484	1,501
Cotton	-	-	-	-	-	-
Forest-5%	327,207	327,490	328,310	328,213	327,468	327,738
Forest-10%	615,620	618,295	620,969	620,149	616,208	618,248
Forest-20+%	3,362,292	3,424,308	3,431,920	3,447,570	3,449,436	3,423,105
Milo	-	-	-	5	-	1
Open Water/Aquatic	26,954	26,144	24,996	24,646	26,833	25,915
Other	-	-	-	-	-	-
Rice	408	435	67	88	376	275
Scrub-shrub	4,426	-	594	61	1,485	1,313
SHM-Passively Managed	120,174	586,661	523,216	105,794	85,063	284,182
Soybeans	42,672	2,739	6,776	36,077	34,779	24,609
Wheat	122	60	160	268	728	268
Total	4,502,578	4,986,796	4,937,647	4,564,889	4,543,861	4,707,154

Table 14. Summary of area and foraging habitats that occur within the Yazoo Study Area before and after the implementation of the 25,000 cfs pump station operation outlined under Alternative 2.

	No Action Alternative			Action Alternative 2			Reduction from No Action to Action Alternative 2		
Habitat Type	Acres[a]	Hectares[a]	DUD	Acres[a]	Hectares[a]	DUD	Acres[a]	Hectares[a]	DUD/Year
Corn	14	6	2,131	10	4	1,952	-4	-2	-178
Cotton	-	-	-	-	-	-	-	-	-
Forest-5% Canopy Gaps	1,037	420	460,386	999	404	444,859	-38	-15	-15,527
Forest-10% Canopy Gaps	1,828	740	843,551	1,813	734	843,373	-16	-6	-178
Forest-20+% Canopy Gaps	9,747	3,944	4,790,849	9,417	3,811	4,679,429	-330	-134	-111,420
Milo	-	-	11	-	-	6	-	-	-5
Open Water/Aquatic	441	178	33,538	458	185	28,389	17	7	-5,150
Other	184	74	-	166	67	-	-18	-7	-
Rice	4	2	364	5	2	352	1	0	-12
Scrub-shrub	0	0	1,207	9	4	1,711	8	3	504
SHM-Passively Managed	191	77	403,706	139	56	336,155	-52	-21	-67,551
Soybeans	839	340	35,436	764	309	32,154	-75	-30	-3,282
Wheat	4	2	341	4	2	267	0	0	-73
Total	14,290	5,783	6,571,519	13,783	5,578	6,368,648	-507	-205	-202,871

[a] Average of acres across all months of the winter waterfowl period (November-February); therefore, not a true representation of actual acres at any given time but rather used to account for DUDs over entire winter period.

Table 15. Summary of area and foraging habitats that occur within the Yazoo Study Area before and after the implementation of the 25,000 cfs pump station operation outlined under Alternative 1.

	No Action Alternative			Action Alternative 1			Reduction from No Action to Action Alternative 1		
Habitat Type	Acres[a]	Hectares[a]	DUD	Acres[a]	Hectares[a]	DUD	Acres[a]	Hectares[a]	DUD/Year
Corn	14	6	2,131	10	4	1,955	-4	-2	-176
Cotton	-	-	-	-		-	-	-	-
Forest-5% Canopy Gaps	1,037	420	460,386	1,000	405	445,334	-37	-15	-15,053
Forest-10% Canopy Gaps	1,828	740	843,551	1,815	735	844,284	-14	-6	733
Forest-20+% Canopy Gaps	9,747	3,944	4,790,849	9,425	3,814	4,683,683	-323	-131	-107,166
Milo	-	-	11	-		1	-	-	-9
Open Water/Aquatic	441	178	33,538	458	185	28,406	17	7	-5,132
Other	184	74	-	166	67	-	-18	-7	-
Rice	4	2	364	5	2	357	1	0	-7
Scrub-shrub	0	0	1,207	9	4	1,712	8	3	505
SHM-Passively Managed	191	77	403,706	139	56	336,607	-52	-21	-67,098
Soybeans	839	340	35,436	765	310	32,191	-74	-30	-3,245
Wheat	4	2	341	4	2	268	0	0	-73
Total	14,290	5,783	6,571,519	13,795	5,583	6,374,797	-495	-200	-196,721

[a] Average of acres across all months of the winter waterfowl period (November-February); therefore, not a true representation of actual acres at any given time but rather used to account for DUDs over entire winter period.

Table 16. The average number of acres across the POR that are flooded ≤ 18 inches in depth and available for feeding by waterfowl. Acres are defined according to the Hydrologic Unit Codes (HUC).

	No Action Alternative (Acres)				Action Alternative 2 (Acres)				Reduction from No Action to Action Alternative 2 (Acres)			
HUC	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb
Little Callao	46	115	96	113	46	113	95	111	0	-2	-1	-2
Anguilla	192	953	873	1,098	175	916	819	1,043	-17	-37	-54	-55
Holly Bluff	302	990	1,614	1,763	214	814	1,350	1,478	-88	-176	-263	-285
Lower Sunflower	634	2,114	4,298	4,706	633	2,134	4,307	4,700	-1	20	10	-5
Grace	289	310	296	332	290	308	291	314	1	-2	-5	-18
Steele Bayou	501	1,487	2,592	2,867	512	1,503	2,589	2,808	11	16	-2	-58
Total	1,965	5,969	9,768	10,878	1,871	5,788	9,453	10,455	-94	-181	-316	-423

Table 17. The average number of acres across the POR that are flooded ≤ 18 inches in depth and available for feeding by waterfowl. Acres are defined according to the Hydrologic Unit Codes (HUC).

	No Action Alternative (Acres)				Action Alternative 1 (Acres)				Reduction from No Action to Action Alternative 1 (Acres)			
HUC	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb	Nov	Dec	Jan	Feb
Little Callao	46	115	96	113	46	113	95	111	0	-2	-1	-2
Anguilla	192	953	873	1,098	175	916	820	1,044	-17	-36	-53	-54
Holly Bluff	302	990	1,614	1,763	214	817	1,354	1,483	-88	-173	-260	-280
Lower Sunflower	634	2,114	4,298	4,706	635	2,156	4,292	4,698	1	42	-6	-8
Grace	289	310	296	332	290	308	291	314	1	-2	-5	-18
Steele Bayou	501	1,487	2,592	2,867	512	1,497	2,602	2,804	12	10	11	-63
Total	1,965	5,969	9,768	10,878	1,873	5,808	9,455	10,454	-92	-161	-313	-424

FIGURES

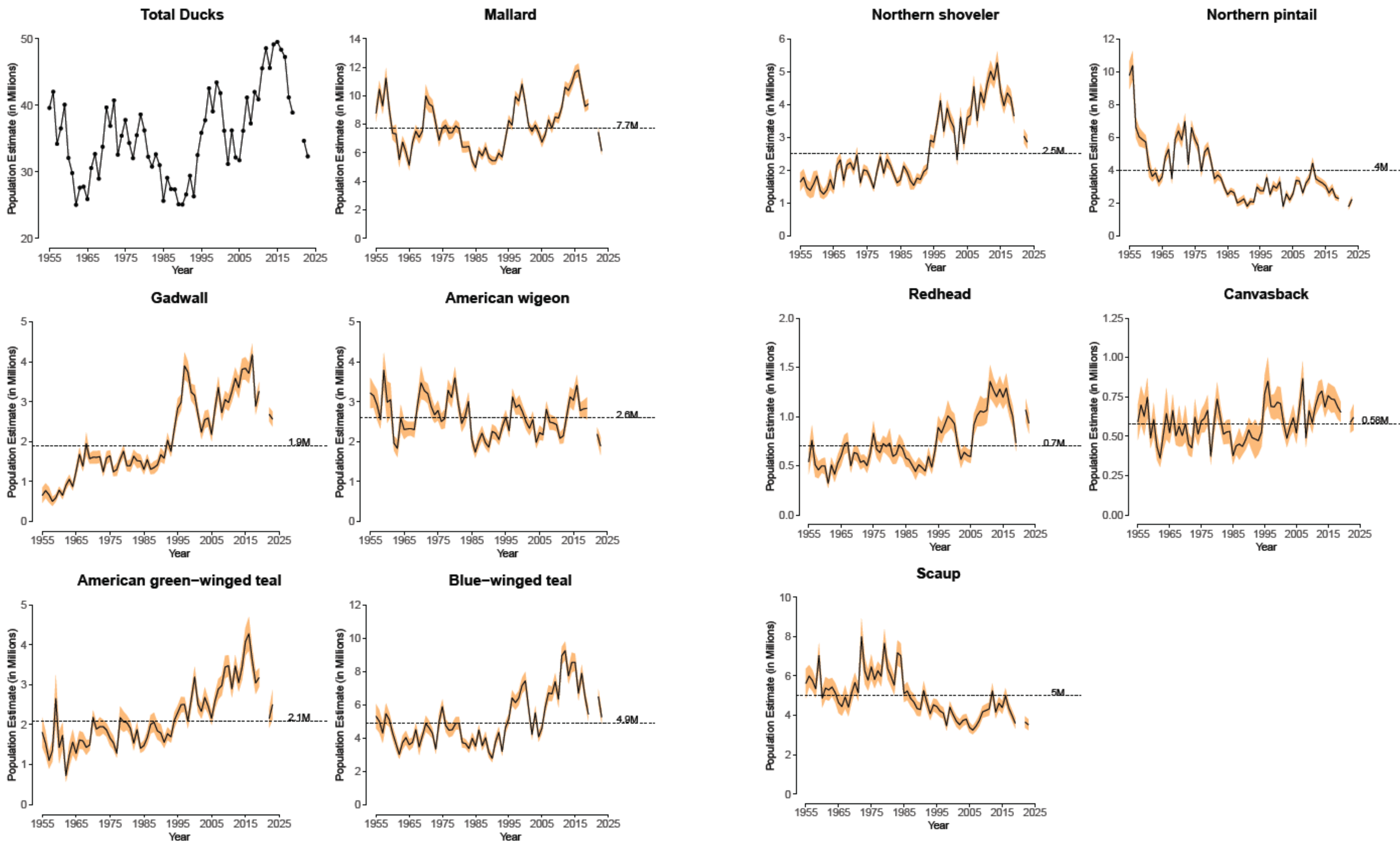

Figure 1. Breeding populations estimates for species of dabbling ducks from the period 1955-2023. Population estimate (in millions) on the vertical axis and survey year on the horizontal axis. Original figures obtained from the Waterfowl Population Status, 2023 Report (USFWS 2023).

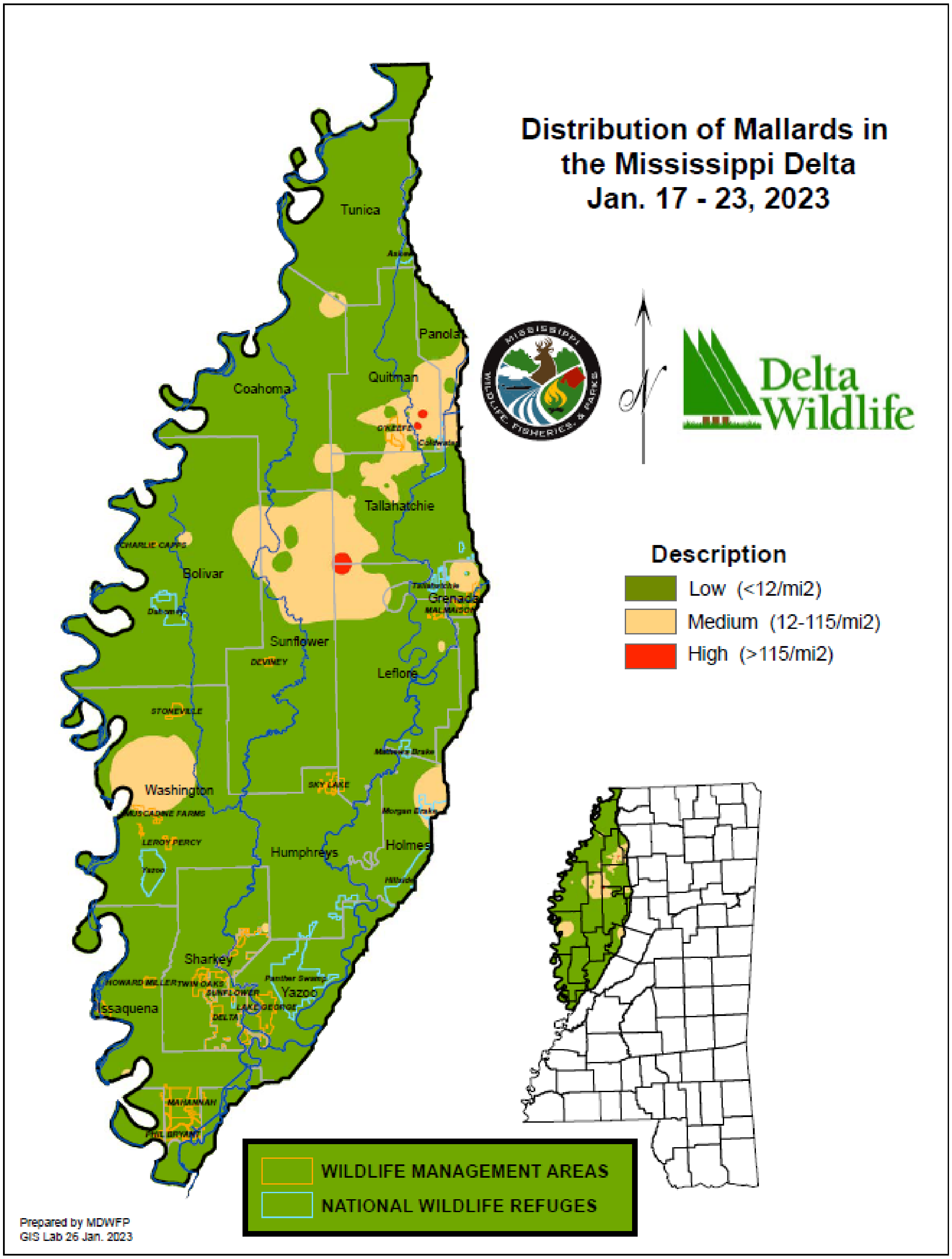

Figure 2. Map of survey area for winter waterfowl surveys in the Mississippi Delta conducted by the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). Figure directly obtained from the late-January survey report from the MDWFP Aerial Waterfowl Survey Report (Havens and Hardesty 2023b).

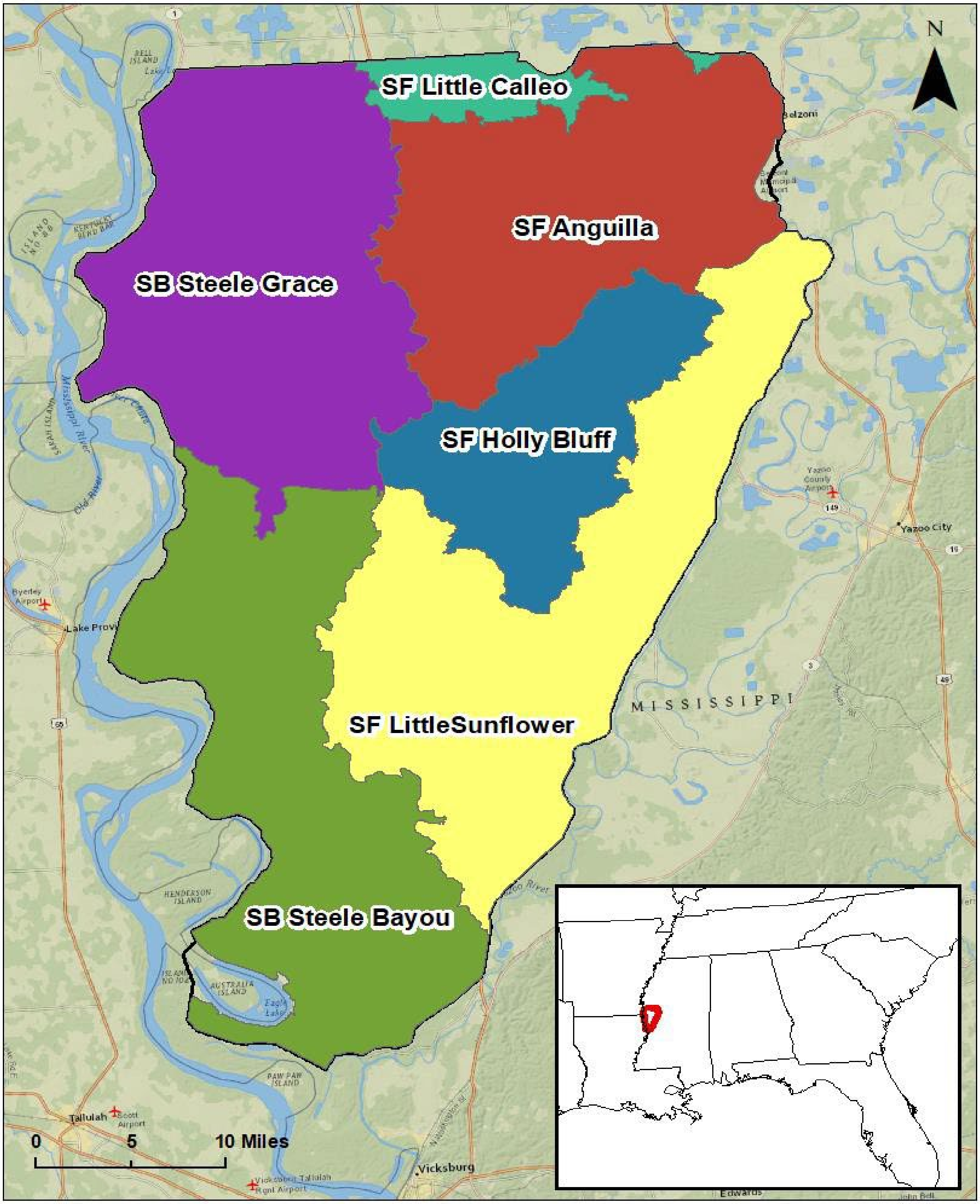

Figure 3. The six HUCs within the Yazoo Study Area used to calculate flooded acreages within the Enviro-Duck program.

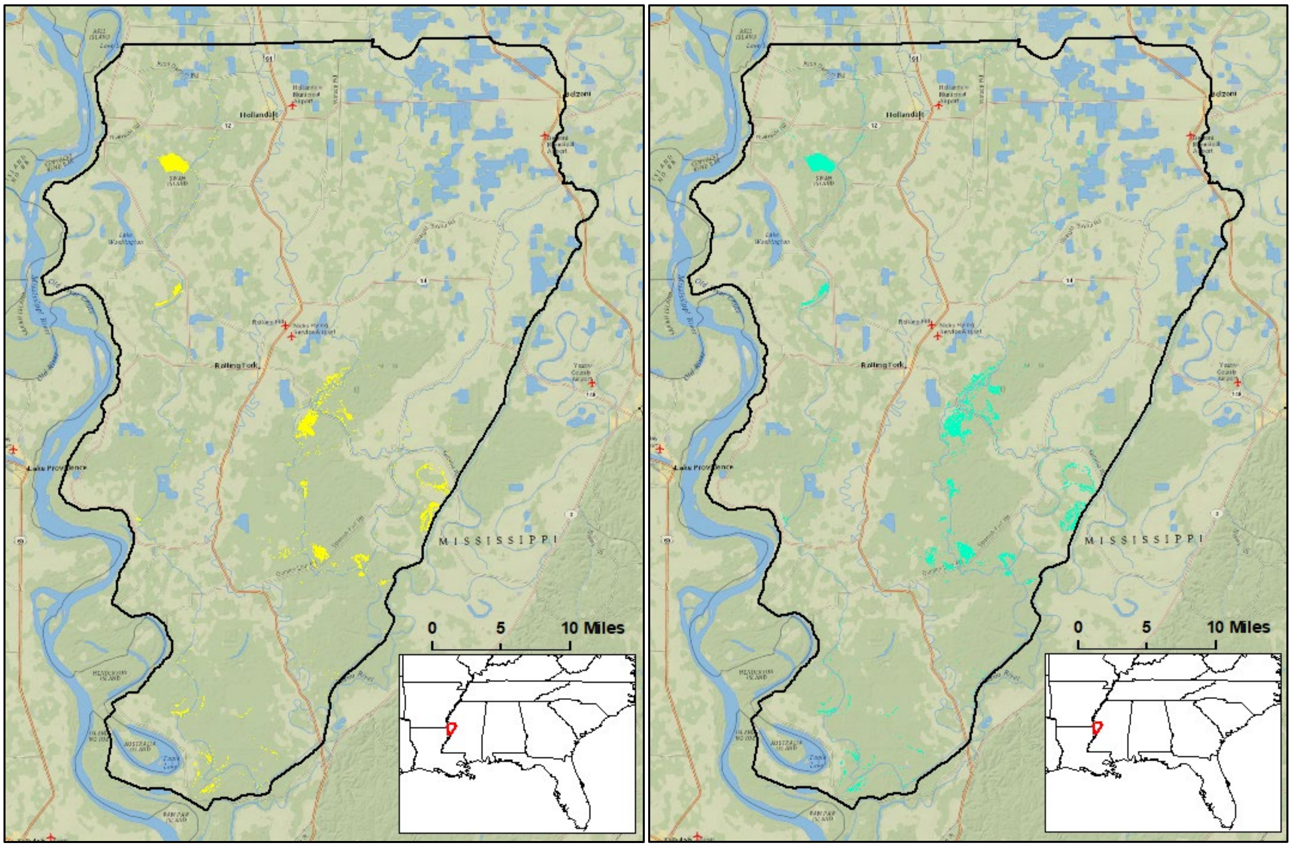

Figure 4. Areas expected to be inundated less than 18 inches in depth according to the 75th percentile for the hydrological POR for the Action Alternative (left) and the No Action Alternative.

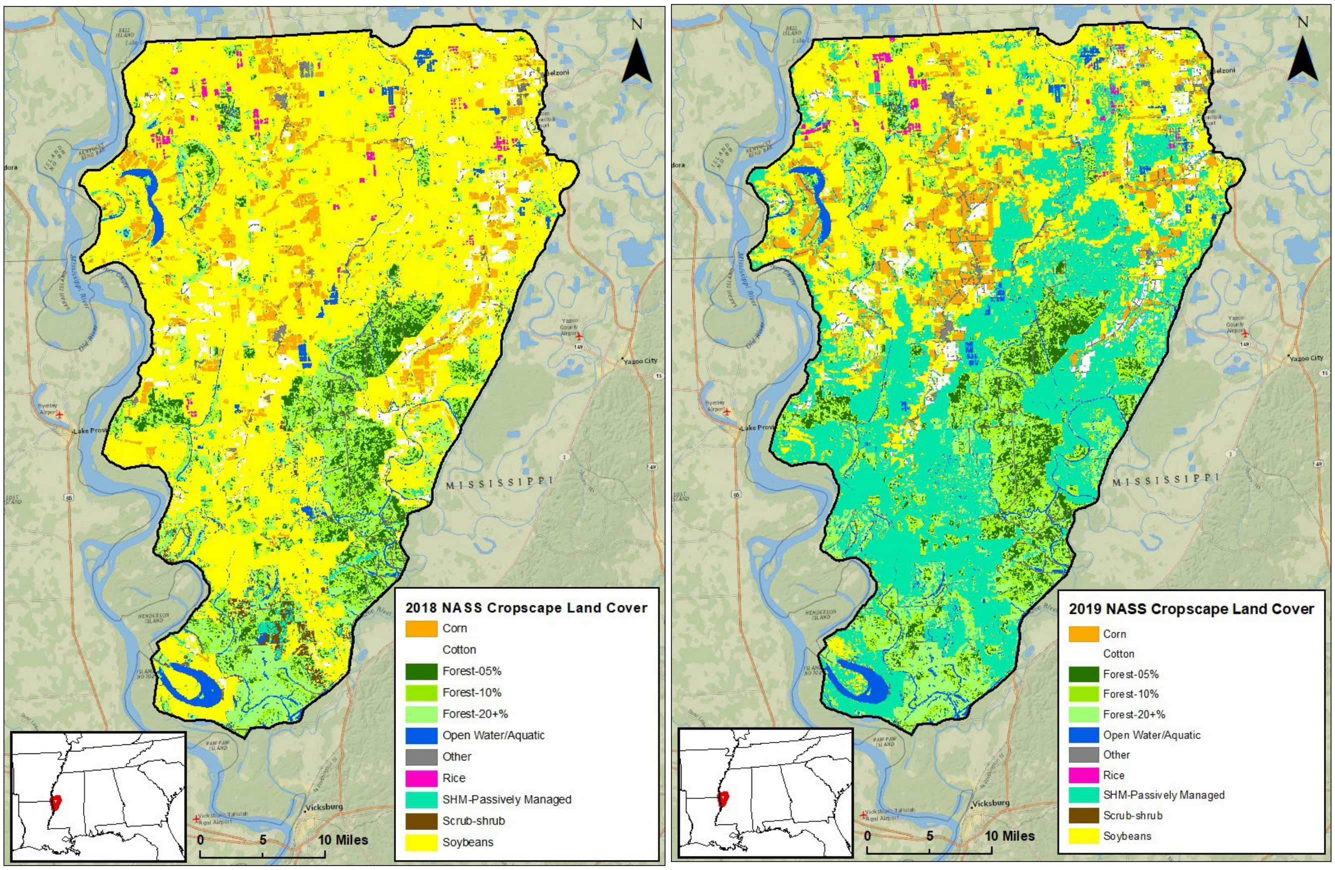

Figure 5. Comparison of land cover use between years with average precipitation/flooding (2018; left) and higher levels of precipitation/flooding during the growing season (2019; right).

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